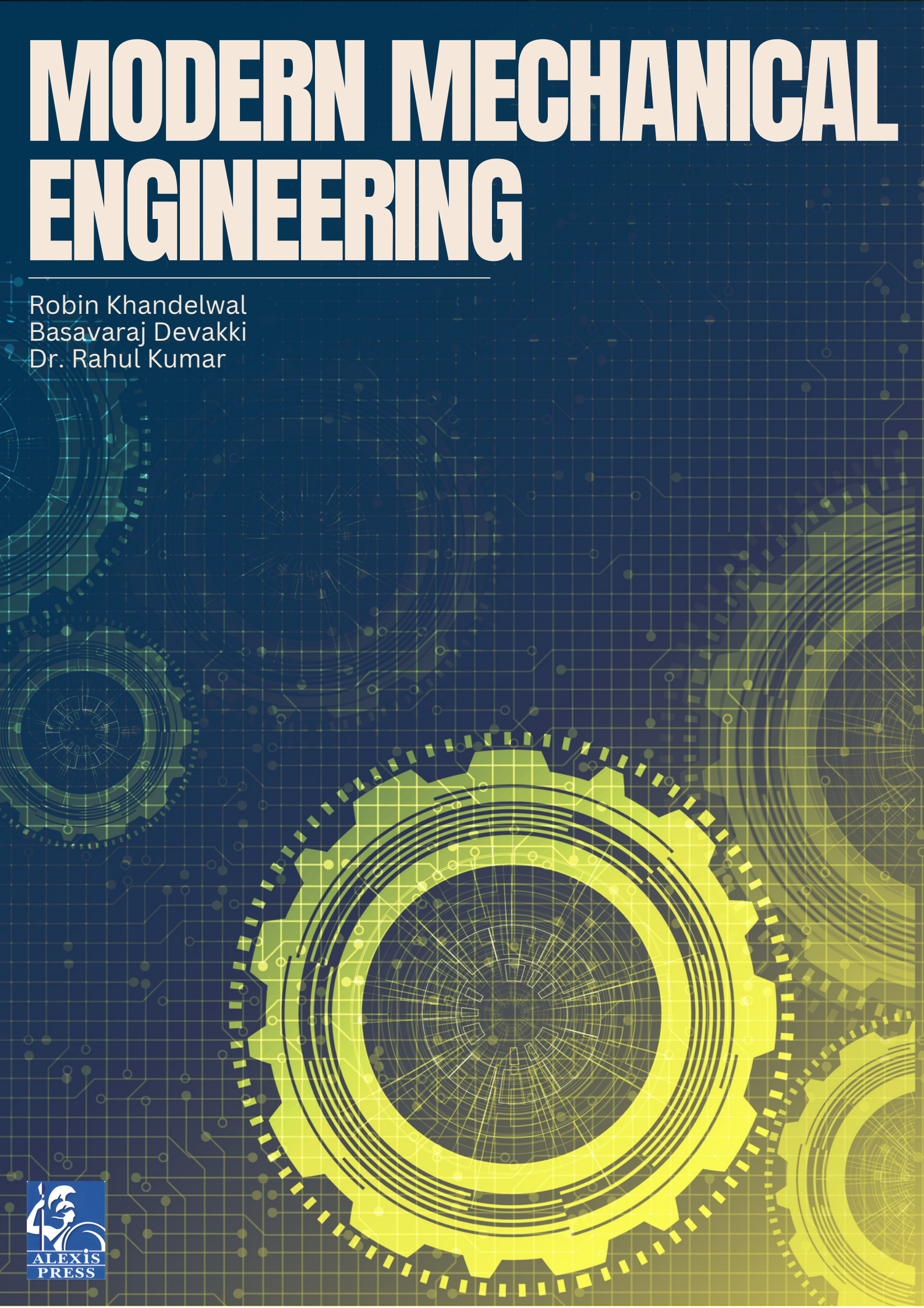
MODERN MECHANICAL ENGINEERING

Robin Khandelwal
Basavaraj Devakki
Dr. Rahul Kumar



ALEXIS PRESS

MODERN MECHANICAL ENGINEERING

MODERN MECHANICAL ENGINEERING

Robin Khandelwal

Basavaraj Devakki

Dr. Rahul Kumar

ALEXIS PRESS

Published by: Alexis Press, LLC, Jersey City, USA
www.alexispress.us

First Published 2022

A catalogue record for this publication is available from the British Library

Library of Congress Cataloguing in Publication Data

Includes bibliographical references and index.

Modern Mechanical Engineering by *Robin Khandelwal, Basavaraj Devakki, Dr. Rahul Kumar*

ISBN 978-1-64532-416-4

CONTENTS

CHAPTER 1

ANALYSIS OF THE PROGRESS OF AEROSPACE SCIENCE WITH VARIOUS ADVANCES IN TECHNOLOGY

Mr. Robin Khandelwal, Assistant Professor,
Department of Mechanical Engineering, Jaipur National University, Jaipur, India,
Email Id-robinkh16@jnujaipur.ac.in

ABSTRACT:

Aerospace science is a developing field of science that deals with the study of space and the atmosphere. Aerospace science is mainly divided into two types of study which are aeronautics and astronautics, where aeronautics is simply the study of in-earth sky aviation and space science is the study of space aviation from Earth to the universe. Various types of research are done in aerospace science as this field is vast and developing aviation technology. Aerospace science has scope in defense, commercial and industrial sectors. The focus of the study is to analyze advances in aerospace science due to advances in technology to improve human life. Various experts have studied and highlighted various points in their research, which are reviewed to summarize developments in aerospace science. Aerospace science has many applications that should be studied deeply. Advances in aerospace science will help analyze various aspects of space and sky aviation as everyone is researching it.

KEYWORDS: A

Aeronautics, Aerospace, Aircraft, Astronautics, Space, Science.

1. INTRODUCTION

The term aerospace is derived from the word's atmosphere and outer space, as aerospace studies relate to the sky and the universe. The functioning of aerospace is diverse as it is used for military, commercial, and industrial purposes all over the world. Aerospace studies include aeronautical science and astronautics, in which aeronautics is researching, designing, building, controlling, and operating aircraft, and astronautics researching, designing, building, controlling, and operating spacecraft. Aeronautics is the study of the development of aircraft that operate in the sky under the gravity of the Earth whereas space science is the study of space science that is not concerned with the gravitational pull of the Earth [1]–[3].

In most industrialized nations, the aircraft industry is a public-private partnership. The "National Aeronautics and Space Administration in the United States", "the Japan Aerospace Exploration Agency in Japan", "the Canadian Space Agency in Canada", "Roscosmos State Corporation for Space Activities in Russia", "China National Space Administration in China", "Iran Space Agency in Iran", "the Indian Space Research Organization in India", "Korea Aerospace R&D in Korea" and "the European Space Agency in Europe", all have government-funded civilian space programs. Space science is evolving and improving with time, thanks to the efforts of both government and commercial firms. Many corporations create technological equipment and components, like spacecraft and satellites, in addition to these public space initiatives such as the "Tracking and Data Relay Satellite-13" (TDRS) project of NASA which is shown in Figure 1.

These firms are also active in other aspects of the aerospace industry, such as aircraft construction [4]–[6].

Figure 1: Represents the TDRS-13 of NASA Used for the Surveillance of Earth for communication service since 2020 [7]**.**

Aerospace engineering is the primary area of engineering engaged in the development of airplanes and spaceships. Aeronautics and space science engineering are two professions that overlap significantly. Aeronautical engineering is similar to avionics engineering, although avionics engineering concentrates on the small electronic aspect of things. Previously, the field was designated as Aeronautical Engineering. As flying technology has advanced to include vehicles operating in space, the broader term "Aerospace Engineering" has come into use. The word "Rocket Science" refers to aeronautical engineering, particularly the astrophysics subject. The idea and practice of moving above upper orbit into space are known as astronautics. One of its principal uses is spaceflight, and its umbrella area is cosmic science[8]–[10].

Aircraft vehicles are designed to withstand a variety of conditions, including pressure changes and heat, as well as physical stresses on engine components. As a result, they typically combine technical and industrial disciplines including aviation, conceptual design, engines, radar, fabrication techniques, and production. The examination of how all of these systems interact is known as aerospace engineering. Given the complexity and variety of topic areas, aeronautical architecture is done by organizations of experts, each with a specialized field of competence. Figure 2 shows the United States of America's Lockheed Martin's F-35, which is a single-engine single-operator highly advanced fighter plane [11], [12].

Figure 2: Represents the F-35 Fighter Plane which has Advanced Technologies in Operating and Attacking Systems [13]**.**

The analysis of automobile characteristics as seen by radar remote sensing is known as radar cross-section. The examination of liquid dynamics around things is known as fluid mechanics. Aerodynamics, which deals with the airflow over objects like wings or through devices like wind tunnels, is also used in lifting and aeronautics. Astro-dynamics is the subject of orbital mechanics, which includes the predictions of orbiting elements given a limited set of parameters. The analysis of motion, pressures, and phases in mechanical systems is known as statics and dynamics. Calculus, derivations, and algebra are examples of mathematics. Within engineering, electro-technology is the studying of electronics. Combustion engines, propulsion systems, turbo-machinery, and rockets all generate propulsion to control the vehicle through the air.

The propulsion system and ion propulsion are two new additions to this module. Control dynamics is the design of numerical simulations of systems' dynamic behavior and designing them to have desirable dynamic behavior, generally via feedback signals. This pertains to the dynamic behavior of aerospace vehicles such as airplanes, spaceships, jet engines, and subsystems. The "Artemis" is one of the new projects of NASA mounted on the launch pad 39 B which will be ready by 2030 for its space journey, as shown in Figure 3. The configuration of the complex geometry of the design to survive the influences experienced during flight is known as aircraft structures. Structures in aerospace engineering are designed to be portable and reduced while yet preserving structural integrity. Materials science is concerned with structures, while aerospace engineering is concerned with the materials that will be used to construct aerospace structures.

Figure 3: Represents the Artemis NASA's rocket at Launch Pad 39B which will take off after 2030.

Existing materials are tweaked to increase their performance, or new materials with highly particular qualities are developed. Solid mechanics, which focuses on the stress-strain measurement of the vehicle's components, is closely connected to material science. Several Finite Element packages, such as MacNeal-Schwendler Corporation (MSC), and PATRAN/NASTRAN are now available to assist designers in the analytical process. Aero-

elasticity is the result of the interplay of aerodynamic forces with structural flexibility, which can result in a flutter, divergence, and other problems. The development and coding of computer networks onboard an airplane or spaceship, as well as the modeling of systems, are all part of avionics. Technology for aerospace industries refers to the description, design, development, testing, and deployment of computer software, such as flight computers, ground-based operating systems, test & evaluation software, and so on.

The study of danger and durability assessment methodologies, as well as the algebra involved in quantitative approaches, is known as risk and reliability. The study of sound transport mechanics is known as noise control. The study of noise creation caused by turbulent fluid motion or aerodynamic forces reacting with surfaces is known as aero-acoustics. Designing and implementing a flight test program to collect and evaluate data on performance and handling attributes to evaluate if an aircraft fulfills its implementation and quality goals and certification criteria are known as flight testing. Quantum physics, including fluid mechanics for aerodynamics or equation of movement for flight dynamics, underpins the majority of these aspects. There is a significant empirical component as well. This scientific element was traditionally acquired through the evaluation of scaled models and prototypes in wind tunnels or the open air.

More recently, computer development has allowed the use of fluid mechanics to mimic the behavior of a fluid, reducing the amount of time and money required for wind tunnel testing. Aerospace engineering degrees are often obtained by those who study hydrodynamics or hydro-acoustics. Aircraft engineering is also concerned with the assembly of all the parts that make up an aviation aircraft as well as its evolutionary history. Aerospace is a domain that needs to be studied in depth to analyze various aspects of Aerial Aviation. Aeronautics and astronautics are the fields of study of aerospace science regarding sky aviation and space science is related to space aviation to orbit the Sun. Thus, aerospace science needs to evolve after which the use of aviation within the sky is possible and space activities can be easily known and understood.

2. LITERATURE REVIEW

Christina Harvey et al. For “Unmanned Arial Vehicle (UAV)” flight control, researchers looked at avian-inspired morphing. To combine both a technical and a biological perspective, the study collated and examined the research on flight control and coordination of avian-inspired transforming UAVs and birds. Wing morphing may be utilized to tune lift distributions using morphing mechanisms including sweeping, twisting, and deflection, as well as create lateral control using asymmetrical morph processes, according to the survey. They found various unique avian flight control approaches that engineering studies may test and apply to improve maneuverability by contrasting the current research. It also spoke about how avian-inspired UAVs might help experts learn more about a bird flying in certain scenarios [14].

Kavindu Ranasinghe et al. discussed mission-critical and safety-critical aerospace applications, and researchers looked into advances in “Integrated System Health Management (ISHM)”. The paper also discusses the major challenges that ISHM systems face in the aerospace industry, as well as the critical role that ISHM will perform in upcoming computer crimes and independent application areas, including Unmanned Aircraft Systems, Traffic Management, Urban Air Mobility, and Distributed Satellite Systems. It is necessary to study the applications of aerospace for the betterment of society. The health issue is the main factor that should be considered in an

emergency during the fight. Thus, it can be said that the health factor is important in aerospace applications.

Runqi Chai et al. studied the development of improved "Guidance and Control (G&C)" technologies for space systems have gotten a lot of consideration in the last few years and continue to be a major emphasis of the aerospace industries. Dynamic programming-based approaches, trajectory tracking authority methods, and other expanded versions are among the newly established optimization hypothesis methods that may create optimal guiding and control instructions. Following that, a special emphasis is placed on recent attempts to investigate the potential applications of AI approaches concerning the optimum operation of drive systems. The discussion's highlights show how these AI models may help with space/aerospace vehicle control issues [15].

Tao Zhang et al. talked about how regolith penetration for putting sensors in the ground and regolith sample for re-entry research are both crucial in the hunt for extra-terrestrial life and disclosing the subsurface of extraterrestrial bodies. The difficulties and limits of sampling extraterrestrial entities are thoroughly examined and explored, encompassing grounded technique, celestial atmosphere, and secluded location. Design and manufacture, tool regolith interface, grounded confirmation, supervisory robots, and sampling fidelity are among the necessary technologies enabling "Planetary Regolith-Sampling" to go from a concept to a working prototype. Finally, key PRS trends are discussed, ranging from relatively close robotic exploration to the complete territory of considerable and growing colonies [16].

A.J. Wileman et al. spoke about the future of dependable electrical machines for further electric airplanes. This study investigates the current state of power electronics and gives an analytical review of battery technology in "More Electrical Aircraft (MEA)", as well as power production and distribution within these aircraft. More importantly, the recommended procedures for assessing the health of these devices must be optimized through the best utilization of essential parameters. In light of these important discoveries, a road map detailing numerous options for microelectronics optimization in MEA is presented to inform the aerospace community of its expanding importance [17].

Umair Ahmed et al. "Auxiliary Power Unit (APU)" problems, diagnoses, and acoustic quantities were covered. APU is a component of an aircraft that supplies electrical and pneumatic power between two onboard subsystems. APU, its breakdown mechanisms, maintenance plans, fault detection procedures, and acoustic signature are all covered in this paper. The necessity for novel fault diagnosis techniques and acoustic measures for future aircraft has also been described, as has the latest development in APU design and needs. Finally, the study discusses the survey's flaws, as well as the problems and potential of using sound as a diagnostic tool for aviation auxiliary power units [18].

Muhammad Faiz Izzaturrahman et al. discussed the Application of "Deep Gaussian Processes (DGP)" in Aerospace Engineering. DGP's capacity to beat the regular GP in non-stationary variables, as found in multiple studies, is an intriguing result. The current work compares three situations with discontinuous-like characteristics to a stationary GP and analyses the job of surrogate modeling and confusion assessment with DGP-SI. DGP-SI performs better on average and shows promise, according to the findings. However, because DGP-SI is still in its early stages of development, it is susceptible to predictive algorithms, which might emerge in a system that is somewhat poorer than the regular GP.

Vladimir Kalugin et al. developed in aerospace education, instructional packages of AI approaches are available. The essential ideas and terminology connected to AI itself with the requirement for the construction of a training program were studied as part of the "Russian Federation's National Strategy for Artificial Intelligence Development". The Federal state educational requirements and ethical guidelines for expanded sets of specializations and inclinations in Aerospace Engineering were examined, and prospective programs based on AI and smart data analysis were presented.

Satyendra Kumar studied aircraft applications, welding technology is used. This paper will look at terahertz imaging applications in aerospace. To sustain the structure, the aircraft's exterior skin is composed of thin plates of thin fibers combined with honeycomb composites. The Terahertz transmission system may be used to perform quality assurance checks on these tiny sheets throughout the production process. With a wide spectrum of commerce, industry, and defense uses, aerospace operations are extremely diversified. Aerospace companies work on planes and spacecraft research, design, build, operate, and repair them. The wind's beginning and end are regarded to be hundreds of kilometers above the earth, in the sense that the air density is too insufficient for the raising object to create a sufficient lifting force without surpassing the duty cycle.

Chongqing Liu et al. developed an aerospace manufacturing engineering talent cultivation method that incorporates modern aerospace technology This study establishes the notion of nurturing customized skills with a scientific investigation as feedback to instruction to investigate the training method of artistic abilities in the new era. The most recent aerospace research findings are integrated into the training of airplane construction management experts, and necessary knowledge systems are improved. An off-campus preparation Centre for tailored aptitude training is built, and the instruction materials and techniques are revised, by developing high-level courses with abroad academics and local industry professionals. The tailored skill education methodology and approach presented in this study are effective in practice.

Lei Xing et al. discussed external Disturbance and Limited Data Communications in Spacecraft Formation the challenge of finite-time path management in spacecraft formations navigating the external forces and restricted data connection is addressed in this paper. A fresh limited locating control scheme with adjustment legislation is intended to ensure that the complex system is functional and relatively limited and steady but also that the monitoring mistakes of comparative speed and direction are constrained within bounded despite the limited transmitting data and external disturbances when combined with the addition of one electricity integrator technique and back-stepping technique.

The development of aerospace is seen in many countries as people are becoming aware of aircraft and space craft. Considerable research has been done in the field of aerospace science application and optimization. The use of various aviation technologies is now increasing which makes air transport a faster and easier mode of transport. His studies focused on the applications of various techniques used in aerospace science. Thus, all the separate studies are combined in this paper to analyze developments in aerospace science, which is discussed further.

3. DISCUSSION

Aerodynamics is the study of how air moves, especially when it is affected by a fixed material such as an airplane wing. It includes material from the field of hydrodynamics and its

subdivision, gas dynamics. Aerodynamics and gas dynamics are often used interchangeably, with the difference that gas kinematics involves the study of the motion of not only air but all gases. Differences in air temperature and pressure, as well as the predetermined sequence of automotive parts, subject flight instruments to extreme conditions. As a result, they usually combine design and professional disciplines such as aerodynamics, engines, navigation, robust mechanics, computer modeling, and construction. The investigation of how these elements interact is known as aerospace engineering. Considering the scale and breadth of subject areas, aerospace engineering is performed by teams of experts, each with its area of expertise.

A rocket is a spacecraft propelled by a propulsion system that emits exhaust purely from the fuel carried within. Propulsion systems work on the action-reaction principle, propelling rockets forward by rapidly expelling their excrement in the opposite direction, enabling them to function in the vacuum of space. Rockets are more productive in space than they are in the atmosphere. Multiphase rockets can attain light speed from Earth, the ability to reach limitless heights. When compared to air-breathing engines, rockets are light, strong, and capable of great acceleration. To control their trajectory, rockets employ motion, vanes, extra reaction engines, torpedo launcher thrust, inertia wheel, effluent flow diversion, reactant fluxes, spin, or gravity. Unless there is no other material or pressure that a spacecraft may utilize for acceleration, such as in space, a rocket transporting its charge must be employed. It is vital to carry all of the propellants that will be needed in these conditions. Rockets are used in several military weapons to deliver warheads to their intended targets. When a rocket has a guidance system, it is considered a missile; if the weapon is largely uncontrollable, it is known as a rocket. Anti-tank and anti-aircraft weapons employ rocket engines to strike targets at high speeds across long distances, but hypersonic missiles may carry multiple nuclear bombs from thousands of miles away, and anti-ballistic missiles attempt to stop them.

Larger rockets are generally triggered from a launch platform that offers solid support until the rocket is ignited. Rockets are particularly effective while very high speeds are necessary, such as an orbital speed of roughly 7,800 m/s, due to high emission velocities ranging from 2,000 to 4,500 m/s. Spacecraft that are sent into orbit become manmade satellites that may be utilized for any commercial purpose. Rockets are still the sole means to put satellites into space and beyond. They're also employed to quickly accelerate spacecraft changing orbits or de-orbiting for landing. A rocket can also be used to ease a harsh parachute descent just before landing. Operating powered aircraft, like other combustion-based operations, emits soot and perhaps other contaminants into the environment. Carbon dioxide and other greenhouse gases are also created. There are other environmental implications particular to air transport, for example, aircraft flying near the tropopause release aerosol and create different densities, both of which can accelerate the production of cirrus clouds. Since the invention of flight, clouds may well have grown by as much as 0.2 percent.

Clouds can both chills and warm the environment. Part of the sun's rays are reflected into space, but they also deflect some of the heat emitted by the Earth's surface. Both thin native stratus formations and contrails, on average, warm the atmosphere. At high elevations near the tropopause, aircraft can emit chemicals that react with greenhouse gases, especially nitrogen molecules, which link with ozone and increase ozone concentrations. Avgas, which includes “Tetraethyl Lead”, is used in most light-piston aircraft. Some relatively low internal combustion engines can run on neutral mogas, and some new light aircraft are using turbojet engines and internal combustion engines that don't require lead. Another influence of aviation on the

ecosystem is unwanted sound, which is mostly generated by aircraft landing and taking. With supersonic planes like the Concorde, supersonic booms were an issue.

Thus, it is needed for every country to develop a deep study on the applications of aerospace science. The aerospace science development in the country affects its economy as well as shows the prosperity of the country. Many applications in the field of aerospace science deal with the sky and space. The aviation system is used for transports using airplanes while using the propulsion system rockets can go out of the earth's gravitational loop. There were different research carried out in the fields of aerospace science. Studying aerospace science that helps find the different aspects of space and aviation.

4. CONCLUSION

Thus, after analyzing different research by different experts in the field of aerospace science, the functioning of aerospace is diverse as it is used for military, commercial, and industrial purposes all over the world. The use of fighter jets is now increasing in wars which makes it easy to cover long distancesand short periods, while there are many advanced aircraft with help in aviation from one part of the earth to the other within less time. Aerospace studies include aeronautical science within the Earth and aeronautical science related to space outside the Earth. Different approaches have been made by different researchers in aerospace science to study technological progress. Some research is done on aircraft, space vehicles, non-territorial life of space, developments in aircraft aviation, and health management in aerospace during an emergency. There is still a lot of research going on in aerospace science to develop advanced aviation and techniques to improve human life. Life in space is still a major research topic studied by many scientists. An auxiliary power unit is installed in every aerospace machine as it is needed to maintain the power source in them. Thus, various advances have been developed in aerospace science and still, this process continues over the past few decades. In the next few years, there will be more technological advances, from aeronautics to space science, to improve human life.

REFERENCES

[1] J. LU, Y. GAO, X. WANG, C. BAI, B. WANG, and Z. WU, “80 years education of aerospace science and technology in Tsinghua University,” *Chinese J. Aeronaut.*, 2018, doi: 10.1016/j.cja.2018.06.017.

[2] O. Gohardani, M. C. Elola, and C. Elizetxea, “Potential and prospective implementation of carbon nanotubes on next generation aircraft and space vehicles: A review of current and expected applications in aerospace sciences,” *Progress in Aerospace Sciences*. 2014. doi: 10.1016/j.paerosci.2014.05.002.

[3] B. C. Gunter, “Aerospace sciences,” *Aerospace America*. 2018. doi: 10.2307/3958411.

[4] V. S. Trush, O. H. Lukyanenko, V. M. Voyevodin, and P. I. Stoyev, “Reactor and aerospace metals science,” *Metallofiz. i Noveishie Tekhnologii*, 2019, doi: 10.15407/mfint.41.02.0227.

[5] Z. Xu and Yi Zhang, “An Analysis of Interpersonal Meaning of Modal Verbs in Abstracts from Scientific Papers: Case Study of Progress in Aerospace Sciences,” *LingLit J. Sci. J. Linguist. Lit.*, 2021, doi: 10.33258/linglit.v2i2.462.

[6] O. I. Spol'nik, A. Y. Haydus', and L. M. Kaliberda, "Reactor and aerospace metals science," *Metallofiz. i Noveishie Tekhnologii*, 2021, doi: 10.15407/mfint.43.06.0843.

[7] NASA, "Last NASA Communications Satellite of its Kind Joins Fleet," *2018*.

[8] J. Mieloszyk, "Practical problems of numerical optimization in aerospace sciences," *Aircr. Eng. Aerosp. Technol.*, 2017, doi: 10.1108/AEAT-11-2016-0201.

[9] S. R. Hatua and D. P. Madalli, "AERIS: An integrated domain information system for aerospace science and technology," *Program*, 2011, doi: 10.1108/00330331111129732.

[10] M. Vasile, E. Minisci, and K. Tang, "Computational Intelligence in Aerospace Science and Engineering [Guest Editorial]," *IEEE Computational Intelligence Magazine*. 2017. doi: 10.1109/MCI.2017.2742866.

[11] S. L. Brunton *et al.*, "Data-driven aerospace engineering: Reframing the industry with machine learning," *AIAA J.*, 2021, doi: 10.2514/1.J060131.

[12] H. Hefazi, "Aerospace Engineering," in *Springer Handbooks*, 2021. doi: 10.1007/978-3-030-47035-7_24.

[13] Wikipedia, "Lockheed Martin F-35 Lightning II."

[14] C. Harvey, L. L. Gamble, C. R. Bolander, D. F. Hunsaker, J. Joo, and D. J. Inman, "A review of avian-inspired morphing for UAV flight control," pp. 1–38.

[15] R. Chai, A. Tsourdos, A. Savvaris, S. Chai, Y. Xia, and C. L. Philip Chen, "Review of advanced guidance and control algorithms for space/aerospace vehicles," *Prog. Aerosp. Sci.*, vol. 122, no. 100696, 2021, doi: 10.1016/j.paerosci.2021.100696.

[16] T. Zhang *et al.*, "Review on planetary regolith-sampling technology," *Prog. Aerosp. Sci.*, vol. 127, no. November, p. 100760, 2021, doi: 10.1016/j.paerosci.2021.100760.

[17] A. J. Wileman, S. Aslam, and S. Perinpanayagam, "A road map for reliable power electronics for more electric aircraft," *Prog. Aerosp. Sci.*, vol. 127, no. October 2020, p. 100739, 2021, doi: 10.1016/j.paerosci.2021.100739.

[18] U. Ahmed, F. Ali, and I. Jennions, "A review of aircraft auxiliary power unit faults, diagnostics and acoustic measurements," *Prog. Aerosp. Sci.*, vol. 124, no. March, p. 100721, 2021, doi: 10.1016/j.paerosci.2021.100721.

CHAPTER 2

AN ANALYSIS OF DESIGN AND FABRICATION OF SEMI-AUTOMATIC GROUNDNUT SHELLING MACHINE

Mr. Dipendra Kumar, Associate Professor,
Department of Mechanical Engineering, Jaipur National University, Jaipur, India,
Email Id-dipendra1987@jnujaipur.ac.in

ABSTRACT:

The use of groundnut is increasing day by day as the groundnuts contain high fats, and removing groundnut shells by hand is a time-consuming task that results in hand pain as well reduces productivity in hand shelling activity. There are many automatic and manual machines used for groundnut shelling to obtain the complete groundnut without damage, but the cost of machines available in the market is high everyone not affords so, most people use a manual machine which is time-consuming as after shelling they have to manually blow the crush to obtain the groundnuts. But as there is no option for blowing the crush manually people use the same manual machine which is low in cost. So there is a need for a manual machine that not only crushes the shell but also blows it from the groundnuts. The research focuses on developing such a machine that satisfies the requirement of small-scale producers with proper analysis. The different types of groundnut samples with shells are used for testing to understand the working of the machine. The results obtained by using the machines were good for dried and partially dried groundnuts. So the shelling machine designed is useful for household works of groundnut shelling without wasting time and is also available cheap. Thus, it can be said that in the next few years, the use of a machine is going to increase with the increasing demand for groundnut in the market so the people will use such machine which is low in price and has more benefits.

KEYWORDS:

Crush, Groundnut Shelling Machine, Oilseed, Shell, Soil.

1. INTRODUCTION

Agriculture is the main occupation in India as most of the population in the country is dependent on agriculture as a primary occupation. There is a variety of crops that are cultivated in different parts of the country depending on climatic conditions [1],[2]. There is a variety of pulses, oilseeds, and cereals that are cultivated in different seasons which are rabbi and Kharif. Many oilseeds are growing in India for oil production out of which one most commonly used oilseed is groundnut. Groundnuts are used as snacks, a source of oil, and one important food ingredient in the diet [3]–[5]. The groundnut is big like maize seed and no other seeds are that big among the seed bank of crops [6]. The groundnut is covered with shells to protect it from external damage like insects, birds, excess sunlight, and water and to maintain its growing ability. For consuming groundnut seeds the shell which is covering it that is to remove as it is tasteless and may contain

some amount of soil. Groundnuts are a good source of oil as it contains fat in a saturated form which is obtained by removing the shell [7]–[11].

Since oil time removing shells from the groundnuts was a time-consuming task that is still performed by many peoples, where women in the family sit together once a week and do the shell-removing activity to get groundnut for weekly or monthly use or may be used for seeds required for agriculture for groundnut production and cultivation [12]–[15]. Due to the change in lifestyle of people with changing times, people don't have the time to sit in one place for a long time and do the manual shell-removing task [16]. The shell-removing task is a time-consuming task that results in buying seeds from seed banks and for daily consumption, it is brought from the supermarket or food store, where the work of groundnut shell breaking and groundnut seed collection is followed in a large number of tones daily as shown in Figure 1. So there are big machines in the factory that do the same work and sell such groundnuts to get huge profits [17]. The factories are part of the groundnut is of profit business as the consumers of groundnuts and their products are more due to their taste and properties [18]–[21].

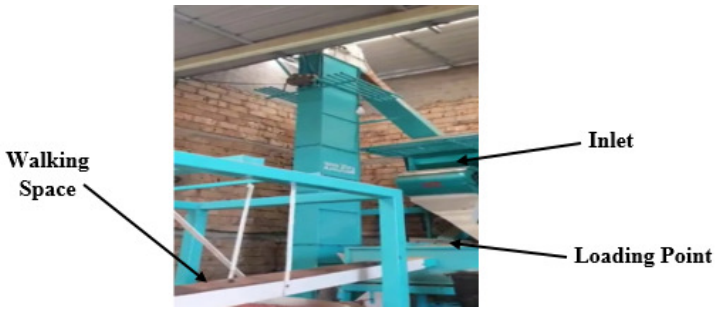


Figure 1: Represents the Automatic Groundnut Shell Removing and Collecting Plant in the Factory.

Other than factories there are small automatic machines that do the same work as done in the factory for the braking shell as shown in Figure 2. The machine is connected to an external power source which is connected to electricity, solar energy, or any fuel depending on its engine or motor requirement. These automatic machines are used by most farmers who had a high annual production of groundnuts. There are many designs of such machines in the market which are useful for small business shell breaking work, using the such automatic machine is not affordable to every common man due to its high price, so there is a need for such machine which is affordable to everyone. There is a manual shell-removing machine on the market that is used for removing the shell of groundnuts, without any external power source as shown in Figure 3.

Figure 2: Represents the Automatic Groundnut Shell Removing Machine for Small Scale Producers.

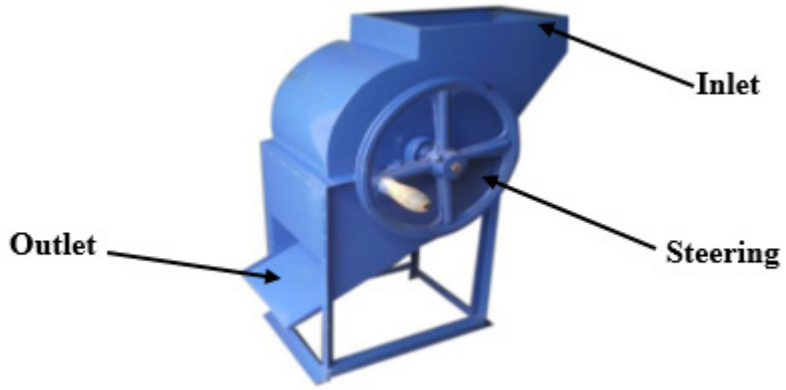


Figure 3: Represents the Manual Groundnut Shell Removing Machine for Small Scale Producers.

Figure 4: Represents the Manual Groundnut Shell Removing Machine for House or Domestic Use.

The manual machine is small and compact, easy to carry by adults as light in weight,and has less maintenance, due to which it is easy for the common man to afford such a machine who does the groundnut production at any scale, which will help the groundnut producer to improve the production of groundnut without having any hand pain as shown in Figure 4. The collected shell is crushed and groundnuts are separated through air blowing naturally or under the fan. Fewer manual machines are used for such a process, the manual machine is very easy to operate and needs less time to finish the groundnut shell removing activity. Still, many peoples don't know about such a machine and had a negative impact of using the such machine, some people say the machine crush the groundnuts while process, so the seeding rate is reduced while some say groundnuts are not properly removed from the shell in the machine some say the size is not compatible of a strainer. All the points regarding manual machines are researched and analyzed in this paper to design and fabricate the groundnut shell-removing machine.

2. LITERATURE REVIEW

Gbabo A. et al. developed a groundnut decorticator with an aspiration cleaner with the objective was to design, testing, and developing a device used to analyze and resolve the problems of groundnut shelling, cleaning, and groundnut breakage efficiencies. The machine is made of a metal frame, Hopper, shelling unit, aspiration, and collection units are used to design the

machine. The machine was tested for three types of groundnut seeds, working with different speeds of 200, 250, and 300 rpm. According to the data, the machine with the maximum capacity has a shelling efficiency of 89.35 %, a cleaning efficiency of 85.06%, and a percentage of whole grains of 75 percent with 5-11 percent broken grains for the three varieties. It is believed that the machine would be able to alleviate the issue of farmers by decreasing labor in hand groundnut shelling to maximize efficiency [22]. Ashok S. Andhale et al. has designed and developed "a groundnut pod separator machine". The lack of groundnut handling equipment or the high cost of the machines that are available on the market is a big concern for groundnut production in India. Before anything else, workers separated groundnut pods from their plants as they just separate the groundnut pods from the vines with their hands. Because it was such a time-consuming operation, the yield from this method was exceedingly poor. It was also a discouraging job for the employees. So to reduce the use of labor and to improve the process of detaching the groundnut beans the machine is designed. The machine can isolate 400 kg of groundnut per hour, with isolating efficiency between 90% and 95%. Because the machine is built of local materials, it has a low installation cost and a basic design that requires little maintenance. It consists of two spinning rotors, a 1HorsePower single-phase motor, and separators to remove soil and collect groundnuts [23]. Srila, M. et al. discussed the factors affecting a Twin Roller performance on the Groundnut on Shells. The use of a twin roller helps in removing the pod separations from the plant, but there are variations in the size of the pods which may damage the groundnuts, so size adjustment is provided for the rollers to avoid the losses. The rollers of diameter 50.80 mm with 200 mm in length, and were used to test different shelling roller speeds and roller clearance. The results obtained after the testing of the machine show that there is 88% shelling efficiency. From the study, it is seen that the best roller speed was 250 rpm, while the ultimate roller speed difference was 35 rpm (Revolution Per Minute) [24].

There is abundant research performed on the groundnut shelling machines as their working mode are different. Most factory machines are big and their cost is high among all the machines as the group of machines in a factory make a plant. The automatic machines are good in their working but the use of a motor or engine for improving the performance of increases the cost of the machine. There are many machines available in the market but the cost of the machine is not affordable to everyone. While there are manual machines that are operated by man but the cleaning of shells from groundnut is not possible which is time-consuming. Thus there is a need for a machine that is manual to work at a low cost and a shell-blowing apparatus like a blower or fan to remove the shell from the groundnut so that everyone can afford it.

Research Question:

- What are the methods of removing groundnut from the shell?
- Why everyone is unable to use an automatic groundnut shelling machine?
- How manual shell-removing machine is affordable and useful?

3. METHODOLOGY

3.1.Design:

The analysis of the groundnut shelling machine operated on semi-automatic mode to obtain the groundnuts without dirt like shell crush or soil. The operation of the machine is simple and easy and any unskilled person can use the machine as shown in Figure 5. Firstly, the groundnuts with the shells are put in the open container of the machine whose upper side is an inlet and the

bottom side is an outlet where the adjustable strainer is placed to adjust the size according to the size of the groundnuts. The moving of the handle crushes the shell such that the shell is crushed and groundnut comes out of it and from the outlet goes out of the machine with the shell crush where the blower is activated which flews the lightweight shells and soil to some distance while small size groundnut blows little and placed in-between crush collection and big groundnut collection.

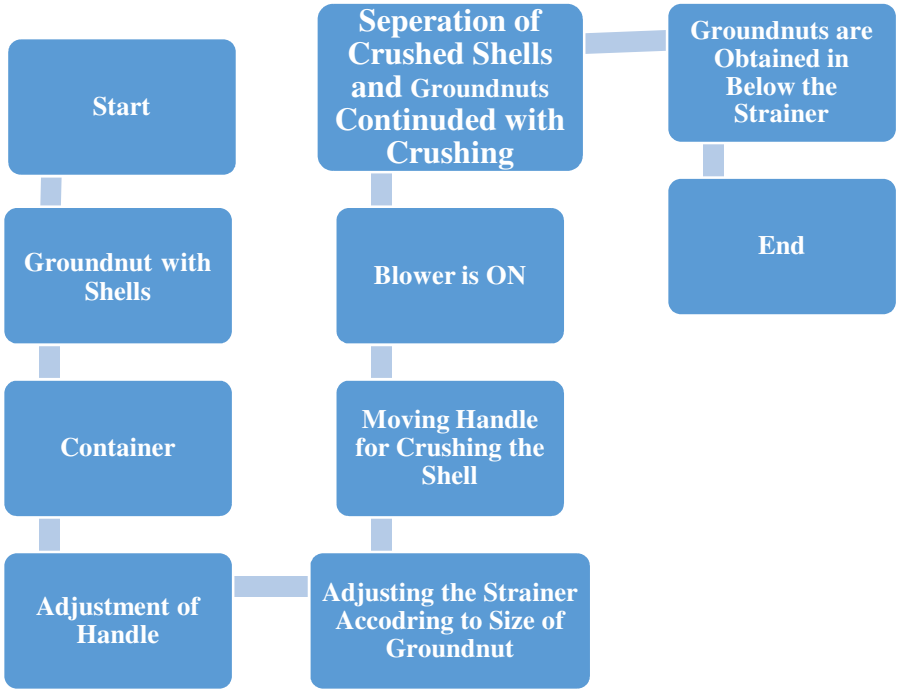


Figure 5: Illustrates the Stepwise Working Process of the Modified Groundnut Shelling Machine.

3.2.Sample:

For designing the sample groundnut shelling machine with modifications is easy compared to big machines with the same functions. Table 1 shows the all components required in the manufacturing of a semi-automatic groundnut shelling machine. The material used for manufacture is mild steel (MS) as it has high corrosion resistance properties with toughness. The fan or blower embodiment is attached below the strainer such that the crushed material which is light in weight gets blown with air from the groundnuts to maintain the quality so that the person does not need to clean the groundnut after the process. The weight of the machine is 7-8 kg as steel is used for the fabrication of the machine including the adjustable blower.

Table 1: Illustrating the Components Used for Manufacturing the New Groundnut Shelling Machine with Separator.

Sr. No.	Components	Dimensions	Quantity
1.	MS Hollow pipe	Radius 25mm, Length 60 cm	1
2.	MS L Channel	Length 60 cm, Length 30 cm	6 2

3.	MS Sheet	60 x 45 x 0.05 cm	2
4.	MS Hole Patterned Sheet	Length 95 cm with Thickness of 2 mm	2
5.	Electric blower	-	1
6.	MS Flat Solid Bar Thickness 5 mm	Length 95 cm Length 30 cm	2 2
7.	Telescopic rod	Length 60 cm	1

3.3.Data collection:

There are different forms of seeds that are crushed in a machine which has different effects on different groundnuts, for testing some samples of groundnuts based on their physical properties are collected to obtain the analysis. The list of such seeds is mentioned in Table 2 with the amount that is to be crushed in the machine with their weight and size. Based on the orientation of groundnuts with shells they are classified as, big and wet groundnuts, big and partially wet groundnuts, big and dried groundnuts, big and over-dried groundnuts, small and over-dried groundnuts, small and wet groundnuts, small and partially wet groundnuts, and small and dried groundnuts.

Table 2: Illustrates the Types of Groundnuts Used in Testing with the Same Volume but Different in Weight.

Sr. No.	**Types Of Groundnuts Used In Testing**	**Quantity kg**
1	Big And Wet Groundnuts	18
2	Small And Wet Groundnuts	20
3	Big And Partially Wet Groundnuts	15
4	Small And Partially Wet Groundnuts	18
5	Big And Dried Groundnuts	12
6	Small And Dried Groundnuts	15
7	big and over-dried groundnuts	10
8	small and over-dried groundnuts	13

3.4.Data analysis:

There are various orientations and aspects of groundnut that should be considered while designing the machine. Different conditions in the groundnut are considered in testing, there are two sizes of groundnuts big and small based on the size of a shell as shown in Table 3. The wet groundnuts are taken out from the ground recently before the testing, while partially wet groundnuts are dry groundnut but they were soaked in water to reduce the toughness of the shell. Dried groundnuts are mostly used in agriculture as well as diet, as they are dried under inadequate sunlight before use. The over-dried groundnuts are mostly having a hard shell that

breaks or gets crushed easily after applying the load. From the data collected from Table 2 about the types of groundnut, the damage rate in groundnut is given below in Table 3.

Table 3: Illustrates the Different Types of Groundnuts Used in Testing and the Analysis Data after the Crushing.

Sr. No.	Types Of Groundnuts Used In Testing	Damage Rate in Groundnuts after Crushing the Shell (%)
1	Big And Wet Groundnuts	12
2	Small And Wet Groundnuts	10
3	Big And Partially Wet Groundnuts	1
4	Small And Partially Wet Groundnuts	5
5	Big And Dried Groundnuts	2
6	Small And Dried Groundnuts	5
7	Big And Over-Dried Groundnuts	20
8	Small And Over-Dried Groundnuts	15

4. RESULTS AND DISCUSSION

Based on the orientation of groundnuts with shells they are classified as, big and wet groundnuts, big and partially wet groundnuts, big and dried groundnuts, big and over-dried groundnuts, small and over-dried groundnuts, small and wet groundnuts, small and partially wet groundnuts, and small and dried groundnuts were tested in the machines, where different results are obtained for different types of groundnut which gives the detailed idea about the working of the machine as shown in Table 4. The weight groundnuts are heavy in wet as they contain more water while dry groundnuts are light in weight. It is seen in the result table that 30-60 % of there is shell crush, with the presence of soil and damaged groundnuts for each complete round of crush. There is a very small amount of soil present in the dried groundnuts but due to drying the weight of the groundnuts changes with little shrinkage in the size. Thus using the machine for dry groundnut is very useful as compared to wet or over-dried groundnuts. The results clearly show that the dried and partially wet groundnuts are preferably good for crushing and are mostly used types of groundnut for seed banks as well as a food ingredient.

Table 4: Illustrates the Results Obtained for the Actual Amount of the Various Types of Groundnuts.

Sr. No.	Types of Groundnut Used in Testing	Total Weight in Kg	Groundnuts Obtained With Soil in Kg	Shell Crush Obtained in Kg	Actual Amount of Groundnut Obtained in Kg

1	Big And Wet Groundnuts	17	9.7	7.3	6
2	Small And Wet Groundnuts	18	10.8	8.2	6
3	Big And Partially Wet Groundnuts	14	8	6	7.8
4	Small And Partially Wet Groundnuts	17	11	6	10.5
5	Big And Dried Groundnuts	13	9	4	8.5
6	Small And Dried Groundnuts	14	9	5	8.3
7	Big And Over-Dried Groundnuts	10	5	5	3
8	Small And Over-Dried Groundnuts	13	8	5	5

5. CONCLUSION

The use of groundnut is increasing day by day as groundnuts contain high fats. Removing groundnut shells by hand is a time-consuming task that results in hand pain as well as reduces the productivity in hand shelling activity. There are many automatic and manual machines used for groundnut shelling to obtain the complete groundnut without damage, but the cost of machines available in the market is high everyone does not afford so most people use the manual machine which is time-consuming after shelling they have to manually blow the crush to obtain the groundnuts. But as there is no option for blowing the crush manually people use the same manual machine which is low in cost. So there is a need for a manual machine that not only crushes the shell but also blows it from the groundnuts. The over-dried groundnuts should not be used because they get crushed easily with small pressure also which reduces the efficiency also the use of wet groundnuts in the machine should be avoided as the wet groundnut has soil attached to the shelling and there are more chances of getting damaged groundnuts. The research focuses on developing such a machine that satisfies the requirement of small-scale producers with proper analysis obtained. The results obtained by using the machines for dried and partially dried groundnuts are satisfactorily good as there is less soil and shelling is also able to blow easily. Thus, it can be said that in the next few years, the use of a machine is going to increase with the increasing demand for groundnut in the market so the people will use such machine which is low in price and has more benefits.

REFERENCES

[1] M. A, M. P, K. M, and K. U, “Groundnut Peeling Shelling Machine,” *Int. Res. J. Adv. Sci. Hub*, 2020, doi: 10.47392/irjash.2020.51.

[2] T. Walke, P. Gadge, G. Gohate, and R. Banpurkar, “Design & Fabrication of Groundnut Sheller Machine,” *Int. Res. J. Eng. Technol.*, 2017.

[3] E. M. Banla, D. K. Dzidzienyo, I. E. Beatrice, S. K. Offei, P. Tongoona, and H. Desmae,

"Groundnut production constraints and farmers' trait preferences: A pre-breeding study in Togo," *J. Ethnobiol. Ethnomed.*, 2018, doi: 10.1186/s13002-018-0275-y.

[4] P. Janila *et al.*, "Genomic tools in groundnut breeding program: Status and perspectives," *Front. Plant Sci.*, 2016, doi: 10.3389/fpls.2016.00289.

[5] M. D. M. Kadiyala *et al.*, "Modeling the potential impacts of climate change and adaptation strategies on groundnut production in India," *Sci. Total Environ.*, 2021, doi: 10.1016/j.scitotenv.2021.145996.

[6] G. M, S. A, and J. S, "Design and Fabrication of Groundnut Shell Remover," *Int. J. Sci. Res. Sci. Eng. Technol.*, 2019, doi: 10.32628/ijsrset196265.

[7] M. Punithavathi, R. Vasanthakumar, and V. N. Mariappan, "Studies on Drought Tolerant and High Yielding Groundnut Varieties in Perambalur District," *Int. J. Bio-resource Stress Manag.*, 2021, doi: 10.23910/1.2021.2161.

[8] A. Orr, T. Tsusaka, S. H. Kee-Tui, and H. Msere, "What Do We Mean by 'Women's Crops''? Commercialisation, Gender and the Power to Name,'" *J. Int. Dev.*, 2016, doi: 10.1002/jid.3224.

[9] A. I. Muhammad, M. Isiaka, M. L. Attanda, S. K. Shittu, I. Lawan, and M. I. Bomoi, "Performance optimization of groundnut shelling using response surface methodology," *Acta Technol. Agric.*, 2021, doi: 10.2478/ata-2021-0001.

[10] O. Z. Ayodeji, A. A. Adegun, and S. A. Anjorin, "DEVELOPMENT AND PERFORMANCE EVALUATION OF A SMALL-SCALE GROUNDNUT SHELLING MACHINE," *FUTA J. Eng. Eng. Technol.*, 2021, doi: 10.51459/futajeet.2021.15.2.312.

[11] J.-L. C. Fannou *et al.*, "Design and Manufacture of a Groundnut Sheller," *J. Exp. Agric. Int.*, 2020, doi: 10.9734/jeai/2020/v42i730555.

[12] A. I. Muhammad and M. Isiaka, "Modification of locally developed groundnut sheller," *Bayero J. Eng. Technol.*, 2019.

[13] Z. Iqbal *et al.*, "Designing small-medium scale groundnut (Arachis hypogea L.) shelling machine for local merchant in Tuban, East Java," in *IOP Conference Series: Earth and Environmental Science*, 2019. doi: 10.1088/1755-1315/230/1/012013.

[14] M. Quamruzzaman, M. J. Ullah, M. F. Karim, N. Islam, M. J. Rahman, and M. D. Sarkar, "Reproductive development of two groundnut cultivars as influenced by boron and light," *Inf. Process. Agric.*, 2018, doi: 10.1016/j.inpa.2017.12.004.

[15] E. Owusu-Adjei, R. Baah-Mintah, and B. Salifu, "Analysis of the Groundnut Value Chain in Ghana," *World J. Agric. Res.*, 2017, doi: 10.12691/wjar-5-3-8.

[16] D. A. Mada, I. D. Husseini, G. A. Idris, and S. Mahai, "The Role of Agricultural Engineering to Take Agriculture to Greater Height in Adamawa State," *J. Agric. Sci.*, 2013, doi: 10.5539/jas.v5n9p51.

[17] A. F. Alonge, E. Bassey, O. J. Esua, and D. I. Onwude, "Development and preliminary testing of a bambara groundnut sheller," *Int. Food Res. J.*, 2016.

[18] J. N. Maduako, M. Saidu, P. Matthias, and I. Vanke, "Testing of an Engine-powered Groundnut Shelling Machine," *J. Agric. Eng. Technolgy*, 2006.

[19] E. Yol, S. Furat, H. D. Upadhyaya, and B. Uzun, "Characterization of groundnut (Arachis hypogaea L.) collection using quantitative and qualitative traits in the Mediterranean Basin," *J. Integr. Agric.*, 2018, doi: 10.1016/S2095-3119(17)61675-7.

[20] A. Ravindra, G. Rohit, A. Saurav, and G. N. Khare, "A Review on Design and Fabrication of Groundnut Shelling and Separating Machine," *Int. Res. J. Eng. Technol.*, 2008.

[21] P. A. Duc, P. Dharanipriya, B. K. Velmurugan, and M. Shanmugavadivu, "Groundnut shell -a beneficial bio-waste," *Biocatalysis and Agricultural Biotechnology*. 2019. doi: 10.1016/j.bcab.2019.101206.

[22] O. O. O. P. U. B. Gbabo A., Gana I.M. and A. O. T., "Development of a Groundnut Decorticator with an Aspiration Cleaner".

[23] A. S. Andhale, S. Wajahat, P. Lawhale, and K. Mendhe, "Design and Development of Groundnut Pod Separating Machine," *Int. J. Latest Eng. Manag. Res.*, vol. 6, no. 8, pp. 233–239, 2021.

[24] M. Srila, A. Pachanawan, and S. Chuan-Udom, "Factors affecting a Twin Roller Groundnut Sheller on Shelling Performance," *Int. J. Agric. Technol.*, 2021.

CHAPTER 3

INDUSTRIAL APPLICATION OF MODERN TECHNIQUES USED IN TABLE SAWS TO CUT VARIOUS OBJECTS

Mr.Sanjeet Kumar, Associate Professor,
Department of Mechanical Engineering, Jaipur National University, Jaipur, India,
Email Id-sanjeet.kumar@jnujaipur.ac.in

ABSTRACT:

A saw table is a small machine used in the cutting process that cuts any object with the circular motion of the blade. Table saws are mostly used for cutting aluminum and wood as the machines are mostly used in workshops of carpentry or construction sites. There are many machines available in the market that are used in workshops to cut various products, but table saws are the most important machines in a workshop that are not studied together to understand their working and their design. The focus of the study is to analyze new techniques, technologies, and methods to improve the applications of table saw in the industry. Another focus of the study is to show the various aspects of the table as the effect of sawdust to effectively highlight the use of sawdust in any cutting process. The use of diamond chains in machines is also a useful new technique. Thus the study of table saw is important as the machine is very useful for any workshop as the machine is multifunctional with less maintenance. The study of table saws will soon be automated and this will improve the cutting process and reduce the rate of accidents during any cutting process.

KEYWORDS:

Bench-top, Blade, Dust, Table Saw, Workshop, Wood.

1. INTRODUCTION

A table saw is a carpentry machine consisting of a round blade mounted on an arbor that is driven by a direct DC motor. The blades continue into the top of the frame, which supports the cutting material, which is usually wood. In some early table saws, the blade and arbor were stationary, with the tabletop being cycled vertically and horizontally to reveal more or less of the blade. The angle of the blade can be changed to change the degree of cut and the cut angle. To avoid losing a finger in the event of a cutting accident, the blade should protrude as little as possible over the piece. Jigsaws have various applications in an industry where different cutting processes for different materials range from manual saws to automatic saws. Cutting is a very primary operation in any manufacturing and construction work. The table saws now used in the market are multi-operational and help to reduce the working time for the process. Cabinet, compact, hybrid, Jobsite, contractor, sliding, and bench-top table saws are the most common varieties [1]–[5].

1.1. Bench-top:

Bench-top table saw is small and light, and they're meant to be used on a table or other surface as shown in Figure 1. Homeowners and Dyers are the most common users of this sort of saw. They nearly always have a universal direct-drive motor. Some early versions had tiny induction motors that were not particularly strong, causing the saw to be heavily weighted and vibrate more. The

most current saw can be lifted and transported by one person to a specific spot. Steel, aluminum, and plastic are commonly used in these saws, which are the cheapest and least competent of the table saws, yet they can handle most tasks with enough ripping capacity and precision [6]–[9].

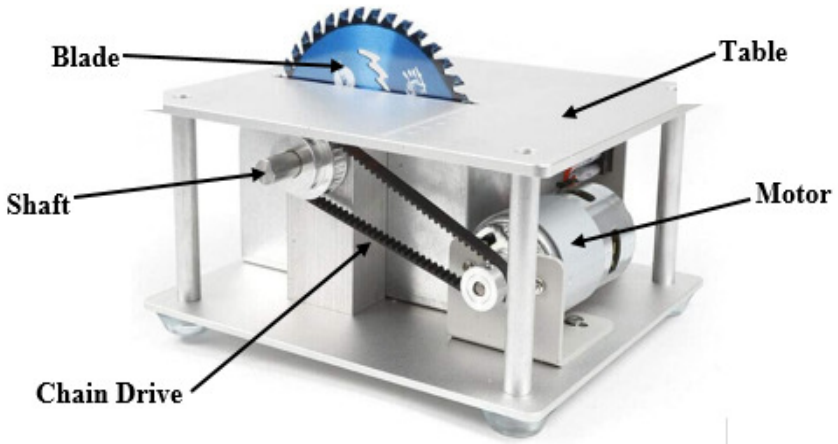


Figure 1: Represents the Design of a Bench-Top Type Table Saw Used for Various Cutting Operations [10]**.**

1.2. Jobsite:

Jobsite table saws are small as compared to bench-top table-saw, which are often utilized with foldable stands as shown in Figure 2. Such a saw is frequently applied on the job site by architects, contractors, and artisans, as the name implies. Most cutting machines in this category have small but strong 15-amp universal motors whereas higher-end saws use a gear-drive motor system. The bulk of cutting machines is small and portable, making them easy to transport to a workplace. Many of these cutting machines are built to last long and to be more accurate than bench-top models. The motor, gear, and casing are all designed to withstand the rigors of construction sites [11].

Figure 2: Represents the Design of the Jobsite Type Table Saw Used for Various Cutting Operations.

1.3. Compact:

The shape of the saw is small and compact and hence the name is the compact table saw as shown in Figure 3. A portable table saw set on a permanent platform is significantly larger than a compact table saw. Even though the motor is always universal, it drives using a belt conveyor with having small tooth. The machine lathes have cast iron heads that look related to contractor saws, but the compact saw is smaller and the construction is easier. Sliding-miter panels with an integrated miter sled that can be changed to a range of angles are available on some models.

Figure 3: Represents the Design Of a Compact Type Table Saw Used for Various Cutting Operations.

1.4. Contractor:

Contractor table saws are larger and heavier and are normally set on a stand with a wheel as shown in Figure 4. They are most often used by hobbyists and homes since they can be powered by standard electrical circuits and are generally cheaper than larger saws. Dust collection is frequently difficult, if not impossible because the engine is attached to the back of the saw. When compared to cabinet saws which are more weight than bench-top and may be utilized for larger jobs because of their larger size and power, they are more robust, accurate, and long-lasting than bench-top saws.

Figure 4: Represents the Design of the Jobsite Type Table Saw Used for Various Cutting Operations.

1.5. Cabinet:

To reduce vibration and improve accuracy, cabinet table saws are made of a lot of cast iron and steel. The enclosed base of a cabinet saw distinguishes it from other saws as shown in Figure 5. For household use, this type of motor normally demands the construction of a heavy-duty circuit. A cabinet-mounted trunnion enhanced waste gathering because of a closed cabinet having similar integration of a grime removal valve, and a cabinet-mounted advanced version is all benefits of cabinet saws over contractor saws. Cabinet saws are designed to handle incredibly high power levels, such as those found in industrial and commercial environments. Cabinet saws had a simple and exchangeable attachment in the tabletop surrounding the blades that permits negligible inserts to be utilized, which considerably lowers the cut just on the bottom of a workpiece.

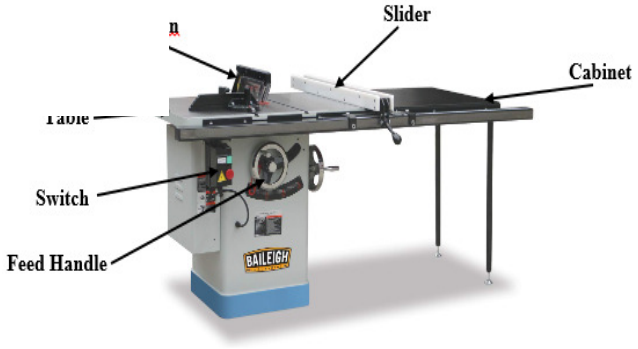


Figure 5: Represents the Design of the Cabinet Type Table Saw Used for Various Cutting Operations.

1.6. Hybrid:

This type of machine provides few benefits of cabinet saws at a lesser cost than conventional cabinet saws. Cabinet-mounted trunnions are used on certain hybrid saws, whereas table-mounted trunnions are found on others. Trunnions that are installed on a cabinet are often easier to assess than those that are positioned on a table. Contractor saws are heavier than hybrid saws, whereas cabinet saws are lighter. A sliding table is an option on some hybrid saws to increase cross-cutting capability as shown in Figure 6. Hybrid saw working differs from contractor and cabinet saw drive methods.

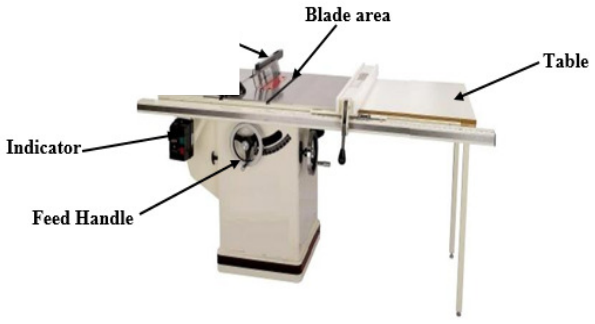


Figure 6: Represents The Design Of a Hybrid Type Table Saw Used For Various Cutting Operations.

1.7. Mini and micro:

Table saw blades with a radius of fewer than 2 inches (50 mm) are known as mini and micro table saws as shown in Figure 7. Hobbyists and model builders often utilize mini and micro table saws, while building companies that only require a tiny saw to cut little sections have begun to use mini table saws. They are significantly simpler to handle and travel and they are quarter dimensions than a traditional saw which is significantly safer in use for cutting extremely small bits because they are small in size. By using blades with a lower kerf than standard edges, less material is wasted and the risk of kickback is decreased.

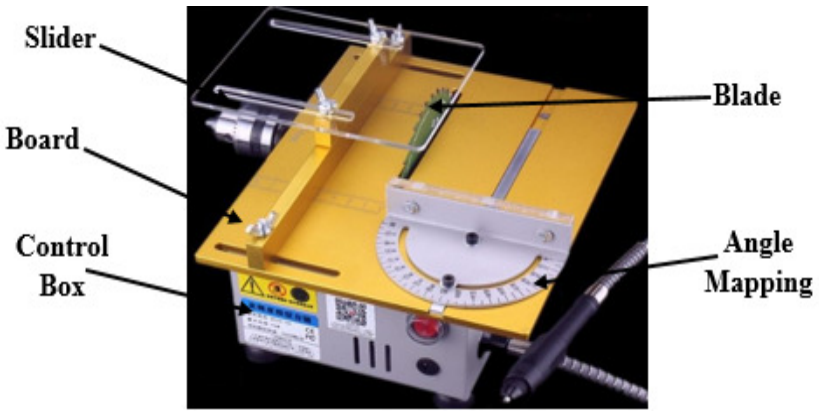


Figure 7: Represents the Design of Mini and Micro Type Table Saw Used for Various Cutting Operations [12]**.**

1.8. Sliding:

On sliding table saws as shown in Figure 8, a moving table on the left-hand side of the tool, usually coupled with a hinged arm-mounted beneath the tabletop, would be applied for tearing heavy materials. The sliding saw is the most common category of table-saw, and it is generally used by major cabinet manufacturing businesses. In most saws, 3-phase motors of 3–7 horsepower are employed. To prevent blowback, most sliding saws come with a riving blade. On certain sliding saws, a scoring blade, which is a secondary, smaller blade placed in front of the main saw blade, is offered.

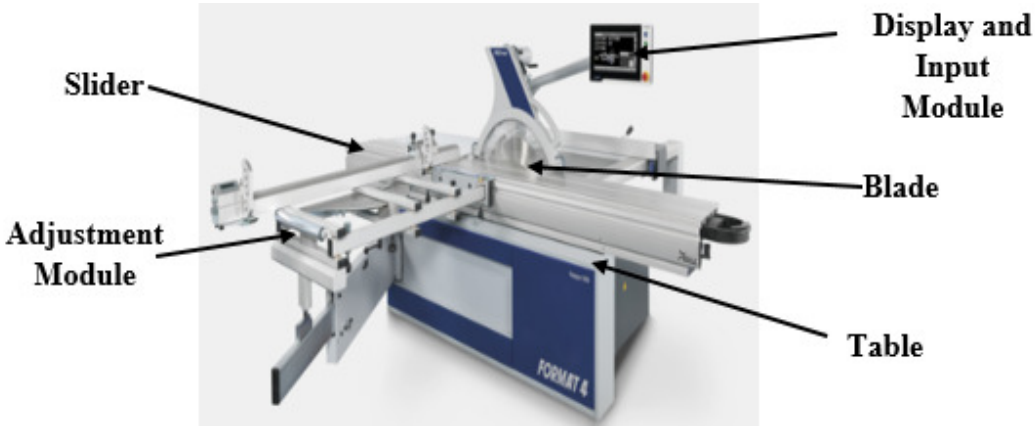


Figure 8: Represents the Design of the Sliding Type Table Saw Used for Various Cutting Operations [13]**.**

1.9. Components of Table Saw:

Out-feed tables are the longboards, sheets of plywood, and other sheet materials that are frequently ripped with table saws. This technique is made safer and easier by using an out-feed table. Infeed tables are aided in the feed of longboards as well as plywood. Downdraft tables: These tables pull dangerous dust away from users without impeding their mobility or productivity. A rip fence runs from the front of the table to the rear, parallel to the blade's cut surface. The distance between the fence and the blade may be modified, determining where the cut is made on the workpiece. The fence is usually referred to as a "rip fence" since it is used to guide the workpiece during the rip-cut operation.

A Feather board is used to protect the timber from ripping through the rip fence. Hold downs are a vertical form of feather boards that are magnetized or clamped to a fence. Another form of hold-down employs spring wheels that adjust the workpiece to blades. A miter gauge is a table with 1-2 slots running to and fro directions which is parallel with the cut section. The crosscut sled holds the object perpendicular to the blade. A “stacked dado” blades are equipment that includes 2 outside edges and multiple interior “chip breakers” for cutting dados up to the maximum width of 6-10 inch diameter stacked.

The blade is projected through a replaceable insert in the table and a material, like plastic or wood, can be used to create zero-clearance inserts. The blade is elevated through the insert when a zero-clearance insert is first introduced, forming the slot with no gaps. Other inserts, such as a dado insert, can be purchased or made in the same way. A riving knife, sometimes known as a splitter, is a perpendicular protrusion situated back to the saw blade. It is somewhat thinner than the blade and is positioned parallel to it. The splitter helps to avoid backlash by preventing the rotation of the material from being sliced. A push stick is a safety device that is used to maintain the level of the table.

The saw table is used for cutting purposes in industries and workshop applications. Various materials can be cut using these machines, which include both metals and nonmetals. There are many types of table saws available in the market but little research is done on this type of table saw, the focus of this study is to know the technical aspects of different types of saws and their area of application. A saw table is a well-known machine, but the analysis of its different types is less, which is to be discussed in this study. The study also highlights the types of sawdust and the cutting ability of the machines.

2. LITERATURE REVIEW

Jawad Ul Haq et al. designed a Machine for various cutting materials. Power saws are extremely helpful instruments for cutting and shaping materials used in a variety of construction projects, but they may also inflict significant hand injuries. The operator's hands are vulnerable in a table saw operation for wood cutting, for example, because they are utilized to guide pieces into the saw. Existing table saws have a cutting capacity that prevents them from cutting both wood and aluminum. In this study, an Axiomatic Design idea for a Saw Cutting Machine is offered to guarantee design objectives such as safety, user comfort, domestic use, and the capacity to cut both types of materials are met. Based on the aforementioned design objectives, the mapping from Customer Attributes to Functional Requirements and then associated Design Parameters resulted in an uncoupled design, which led to a comprehensive mechanical design and finally the control system [14].

Bartosz Pałubicki et al. studied different speeds of feed and their effect on the design of sawdust. The goal of the research was to determine the relationship between feed rate, feed force, and sawdust paper size. In the trials, a K700 machine was employed which was connected to a horizontal pneumatic actuator having three different feed rates in meters/min. According to the findings, there is a positive association between feed rate and feed forces in a circular sawing process, as well as an unanticipated paper size distribution based on the feed rate [15].

Ján Svoren et al. studied the techniques to save energy required during cutting and for wood processing, optimal cutting conditions are critical, so it is necessary to reduce energy as high finishing is required. The power usage by blades was evaluated in the experiment to determine the best cutting parameters. The results are the feed speed was raised, and the circular saw blade's cutting power and heat rose. The blade CSB3 displayed the lowest cutting power ratings. The values were 8% lower as compared to the original CSB1 circular saw blade. Between machine productivity and energy consumption, a trade-off must be made.

Kazimierz A. Orlowski et al. designed and developed the Sliding Table Saw and the goal of the research is to provide a new approach for modifying the sliding table saw design. This paper discusses saw spindle design variations, adjustments that improve spindle critical speeds, and measurement findings on operation systems' dynamic characteristics. It was demonstrated that using just sensible limitations in the spindle design based on previous sliding table saws produced does not result in the desired impact of proper spindle functioning [16].

Tafsir Ansari et al. has designed and fabricated the Table Saw for Small Wood Working Workshop. The project research was primarily focused on the issues that many operators experience, which includes having to use a larger machine to produce a tiny woodwork item, which consumes more power and is more expensive. To tackle all of the difficulties described above, we need to discuss and build a portable table saw that can virtually solve all of the problems. Because it will be smaller in size, it will take up less room and can be adjusted on several shelves. It will be powered by a 12-volt dc motor, which will use less electricity and therefore alleviate the problem of excessive electricity use. The operators will be able to purchase this table saw since its supporting structure will be made of wood and will be able to carry a significant amount of weight while remaining compact. Because it is simple to use, this equipment will enhance productivity. This equipment will be advantageous to all who will undertake wood operations and will be cheap to all. This machine will also lower the danger factor since when operated properly, it will be significantly safer [17].

Thus, the table saw is a machine that is very useful in many applications in a workshop as well as on construction sites. Woodcutting, metal cutting as well as polymer material cutting can be done using these machines which help small startups to use this device with ease. There are many machines available in the market which are used to cut thick material from thin material. The use of machines saves the power which is researched as well as reviewed by many experts where the usage of the machine and the various aspects of the machine are discussed. So the use of a table saw is necessary with precautions as the machines are used for cutting and trimming objects. Table saw machines have several points that make the machine industrially applicable and useful for cutting operations.

3. DISCUSSION

The table saw has a vast field of application, which is related to the cutting and shaping of elements in the desired size. There are many types of table saws available in the market their applications are different depending on their industrial installations. The use of a mini and micro table saw is for cutting small objects having a small diameter of 4 millimeters, while the other types of the saw are for cutting big objects. The blade arrangement is the same in all these table saws out of which some table saw uses the diamond chains and toothed blades for cutting the objects. The use of a table saw is done since ancient times for cutting purposes which evolved from manual to automatic and can operate using AI. The focus of all the machines is to cut the object in less time with less noise and vibrations.

The design of table saws is simple in construction, and using different technologies makes it automatic. The study of different aspects of table saws is done by many experts which focuses on their cutting speed, type of sawdust and its effect and the feed rate of the object in the table saw. The use of blades and a motor affects the working efficiency of the machine. The sawdust for wood is more and which may affect the inhalation of the user so it is necessary to use masks while cutting the softwood. The studies by different experts conclude the significance of using a table saw with button starts, now the technologies used in the machines are using IoT and AI for smart cutting of objects. The table saws used in the industry should have high efficiency and cutting speed of the motor. The cabinet table saw provides the extra cabinet for cutting the object, while the bench top table saw is cheap and used in most cutting operations and also has simple constructions.

The table saw design is easy to understand and the functioning of the machine is smooth. Different designs are used in different countries for different applications depending on the object they used as inputs. The machines used for cutting operations are unique and have a specific function like mini and micro machines that cut small size objects without damaging them. While the bench top is a low-cost machine as compared to other machines. Smart machines are now on the market which provide extra functions during the working to control the speed of the blade as well as to control the sawdust exploration in the environment. As the study focuses on the different types of table saw used for cutting different elements in different parts of the world to understand their design and working all together. Thus, the study of table saws is beneficial for workshops and construction site applications.

4. CONCLUSION

Many experts have conducted a variety of studies on the various elements of table saws, with some focused on design and manufacture and others on blade configuration and dust generated during operation. The manufacture and design of a portable table saw are easy and effective as the user can carry it to the work site and process the task. The use of slipping aids in tool adjustment and maintains the working efficiency of the machine. Large machines consume more energy, which can be reduced by using a table saw for smaller and more time-consuming tasks. FDS increases the feed rate and blade efficiency for cutting operations, minimizing friction losses. The size of sawdust produced during the entire operation varies depending on the material speed and design affecting the efficiency of the machine. Materials used in construction work, including metal and non-metallic materials, can be cut with a jigsaw. As a result, the table saw is particularly beneficial for both metal and non-metal cutting activities, which are studied. The different approaches made by different experts in table-saw help to improve the cutting process

using modern machinery using technology. The use of IoT and AI helps in the development of machines with smart technology for operating. The study will also increase the atomization of such machines, reducing the risk of injuries or accidents.

REFERENCES

[1] A. B. Kihero, M. Karabacak, and H. Arslan, "Emulation Techniques for Small Scale Fading Aspects by Using Reverberation Chamber," *IEEE Trans. Antennas Propag.*, 2019, doi: 10.1109/TAP.2018.2883571.

[2] S. K. Ahn, "Framework for investigating wire saw rock cutting," *Int. J. Mach. Tools Manuf.*, 2020, doi: 10.1016/j.ijmachtools.2020.103581.

[3] M. Altan, A. Uysal, and E. Altan, "Effects of process parameters on surface roughness in saw cutting of polypropylene/TiO2 nano composites," *J. Brazilian Soc. Mech. Sci. Eng.*, 2014, doi: 10.1007/s40430-013-0105-z.

[4] T. Sok, S. J. Hong, Y. K. Kim, and S. W. Lee, "Saw cutting (or not) of joint spacing in roller-compacted concrete pavement," *Proc. Inst. Civ. Eng. Transp.*, 2020, doi: 10.1680/jtran.17.00041.

[5] A. A. R. Barbosa and S. R. Bertoli, "Occupational Noise Exposure to Masonry Saw Cutting Materials," *J. Environ. Pollut. Hum. Heal.*, 2017, doi: 10.12691/jephh-5-2-1.

[6] K. Raoufi, A. Radlinska, T. Nantung, and J. Weiss, "Methodology for determining the timing of saw cutting in concrete pavements," *Transp. Res. Rec.*, 2008, doi: 10.3141/2081-12.

[7] A. Otto and J. Parmigiani, "Velocity, Depth-of-Cut, and Physical Property Effects on Saw Chain Cutting," *BioResources*, 2015, doi: 10.15376/biores.10.4.7273-7291.

[8] A. Ersoy and U. Atici, "Performance characteristics of circular diamond saws in cutting different types of rocks," *Diam. Relat. Mater.*, 2004, doi: 10.1016/j.diamond.2003.08.016.

[9] wikipedia, "Table saw."

[10] ubuy, "Electric Mini Table Saw Precision Bench Saw Multi-function DIY Cutting Machine Low Noise Acrylic Protection Plate Wood Working Tools with Power Adapter."

[11] P. J. Hyup and L. M. Kwan, "An experimental study on the development of new diamond wire saw cutting system of concrete structure," *Int. J. Appl. Eng. Res.*, 2017.

[12] pintrest, "Raitool T5 Mini Precision Table Saw DIY Wood Working Lathe Polisher Drilling Machine DC 12-."

[13] felder-group, "Sliding Table Saws."

[14] J. Ul Haq, A. J. Qureshi, and M. Al-Hussein, "Design of a saw cutting machine for wood and aluminum," *ICINCO 2018 - Proc. 15th Int. Conf. Informatics Control. Autom. Robot.*, vol. 2, no. Icinco, pp. 456–464, 2018, doi: 10.5220/0006909704560464.

[15] B. Pałubicki, L. Hlásková, S. Frömel-Frybort, and T. Rogoziński, "Feed force and sawdust geometry in particleboard sawing," *Materials (Basel).*, vol. 14, no. 4, pp. 1–10, 2021, doi: 10.3390/ma14040945.

[16] K. A. Orlowski, P. Dudek, D. Chuchala, W. Blacharski, and T. Przybylinski, "The design development of the sliding table saw towards improving its dynamic properties," *Appl. Sci.*, vol. 10, no. 20, pp. 1–12, 2020, doi: 10.3390/app10207386.

[17] T. Ansari, H. Bhatt, G. Bogati, and O. Chavan, "Design & Fabrication of Portable Table Saw For Small Wood Working Project & Workshop," vol. 1, no. 4, pp. 175–178, 2021.

CHAPTER 4

APPLICATION OF ROBOTICS IN VARIOUS BUSINESSES TO MAKE THE SYSTEM HIGHLY ATOMIZED AND PRODUCTIVE

Mr .Ashok Singh Gour, Assistant Professor,
Department of Mechanical Engineering, Jaipur National University, Jaipur, India,
Email Id-asgour@jnujaipur.ac.in

ABSTRACT:

The manual work and labor application system is time-consuming and also has less efficiency which affects the profits and production of industries. With developing industries, there is development in new technologies that increase production where time-saving smart working is required. Robotics is the technology that focuses on making the life of humans comfortable and automatic. The focus of the study is to analyze the various applications of robotics to know the importance of robotics in industries for reducing labor cost. Different experts research the applications of robotics in industries from their view which gives new scope to robotics in various fields. Thus, it can be said that robotics has become an important part of the industry as most of the work is done by machines. Within the next few years, robotics will cover all the main industrial sectors where the use of labor is more to reduce the cost of labor for industries.

KEYWORDS:

Automation, Industry, Production, Robotics, Technology.

1. INTRODUCTION

Automation is the application system to accomplish previously done jobs or, progressively, those that might be impossible to implement manually. Although the term “mechanization” is often used to refer to the mere substitution of tools for human workers, the term “automation” is more generally used to refer to the inclusion of technology into an auto entity as shown in Figure 1. Automate has changed the industries where it is utilized and has had an impact on almost every area of modern life. The term “automation” was first used in the automobile industry in 1946 to characterize the increasing use of automated equipment and systems in mechanized manufacturing operations.The term is widely used in the manufacturing business, but it may also apply to a multitude of platforms in which technical, electromechanical, or computerized activity is used to substitute manual input and intellect [1], [2].

Figure 1: Represents the Multipurpose Robots Used for Domestic Applications.

An application that includes completing a process using predefined orders and unsupervised feedback control to ensure that the orders are executed successfully can be classified as automatic. An end outcome is a machine that can work without the involvement of humans. In the progress of technology, the use of digitally operated systems has grown increasingly crucial. As a result, computerized systems have grown in complexity and intelligence. Advanced systems provide a level of efficiency that, in many aspects, exceeds the biological capacity to do identical tasks. Industry 4.0 has progressed to the point that it has spawned a slew of new technologies, each with its own identity and significance. "Anthropomorphic automation", a kind of automation in which robots have human-like qualities, is one of these developments. The powered prosthetic arm of a modern manufacturing robot is the most humanlike feature as shown in Figure 2. The robot's arms could be configured to execute a range of activities, such as emptying elements from a production floor or completing a series of weldments on metal sheets used in the fabrication of an automotive body. Robotic arms are frequently utilized to replace human labor in industrial processes, as these instances demonstrate [3]–[6].

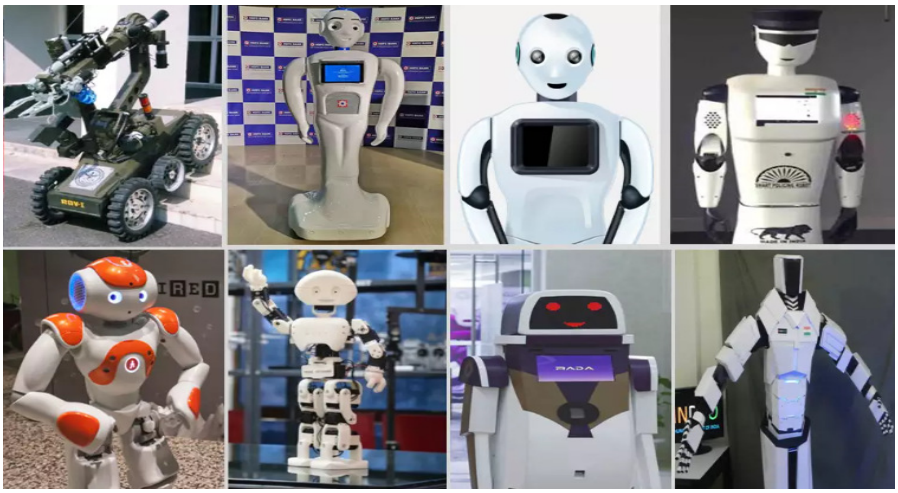


Figure 2: Represents the Different Types of Humanoid Robots Used In Industries for Receptions and Daily Data Collection of Employees In Office.

1.1.Principles of automation:

The performance or working of any machine follows some parameters to maintain the pattern of working. Some principles of automation are developed to follow the programs by pattern in the industry. There are principles of power-source, feedback control, and machine programming on which the foundation of automation grows as shown in Figure 3. These principles are important and should be considered while designing and developing automated systems. There are various parameters in the programming that are followed by the machines and robots which are discussed further. The power source is the main component in the system as it supplies power to the system to work further for multiple tasks. There are various applications of robots in industries where the feedback is given by control systems at work. Thus it is necessary to know the principles of automation on which all the automation and robots are designed [7].

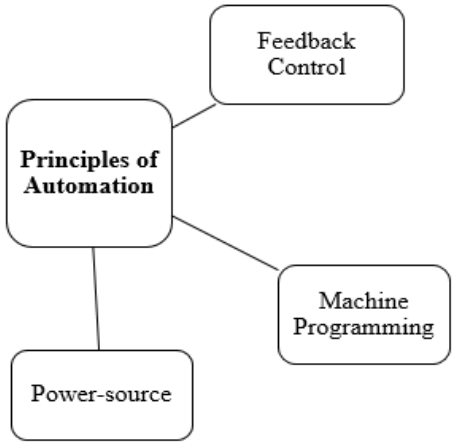


Figure 3: Illustrates the Principles of Automation in the Machines and Robots.

1.1.1. "Power-source":

"Electrical energy" may also be stored in high-capacity, long-life batteries. An automated system is designed to perform a useful activity that requires the use of energy. Supply is the most extensively used power source in today's automation, although there are other options. The most flexible is "electrical energy", which may be generated for a diversity of reasons and converted into various types of power to execute vital tasks. Production and delivery and installation are two types of operations that technological solutions may undertake. Energy is utilized first to conduct a processing operation on a given object. Metal shaping, polycarbonate concrete pavers, and analog waveform switching in data transmission or computation in advanced technology are examples of the process, such processes require the consumption of energy to shift the unit from one state that occurs to another more useful [8].

The second stage is transfer and placement is most commonly found in industrial automation systems that do product work. Generally, the commodity must be transported from one location to another during the sequence of processing activities. At each production step, commercial advertising precision is frequently required. The phrases transfer and positioning are used in automation information and communications systems to describe the transfer of data among multiple processing systems and the transmission of data to output terminals for human interpretation and application [9].

1.1.2. "Feedback controls" (FC):

In today's automated systems, FC is commonly employed. The necessary modules that create an FC system are input, regulated process, output, sensor components, controllers, and actuation devices. This type of technology is commonly referred to as closed-loop FC. The system input is predefined for the system output. This is the intended operating range for the output. The source is the desired room temperature and the component being managed is the radiator, as indicated in the preceding heating system concept. A manufacturing process, a satellite's rocket engines, an automobile's autopilot motor, or any of a variety of other processes upon which power is supplied has to be the methodology in other control techniques. The result is the method for determining what is directly associated with the sources, for example, the output, in this case, is ambient temperature [10].

The measuring devices employed in the response system for measuring the electromagnetic values parameter are known as sensory modules. A "bimetallic strip" is frequently utilized to accomplish this task in the case of a radiator. Two metal strips are linked along their lengths to form the device. Because different materials have large thermal expansion coefficients, the strip bend following the heat transfer as the temperature exceeds, as a result, the temperature may be measured by the bimetallic strip. In FC, a variety of sensors are used to automate the process. An FC system's processors and actuation devices compared the final result to the referenced input value and sought to narrow the gap. The controller and actuator of a system, in general, are the devices that help modifications in the process to affect the output variable. Solenoid valves, piston cylinders, gearboxes, power screws, valves, pulley mechanisms, sprockets, motors, and other electromechanical parts that are specially designed for the system are common examples of these mechanisms. The heating platform's regulator and activation method is the switch connected to the "thermostat's bimetallic strip".

1.1.3. Machine programming:

The program defines the series of numbers for the entries of the numerous output feedback loops that constitute the automation process, which is connected to loop regulation in an automated service. A programming command can indicate the set-point for the feedback mechanism, which regulates the system's activity. In reality, the response loop's goal is to ensure that the provided step is completed. In a controller, for example, the software may demand the arm to move to a specific point, and the control strategy is utilized to ensure that the action was completed successfully. An instruction to turn on an interrupt signal, for example, shouldn't need responses. An independent method also includes a control strategy when such commodities being fed into a manufacturing process vary, and indeed the equipment must accept these alterations by adjusting its controlled operations. Without responses, the machine would have been unable to maintain enough control over the process output quality.

The assortment of jobs that the device will do automatically is specified by the coded instructions. The program describes what the Internet of Things (IoT) platform should accomplish and how its many components should interact to achieve the intended outcome. In extremely basic systems, the program contains a set of well-defined operations that are carried out in a particular order from one phase to the next. In increasingly complex systems, the order quantity may be rather large, and the quantity of data in each order may be quite large. In more sophisticated systems, the program allows for modifications in process sequence given the increase in raw materials or other operating factors.

Mechanical systems punched paper tape, storage devices, magnetic discs, or any of several many other technologies that have been created throughout the years for specific uses may contain the programmed instructions. Today, it is typical for automated equipment to employ computer storage technology to store planned instructions and translate them into organized actions. The ease with which software may be altered or modified is one of the benefits of flash memory. It takes a lot of effort to change a program that is stored on power devices. In most cases, programmable devices are capable of making judgments while in use. The cognitive guidelines that regulate the flow of events under various conditions include judgment skills in the functionality. The system behaves one way in one set of conditions and another way in another set of circumstances. There are various reasons for offering a decision-making capacity to an automated system, such as (1) error detection and prevention, (2) supervision, (3) human involvement, and (4) performance improvement.

Validation and restoration are concerned with the decision that the machine must make in reply to undesirable operating situations. Every automated system makes mistakes and missteps from time to time, prompting some form of remedial action to restore the system's functionality. Requesting human assistance has long been the standard response to a system breakdown. In industry 4.0, there is an increasing trend toward allowing devices to identify and rectify defects even without human interaction. Diagnosis and restoration refer to the detection and correction of problems, and it requires the system to have a judgment capability [11].

Surveillance is a type of defect detection and prevention that occurs when a malfunction poses a danger to people. Choices must be taken when the automated sensors detect a security status that might be hazardous to the apparatus nearby. The stability system's goal is to distinguish a concern and take necessary action to eliminate or mitigate it. This may simply entail pausing operations and informing skilled machinists of the problem, or it could entail enacting a more comprehensive set of instructions to address the safety issue. In most cases, computer machines must interact with humans. In certain automation systems, a variety of substitute user guidance may be possible, and the device's judgment capacity must be exceedingly complicated to handle with the variety of options. The goal of the real-time decision is to make the process more efficient. When there are measurable economic performance parameters that may be improved, the need for optimization is very frequent. In the industrial sector, for example, cost reduction is usually a top priority. This study discusses the foundations of mechanization, such as its background, concepts, and practices of operation, and industrial adaptations, as well as some of the most essential business sectors in everyday life, such as its influence on individuals and the environment as a whole.

2. LITERATURE REVIEW

Svitlana Sotnik discussed the application of Industrial Robotics in the 21st Century. The goal of this study is to look at the potential for using industrial robots in contemporary manufacturing, and the study's goal is to look at where they are now. The following industrial robots are regarded as "novelties" from worldwide trend manufacturers of “Fanuc's strong M-1000iA and compact LR-10iA/10 robots”, “Yaskawa's GP 215”, and “KUKA's” are ready-to-spray robots. A brief comparison of the robots' fundamental capabilities is presented for each of the three businesses. An expanded categorization of PR is presented in this work. The key themes in the growth of manufacturing robots are emphasized during an investigation of the present IR sector.

T. Sethibe and E. Naidoorobots' adoption in the auditing the variables impacting companies' usage of robots technology for auditing operations were investigated using a "Unified Theory of Acceptance". The survey consisted of 37 checklists and 2 sub-interview questions, and the research was quantitative. The findings of the study demonstrate that performance expectations and enabling conditions are important variables in the deployment of robots in auditing. Lack of training, poor data quality, and insufficient investment in robotics and automation are all cited as major roadblocks to robotics adoption in auditing. As possible important facilitators of robotics and automation in the auditing profession, managerial support, excellent change management methods, and technical skills have been mentioned. The study's findings lead to two conclusions. To begin with, the performance appraisal and the business requirements for robots in the process of auditing must be linked to auditors' tasks. Second, resources to facilitate the use of technologies in the profession should be made available. The study adds to our understanding of how auditing leaders and management may affect the use of robotics in auditing.

Mohd Javaid et al. discussed "Industry 4.0" technology to balance ecological sustainability. Advanced technologies provide new possibilities for future development and business expansion. "Industry 4.0" is being implemented using Artificial Intelligence (AI), the IoT, big data, Algorithms, and other sophisticated emerging technologies. The goal of this study is to investigate the substantial advantages of "Industry 4.0" for manufacturing, as well as to identify tools and features of "Industry 4.0" that may be used to enhance environmental sustainability. 20 significant uses of "Industry 4.0" are identified and explored to build a sustainable environment. As a result, it allows for a better knowledge of the manufacturing background, source networks, provision channels, and market outcomes. Generally, "Industry 4.0" appears to be ecologically friendly, as it improves the efficiency of manufacturing and reduces resource use.

Mohd Javaid et al. Exploring the influence and characteristics of "Machine Vision" (MV) in the background of the modern "Industry 4.0" culture. The MV versions are required for large-scale manufacturing, with applications in product testing, compliance, and inventory management. By eliminating human error, the chances of making a mistake are reduced. The purpose of this study is to provide a quick overview of MV and how much it contributes to "Industry 4.0". The diagrammatic presentation of several collaboration elements and advanced devices for "Industry 4.0". In addition, the scholars have highlighted and explored twenty major MV applications for "Industry 4.0". One of the goals is to create MV that is competent to see, communicate, and operate with greater precision than humans. MV will play a crucial part in the intelligent plant of the future, in which programmed manufacturing lines will adjust to maximize efficiency, enactment, and viability.

Jinsoo Hwang et al. The Effects of Different Service Provider Types on the Restaurant Industry Based on the kind of service suppliers, such as robotic waiters and man waiters in the hotel business, this study was meant to examine the linkages between the business world, brand personality, and brand loyalty. More than 200 peoples use humanoid robots and nearly about the same number of people use human waiters, the results were good for robots as they were good at their work and quick to respond. Furthermore, statistical disparities in the overall average of the six factors were discovered dependent on the kind of service suppliers, such as robotic waiters versus human waiters.

N. Emaminejad and R. Akhavian, Consequences of the "Architecture, Engineering, And Construction (AEC)" industry from AI and robots. This study summarizes the findings of a

comprehensive evaluation of the literature on AI and AI-powered robotics, as well as advanced computational applications in the AEC sector, published in the previous two decades. Common trust aspects are established and the linkages to current AEC implementations are determined and described after a comprehensive examination. In addition, key prospects in AEC study and experimentation on reliable AI and robots are presented. The findings show that, while AEC researchers and business experts are increasingly studying and deploying AI and robots, comprehensive research on important trust characteristics such as explanatory ability, dependability, durability, efficiency, and security in the AEC context is lacking.

K. Blöcher and R. Al, as in the European restaurant business, AI and robots are being used to assess the possibilities for process improvement in an elevated service industry. In restaurants, technology is constantly growing, changing the restaurant industry into an important tourist and hospitality sector. Even with growing curiosity, the application of AI and robots in restaurants is quiet in its initial stages, and business owners are looking for direction on how to make the most of these technologies. The current study examines the current level of AI and robots in the restaurant industry and presents a method for systematically identifying process innovation opportunities. Market research of AI and robotics business for restaurant management is carried out for this goal, resulting in an approach to the data starting point for the development and conceptual development [12].

Ildar Begishev et al. study different “Robotics’ Technological, Ethical, Environmental, and Legal Features”. The most common technical technique for evaluating this idea is to assess its current state and accomplishments in the technological world, including its market prospects. In recent years, legal experts have begun to investigate issues related to the emergence of robotics, focusing on topics such as the constitutional jurisdiction of smart robots and AI's accountability for harm. The investigation of this idea and the relationships connected with this, from the standpoints of morals, ethics, and technology, is a distinct line of inquiry in the subject of robotics [13].

Industry 4.0 is the revolution of automation and innovation, different technologies and methods are introduced into the market. Many business methods are adopted by industries one of which is robotics and automation. The number of robots used is increasing which helps to maintain the production line without wasting time maintaining productivity. The study by different experts says that using robots or automated systems is very helpful to increase production efficiency and reduce labor costs. Most studies are showing the advantages of atomization in industries and how it affects Industry 4.0, further to analyze of their research review is discussed.

3. DISCUSSION

Most robots are utilized in production today, and there are three types of applications material management, processing procedures, and assembling and inspection are all things that need to be done. Product conveyance and mechanized packing and unpacking are cases of material-management uses. The robot must convey commodities or work elements from one place to another in material-transfer applications. Other transfer activities, such as transferring elements to containers in a specified order that the system must compute, are much more challenging. A robot implants and slings pieces at a manufacturing line during the lifting and carrying of machinery. This necessitates the robot's grasp being capable of holding pieces. Typically, gripping must be tailored to the shape of the component.

Robotics recognizes how to use a tool to focus specifically on the work component in robotic business operations. Weld, continuous soldering, and painting are examples of such uses. One of the most common applications of automation technologies in the U. S. is the laser cutting of vehicle body panels. To complete the fundamental vehicle structure building, the robot positions spot construction employees against research and production panels and frames. The robot runs the metal working along the distance to be soldered in a repetitive pattern known as soldering. With a sprayer, paint is applied to the surface of the object to be covered.

Arrangement and quality audit is the third area of concentration for robotic systems. Because of the obvious massive cost of physical labor in these tasks, the usage of robotic systems in manufacturing is projected to grow. Because robotics can be modified between phases, generating a large number of batches can result in batch modifications. Robotic assembly necessitates a thorough examination of the specific module. Robots don't necessarily require human-friendly assembling procedures. In human assembly, would use a fine adjustment as more than just a combining strategy is simple, but with a single robot, the same procedure is exceedingly difficult. Robots and automated drive assembly methods may accomplish the operation faster when the pieces are introduced from the same direction utilizing snapped fittings and other anchoring procedures. Inspection is another area of manufacturing where robots are rapidly being employed. A typical inspection task is a robot putting a detector on the task performed and assessing whether or not the part satisfies the quality requirements.

3.1. Merits of an Industrial Robot:

3.1.1. Better quality and consistency

Along with other techs such as the IoT or 3D printing robots, industrial robots can provide better product quality and more precise and reliable processes. Added benefits also include reduced cycle times and real-time monitoring to improve preventive maintenance practices.

3.1.2. Maximum productivity and throughput

An industrial robot increases the speed of manufacturing processes, in part by operating 24*7. Robots don’t need breaks or shift changes. The speed and dependability of robots ultimately reduce cycle time and maximizes throughput.

3.1.3. Greater safety

Using robots for repetitive tasks means fewer risks of injury for workers, especially when manufacturing has to take place under hostile conditions. In addition, supervisors can oversee the process online or from a remote location.

3.1.4. Reduced direct labor costs

The cost of having a person handle many manufacturing operations is often more expensive than a robot. This can also free up workers so their skills and expertise can be used in other business areas, such as engineering, programming, and maintenance.

3.1.5. Keeping manufacturing in the U.S.

Some argue that robots are taking jobs away from U.S. workers, but that’s not necessarily the case. Industrial robots there are typically integrated into a series of operations that require human expertise. For example, you could have a robot welding parts that are handed off to a person to perform a task that requires a human's intuitive “if, then” thinking.

3.2. Demerits of an Industrial Robot:

3.2.1. High initial investment

Robots typically require a large upfront investment. As you research your business case for purchasing, consider all the costs of industrial robots, including installation and configuration. Users should also evaluate whether a robot can be easily modified if need to alter operations in the future.

3.2.2. Expertise can be scarce

Industrial robots need sophisticated operation, maintenance, and programming. While the number of people with these skills is growing, it's currently limited. As a result, it's important to consider the personnel investment user needs to make to bring in that expertise or "retool" existing staff to take on the task.

3.2.3. Ongoing costs

While industrial robots may reduce some manufacturing labor costs, they do come with their ongoing expenses, such as maintenance. In addition, users want to consider the costs to keep robots and any related IoT-connected devices protected from cyber threats.

Today's industrial robots work in a wide range of industries, from semiconductors and automobiles to plastics processing and metal forging. Pretty much any repetitive operation is a great job for a robot, particularly if it's dangerous or difficult for people. The application of robots in manufacturing industries is particularly valuable. Robots have been used for high-volume operations, but as technology advances and the cost of industrial robots decline, more options and opportunities are opening for medium- and small-sized operations. At the same time, these robots are helping manufacturers address many of the key challenges they face, including tight labor pools, global market competitiveness, and the safety of the workers which makes the study useful for future analysis.

4. CONCLUSION

The robot is used to replace human labor in almost all industrial robotic applications. Certain aspects of human-powered industrial occupations indicate that they might be a good fit for robots the procedure is repetitive, requiring the very same basic work movements in each process, the procedure is harmful or inconvenient for the human employee, the task necessitates a heavy and awkward-to-handle work part or tool, and the procedure enables the robot to work 2 or 3 shifts. As a result, it can be claimed that robots are assisting humans in a variety of areas. Thus, the use of robotics in the industry is increasing and as seen in research robotics has great industrial impacts different robots for special functions are designed and developed. Thus the study helps analyze the growth of Industries 4.0 for the development of society. The study will help to review the overall development in the use of robots in different industries which will help for further improvement in the research.

REFERENCES

[1] M. Schranz, M. Umlauft, M. Sende, and W. Elmenreich, "Swarm Robotic Behaviors and Current Applications," *Frontiers in Robotics and AI*. 2020. doi: 10.3389/frobt.2020.00036.

[2] P. A. Castiblanco, J. L. Ramirez, and A. Rubiano, "Smart materials and their application in robotic hand systems: A state of the art," *Indones. J. Sci. Technol.*, 2021, doi: 10.17509/ijost.v6i2.35630.

[3] C. Follini *et al.*, "Bim-integrated collaborative robotics for application in building construction and maintenance," *Robotics*, 2021, doi: 10.3390/robotics10010002.

[4] J. Zhong, C. Ling, A. Cangelosi, A. Lotfi, and X. Liu, "On the gap between domestic robotic applications and computational intelligence," *Electronics (Switzerland)*. 2021. doi: 10.3390/electronics10070793.

[5] W. S. Li, Q. Yan, W. T. Chen, G. Y. Li, and L. Cong, "Global Research Trends in Robotic Applications in Spinal Medicine: A Systematic Bibliometric Analysis," *World Neurosurg.*, 2021, doi: 10.1016/j.wneu.2021.08.139.

[6] T. Yuksel, I. Delen, and A. Ilhan Sen, "In-service and pre-service teachers' views about stem integration and robotics applications," *Eurasian J. Educ. Res.*, 2020, doi: 10.14689/ejer.2020.90.13.

[7] WIPFLI, "Pros and cons of using industrial robots in your manufacturing operation," 2021.

[8] N. El-Atab *et al.*, "Soft Actuators for Soft Robotic Applications: A Review," *Adv. Intell. Syst.*, 2020, doi: 10.1002/aisy.202000128.

[9] britannica, "Robots in manufacturing," *Robotics and Computer Integrated Manufacturing*.

[10] I. B. Oran and H. R. Cezayirlioglu, "AI - Robotic Applications in Logistics Industry and Savings Calculation," *J. Organ. Behav. Res.*, 2021, doi: 10.51847/juxqmvcvqf.

[11] M. Menolotto, D. S. Komaris, S. Tedesco, B. O'flynn, and M. Walsh, "Motion capture technology in industrial applications: A systematic review," *Sensors (Switzerland)*. 2020. doi: 10.3390/s20195687.

[12] K. Blöcher and R. Alt, "AI and robotics in the European restaurant sector: Assessing potentials for process innovation in a high-contact service industry," *Electron. Mark.*, vol. 31, no. 3, pp. 529–551, 2021, doi: 10.1007/s12525-020-00443-2.

[13] I. Begishev, Z. Khisamova, and V. Vasyukov, "Technological, Ethical, Environmental and Legal Aspects of Robotics," *E3S Web Conf.*, vol. 244, pp. 1–10, 2021, doi: 10.1051/e3sconf/202124412028.

CHAPTER 5

EXPLORING THE VARIOUS APPLICATIONS OF HUMANOID ROBOTS FOR THE DEVELOPMENT OF SOCIETY USING ARTIFICIAL INTELLIGENCE (AI)

Mr. Robin Khandelwal, Assistant Professor,
Department of Mechanical Engineering, Jaipur National University, Jaipur, India,
Email Id-robinkh16@jnujaipur.ac.in

ABSTRACT:

Technological progress is helping man to improve his lifestyle, various machines, and techniques have been invented that change the way things work from manual to automatic. Robots are used in various applications and are used in advanced industries for domestic and commercial purposes. Their various applications are done by using various robotic techniques which reduce the work stress and labor cost. The focus of the study is to explore the various advances in robots and how humanoid robots are used in different fields. Robotics is one of the developing areas using artificial intelligence (AI) where robots are used instead of human labor. Various experts researched different techniques where humanoid robots are used to improve the technology. Thus it can be said that robots are now becoming the main part of industries that can work more efficiently without brake, and it is better for the betterment of society. So the use of robotics will be increased in the next few years and with time and innovative technologies the use of robots will increase.

KEYWORDS:

Artificial Intelligence, Humanoid Robots, Sensor, Society, Technology.

1. INTRODUCTION

An autonomous robot, especially one that can be configured by a processor and performs a complex set of tasks autonomously. Robots are human-controlled machines that contain a set of programs and instruction formats. Humanoid robots are designed in such a way that they look like humans. Humanoid robots have many applications for personal and business purposes. These describe interactions between people and automated machines that may find application in hazardous conditions or manufacturing processes, or that appear, act and think as individuals. Robots are machines that are a combination of technical programming and kinematics. Various automatic machines are used in industries. Robots are self-analysis and processing machines that work using artificial intelligence (AI).

The robots are used for various applications which are designed in such a way to follow a program for applications. There are many problems with using labor for completing any task. Using robots increases the efficiency of any work as is now seen in big manufacturing industries.

Most industries replace human labor with automatic robots. Automatic robots are now used and the applications of robots are now increasing as they are applied in many fields. Using manual work or labor takes time, so machines like robots are developed so that the person does not need to do much time and small work and the machine called robot can give high efficiency. The applications of robots have increased in the fields of agriculture, security, industry, and military forces. Robotic drones were one of the main developed designs of robots. Robots and Robotics is the field in which skilled experts work together to create unique and developed designs [1], [2].

Several techniques have emerged to be used for the study of automation and robots. One method is to use evolutionary robotics to put many devices to the test. Even those that do the finest are used as prototypes for future robot generations. Another method is developmental robotics, which looks at how a particular machine's problem-solving and other duties develop and grow through time. Autonomous systems are not restricted to a particular physical space and may move around in them. The "Automated Guided Vehicle (AGV)", is just a type of vehicle that is now in use. An AGV is a vehicle that follows marks or wires on the floor using vision or lasers. Mobile robots are the subject of a lot of existing research, and nearly every major university has one or even more departments focused on robot navigation research. Industrial robots often include a hinged limb and a terminal effector attached to a fixed surface, as seen in Figure 1[3]–[5].

Figure 1: Represents the Humanoid Robot Sophia Developed by Hanson Technologies in Hong Kong [6]**.**

According to ISO 8373, a controlling industrial robot is an independently managed, reconfigurable, multifunctional manipulator programmed in 3 or further planes that may be placed in the place or transported for use in industrialized systems. The most common industrialized robots are fixed electromechanical supports and exploiters, which are used mostly in the manufacture and transportation of goods. According to another "International Association of Robotics", a utility robot is an android that operates continuously or moderately to accomplish services important for persons and technology, eliminating production activities.

Flexible robotic systems are a new type of robot that is aimed to maximize robot utilization by modularizing its architecture. When compared to traditional robots, a modular robot's capability and efficacy are easier to expand. These machines are considered as a single kind of duplicate

module, many types of identical modules, or similar-looking modules of varying sizes. Modular robots may be created with much more than 8 degrees - of - freedom thanks to their architectural framework, which allows for hyper-redundancy. Modular robots require more method-focused, kinematic, and dynamic than regular robots. L-shaped units and cubic components, including U and H-shaped components may all be found in modular robots. “Robotics Design Inc.” has licensed “ANAT technology”, which allows for the manufacture of modular robots utilizing “U and H” constructed elements that link together in a string and are used to create “homogenous and heterogeneous modular robot systems” [7].

Domestic robots are capable of doing a wide range of tasks on their own. Domestic robots can usually move around familiar locations on their own, handle their recharging requirements, and interact with computerized entrance systems. Thus, they might be able to recognize people or things, converse, give companionship, check ecological integrity, respond to agitations, retrieve papers, and conduct supplementary valuable duties. Domestic robots may do a range of tasks at the same time or play involved at different periods of the day. A humanoid robot attempts to imitate humankind and may even match people in appearance. Mobile robots are in their infancy since no humanoid robot has yet been capable of navigating around a room it has never visited. As a result, despite their sophisticated actions in well-known contexts, humanoid robots are rather constrained.

Country Japan is home to 40% of the world's robots, the country with the most robots. As robots have become more powerful and smart, experts and academics have become highly engaged in what ethics would govern robot behavior and if robots would be eligible to claim any form of public, artistic, moral, or civil protection. Others foresee advancements in robot intelligence by 2050, as seen in Figure 2 with the female robot utilized in the workplace for employee announcements. Robotic behavior has become more complex as a result of recent advancements,[8].

Figure 2: Represents the Humanoid Female Robot Used to Resemble Humans in the Society [9]**.**

Ranjit Shrivastav introduced Rashmi, a multilingual realistic humanoid robot with emotional interpretation skills, in India in 2018. The “Indian Space Research Organization” is developing “Vyommitra”, a female space robot that will fly onboard the “Gaganyaan”, a space vehicle, in 2020. “The Cognitive Science Robotics Group” at “Lund University” created Epi, a humanoid robot to be used in developmental robotics research, hence its functionality is geared toward facilitating the research of cognitive development. The Ikaros system is in charge of the robot. “Dinesh Kunwar Patel”, constructed an “Indian Multilingual Humanoid Robot” designed from waste resources that can speak 47 different languages in 2020. Shalu can recall and recognize people, identify a variety of items, solve arithmetic problems, provide horoscopes and climate forecasts, explain in a classroom, administer a quiz, and do a variety of other tasks [8].

The use of humanoid robots is now increasing and has various applications in the commercial as well as domestic market. Robots are used for housework in many countries as their programming is made in such a way to perform particular tasks. Humanoid robots are now developed in many countries which help to perform many tasks. There are many applications of humanoid robots in many fields and still, many applications of robots are designed according to that. There are various robots used for various applications which are utilized by different countries. Robots having human intelligence are very useful to human operations as seen in many studies.

Thus, there are many robots in the market designed by different countries in the world which are capable of using their knowledge and skill as per their software for the betterment of society. Robots are seen mostly in two types which are human robots and industrial machines. Human robots are used where quick and accurate work is required. There are many official places where robots can be used. The use of robots in agriculture is new and many inventions are developed on the agricultural robots which can do all agricultural activities. Drones, sprayers, and weed-removing activities are carried out using robots in many countries which makes farms highly active and creative in the field of agriculture. Different approaches are made according to their field of applications and to study the kinematics of robots.

2. LITERATURE REVIEW

Nguyen Khac Toan et al. developed the Humanoid Robot Head Based on the Facial Action Coding System (FACS). The FACS is a revolutionary humanoid robot development technology. The research centered on the usage and development of humanoid robots to make them aware of human emotions. The study of the design and development of the head of humanoid robots to create a human-like nature using FACS is the emphasis of the paper. For each movement and reaction of the robot, kinematic equations were used to construct and refine the control system. The robot has been built to be over 90% active in the process and environment simulation. Fan Wang et al. discussed the “Human-Machine Interface” (HMI) on an “electrooculogram (EOG)” with Gyroscopes. The research is focused on robot control and its applications in the home. The study's goal was to assist persons with mobility limitations and raise their environmental awareness. The addition of a gyroscope allows the robot to swivel its head easily, and HMI aids in improving the robot's response or actions in response to the surroundings. Because they employ a graphical user interface for detecting and analyzing, robots used for various home applications are beneficial for a variety of tasks. Controlling robot actions and performance is an important aspect of the design, which will be enhanced by technologies that have a 99.2 percent accuracy and a response time of 2.30 seconds. The humanoid robot created in this way is fast to react and has a high work efficiency.

J. Y. Kumar and S. Akhilasaistudied the revolution in agriculture by using a Humanoid robot. The goal of the research was to come up with a concept for humanoid robots that would assist farmers in farming operations utilizing technology so that artificial intelligence might help farmers increase their production. The goal of the research was to safely lead the farmer through his agricultural activities. The robots may demonstrate both ancient and contemporary farming practices, guiding the farmer in their tongue. S. Sowmiya, et al. studied the Psychological Assessment of Humanoid Robots. Autonomous robots are sophisticated robots designed to move and converse in the same way as humans do. They bring value by automating duties that save money and boost productivity, just like any other service robot. Humanoid robots are still a relatively new sort of professional service robot. Humanoid robots are being investigated and tested in areas such as personal services and support, recreational opportunities, disaster response, manufacturing and maintenance, media affairs, and health. Certain components, like sensors and actuators, allow human figures to move, speak, and operate. Ginoid is a female robot, while Android is a man robot. They have sensors that allow them to perceive their environment, as well as a variety of other qualities such as unpredictable tractability, law implementation, and agility. Working people are helped by the humanoid robot, which ensures their care and safety. The robots are examined in light of technological advancements.

Sohaib Siddique Butt et al. studied “Binaural Auditory Perceptual Systems in Humanoid Robots”. Audio receptors are used to create and run the robots, which will approach sound directions. The research on “Sound Source Localization (SSL)” was insufficient due to a lack of audio detection, thus the robots were intended to provide precise and speedy responses to showcase the enhanced SSL system. The goal of this research is to offer a learning-based approach to voice detection and analysis. To projection and adjust toward the wide-ranging source, the suggested model is combined with an efficient gyration method. The suggested method's performance is compared to network-based sound foundation familiarity approaches with more than 90% accuracy. J. A. Rojas-Quintero and M. C. Rodríguez-Liñánreviewed heads for a humanoid robot with heads. Many studies have been conducted on humanoid robots, but only a few studies have focused on the use of sensors in the robot head for swift action and reaction. Humanoid robots interact with humans because they are meant to assist humans in a variety of household and commercial tasks. The research also looks at the control mechanisms used in humanoid robots. They concluded that there are two categories of robots based on their design and cost, with robots with human faces costing more than robots with machine designs. Further research reveals several methods and tactics for improving human-robot interaction [10].

Lancelot Da Costa et al. discussed revolutionizing robotics using mathematical formulas and advances in neuroscience. The study aims to design and create a human interference system that will increase robot reaction time efficiency. The research also emphasizes the relationships between robots and humans in various service applications. The methods demonstrate hi-tech presentation in a variety of automation contexts and indicate how this framework may be utilized to progress robotics, making this system extremely valuable for humanoid robot design. Antonella Marchetti et al. developed the application of robotics in clinical and psychological applications. This chapter examines the usage of “Socially Assistive Robots” in diverse care contexts and provides an acute assessment founded on data from the collected works. Research illustrates the vast variety of possibilities for robot usage by framing the question in terms of life duration. Finally, the prospective application of non-humanoid social robots in the carefulness of

the senior provides a unique contest on the deployment of societal machines that combine excellent expert involvement with relatively basic looks and behaviors [11].

Monika Guilin et al. studied the effect of robotics on the treatment of children and teenagers having "Autism Spectrum Disorders (ASD)". Numerous components of robotics, particularly humanoid machines that appear like human people with their phenotypic features, have been applied in the treatment of students with Autism for more than 30 years. ASD is a serious disease in which a person needs proper care and medication for recovering through it. Their mode of communicating, on the other hand, is far more straightforward. Specifically, multiple readings have demonstrated the usefulness of automatons in the management of children with ASD, particularly in the training of societal and communicational skills. As a result, humanoid robotics is continually advancing, and robots are increasingly employed in the rehabilitation of children with ASD in various nations. Humanoid robots are mostly advanced robots that are used to work for humans in different tasks. There are different types of humanoid robots in the market produced by many countries, which makes them very advanced in their technology. Some robots are programmed using AI that is capable of responding to the specified tasks on their own. Different studies are made by different experts on the application of robots in various fields. The study of humanoid robots says that many robots are capable to perform any task quicker than any human which helps to reduce time and improves efficiency. The use of robots is done in many countries that value time, the country like japan is mostly active in robot development and programming. Very advanced and highly skilled robots are developed for human service. Thus it becomes necessary to know about such robots which replace humans in work due to their advanced technologies.

3. DISCUSSION

Humanoid robots are now used in many domains including all the fields of domestic and industrial applications. The use of robots in the medical field makes medical facilities easy to understand and the general reminders are alerted which becomes helpful for patients as well as doctors to focus on their work. There are assistant robots that are used in the industry for different purposes of monitoring alerting or at receptions. Designing robots is no easy task but using machine kinematics and deep knowledge of computer programming it becomes to design the humanoid robots of advanced technology. The efficiency and speed of robots to give quick responses make them superior. Thus, these humanoid robots are now used in many big industries in different parts of the world where the labor cost is high.

The application of humanoid robots is increasing with time and developing technologies. The focus of study by different experts is also highlighted in their different papers. There are different technical advancements made in robots that change them from automatic to AI. Overall autonomous robots and specialized robots are the two types of robots now available, dependent on their intended function. A robot's purpose could be used to categorize it. A machine may be programmed to specialize in a specific task or to do several tasks badly. All machines can be reconfigured to perform differently by their basic nature, although some are limited by their morphology. A humanoid robot has a body that resembles that of a person. The construction might be for applied determinations, such as intermingling with modern tools and surroundings, or it might be for research purposes, such as investigating bipedal walking. A chest, a head, arms, and legs are standard features of humanoid robots, while some may only copy a section of the body, like the waist up.

Domestic robots can perform a broad variety of tasks according to their own. Overall, autonomous robots can often navigate familiar environments on their own, manage their own recharging needs, communicate with automated gates and elevators, and do other basic tasks. To increase their capabilities, general-purpose robots, like computers, may link to systems, software, and accessories. It might detect people or things, communicate, give companionship, assess ecological integrity, respond to alerts, get resources, and do other helpful functions. Domestic robots can do many tasks at once or perform roles at different times of the day. A "humanoid robot" tries to replicate human behavior and may even look like humans. Humanoid robots are increasingly employed as research tools in the variability of fields. Humanoid robots are being developed as a result of research into human physique configuration and manners ("biomechanics"). Attempting to imitate the human body, on the other hand, leads to a better knowledge of it. "Human cognition" is the study of how people develop sensory and motor abilities as a result of sensory information. This information is used to create digital models of human behavior, which have become more sophisticated over time. The use of such robots helps in making the systems autonomous in which users need to do less moderation or supervision.

Humanoid robots are useful in medical and biotechnology research, as well as other areas of research such as bones and joints and information psychology. Complex prostheses for sufferers with physical limitations, like lost limbs, are being created by humanoid robots. The "WABIAN-2" is a ground-breaking therapeutic robot that can aid with lower-limb rehabilitation [8]. Even though the major goal of the behavioristic study was to develop better orthotics and prosthetics for people, knowledge was shared across the two fields. Powered foot arthroplasty for neuromuscularly challenged people, lower leg reconstructive surgery, naturally genuine leg replacements, and forearm prosthetic devices are only a few examples. "Humanoid robots" can be employed as experimental groups for the development and implementation of individualized healthcare solutions, essentially acting as geriatric robotic nurses. Robotic arms are both well for some procedural duties, like customer service reps and automobile assembly line employees. Humanoids can, in theory, utilize tools and control equipment and vehicles built for people, thus with the correct software, they could do any job a person can. However, doing so is extremely tough.

From their creation and conceptions of Olympus to the use and actual construction of current animatronics utilized in theme parks, intelligent machines have an ancient legacy in the domain of entertainment. Stuntronics is the most prevalent usage and enhancement of robotic systems in today's amusement parks. Stuntronics are artificial robots used as body doubles and developed to imitate life-like, unconstrained, dynamic movement. Animatronic robots that appear, perform, and communicate like people are used in multiple Disneyland Park presentations. Robotics and animation is a very unique concept which is used for kids' entertainment as these robots are capable to attract kids easily. These robots lack intellect and bodily autonomy, despite their lifelike appearance.

Humanoid robots are now one of the important machines that are working for humans, identical to caretakers. The robots used in offices are for making the announcement and data collection and storing, which further process it and deliver it to main servers. The machines used for working in the hotel are also known as humanoid robots which serve the customer in less time. Working with machines follows the set of instructions and programs which are controlled by controllers or processors. So it is necessary to know and study all the aspects of using and operating robots as there are many experts behind one design of the robot. The developing robot

is a very skilled operation as the machines are working in different fields. Thus, robotics is now playing a key role in the betterment of society where the focus of the study is to design robots with less cost so that every individual can afford to use them for their different work within less time. The use of the internet of things and AI makes the system easy for to use the robots from long distances and ranges to reduce their time. Many methods are utilized to design the robots, and the application of robots in agriculture and the military plays an important role and soon changes the planning and dynamics strategies of study. The animation industry also uses robots as the kids are attracted to such new and innovative things that are different from their knowledge. Thus, robots and humanoid robots are very useful and developing fields that are related to human comfort to reduce time and efficiency.

4. CONCLUSION

Humanoid robots are now used in many countries instead of human laborers because they are efficient and quick to work. Many types of research and new perspectives have been created by experts on the technologies used in humanoid robots. Humanoid robots are used in the medical field, entertainment, industry, and hotels as well as for household purposes. Working speed and quick response are the key features, which make robots more efficient than humans. Using robots to help reduce time, humanoid robots are now well-known in the human-environment because they are particularly functional in human interactions. The technology used in robots is very advanced and pre-programmed which makes them automatic. The aim of developing such robots was to reduce the work stress of labor and increase productivity with high efficiency. The use of advanced technologies helps in the updating of robots where AI plays a vital role. The social approach of humanoid robots is now increasing as per research by different experts. There are now many industrial approaches developing based on the robotic system. The robots are used in domestic applications which make household chores easy and very easy. The study helps in further analyzing the importance of humanoid robots in society and how they are useful in work. Thus after reviewing the different opinions of experts it can be said that the number of humanoid robots will increase within a few decades when they can analyze situations and react on their own is also possible.

REFERENCES

[1] L. Nyholm, R. Santamäki-Fischer, and L. Fagerström, “Users’ ambivalent sense of security with humanoid robots in healthcare,” *Informatics Heal. Soc. Care*, 2021, doi: 10.1080/17538157.2021.1883027.

[2] L. J. Wood, A. Zaraki, B. Robins, and K. Dautenhahn, “Developing Kaspar: A Humanoid Robot for Children with Autism,” *Int. J. Soc. Robot.*, 2021, doi: 10.1007/s12369-019-00563-6.

[3] M. Manca *et al.*, “The impact of serious games with humanoid robots on mild cognitive impairment older adults,” *Int. J. Hum. Comput. Stud.*, 2021, doi: 10.1016/j.ijhcs.2020.102509.

[4] M. Mara *et al.*, “User Responses to a Humanoid Robot Observed in Real Life, Virtual Reality, 3D and 2D,” *Front. Psychol.*, 2021, doi: 10.3389/fpsyg.2021.633178.

[5] D. Pucci, S. Traversaro, and F. Nori, “Momentum Control of an Underactuated Flying

Humanoid Robot," *IEEE Robot. Autom. Lett.*, 2018, doi: 10.1109/LRA.2017.2734245.

[6] the american society of mechanical engineers, "10 Humanoid Robots of 2020," 2020.

[7] A. M. Alcorn *et al.*, "Educators' Views on Using Humanoid Robots With Autistic Learners in Special Education Settings in England," *Front. Robot. AI*, 2019, doi: 10.3389/frobt.2019.00107.

[8] Wikipedia, "Humanoid robot - Wikipedia," *Wikipedia*, 2020.

[9] wikipedia, "An android, or robot designed to resemble a human, can appear comforting to some people and disturbing to others."

[10] J. A. Rojas-Quintero and M. C. Rodríguez-Liñán, "A literature review of sensor heads for humanoid robots," *Rob. Auton. Syst.*, vol. 143, p. 103834, 2021, doi: 10.1016/j.robot.2021.103834.

[11] A. Marchetti, C. Di Dio, F. Manzi, and D. Massaro, "Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID- 19 . The COVID-19 resource centre is hosted on Elsevier Connect , the company ' s public news and information ," no. January, 2020.

CHAPTER 6

COMPREHENSIVE STUDY ON THE APPLICATION OF ENGINEERING MECHANICS IN THE DEVELOPMENT OF ROBOTS

Mr.Sanjeet Kumar, Associate Professor,
Department of Mechanical Engineering, Jaipur National University, Jaipur, India,
Email Id-sanjeet.kumar@jnujaipur.ac.in

ABSTRACT:

Robots are pre-programmed machines that follow a set of programs to finish any assigned activity or task by the server or host. The use of robots is increasing with time in different fields of industries, domestic applications, and military purposes. With time many advancements in robotics helps in increasing productivity which technologies are not known. Thus, the study focuses on the various mechanics behind the designing of the robot, and the key aspects that should be considered while assembling the robot in the workshops. Different robot manufacturing technologies are researched and reviewed by different experts in their study. The outcome of the study shows that mechanics and programming are important aspects of design, which should be done with precautions because of the autonomous programming of robots. While designing any autonomous machine it is necessary to design its working and linkage kinematics. This study will help to understand the importance of machine mechanics in the manufacturing of robots to develop the future scope of robotics in the world.

KEYWORDS:

Actuator, Kinematics, Mechanics, Motion, Program, Robots.

1. INTRODUCTION

Robotics is a mechatronics field that deals with the design, manufacture, operation, and use of robots. The goal of robotics is to develop gadgets that can help and benefit people. Robotics includes mechanics, electricity, telecommunications, systems engineering, electronics, biotechnology, mechatronics, computer engineering, programming languages, arithmetic, and probably other fields. Robotics is the science of developing gadgets that can act like humans and mimic their actions. Robots can be used in many contexts and for a variety of purposes, and many are already used in hazardous environments, manufacturing processes, and other situations where people would perish. Robots come in many shapes and sizes, but some are built to look like people. This is believed to help robots adapt to certain clonal expansion actions that humans routinely perform. These robots want to walk, lift, speak, think, and perform any other human behavior. Microbial, robotics is an emerging field as many of today's modern advanced robots are influenced by the environment [1]–[5].

Several mobile robot operators input, while others are completely self-contained. Self-contained robots have been around since the dawn of time, but research into their functioning and potential

uses did not begin until the 20th century. Numerous academics, architects, researchers, and technicians have asserted throughout history that robotics might one day be able to imitate human behavior and handle professions in a living thing manner. Robotics is a rapidly growing field, with researchers investigating, creating, and producing new robots for a range of applications, whether domestically, commercially, or militarily. Robots are meant to do things like defuse bombs, seek survival in dangerous ruins, and investigate mines and disasters, to name a few [6]–[9].

Robot designing is an important task so while designing robots it is necessary to know the importance of links and linkage mechanisms of robots. There are various applications of robots useful for reducing the work stress of humans as well as reducing the labor cost of humans. Robots exist in a wide range of forms and sizes, and they're used in a wide range of situations and for a wide range of objectives. Even though they are all very variable in terms of function and design, all share three basic construction characteristics:

1. Every robot has mechanical parts, such as a frame, structure, or shape that serve a specific purpose. The mechanical component is essentially the creator's reaction to achieving the specified aim while simultaneously dealing with the characteristics of the environment.

2. Robotic machinery is powered and operated by electronic systems. Electricity, which must flow via a wire and originate from batteries as part of a primary electrical system, provides that energy. Even systems that run largely on gasoline require an electric charge to start the complete combustion, hence batteries are included in most gasoline-powered equipment, such as vehicles. Electric components in robots are used for motion, detection, and management.

3. All robots have some sort of digital software program in them. Programs are the lifeblood of a robot; they can have superb mechanical and electrical architecture, but their performance will suffer greatly if their software is badly written. Remote control, artificial intelligence, and hybrid robotic programs are the three categories of robotic programs. A robot with remotely controlled software has a set of pre-programmed signals to execute when and if it gets a response from its controlling unit, which is usually a person having a control module. It's probably more accurate to classify technologies that are controlled mostly by human instructions as automated rather than robotics. AI robot interacts with their surrounding on their own, without the need for a controller, to employ their pre-programmed responses to items and challenges they face.

As more robotics are constructed for specific tasks, this form of classification becomes more important. Many machines, for example, are designed for manufacturing and assembling and may be difficult to adapt to other activities. They're referred to as "assembly robots". As an integral system for seam welding, some companies offer whole welder operations with the robot, including construction machinery as well as extra heavy equipment such as turntables. Even though its modular manipulation unit may be adapted for a variety of applications, such an adaptable and smart system is known as a "welding robot". Because they are designed primarily for managing large weights, certain robots are referred to as "heavy-duty robots".

There are many programs, software, and dimensional calculations to carry out for implementing it on the robot as shown in Figure 1. There are different programs and tools used in developing

one design of a robot. There are various types of tools used for developing robots in the industry which are Arduino, CAD-CAM, Internet of Things (IoT), etc. Mostly the robots have a high industrial application which is used for different purposes where more labor is utilized or where there are dangerous situations [10]–[15].

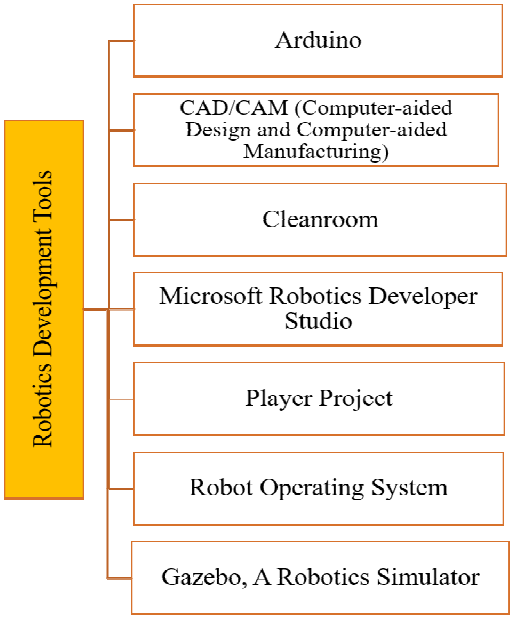


Figure 1: Illustrates the Different Robotics Development Tools which Help in Analyzing the Different Aspects of Robots Design.

1.1.List of the Components of Robots:

There are various components used in the development of robotic machines which perform some of the main functions in the system. The main components of robotic systems are an actuator, delta robot, drive power, end effector, forward chaining, haptic, hexapod, hydraulics, Kalman filter, Klann linkage, manipulator, parallel manipulator, remote manipulator, serial manipulator, muting, pendant, pneumatics, servo motor, servomechanism, point of control, speed control, stepper motor, Stewart platform, subsumption agriculture and teach mode whose functions are mentioned in Table 1.

Table 1: Illustrates the List of Various Components Used In the Construction of Robots.

Sl.	Components	Functions
1	Actuator and Linear actuator	Control signals are translated into linear actuators by the motor. The commands are often electrical, although they can also be hydraulic or mechanical in exceptional cases. Any of these might be used as a power source. The use of electrical control to regulate a slightly elevated hydraulic or pneumatic actuator is frequent. A linear actuator is a variety of motors that directly perform a translational motion.
2	Delta robot	Quicker opportunists with a large range of motion are made utilizing tripod attachment.

3	Drive power	The robot actuators' power source.
4	End-effector	Support equipment or item meant to be attached to the robot's upper arm or tools installation plate for the robot to do its specified mission.
5	Forward chaining	An intuitive method or incoming data to effectively change its behavior.
6	Haptic	The driver's sensation is used in tactile feedback technologies. With their tactile sensitivity, it's also frequently used for motion control.
7	Hexapod	"6-linear actuators" are used to move the surface. They are commonly employed in flight simulations and fairground attractions, but they may also be utilized as a robot system.
8	Hydraulics	The usage of fluid below pressures generates mechanical stress and motion, which must be controlled.
9	"Kalman filter"	From a sequence of inconsistent and inconsistent data, a mathematical approach is used to determine the amount of a signal obtained.
10	"Klann linkage"	For moving robotics, a simple connection is required.
11	Manipulator	A mechanized hand is known as Grippers.
12	Parallel-manipulator	Parallel kinematics networks, controllers, and hinges are used to create an articulating humanoid or probe.
13	Remote-manipulator	Working with dangerous materials frequently necessitates the employment of robotic arms under personal comprehension.
14	Serial-manipulator	A single-switch kinematics sequence of actuation is used to create an articulating robot or manipulator.
15	Muting	Throughout a segment of the robotic cycles, an existing protecting component is deactivated.
16	Pendant	Any transportable control device that allows a user to control a robot while remaining within the machine's limited perimeter.
17	Pneumatics	Regulation of force applied and movements created by the pressurized gas implementation.
18	Servo-motor	Instead of moving constantly, a motor that goes to and holds importance is given on demand.
19	Servomechanism	An automated device that corrects a mechanism's efficiency through fault-negative responses.

20	Single-point of control	Power to manage the robots in a rather way that robot movement can only be initiated from one point of control and can be overcome by another.
21	Slow-speed control	Type of robotic navigation controller in which the machine's speed is regulated to provide people enough time to halt the robot or remove the harmful action.
22	Stepper-motor	A motor rotating in step-wise manners from pole to pole.
23	"Stewart-platform"	The moveable platform is known as a Hexapod because it has a 6-linear actuator.
24	Subsumption architecture	Robotic structure built on a flexible, underside approach, starting with the simplest respective application.
25	Teach-mode	The regulator phase enables the collection and storing of positioning sample-point influenced by operating the robotic arms along a predefined route.

1.2.The motion of Robots:

Based on motion robots are mostly classified based on the environment of their traveling and the mechanism used for motion. The natural conditions and habitats are very important to consider while designing the robots which are classified as land robots for land operations, aerial robots, as well as the "Unmanned Aerial Vehicle (UAV)", for in-water, and on-water travel robots, which are known as "Autonomous Underwater Vehicles (AUV)" and polar robots for moving easily on the ice. The mechanisms used by robots are mainly legs, tracks, and wheels. The robots used in the different fields have different functions and their mode of motion is also different which is shown in Figure 2.

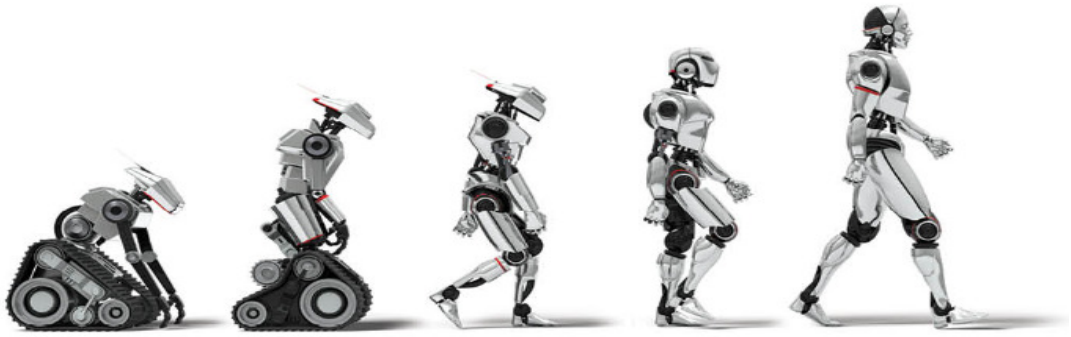


Figure 2: Represents the Evolution of Robots from a Machine to Humanoid Robots.

The use of robots is increasing which changes the production rates in the industry. There are many domains where the application of robotics affects their efficiencies of production. The focus of developing robots is not an easy process as the designing of any robots for a particular application is time-consuming. The programs are key to robots which are different for different applications to regulate the functioning of robots. Different countries in the world are trying to

develop new and better versions of robots and robotic systems. The production lines and their assemblies are very developed by the application of robotics which helps in advanced industrialization. The various industrial process like cutting, molding, cleaning, welding, surfacing, etc. became easy in the production line.

2. LITERATURE REVIEW

E. O. Babalola and E. V. *Omolafe* discussed the procedure of designing robotic devices. There are many applications of robotics in industrial, commercial, and military fields. The focus of the study was to elaborate on the procedure of designing robots and the steps that should be considered while manufacturing robots. The industrial application of robots is now not only in analyzing and monitoring but is also applied in production and assembly lines. They discussed the importance of the skilled person in the designing of robots and the methods used for designing them. The study says that designing and implementing are interrelated terms in the construction of robots.

Hongwei Sun et al. studied the analysis of the application of industrial robots. Their study focuses on the application of 5 axes robotic systems in industrial applications. The initial cost of robots is high which is not afforded by everyone so it becomes necessary to design the robots with having 5-axis. The design using 5 axis robot is constructed and applied in the industrial analysis. The modal obtained after the analysis is used for studying their vibration pattern. Thus the 5-axis design of robots is useful for the industrial application of automatic productions.

Marek Noga et al. studied the design and application of Digital Twins (DT) using a robotic manipulator. *The digital twins are the duplicates of the original machines that are designed for understanding the working of robots in different conditions and aspects. The use of DT helps in analyzing the different aspects of machines concerning time and their applications. The study discusses the designing of DT for a particular application and its advantages after the application. The use of a robotic manipulator in the study is carried out for improving the efficiency of robots in industrial production lines and assemblies.*

S. Sowmiya et al. researched and discussed the evaluation of humanoid robots. There are many evolutions in the robots from automatic machines to humanoid robots. The design and applications of the robots increased with time as the most of work in industries is utilized using robots. The research focuses on the development of robots with technical and controlling their systems. The study helps to improve the evaluation of robots from automatic to AI-based robots. Both genders' robots are designed and can work under different conditions which are now mostly used in domestic applications.

Andrius Dzedzickis et al. discussed the latest Applications of Industrial Robotics. The study reviews the different aspects of robotics where the applications of robots are discussed. The use of artificial intelligence and the internet of things is the key feature of designing and developing robots and the industrial trends in production lines. Different experts and researchers in the field of robotics have analyzed the development and evaluation of Industry 4.0. There is much research that is done useful for making the industrial systems automatic which increases the robotic efficiencies. Thus, the study gives the idea of the evaluation and application of robotics in industries.

Thus, there are many technologies, operating systems, and methods used in the designing of robots. The IoT and AI are used mostly for controlling the operations performed by the robot. While designing robots the machine's kinematics should be analyzed and studied based on the area of application of the robot. Most of the studies conclude the various application of using robotics in an industry which also highlights the development of robots while there are very less studies on the working principle of robots with current applications of technologies. Thus, it is necessary to know the working principle of robots used while designing and analyzing them with studies.

3. DISCUSSION

The robots are designed and developed with specific techniques by skilled persons. Robots are used in production and assembly lines for various purposes. The use of IoT and AI helps in the designing and construction of robots. These robots are used in various fields where the laborers are used which costs more than their efficiency so the autonomous machines are used to process the work. There are many fields where robots are used which are developed according to their areas of application based on their working principles. These principles of robots are used while designing robots for the proper functioning of them in their area of application to get maximum work efficiency. AI is the ability given to a machine to perform different functions based on conditions, which is developed by a set of programs and follows a specific pattern. Degree of freedom is the mechanical term used to describe the movement of the body in different directions which changes with the application of robots. The axis of robots are different same but the application or the functions of robots varies with the design.

Emergent behavior is critical resultant behavior that comes from repeated operations of simple underlying behaviors of robots for particular and repetitive types of tasks. Humanoids are human-like robots that are designed with human-like nature using a set of programs. "Robo-ethics" is the set of programs that are designed for the robot, which says the ideal behavior of any robot or how the ideal robot should behave. "Three Laws of Robotics" by "Isaac Asimov" tell about the "ethics and robopsychological" aspects of robotics. The use of the "Tool Center Point" from the tool coordinate systems was considered while designing the robot. The "uncanny valley" is a hypothetical point where humanoid robot behavior and aspect are similar, to that of genuine humans, but not exactly plentiful to elicit repulsion.

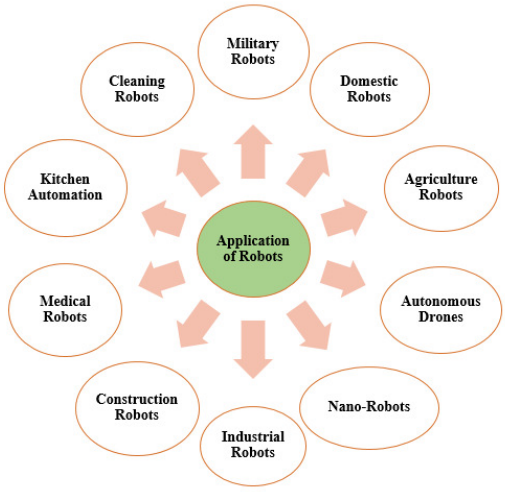


Figure 3: Illustrates the Application of Robots Developed Using the Application of Engineering Mechanics

The applications of robots are different and the robots are designed considering the same, as the research says for designing any robot different experts are required. Experts from different fields of computer, programming, electronics, mechanics, and kinematics work tighter to make one robot. The pattern or set of instructions is fed into the system of the robot which controls the action of the robot with the help of programs. The body of any humanoid robot is made by using compounds of elements that have different mechanical properties. The mechanics used in designing a robot plays an important role as the movement of the robot depends on its kinematics. The applications of robots are shown in Figure 3, which are military, domestic, cleaning and sanitation, kitchen mechanics, medical, drones, construction, industrial, and nano-robots. The traction system, working, and operations of robots are followed by the pattern set by the control system.

As shown in above Figure 3, various applications of robots reduce the work and labor costs. The industrial applications of robots are different and developed according to requirements. The use of robots changes the methods of manufacturing in the industry which brings the industrial revolutions to improving productivity and profits. The study of robots and robotics help in designing and developing new technologies which help in the betterment of society. Military robots are used very useful for patrolling and defense against invaders. The different self-operated and pre-programmed robots are used in the defense system of countries where the best technologies are utilized which are highly mechanized. Thus, using robots is changing lives and industries to a new era for the upcoming generations.

Thus, it can be said that the development of robotics is changing the vision of society toward Industry 4.0. The use of robots is now increasing and developing the mechanics for designing robots is very important which will help to analyze the outcome of developing the robots in the right tractions. The study of the mechanics of the robots is a little difficult and time-consuming as it is a very complicated task so finite work is necessary for designing the robots. The development of robots is the work done by a bunch of different experts in their field. There are many applications of robots now in the industry used for reducing labor costs and improving the efficiency of production. Thus, mechanics is an important part of designing robots having motion and mechanisms for different functions.

4. CONCLUSION

Robots are used in many applications so it is necessary to design multifunctional robots to increase productivity. Different experts studied and analyzed the application of robots in different fields where some studied the design and their development while some studied the social effects of using robots. Robots are automatic machines used for performing various activities which could be time-consuming for humans. Robots are known for their speed and quick response. Different components and technologies developed by many countries in the world using AI and IoT show the impact of Industries 4.0. Medications, production, domestics, and entertainment are the application of robots. Humanoid robots like identical twins are now developing to cut off the difference between humans and robots. The applications of robots are now increasing which helps humans to reduce work stress and help them to increase their profit in industries. The use of robots in agriculture helps the farmer to grow crops depending on the soil and climates as per the crop requirement. Thus, it can be said that while designing the robot

the programming and study of mechanics are also necessary. So mechanics is considered an important part when designing autonomous robots, which will develop with time in the next few years as the use of robots is increasing in the market.

REFERENCES

[1] L. E. Alvarez-Dionisi, M. Mittra, and R. Balza, "Teaching Artificial Intelligence and Robotics to Undergraduate Systems Engineering Students," *Int. J. Mod. Educ. Comput. Sci.*, 2019, doi: 10.5815/ijmecs.2019.07.06.

[2] C. Majidi, "Soft-Matter Engineering for Soft Robotics," *Adv. Mater. Technol.*, 2019, doi: 10.1002/admt.201800477.

[3] Syed Mutahir Mohiuddin, "Agricultural Robotics and Its Scope in India," *Int. J. Eng. Res.*, 2015, doi: 10.17577/ijertv4is070784.

[4] P. Tandon, S. Lam, B. Shih, T. Mehta, A. Mitev, and Z. Ong, "Quantum Robotics: A Primer on Current Science and Future Perspectives," *Synth. Lect. Quantum Comput.*, 2017, doi: 10.2200/s00746ed1v01y201612qmc010.

[5] wikipedia, "robotics."

[6] C. Gotti, A. Sensini, G. Fornaia, C. Gualandi, A. Zucchelli, and M. L. Focarete, "Biomimetic Hierarchically Arranged Nanofibrous Structures Resembling the Architecture and the Passive Mechanical Properties of Skeletal Muscles: A Step Forward Toward Artificial Muscle," *Front. Bioeng. Biotechnol.*, 2020, doi: 10.3389/fbioe.2020.00767.

[7] L. Tsai, "Robot analysis: the mechanics of serial and parallel manipulators," *The Mechanics of Serial and Parallel Manipulators*. 1999.

[8] M. V. Chugunov, I. N. Polunina, A. G. Divin, A. A. Generalova, A. A. Nikulin, and D. S. Bychkov, "Integrated Mobile Robotic Platform Model," *Eng. Technol. Syst.*, 2021, doi: 10.15507/2658-4123.031.202104.609-627.

[9] M. Indri and R. Oboe, *Mechatronics and Robotics*. 2020. doi: 10.1201/9780429347474.

[10] Z. Wan *et al.*, "A Survey of FPGA-Based Robotic Computing," *IEEE Circuits Syst. Mag.*, 2021, doi: 10.1109/MCAS.2021.3071609.

[11] S. Nummelin, B. Shen, P. Piskunen, Q. Liu, M. A. Kostiainen, and V. Linko, "Robotic DNA Nanostructures," *ACS Synth. Biol.*, 2020, doi: 10.1021/acssynbio.0c00235.

[12] D. Baby, A. Van Den Broucke, and S. Verhulst, "A convolutional neural-network model of human cochlear mechanics and filter tuning for real-time applications," *Nat. Mach. Intell.*, 2021, doi: 10.1038/s42256-020-00286-8.

[13] R. Feng, L. Chen, H. Zhang, and S. Du, "Practice of soft robotics and innovation education," *Mech. Eng.*, 2020, doi: 10.6052/1000-0879-19-351.

[14] R. E. Patiño-Escarcina, D. Barrios-Aranibar, L. S. Bernedo-Flores, P. J. Alsina, and L. M. G. Gonçalves, "A Methodological Approach to the Learning of Robotics with EDUROSC-Kids," *J. Intell. Robot. Syst. Theory Appl.*, 2021, doi: 10.1007/s10846-021-01400-7.

[15] B. M. Moghaddam and R. Chhabra, "On the guidance, navigation and control of in-orbit space robotic missions: A survey and prospective vision," *Acta Astronautica*. 2021. doi: 10.1016/j.actaastro.2021.03.029.

CHAPTER 7

APPLICATION OF THE SOLAR GRASS-CUTTING ROBOT WITH COMPLETE AUTOMATION USING IOT

Mr. Ashok Singh Gour, Assistant Professor,
Department of Mechanical Engineering, Jaipur National University, Jaipur, India,
Email Id-asgour@jnujaipur.ac.in

ABSTRACT:

Grass cutting is one of the time-consuming and critical tasks which is followed a minimum of once a week. The grass lawns, gardens, and weeds can be removed using such machines. These machines are electric or have a battery for power storage, but in some cases, for big areas, it becomes difficult to maintain the battery level till the complete activity finishes. So the focus of the study is to develop a device that is automatic and works on solar energy which helps to reduce the use of electricity. The device is designed using solar panels with power storage and control using (Internet of Things) IoT, Arduino, (Artificial Intelligence) AI, and Wi-Fi. The fully automatic devices are time-saving as time is important for every human being. The machine designed is good at working with lawns with good efficiency, so using such a machine is useful for gardening as well as grass-cutting operations. The study further helps in making highly advanced grass-cutting.

KEYWORDS:

Battery, Fuel, Grass, Lawn, Robot, Solar.

1. INTRODUCTION

At different times during a person's life, automation is helpful. Any hotel, home, park, meeting hall, etc. is made to look even more gorgeous by the lovely grass that has been cut beautifully. Therefore, regular lawn trimming is necessary to preserve the reputation of any home or hotel. Humans are capable of manually mowing the grass, but it often takes a lot of their time and time. Additionally, manual grass-cutting is ineffective and habitually causes irregular grass growth. Therefore, it is preferable to utilize a grass-cutting robot machine as shown in Figure 1 that can be controlled by an Android phone to eliminate all of these problems [1], [2].

Figure 1: Represents the Solar Grass Cutting Robot Model Used For Lawn Mowing.

An autonomous robot that is used to cut grass on lawns is a robotic lawn mower. The operator of a standard robotic lawn mower must install border wires around the grass to specify the areas that need to be mowed and wire is used by the robots to identify the perimeter of the area that has to be trimmed and, in certain situations, to identify a dock for charging as shown in Figure 2. Up to 30,000 m^2 of grass can be maintained using the robotic mower. Robotic lawn mowers are becoming more advanced, some have self-docking capabilities, and some, if required, have rain sensors, all of which almost eliminate human contact. By the end of the 20^{th} century, robotic lawn mowers were one of the most popular categories of household robots [3], [4].

Figure 2: Represents the Grass Cutting Machine Model Used For Lawn Mowing.

Sales of robotic lawn mowers increased 15 times faster in 2012 than those of traditional models. Since smartphones have become more common, several robotic lawn mowers have integrated functions into a unique application that allows user to change the setting, plan mowing time and frequency, and manually operates the mower through digital joysticks. Specialized sensors may be found in contemporary robotic lawn mowers, enabling them to autonomously mow around obstructions or even turn off when it starts to rain. Most robotic lawn mowers approach the job by using a "random" mowing mechanism. The machine essentially bounces about on the grass until it runs into the wire defining the operating area, at which point it switches direction and swings around some more. This might be a lengthy process depending on the size of the grass, thus the machine must essentially run continuously. One exception is the Bosch "Indego" robotic lawn mowers, which maps the users' landscape before proceeding methodically, much like the more advanced robotic vacuum cleaners [5].

As seen in Figure 3, a lawn mower is a piece of machinery that rotates one or more blades to cut grass at a uniform height. The mower's design may accurately predict the height of the cut grass, but the operator may frequently alter it by using a central server lever or a lever, nut, or bolt on each of the vehicle's wheels. The machinery may be powered by plug-in or battery-operated electric motors, or the blades may be turned by hand and physically fastened to the wheels so that they spin when the mower is propelled ahead. The most common conscience power supply used by lawnmowers is a small internal-combustion engine.

Figure 3: Represents the Highly Advanced Solar Grass Cutting Robot Model Used For Lawn Mowing.

Larger lawn mowers are often either "walk-behind" models that are self-propelled or, more frequently, "ride-on" models that allow the user to sit atop the mower and operate it. Robotic lawn mowers can be programmed to run totally on their own or, less frequently, with the assistance of remote control. In lawn mowers, there are two primary blade types. Rotary lawn mowers have a single blade which has spins around a single vertical axis, whereas cylinder mowers have an assembly of numerous blades plus cutting bars that rotate around a single horizontal axis. Trimming grass to a specified height is the process of mowing lawns, which is often done for hygienic, aesthetic, or sporting reasons. Reel-blade grass cutters, gas-powered mowers, spiral-rope cutters, Cutlasses, and other tools for cutting different types of grass have been created throughout the years, but they present certain difficulties in terms of drudgery and operational effectiveness the advantages and disadvantages of solar energy utilization in the system as shown in Figure 4.

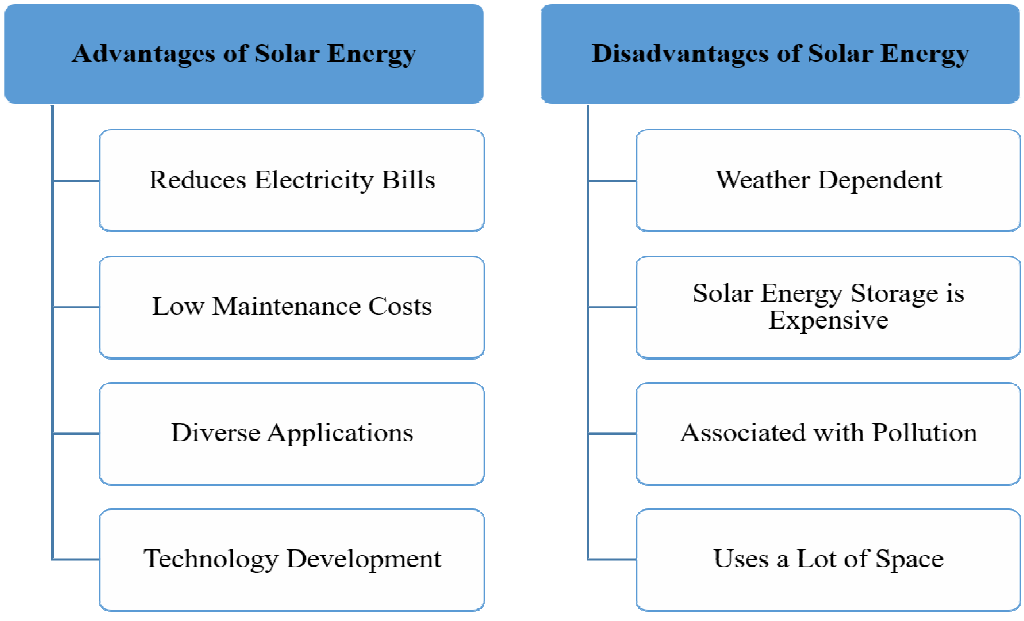


Figure 4: Represents the Advantages and Disadvantages of Solar Energy for Various Applications.

A lawn mower is a machine made up of integrated mechanical and electrical systems with a reliable control system, not simply a simple instrument like a cutlass or scissors. Lawn mowing equipment can be driven by electricity, gas, or solar energy at various levels of automation, from manual to partially autonomous to completely autonomous systems. High-cutting performance is a characteristic of those driven by gasoline or diesel in a combustion engine, but they are also very loud and emit pollutants that contribute to global warming. An extra control system is frequently added to solar-powered autonomous lawn mowers to automate them and turn them into fully functional mechatronics units. Solar-powered grass cutters are tools that use the sun's energy to turn electric motors, which in turn rotate a blade to trim the grass. Thus, the study of such grass-cutting devices is necessary to know the different development and applications of fully automatic grass-cutting robots.

2. LITERATURE REVIEW

Ilesanmi Daniyan et al. used computer-aided design and simulation of the automated lawn mower performed using Inventor 2018. To create a system that can efficiently cut grass with little to no human involvement, the electrical circuit connections between the microcontroller and the other electrical components were also developed with that goal in mind. This is carried out under the sensor readings controlled by C-programmed instructions provided to the microcontrollers. The robot was built in a machine shop using a mix of machining and assembly procedures, and performance test findings showed that the created robot can automatically avoid obstacles. As a result, our study offers a self-governing lawn mower that can cut grass well while dodging obstacles, therefore reducing human labor [6].

M/s. Snehal Popat Jagdale and Prof. Priti Rajput designed a robot over manually mows the grass costs labor, takes time, and may result in an uneven structure of grass height. Therefore, it is imperative to develop a system that can cut grass without the need for human intervention to prevent all of these problems. The robot used in this study to mow the grass includes a battery that can be recharged by solar power. Android phones may be used to control this robot. When compared to other current systems, this system may be built at the lowest possible cost. This is hardy, long-lasting, and requires little care. Due to the utilization of solar energy to charge the battery, this system is pollution-free [7].

Ms. A.P. Nithya Priya et al. discussed the role of automation as automation is prospering quickly and therefore, had a significant role in many industries, particularly in the agricultural sector, which benefits farmers in their day-to-day activities. In the past, people used lawn cutters to physically cut the grass. The use of gasoline and diesel engines causes pollution and energy waste. As a result, automated cutters should take the place of conventional cutters. These cutters use batteries as their power source and operate following instructions. The Node MCU, a motor driver for the robot's wheels, and a linear blade for cutting the grass into different designs based on the user's instructions are the brains of the system [8].

Ibrahim A. et al. researched the use of field robots on football fields. On the other hand, GPS-based guided vehicles or robots with three tools lawn mowers, lawn stripping rollers, and track marking illustrators can operate continuously, in a variety of weather situations, and on unforgiving soil types without sacrificing quality. The suggested method for the automatic operations of the football field provides no or very little human interaction, saving a great deal of time and allowing a worker to concentrate on other activities. An examination of the suggested

method's economic viability revealed that it is more cost-effective than the manual techniques currently in use [9].

R.V. Subrahmanyam et al. developed autonomous trimming and water-spraying rovers and cutting the grass and spraying water together making the project more engaging, and depending on the operators, both jobs may be completed at the same time or in distinct contexts. Arduino will receive input, and the rover will move appropriately. Among the most uninteresting and boring jobs, a person may perform are trimming and watering fields and gardens. These independently carried out jobs raise the overall execution time and associated expenses in addition to being monotonous and uninteresting to the doers [10].

Ms. Shweta U. Ghorpade et al. developed and studied an intelligent grass-cutting robot. Both of the available traditional methods of physically operating lawnmowers and manually cutting grass require specialized labor. When the region to be covered is exceedingly big, the issue becomes quite difficult. The automated lawn mower has been proposed as a solution by several researchers. The length of the perimeter guide wire, the expensive price, and the high maintenance costs are these machines' principal drawbacks. The battery's lifespan is powered by batteries. In this study, intelligent solar-powered lawn-cutting robots with obstacle avoidance are shown. The system consists of an ARM 7 controller with interfaces for color and an ultrasonic sensor. The system was tested under various circumstances, and it was shown to work effectively on a level lawn surface [11].

Punam K. Jadhav et al. designed a robot using a specific methodology and taking into account specific aspects of the agricultural area in which they will operate. This system, which includes an autonomous prototype, discusses these factors and several methodologies. Agriculture Grass cutting robots with storage, whether detecting, crop forecast and 360-degree spraying capabilities are shown. Agricultural mobile robots suffer considerably from poor design and inadequate traffic ability, sharing the majority of their platform with industry mobile robots or commercial research robots [12].

S. Shri Dhurrga et al. designed a lawn mower that can be controlled via WiFi making it easier for people to cut grass comfortably. Their study was completed in a sophisticated manner thanks to the quick development of numerous high-technology tools and equipment. In this project, a robot that can be controlled wirelessly via Wi-Fi technology is being considered. The microcontroller directs every movement of the lawnmower. The world's need for power is rising alarmingly due to the widespread and expanded usage of electrical appliances. People conclude that solar energy is the best option as a result. But there are drawbacks. Rechargeable batteries are a different choice. Environmental and noise pollution are both reduced as a result of this effort. This prototype is a user-friendly, cost-effective, and ecologically responsible product [13].

Argade Pratik Pralhad et al. developed a device called the Solar-Powered Automatic Grass Cutting and Pesticides Spraying Robot to use less manpower and electricity. To offer a source for charging batteries, solar panels are employed. This automated machine is used to trim the grass. Using solar plates, the source is powered by solar energy. Automation is performed by employing a sensor and Arduino UNO R3. Direct Current (DC) motors are used to drive wheels and perform cutting operations. The system is powered by a DC battery and operated in standby mode. The battery powers the whole system, and a battery charger circuit is employed to facilitate battery charging. A second application of the herbicide here involved using a water pump with spreading nozzles [14].

Babangida Ibrahim et al. introduced a novel design of a solar-powered automatic machine is given. This machine can be controlled by Bluetooth from a mobile phone, and it combines several tasks into a single lawnmower, including path finding, obstacle avoidance, and infrared body motion recognition. The system uses 12 Volt batteries to power the motor for grass cutting as well as locomotion, ultrasonic sensors for obstacle and path finding, PIR sensors for Bluetooth modules, motion detection, Arduino Pro mini, and a motor driver that utilizes Pulse Width Modulations (PWM) for speed as well as direct control of motors. Additionally, the simulations of the designs are carried out using proteus software [15].

Ranjitha B et al. studied grass mowing, pesticide application, and seeding are now complex processes. The equipment required for the aforementioned operations is costly and cumbersome to operate. Therefore, by creating a system that would save time and labor, the agricultural system in India should be supported. In this project, a robot that can plant seeds, cut grass, and apply pesticides will be designed, developed, and built. Solar power powers the robots and their complete system. A Bluetooth or Android app sends a signal to the built robot to activate the required components and move it. The robot is fuelled by a solar module and is operated by the signals. This improves the effectiveness of seeding, pesticide application, and grass-cutting while also lowering the difficulties associated with hand planting [16].

There are different studies on the grass cutting devices which include solar energy, electricity, and various fuels. Grass cutting is the main operation in lawns to maintain the beauty and size of grass. Different modes of controlling the device make it easier to use such devices. Different modes of operation and controlling the solar grass-cutting robot are developed by many experts using different modules. So it is necessary to know the different development in the designs of grass-cutting devices using solar energy.

3. DISCUSSION

The solar grass cutter is mainly developed for campus cleaning in a sustainable and effective method. Figure 5 illustrates how one of the key operations used to maintain the cleanliness of the campus is grass mowing. It is a labor-intensive technique that takes a lot of time. Furthermore, it uses a lot of gasoline. The traditional lawn trimmers used on campus are expensive. As a result, both the operational cost and the capital expenditure are quite expensive. Additionally, a campus with big areas like a school, playgrounds, gardens, parks, etc. needs more than one lawn cutter. The diesel-burning cutter pollutes the campus' air while it operates as shown in Figure 6 and its advantages are as shown in Figure 7. All locals find the noise pollution to be quite upsetting.

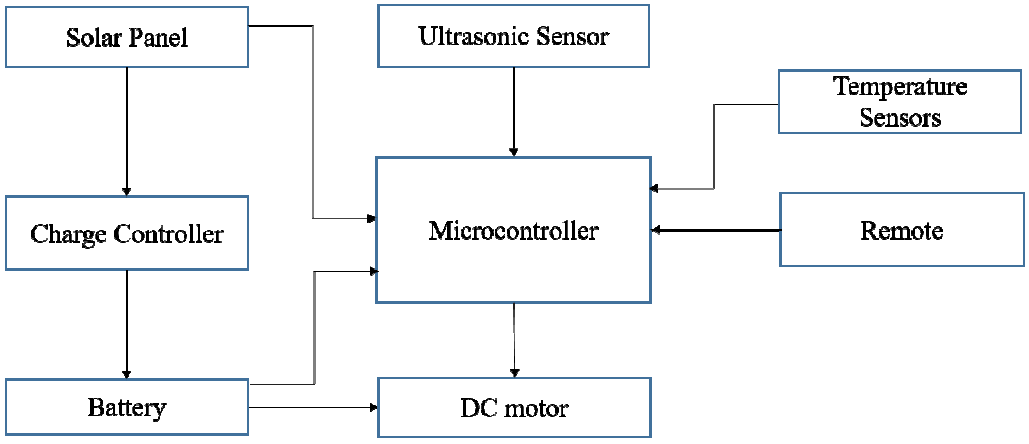


Figure 5: Represents the Working of Components in the System of Solar Grass Cutting Robots.

Figure 6: Illustrates the Working Steps for Using Grass Cutting Machines.

3.1.Trim first:

Use a string trimmer if you have one before cutting the grass. The clippings will be chopped by the mower, eliminating the need for raking. When cutting the grass next to tree bark, avoid using line trimmers that harm the bark, often severely enough to destroy the plants. Instead, create a mulched space free of grass around the trees to close trimming is not required.

3.2.Trim at the right height:

Every variety of grass has a preferred height range. Blue gramma, Bahia, and Mow buffalo grasses when they are 2-3 inches tall. Kentucky bluegrass, Fescue, St. Augustine grasses, and ryegrass, should be mowed at a height of between 1.5 and 2.5 inches. Cut common zoysia, centipede, and Bermuda grasses when they are between 1 and 2 inches high. Hybrid-Bermuda cuts lowest, almost an inch higher.

3.3.Adjusts the blades-height:

Place the lawnmower on a solid surface, remove the spark plugs, and use a tape measure to gauge the blade height. Adjust the deck's elevation to the required levels. By mowing a small area of grass and then measuring the grass height, you may test the setting. Mower adjustments may be required. Drought resilience and root health are improved by mowing on the upper side of the range.

3.4.Keep the blade sharps:

Rotary mower blades should be sharpened at least once every season. Disconnect the spark plugs and with the mowers upended, remove the blades. Check the balance of the blade after

sharpening it on a bench grinder as well as with heavy-duty mill files. Alternately, have a mower repair facility sharpen blades.

3.5.Follow one-third rules for cut:

The ideal time to mow grass is when the blade is about 1/3 higher than the suggested height. For instance, to keep the grass at 2 inches in height, mow it when it is no higher than 3 inches. When mowing, only cut one-third of the grass's height to protect the lawn and reduce stress. A large amount of removal done all at once starves the root systems and exposes new lower leaves to the sun.

3.6.Trim the grass when dried:

Wet grass requires raking to remove the matted clipping that smothers the grass and causes it to cut unevenly. Additionally, mowing wet grass encourages the growth and spread of the pathogenic organism.

3.7.Rake up clumps.

Remove any clumps that might choke the grass but leave little, finely cut clipping on the lawn that decomposes and promote soil health. For a tidy look, sweep debris from roads and sidewalks. The device's disadvantages include difficulty operating during wet seasons, the possibility of blade failure, and a longer time commitment than a regular mower to remove the grass. Due to fewer sunshine hours during the rainy season, it will take a long time for a device to fully charge, which is undesirable for consumers. In comparison to the cutters that are already in use, the cost of the machine is likewise relatively low. Solar energy serves as the fuel and is entirely free. As a result, in this instance, the operation cost is essentially non-existent. The solar panel has a shelf-life of over 20 years. The machine will last for many years as a result. Thus the suing of solar grass-cutting devices is beneficial for reducing the cost and stress for big lawns as well as grasslands.

Figure 7: Represents the Different Advantages of Solar Grass Cutting Robots.

People that take up the project for additional adjustments will find it simpler. The ideas are more suited for the average person since it has additional benefit, such as zero fuel cost, zero emissions, and zero fuel residue. Because there are fewer moving parts, there are low chances of wear and tear, and solar energy may be used to power this. The folks will get considerably more physical activity from this, and it is manageable as shown in Figure 7. This system has the facility of charging the batteries when solar powered lawn cutter is in action. Therefore, it is also much more appropriate for cutting grass. The same things may be used at night as well because it is possible to charge such batteries throughout the day. Thus different devices are used for different grass-cutting operations. The use of solar energy reduces the cost of fuel required for running the device. The study further helps in developing new machines and devices which are working on solar energy to reduce the overuse of fuels to maintain the balance in the environment.

4. CONCLUSION

One of the time-consuming and important jobs that are performed at least once every week is mowing the grass. These tools may be used to get rid of weeds, gardens, and grass lawns. These devices either run on electricity or use batteries to store power, but in some circumstances, particularly in large regions, it might be challenging to keep the battery charged until the activity is finished. Therefore, the goal of the research is to create an autonomous solar-powered gadget that helps cut down on the consumption of electricity. The gadget is built with solar panels and uses IoT, Arduino, AI, and Wi-Fi for power storage and control. The grass cutting for lawns and gardens is now becoming effortless because of machines and by using solar energy the devices become fuel efficient. The completely automated gadgets save time since everyone values their free time. Such a machine is beneficial for both gardening and grass-cutting tasks since it is well-suited to working on lawns with good efficiency. The research also aids in developing cutting-edge grass.

REFERENCES

[1] E. Naresh, B. Babu, and G. Rahul, "Grass Cutting Machine by Solar Energy Power," *Int. J. Mag. Eng. Technol. Manag. Res.*, vol. 3, no. 5, pp. 302–307, 2016.

[2] V. Kubendran, S. George Fernandez, K. Vijayakumar, and K. Selvakumar, "A fully automated lawn mower using solar panel," *J. Adv. Res. Dyn. Control Syst.*, vol. 10, no. 7 Special Issue, pp. 977–983, 2018.

[3] S. D. Shinde, "Solar Operated Automatic Grass Cutting Machine," *Int. J. Res. Appl. Sci. Eng. Technol.*, vol. 9, no. VI, pp. 2956–2960, 2021, doi: 10.22214/ijraset.2021.35659.

[4] K. H. M. Babu and J. Suresh, "Design and Fabrication of Solar Grass Cutter to Increase Cutting Space Using Scotch Yoke Mechanism," *Int. J. Trend Sci. Res. Dev.*, vol. Volume-2, no. Issue-4, pp. 2071–2074, 2018, doi: 10.31142/ijtsrd14206.

[5] Xidian University, "Design and Modeling of Solar Operated Grass Cutting Machine," *J. Xidian Univ.*, vol. 14, no. 5, 2020, doi: 10.37896/jxu14.5/336.

[6] I. Daniyan, V. Balogun, A. Adeodu, B. Oladapo, J. K. Peter, and K. Mpofu, "Development and performance evaluation of a robot for lawn mowing," *Procedia Manuf.*, vol. 49, no. 2019, pp. 42–48, 2020, doi: 10.1016/j.promfg.2020.06.009.

[7] Snehal Popat Jagdale, "Android Controlled Solar based Grass Cutter Robot," *Int. J. Eng. Res.*, vol. V9, no. 07, 2020, doi: 10.17577/ijertv9is070276.

[8] S. Ohviya, S. Priya, and R. Nivetha, "Smart Solar Powered Grass Cutter Robot," *Int. Res. J. Eng. Technol.*, vol. 08, no. May, pp. 76–78, 2021.

[9] I. A. Hameed, C. G. Sorrenson, D. Bochtis, and O. Green, "Field robotics in sports: Automatic generation of guidance lines for automatic grass cutting, striping and pitch marking of football playing fields," *Int. J. Adv. Robot. Syst.*, vol. 8, no. 1, pp. 113–121, 2011, doi: 10.5772/10534.

[10] R. V. Subrahmanyam, N. Vikas, and B. N. Prashanth, "Design and Fabrication of Grass Cutting and Water Spraying Rover," *IOP Conf. Ser. Mater. Sci. Eng.*, vol. 577, no. 1, 2019, doi: 10.1088/1757-899X/577/1/012170.

[11] U. S. Ghorpade, P. S. Jadhav, F. S. Mulla, and P. D. Patil, "Intelligent Solar Powered Grass Cutting Robot with Obstacle Avoidance Intelligent Solar Powered Grass Cutting Robot with Obstacle Avoidance," no. September, pp. 1–4, 2018.

[12] P. K. Jadhav, S. S. Deshmukh, and P. N. Khairnar, "Survey Paper on AgRo-Bot Autonomous Robot," *Int. Res. J. Eng. Technol.*, vol. 06, no. 12, pp. 434–441, 2019.

[13] S. S. Dhurrga, G. Radhika, and J. S. S. Mohan, "Wi-Fi Controlled Grass Cutting Robot," *IJRESM*, vol. 3, no. 5, pp. 3–5, 2020.

[14] A. P. Pralhad, B. S. Bhagwan, K. S. Subhash, P. Nikhil, P. K. R. U, and S. B, "Solar Powered Automatic Grass Cutter and Pesticide Spreading Robot," *Int. Res. J. Eng. Technol.*, vol. 4, no. 5, pp. 3372–3375, 2017.

[15] B. Ibrahim, V. Siva Brahmaiah, and P. Sharma, "Design of smart autonomous remote monitored solar powered lawnmower robot," in *Materials Today: Proceedings*, Elsevier Ltd, 2020, pp. 2338–2344. doi: 10.1016/j.matpr.2020.04.633.

[16] B. Ranjitha, M. N. Nikhitha, K. Aruna, Afreen, and B. T. V. Murthy, "Solar Powered Autonomous Multipurpose Agricultural Robot Using Bluetooth/Android App," in *Proceedings of the 3rd International Conference on Electronics and Communication and Aerospace Technology, ICECA 2019*, IEEE, 2019, pp. 872–877. doi: 10.1109/ICECA.2019.8821919.

CHAPTER 8

INVESTIGATION INTO THE ENVIRONMENTAL AND SOCIAL IMPACT OF AIR TRANSPORTATION

Mr. Robin Khandelwal, Assistant Professor,
Department of Mechanical Engineering, Jaipur National University, Jaipur, India,
Email Id-robinkh16@jnujaipur.ac.in

ABSTRACT:

Air transport is the fastest and most convenient mode of transport, which is done through aviation routes. Fairways are faster than roadway transfers, as not everyone can afford airway transport. The cost of air transport is so limited that the people of the society take the risk of using it which creates a gap between the poor and the rich people in the society. The aviation system uses more fuel which eliminates more gases in the sky, hence pollution is also seen in the sky. The focus of the study is to analyze the environmental and social impact of air transport. Various research has been done in the field of air transport by various experts from different countries highlighting various facts about air transport. Thus, there are many amendments to be made in the field of air transport to make it affordable for all individuals in society, and air traffic control and air pollution are also points that are points of concern in air transport. The development of air transport would be useful to a society that would over the next few decades reduce the rate of exhaust gases and the initial cost of travel for ordinary people in the society.

KEYWORDS:

Aircraft, Aviation, Environment, Pollution, Society, Transportation.

1. INTRODUCTION

Sky and space are the only places where objects can escape Earth's gravity for aerial flight. Along with mechanical aircraft, activities related to the aircraft industry are called aviation. The term aircraft refers to a variety of lighter-than-air vehicles, including hot-air balloons and airships, as well as fixed-wing as well as wing-less lifting bodies, morphable wings, rotary-wing types, and many are included. The hot air balloon, a device capable of displacing the atmosphere by buoyancy, gave rise to aviation in the 18th century. Otto Lilienthal's controlled glider flight in 1896 marked some of the most important developments in aviation technology. The production of the first powered airplanes by the Wright brothers in the early 1900s marked another major advance. Since then, the development of the jet has led to a technological revolution in aviation as shown in Figure 1, which has made it possible to become an important means of transportation around the world [1], [2].

Figure 1: Represents the Emission Observed during Flight Take-Off At the California Airport [3]**.**

The study and use of risk management in aviation constitute aviation safety. This covers things like research, teaching those involved with air travel, passengers, and the broader population, as well as improving aircraft as well as aviation infrastructure. There is a lot of regulation and supervision in the aviation sector. Aviation security is more concerned with preventing deliberate injury or disruption than it is with safeguarding passengers, planes, and infrastructure. Next to heart attack and stroke, Deep Vein Thrombosis (DVT) seems to be the third most frequent vascular illness. DVT is thought to afflict one in every 5,000 passengers on lengthy flights.

Increased flight duration and exposure to multiple flights in a short period both increase risk. Normal flight cabin pressure is kept between 6,000 and 8,000 feet above sea level. The majority of healthy tourists won't experience any consequences. However, the circumstances on board an airplane might aggravate underlying medical issues for travelers who have cardiac disorders, cerebrovascular diseases, anemia, or sickle cell disease. The mucosal tissue of an eye and airways might get dry in an airplane cabin because the air within is normally dry, with a humidity level of between 10 and 20 percent (Figure 2) [4].

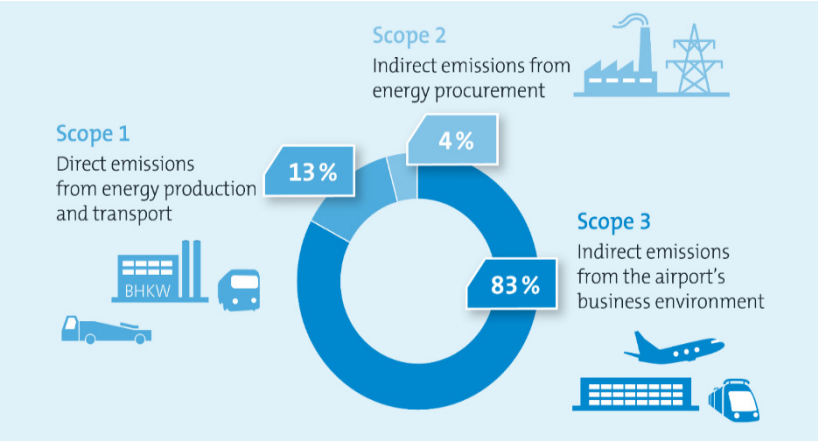


Figure 2: Represents the Different Approaches to Achieve the Zero Emission.

When completely occupied, modern airplanes use less fuel per passenger and mile than vehicles. Two realities go against this argument in favor of air travel: the distances covered are frequently

far greater and do not cancel out vehicle travel, but rather add to it; and not all flights are filled. Instead, the majority of flights are planned, which has a terrible impact on fuel economy. The use of carbon offsets is frequently suggested as a way to reduce aviation's carbon footprint. Numerous Non-Governmental Organizations propose to offset carbon dioxide (CO_2) emissions through the promotion of clean, renewable energy sources, reductions in energy use, and sequestration based on previously released carbon into trees and other plants.

Furthermore, carbon offsetting is a particularly contentious issue because it only seeks to reduce emissions that have already occurred. The use of air transport is now increasing as it is the fastest mode of transportation using the sky route. Flights are now becoming an important part of air transport as there are many airlines in the world. There are various gases exhausted by the plane during travel. Thus, it can be said that there is a need to know the different approaches to control emissions from flights to save the earth from global warming and heat stroke. So it is needed to achieve zero flight emissions over the different parts of the world.

2. LITERATURE REVIEW

Walid Chatti's research on environmental sustainability development. The relationship between information and communication technology (ICT), transportation, and CO_2 emissions is examined in their study. Despite the negative effects that transportation activity has on the environment, this important problem receives little scholarly attention. First, when employed in the railway and inland transportation sectors, the cellphone and smartphones are the most environmentally sustainable technology, but the internet is most effectively used in the aviation sector. Second, the phone acts as an accelerator when engaging with other modes of transportation to enhance the atmosphere. In the study, social policies and their effects are taken into account [5].

John R. Bartle et al. studied the global pandemic and sustainability in air freight transportation. In light of recent, significant human and financial consequences on a global scale, this study explores sustainability while focusing on associated possibilities and problems in air transport management. The effect of the present climate on air cargo operations is also discussed in this paper, including how drastically condensed airline schedules affect total air freight capacity. After that, it looks at pressing but longer-term environmental problems associated with air travel, such as air pollution, global climate change, and the exhaustible nature of energy sources. Carefully crafted solutions may offer sustainability advantages across businesses given the significant influence of air travel on a variety of other commodities and services [6]. Andreas Papatheodorou surveyed studies on tourism and air travel. The Curated Collections of Annals of Tourism Studies on air travel and tourism are introduced in this paper. The study begins with a systematic and chronological assessment of the literature before discussing an analytic framework that is based on techniques from microeconomics and economical geography to emphasize the consequences of accessibility to air travel for the growth of tourism. The research also looks at the systemic link between tourism destination authorities, airports, and airlines. In the post-COVID-19 economic climate, detailed knowledge of these linkages may prove beneficial for resolving disputes, maximizing synergies, and revitalizing air travel and tourism for the advantage of all concerned stakeholders [7].

Xiaoqian Sun et al. compared High-Speed Rail (HSR) and Air Transportation. The notion of rivalry and collaboration with air transportation has increasingly become hazier as HSR services have developed over the past few decades. Numerous research has been done on this issue, with

an emphasis on individual lines or smaller areas in particular. The goal of this paper, which covers services across Europe, North America, and Asia is to find commonalities and variances across various areas throughout the world. It does this by synthesizing and discussing recently published studies in this field. They offer a list of five issues as a key contribution to the future studies agenda on rivalry and collaboration between HSR and air transport. a requirement for the creation of open-source datasets for massive multimodal transportation systems, a thorough evaluation of recently developed transport modalities, and consideration of the resilience of such systems to interruption [8].

Mingli Song et al. studied the assessment of China's operational efficiency in the air transport sector. To assess the operational effectiveness of the regional ATS, this study builds an index system and uses a three-stage data envelopment analysis (DEA) technique that takes into account a variety of regional environmental conditions and statistical noise. Results of the third stage of the operational performance evaluation, which removes these environmental impacts, differ significantly from those of stage one in many ways. Additionally, following the evaluation results, related approaches to development implications in various provinces and areas are presented [9]. Alexandra Köves and Zoltán Bajmócy developed the evaluation of the 2050 climate strategy for the aviation sector from a degrowth viewpoint. In this study, their sustainability policies heavily rely on bio-economic alternatives like renewable energy and sustainable air fuels, yet their need to expand is unassailable. But attaining sustainability is a nasty challenge with awkward answers. To show why economists and politicians must change their ideas from chasing unrestricted growth toward Degrowth viewpoints, this paper will present a critical evaluation. Our analysis of the airline industry is not intended to be a critique, but rather to serve as an illustration of why business-as-usual situations need to be re-examined. The language portrayed in this study would also be valid whenever extended to certain other top carbon-generating businesses.

Ender Çetin et al. implemented Countermeasures to Enhance Urban Air Mobility's Acceptance in Society. This essay outlines the key societal worries about drone use that have already been identified by certain public polls and suggests several mitigating actions. By using a response from the CORUS-XUAM project, the proposed list is then examined, and its application to individual, urban, and extremely big demonstration flights is described. With the assistance of the U-space, CORUS-XUAM will coordinate a series of extremely large drone flight demos across seven European nations to look into how to properly incorporate drone operations within airspace.

Yaghoub Abdi et al. examined how company value and financial performance (FP) in the airline sector are impacted by sustainability disclosure, taking into account the moderating effects of size and age. This study intends to investigate the effects of ESG ratings on the worth and FP of businesses in the aviation sector. To clarify their interactions in this setting, the possible moderating effects of firm age and size have also been investigated. Specifically, influencing factors for two types of businesses full-service and low-cost carriers are considered in the research. According to statistics gathered from 38 airlines throughout the globe from 2009 to 2019, donations to governance efforts increase the firm's market-to-book ratio. As a result, it is suggested that the managerial approach for taking part in these projects be modified based on the firm's overall assets. Meiling Chen examined food waste in airline catering. The airline catering sector urgently needs to investigate the underlying reasons for food waste created in their kitchen and develop effective strategies to handle it better moving ahead because air passenger volume is

expected to rise dramatically over the ensuing decades. In this research, we offered creative approaches to reducing wasted food in catering kitchens while taking into account potential economic and environmental effects. The proposed system analyzed eight distinct waste treatment options for cost and environmental effect with a 91.12 percent accuracy. Through our research, we offered the sponsoring firm data-driven, practical suggestions to support the creation of their initial worldwide organic waste management plan.

Jing Shi et al. discussed the factors influencing university students' decision between high-speed rail and air transportation for tourism evidence from China. This study looks into the students' preferred modes of travel HSR or air travel for vacationing and the variables that affect their choices. According to the findings, there are several important considerations while choosing HSR, including gender, cost, time, and the company of the passenger. It has been discovered that men are more drawn to HSR than women. Additionally, selecting HSR as a method of transportation is inversely connected to the price of transit. According to the study's findings, university students' choice of travel method is greatly influenced by their travel companion and their financial resources. Y.Y. Lai et al. examined the possibilities and difficulties of reducing the influence of aviation on the climate. To lessen the influence of aviation on the climate in Sweden, this paper examines the prospects and difficulties of mitigation strategies that restrict trip volume, energy use, and emission intensity. Regulations and technological replacements for fossil-based aviation fuels are only a few of the steps taken to lessen the aviation sector's impact on the environment. Existing policy initiatives are ineffectual at encouraging change. It is necessary to comprehend the organization as a socio-technical system. This review's importance comes from its comprehensive analysis of the methods for reducing aviation's climate effect, which provides fresh viewpoints and identifies topics for additional study while taking into account all factors, their interconnections, and their interdependence.

Air transportation is a developed industry and various aviation machines are there with the latest technologies. Different experts focus on the different studies on the effect of air transportation on the life of people and the environment while some experts suggested approaches to overcome the effects without disturbing the balance in society and the environment. The technologies used for designing aircraft are advanced with high costs. Mostly the air transport system is used for long-distance transporting while the land transport is used for near-by transport as both method's costs are different. Thus, the emissions in aircraft are more and directly distributed in the sky and the use of this transportation is limited as everyone not afford this with high cost in society.

3. DISCUSSION

Aircraft communicate with air traffic control (ATC) to assist maintain separation or to make sure that aircraft are spaced apart enough horizontally or vertically to minimize the chance of an accident. In regions with heavy traffic, controllers may utilize radar to track aircraft movements or coordinate pilot position reports. ATC can be divided into four categories: center controllers, who direct aircraft between airports; control towers, who direct aircraft near airports; oceanic controllers, who direct aircraft over open water between continents, typically without radar service; and terminal controllers, who direct aircraft in a larger area near busy airports. When airplanes are using instrument flight rules and may be in weather that prevents the pilots from seeing other aircraft, air traffic control is extremely crucial.

ATC orders must also be followed by planes flying within visual flight rules in highly busy locations, particularly those close to busy airports. Depending on their workload, ATC may give

weather warnings, terrain separation, navigation help, and other services for pilots in addition to separating from other aircraft as shown in Figure 3. Operating motorized aircraft discharges soot and other contaminants into the environment, much like any activity involving combustion. Additionally, greenhouse gases like carbon dioxide (CO_2) were created. Additionally, there are environmental effects associated specifically with aviation, such as water vapor contrails emitted by high-altitude jet aircraft. These might aid in the development of cirrus clouds.

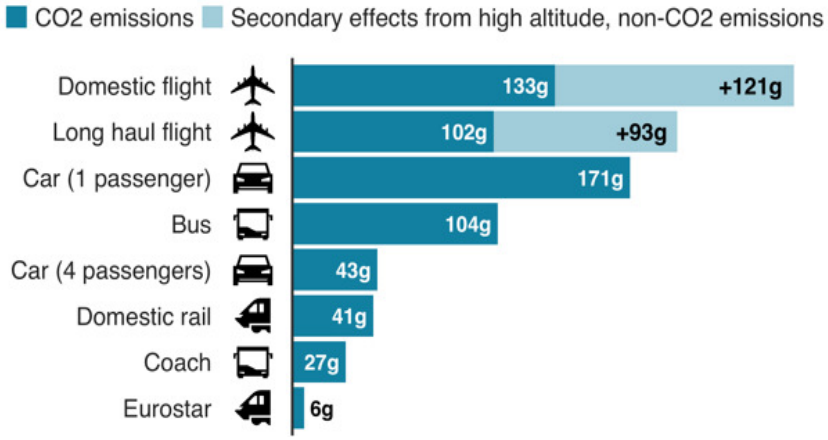


Figure 3: Represents the Different Modes of Emission through different modes of Transportation [10]**.**

High-altitude aircraft operating close to the tropopause release aerosols as well as leave contrails, which also can promote the production of cirrus clouds. Since the invention of aircraft, the number of clouds may have risen by as much as 0.2 percent. Both a freezing and a warming effect may be produced by clouds. They both block part of the heat emitted by the surface of the Earth and refract some of the sun's rays back out to space. Both naturally wispy clouds and contrails contribute to global warming on average. Additionally, chemicals that interact with greenhouse gas emissions can be released by aircraft flying close to the tropopause at high altitudes. In particular, nitrogen compounds can interact with ozone to increase ozone concentrations. Avgas, which includes tetraethyl lead, is burned by the majority of light piston aircraft (TEL). Certain recent light aircraft are using turbojet engines and diesel engines, none of which require lead, even if some lower compression pistons may run on unleaded mogas. Noise pollution, primarily brought on by airplanes taking off or landing, is another negative effect of aviation on the environment. Supersonic planes like the Concorde had issues with sonic booms. Thus, aircraft or aviation should now control pollution and its impact on the environment.

3.1.Various Ways to Achieve Zero Emission:

Environmental monitoring refers to the procedures and actions required to characterize and monitor the environment's overall quality. A monitoring system is employed in the preparatory work of environmental assessment, as well as in many other situations where human activities have the potential to harm the natural environment. All tracking plans and tactics have causes and justifications, which are frequently designed to determine the current state of surroundings or patterns in ecological factors as shown in Figure 4. Monitoring results will be evaluated, statistically analyzed, and compiled in all cases. Before beginning monitoring, the configuration of a monitoring program must consider the last application of the data.

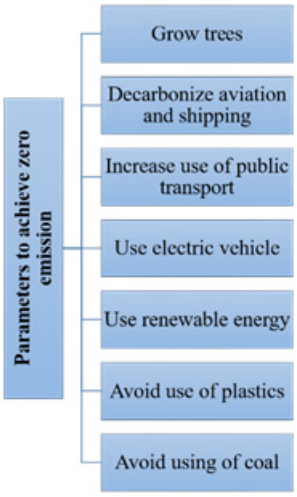


Figure 4: Represents the Parameters Considered to Obtain the Zero Emission in the Environment.

High Speed The kind of freight that can cover large distances quickly is air freight. This makes this model the best option if the client has to export a product urgently or if their freight requires particular protection or acclimation criteria. Since it is the fastest means of transportation, it is perfect for shipping products over great distances. Less time is required. Quick Service, Air travel provides quick, dependable, and convenient transportation options. It is regarded as the least expensive method of shipping peregrinated commodities. It provides a typical service that is practical, dependable, and quick. Send practically anywhere your freight, with air transportation being seen as the sole option in areas that are not easily accessible by other forms of transportation.

Many airlines have access to a huge network of airlines that almost completely covers the whole planet. This makes it possible to send the package just about everywhere. A high level of security, a High level of security with little chance of theft and harm. Due to the tight enforcement of airport safety regulations on goods, shipping by air is extremely secure. Airport security measures are strictly enforced to reduce cargo robbery and damage. Natural Path A plane can fly anywhere without encountering any natural barriers or obstructions. Thus the paperwork for customs is simple to compile. It does away with the requirement for additional time to get permission. When there are quakes, flooding, disasters, or calamities, relief efforts are carried out via air transport. It is not as necessary to use bulky packaging, in general, air exports require less rigid packing than ocean cargo. By not needing to offer additional packaging services, you may save time and money.

Extreme weather and unfavorable climate conditions may force airports to close and flights to be grounded, which will delay supplies over several days as well as render the service useless. Risky, since even a slight crash may result in significant losses to cargo, passengers, and crew, air transport is the riskiest form of transportation. Collisions are more likely when compared to other modes of transportation. Expense, Airline travel is regarded as the priciest form of transportation. Aerodrome and avian construction expenditures as well as the cost of servicing aircraft are substantially greater. Because of this, flying travel has become unaffordable for most individuals [11].

3.2.Approaches by Google:

Google introduced a new feature that shows customers the impact on the environment of flights. Users will now see carbon dioxide emissions previously estimated for well almost all flights in search results as of today. The estimate is displayed alongside the flight price and duration. According to Google, the innovative feature will enable users to consider carbon emissions alongside cost and timing when booking travel. The figures are flight- and seat-specific. For example, when going to look at the economic system or first-class seats, the emission levels estimates will differ because seats that occupy more storage records for a bigger portion of the total emissions. Furthermore, newer planes emit less pollution than older ones. Low-emission flights will be identified with an eco-friendly badge. When looking for a flight, individuals who wish to prioritize carbon impact can sort the results so the planes with the smallest emissions are on top of the results. Flights are classified as having higher, common, low, or unidentified emissions.

Google evaluates the forecasts by incorporating data from the European Environmental Protection Agency with airplane info supplied by airlines, including such air carriers and total seat capacity. The search engine giant observes that precise carbon emissions may vary based on variables such as airplane arrangement, aircraft speed as well as attitude, and distance between origin and destination. To improve accuracy, the business plans to keep revising carbon dioxide emissions over time [12]. There is a wide range of materials that are inappropriate for such items, including, but not limited to, explosives, gases, batteries, burned solids, and liquids that cannot be transported by air. Small Carriage Capacity, the lack of space in the aircraft makes them unsuitable for transporting bulky and less expensive commodities. The loading volume cannot be increased, as is the case with railways. Massive investment, Aerodrome construction, and maintenance must be quite expensive. It also requires professional, qualified, and qualified personnel, all of whom require a large investment.

There are various approaches made by the government of different countries in the world to achieve zero emissions. The greenhouse gas emission causes pollution in the environment. There are different modes of emission of gases which leads to the problems of pollution. Thus, the sudden temperature rise, unfortunate as well as disturbed climate cycle, depletion of ozone layers is observed with the melting of ice on North and south poles. Thus the issue of increasing emissions may cause damage to life on the earth. So it is necessary to achieve zero emissions and to reduce the emission as much as possible. There are different methods to obtain zero emissions from flights as well as other polluting mediums. Thus it is necessary to know the environmental impact of zero emissions and the approaches made by governments made to reduce the emission as well as achieve zero flight emissions.

4. CONCLUSION

Airplanes serve as a means of airways conveyance or aviation. Different models in aviation, including aircraft and spacecraft, are produced for human and scientific purposes. Air and water transport assist society in long-distance travel around the world. Pollution has created a great impact on rising the temperature as global warming is increasing with the depletion of the ozone layer around the earth. Deforestation is another issue that leads to the rise in global warming. The research was created to examine the many effects of air mobility on society and the environment. Food waste is the most serious issue in air travel since everyone's preferences differ. When compared to other forms of transportation, the usage of air transportation reduces travel time and

allows a person to go to any area of the world in less time. Air traffic management aids in the reduction of air transportation costs. Thus, there are many kinds of transportation, the fastest of which are airways. Thus, more research aids in studying the coverage of air travel in society and improving pollution remedies by decreasing the number of combustion products.

REFERENCES

[1] wikipedia, "History of AVIATION."

[2] K. Wang, Z. Zhou, X. Zhu, and X. Xu, "Aerodynamic design of multi-propeller/wing integration at low Reynolds numbers," *Aerosp. Sci. Technol.*, 2019, doi: 10.1016/j.ast.2018.07.023.

[3] Leto sapunar, "Airbus Hopes to Be Flying Hydrogen-Powered Jetliners With Zero Carbon Emissions by 2035," *inside climate news*, 2020.

[4] wikipedia, "Air travel."

[5] J. Whitelegg, "Aviation: the social, economic and environmental impact of flying," *Ashden Trust. London*, no. December, pp. 1–28, 2000.

[6] J. R. Bartle, R. K. Lutte, and D. Z. Leuenberger, "Sustainability and air freight transportation: Lessons from the global pandemic," *Sustain.*, vol. 13, no. 7, pp. 1–13, 2021, doi: 10.3390/su13073738.

[7] A. Papatheodorou, "A review of research into air transport and tourism:: Launching the Annals of Tourism Research Curated Collection on Air Transport and Tourism," *Ann. Tour. Res.*, vol. 87, p. 103151, 2021, doi: 10.1016/j.annals.2021.103151.

[8] X. Sun, Y. Zhang, and S. Wandelt, "Air transport versus high-speed rail: An overview and research agenda," *J. Adv. Transp.*, vol. 2017, 2017, doi: 10.1155/2017/8426926.

[9] M. Song, G. Jia, and P. Zhang, "An evaluation of air transport sector operational efficiency in China based on a three-stage DEA analysis," *Sustain.*, vol. 12, no. 10, pp. 1–16, 2020, doi: 10.3390/su12104220.

[10] BBC, "Climate change: Should you fly, drive or take the train?," 2019.

[11] navata, "Top 6 Advantages and Disadvantages of Air Transport."

[12] Aisha Malik, "Google Flights adds new feature that displays estimated carbon emissions for trips," *techcrunch*, 2021.

CHAPTER 9

ANALYZING THE APPLICATIONS OF AGRICULTURAL ROBOTS IN VARIOUS FARMING ACTIVITY USING IOT

Dr. Rahul Kumar ,Assistant Professor,
Department of Mechanical Engineering,Sanskriti University, Mathura, Uttar Pradesh, India
Email Id-rahulk.me@sanskriti.edu.in

ABSTRACT:

The use of robots in agriculture is now common, the robots are used in pesticide spraying, surveillance, harvesting, fruit plucking, gardening, etc. Most of the robots are multipurpose robots that are capable of doing multiple functions using Artificial Intelligence (AI) and the Internet of Things (IoT). So the focus of the study is to know the advancement in technology according to the application of robots. There are many studies done by experts belonging to the different fields of robotics and agriculture. The robots are used in various applications that humans are unable to perform with the high efficiency as robots perform. So, to reduce the labor cost and to increase the speed of all farming activities robots should be used to increase the productivity of crops. The cost of robots is one of the important factors which reduces the demand for robots as fewer people can buy them. So the study concludes that research should be done on the installation of robots, which increase the demand for robots in the next few decades.

KEYWORDS:

Agriculture, Farming, IoT, Robot, Artificial Intelligence.

1. INTRODUCTION

A robot used for agriculture is referred to as an agricultural robot. Robotics are mostly used in agriculture nowadays during the harvesting process. Weed management, cloud seeding, seed sowing, harvesting, environmental sensing, and soil sampling are examples of new robotic or drone uses in agriculture. In the 1920s, research to combine autonomous vehicle steering into agriculture started to take shape, marking the beginning of robots in agriculture. The development of smart agricultural vehicles between 1950-1960 was a result of this study. Although the idea was sound, the vehicles still required a wired system to direct their course. Agriculture robot development proceeded as other industries' technological advancements also progressed. Machine vision guidance did not become feasible until the year 1980, with the invention of the computer [1], [2].

There are several types of machinery used in agriculture for various tasks. Machines are used to increase production and efficiency while lowering the cost of labor. Agriculture encompasses a variety of interconnected activities that are practiced over the entire globe. Other advancements over the years have included robot-assisted orange picking in Europe and the United States. Although robotics have been used in indoor manufacturing environments for many years, outside agricultural robots are thought to be more sophisticated and challenging to design. This is owing to worries about safety, as well as the difficulty of harvesting crops that are susceptible to various environmental conditions and uncertainty [3], [4].

Robots for harvesting fruit, driving tractors/sprayers, and shearing sheep are all intended to take the place of human labor. Before beginning work, several things must often be taken into account, such as the size and color of the fruit to somehow be plucked. Other horticultural duties including trimming, weeding, spraying, and monitoring can be performed by robots as shown in Figure 1 and Figure 2. Robots may also be utilized in livestock robotics, which includes castrating, washing, and mechanized milking of cattle. These kinds of robots have various advantages for the agriculture sector, including improved fresh food quality, reduced production costs, and less need for manual labor. Machines are used to automate manual activities like spraying bracken or weeds when using tractors and other human-driven vehicles would put the operator in danger [5], [6].

Figure 1: Represents the Application of Robots for Spraying Various Mixtures on the Plants to Improve the Productivity [7]**.**

Figure 2: Represents the Working of Fruit Plucking Robots used in Various Agricultural Activities[8]**.**

Androids are used in a variety of agricultural activities to maintain productivity while being technologically and economically efficient. Many nations have studied robots, and today the majority of farmers utilize them in place of manpower for routine farming tasks. The use of such robots in agriculture decreases the user's workload and level of stress. In different regions of the world, different agricultural practices are used. To improve society, several nations are creating new kinds of robots utilizing IoT and AI. This is because agriculture encompasses much more than just cultivating crops and watering them; it is a broad area with numerous branches that carry out various tasks and provide various outputs. Along with these other important terms in

the community, agriculture also includes horticulture, sericulture, orchids, vineyards, dairy farming, poultry, etc. [9].

Two types of agriculture techniques are followed in the world intensive and extensive agriculture. Both agriculture techniques are useful and have high productivity whose output is part of the global market food is the basic need of all living beings. As the food cycle starts with plants or crops as an initial food source. The use of different technology is done for improving productivity and methods of production on the farms. There are many applications of robots and robotics in agriculture as with time and technology it is changing and developing. Robots or machines are the parts of technology that are now utilized in society for agriculture by many farmers so it is necessary to study all aspects of robots that are used by farmers in farming.

2. LITERATURE REVIEW

Mohd Ariffanan, Mohd Basri, and Muhamad Azizi Adnan studied the "agriculture robot" which refers to the application of a cutting-edge technique that allows automation technology to address the shortcomings of the conventional agricultural approach by substantially improving efficiency. The robot is built with a completely automated navigating system that uses a line-following algorithm, along with extra capabilities for real-time monitoring and image capturing of the plant. Within the constraints of contemporary agriculture, this project intends to construct a system for monitoring crop conditions and design logic-controlling line-following navigation. The program has been developed via a sequential procedure, beginning with the mapping of sensor input to motor speed and position control. Using an IoT-based connection between both the robots and the Blynk application, the user is allowed to keep track of the state of the plant from the image obtained.

Abhijit Khadatkar discussed robots used in transforming agriculture's future. With the development of robots and AI-based technologies over the past few decades, the agriculture production unit has undergone significant changes. Robotics will be used in a variety of field tasks employing drones to handle agricultural production in terms of mobility, localization, capture, targeting, and transferring toward the next target. The same procedure may be utilized for fruit picking, weeding, and spraying. However, robotic technology appears to be in its infancy, and it is necessary to use these technologies since labor is scarce, their costs are costly, and to assure longevity in field operations. Although many research attempts have been made for the development of robots for agriculture applications, more research should be focused on the development of next-generation robots for difficult and laborious farm operations.

Gulbir Singh and Kuldeep Kumar Yogi developed a study on Robots and IoT-Based Devices in Agriculture 4.0 Precision agriculture is a key component of agriculture 4.0. Precision farming may be accomplished in several ways, including improved cultivation techniques, crop selection, risk and volatility reduction, water management, pesticide usage that is maximized, and monitoring of the land and crops with minimal negative environmental effects. The various sensors are available for applications in precision agriculture, such as soil preparation, crop status monitoring, pests, and their identification and detection, watering, and fertilizer spraying, are described. It is discussed how the usage of IoT-based tools aids farmers during all stages of agricultural production, from sowing to harvesting. This study ends and outlines the difficulties encountered while integrating IoT-based agricultural equipment [10].

Zhe An et al. analyses the Application of New Robot Plant Protection Technology in Ecological Agriculture. We present a path-planning technique for agricultural crop security robotics relying on a non-linear algorithm to enhance the quality and precision of crop protection bots in agricultural work route planning. The path distance index was planned using a positive ant colony method by the workplace environment, and the viability of the simulation process was estimated. Positive findings reveal that the nonlinear algorithm uses the fastest time of 5.3 and that path planning accuracy can reach 97.8 percent. The method is superior to the conventional approach in terms of accuracy, computation time, and computing efficiency.

XINYU GAO et al. studied the difficulty of robot navigation in an environment containing obstacles is still difficult. Throughout this study, the navigation issues with Wheeled Mobile Robots (WMR) are investigated, the navigation technique of WMR is analyzed in detail, and the approaches to resolving the sub-issues of mapping, localization, and path planning, all of which are connected to robot navigation, are compiled, and the benefits and drawbacks of the current approaches are discussed. To address the unique difficulty of the agriculture field, this paper proposed a research direction to address the problems of exact wayfinding in an agricultural environment. It also anticipated the implementation of the remedy to the navigation issue of WMR in agricultural science [11].

Robert Bogue discussed Agriculture will soon be revolutionized by robots. In this paper, we'll go through some recent, notable agriculture robot research and innovation. This first gives a quick summary of agricultural robot development after an introduction. The use of robots for precise weed management and fertilizer application is then covered in more detail. The development of harvesting robots is also well along. Both classes make use of cutting-edge machine scanning and picture processing techniques that are the focus of extensive research. These advancements will aid in the farming robot market's anticipated decade-long fast rise. To fulfill the world's growing need for food, robots are predicted to play a crucial role. This paper summarizes some modern agriculture robot research & design operations [12].

Andres Milioto et al. studied and tackle the issue of semantic crop field segmentation using Convolutional Neural Network (CNN) to distinguish sugar beet plants from weeds and background using just RGB (Red, Green, and Blue) data. They suggest a CNN that uses current vegetation indicators to classify data in real-time. Furthermore, with comparatively little training data, it may be successfully retrained to previously unexplored domains. The technology into practice on a genuine agricultural robot that was working in several areas in Germany and Switzerland, and we carefully analyzed it. The findings demonstrate that our system generalizes well, is capable of operating at about 20 Hz, and is appropriate for online use the outdoors [13].

Domagoj Zimmer et al. researched and shows agricultural robots that are capable of handling challenging jobs. A corollary of the rapid advancement of agricultural technology is the rapid development and deployment of agricultural robots. Robots are sophisticated, intelligent devices that play a big part in agriculture and are becoming increasingly important to the advancement of science and technology. The study outlines several significant functions of drones and robotic devices in different agricultural fields and discusses the implementation of new technology with examples from forestry, horticulture, and arable farming. Robotics applications provide considerable manufacturing cost reductions, reduce the placement of human capital, and boost output. Robotic technologies may be used to achieve high levels of precision and rapid repetition in both time and space that are impossible for farmers to match [14].

The use of machines is always seen in agriculture as various operations are done using agriculture. As agriculture is one of the major food-producing sectors in the world where labor is used for working in most parts of the world. Precision farming is best accomplished using IoT-based agricultural equipment. In-depth analyses of wireless sensors, IoT-based devices, and communication methods are provided in this study. There are different studies done on the application of the robot in agriculture which are capable of doing all the farming activities in place of labor with high efficiency. Thus robotic machines are used in agricultural work, use of IoT and AI helps in operating robots conveniently. There are very different types of robots that are capable of doing various agricultural operations as seen during the study. Robots are mostly man-made programmable machine that follows a set of instructions to perform any task. So to highlight the different operations and working of robots study is necessary.

3. DISCUSSION

The agriculture industry is impacted by plant disease, parasitic insects, droughts, weeds infestation, and other problems. These problems are brought on by current agricultural practices, which cause major crop loss, financial loss, and serious environmental risks. Due to the industry's constant change, robotics can only provide a definitive answer to a single complicated problem in the agriculture sector. Several methods have been created to help with these problems and offer a better approach internationally. Plant protection robots exhibit nonlinear characteristics, complexity, and constraints.

A gripper, manipulator, and end effector make up the mechanical design. When designing the manipulator, it is important to take into account the purpose, economic productivity, and necessary motions. The design of the gripper is dependent on the type of crop being picked, and the end effector affects the fruit's market value. A robot arm's end effector, which is utilized for a variety of agricultural tasks, is found on agricultural robots. There are several types of end effectors available today. End effectors are employed for harvesting, fruit picking, spraying, and bagging in a grape farming operation in Japan. Each was created with consideration for the work at hand as well as the size and form of the intended fruit.

A grip is a tool for gripping crops that are intended to be harvested. The gripper's design prioritizes efficiency, economy, and simplicity. As a result, the design often comprises two electromechanical fingers that may move in unison while carrying out their function. The work being done affects the design's specifics. For instance, the gripper included a sharp blade for an operation that needed cutting plants to be harvested. The grip and end-effector can move freely around the manipulator. The gripper's location and level are maintained by the manipulator's four-bar parallel linkages. Additionally, 1, 2, or 3 pneumatic actuators can be used for the manipulation. Due to its high power-to-weight ratio, the pneumatic system is the most efficient actuator for agricultural robots. The single actuator layout is the least versatile but also the most cost-effective solution for manipulation.

The quantity of work required by the agriculture industry is a source of worry. Japan struggles to satisfy the needs of the agricultural labor market due to its aging population. Similar to how the United States today relies heavily on immigrants, but due to the decline in temporary farm laborers and greater government measures to halt immigration, they are also unable to satisfy the demand. Due to the difficulty to gather all of the crops even by the end of the season, businesses are frequently compelled to let them decay. Concerns about the expanding population that will have to be fed in the upcoming years are another issue.

The goal of much ongoing research remains autonomous agricultural vehicles. The development of driver assistance technologies and self-driving automobiles served as the foundation for this study. While many aspects of agriculture farm work have already been automated by robots, harvesting different crops is still largely unaffected. This has begun to alter as businesses create robots that do increasingly specialized duties on farms. The main worry about robots picking crops is that delicate crops like strawberries, which are easily damaged or overlooked altogether, will be harvested. Progress is being made in this field despite these worries. Harvesting of other crops, such as apples, grapes, and others, is also making similar advancements. The present pace of development for apple harvesting robots is too slow for them to be economically feasible. While the typical person harvests one apple every second, a modern robot can do it at a pace of 1 over 5 to 10 seconds.

3.1.Application of Robots:

Lack of manpower during the busiest crop-producing season has also brought attention to a need for an alternatives resilient and secure agricultural system integrating IoT, machine learning, and robots. The functioning of robotic systems for different field activities, including transplantation, harvest, fertilization, etc. for commercial as well as horticulture crops, has been made possible by the enhanced usage of electronics applications. For more precise use, these techniques can be combined with vision-based systems and GPS. In the future, robotic trans-planters for plug-type seedling transplantation could be an excellent choice. Machine learning and trajectory planning software or an AI system can be used to accomplish the process by utilizing a robotic arm, manipulating, and finishing.

3.1.1. Agriculture:

Information and communications technologies in agricultural production also referred to as e-agriculture, aim to improve rural and agricultural development by enhancing information- and communication-based processes. E-agriculture, in particular, entails the conceptual model, design, advancement, assessment, and application of novel ways of using technologies of information and communication technology (ICT) in the sparsely populated realm, with a principal agricultural focus. ICT encompasses devices, networks, mobiles, services, and applications ranging from cutting-edge Digital solutions and sensors to which was before tools such as repaired telephones, television sets, radios, and satellites. E-agriculture includes the provision of standards, social standards, techniques, and tools, as well as the creation of individual and organizational capabilities and policy supports.

3.1.2. Livestock farming:

3.1.2.1.Dairy farming:

Automatic milking mechanisms are self-contained computer-controlled systems that milk dairy cattle without the use of human labor. An agricultural robot, complicated herd software solutions, and specialized computers control the entire milking process. Automatic milking removes the producers from the actual milking procedure, giving them more time to oversee the farm and herd. Farm owners can also enhance herd governance by utilizing computer data. Farmers can achieve optimal milk yields by assessing the influence of various animal nutrition on milk yield. Because the information can be accessed down to the individual level, every cow

can be monitored and analyzed, and the farmer can be notified if any unexpected changes might indicate illness or injury (Figure 3).

Figure 3: Represents the Milking Robot Setup in the Cattle Farm for Milking the Cows with Complete Automation.

3.1.3. Surveillance and security:

Precision farming, as the term suggests, refers to the use of precise amounts of inputs such as water, fertilizer, pesticides, and so on to the crop at the appropriate time to increase productivity and maximize yields. Precision agriculture management practices can help farmers use fewer nutrients and other crop inputs while increasing yields. Farmers get a profit from their investment by saving money on water, pesticides, and fertilizer. The second, larger-scale advantage of targeting inputs is related to environmental impacts. Using the appropriate amount of chemicals at the right time and place benefits crops, soils, and groundwater, as well as the crop growing cycle. As a result, because it respects crops, soils, and farmers, smart farming has evolved into a key component of sustainable agriculture Sustainable agriculture aims to ensure a continuous supply of food while remaining within the ecological, economic, and social constraints ability to maintain manufacturing over time, as shown in Figure 4.

Figure 4: Represents the Agricultural Drone for Different Spraying Activities with Surveillance System.

The gathering of data is a further aim of agricultural businesses. Concerns about the expanding population and the declining amount of labor necessary to feed it are mounting. The development of data collecting is being done to boost agricultural output. By scanning fruit trees, AgriData is now developing new technologies to accomplish this and assist farmers in better deciding when to harvest their harvests. There are various uses for robots in agriculture. The Harvest Automation, lettuce bot, Rosphere, weeder, Robot Milker, and Orange Harvester are a few examples of robot prototypes.

The milk bot is an example of a widely used farming robot. It is popular across British dairy plants due to its effectiveness and lack of relocation requirements. Additionally, robots that do repetitive jobs, like milking cows, do so to a precise and constant level. Horticulture is another application area. Harvest Automation Inc.'s creation of RV-100 is one horticulture application. The RV-100 is made to move plant pots in a greenhouse or outside. The capabilities of the RV-100 for handling and managing potted plants include collecting, consolidation, and spacing. High placement precision, independent exterior, and interior operation, and lower manufacturing costs are all advantages of adopting RV-100 for this operation.

There are different applications of robots in agriculture that are now seen and used in different parts of the world. There are different studies made by different experts in the world as the labor numbers are reducing with time it’s hard for the farmer to sustain agriculture and its productivity for profits. So robots and machines are good options for such farmers to do farming without labor. There are many benefits of robots to the farmers nowadays as the technology is developed with time and has new technological aspects. The study discusses the various approaches, studies, types of research, papers, etc. made by different experts for the applications of robotics in agriculture over the different parts of the world. Thus the study is useful and helpful to understand the differences between robotics in agriculture for increasing the productivity of the farmers after using the IoT.

4. CONCLUSION

The robots used in agriculture help the user to reduce labor costs and to improve productivity. The use of IoT makes it easy to operate the user from a long distance. The robots can analyze and alert users according to various conditions. Mostly agriculture robots are in various forms, some are capable of alerting the user, some are following the instructions and some robots can do multiple operations. The cost of the robots is high which makes it inconvenient for everyone to use the robot for work. The IoT has a great impact on the technology which is now also used in the robot and is very advanced which makes farming easy for the user. The AI application in the robot makes the robot analyze the condition and produce the result and alert the user. Farming is mostly done based on climate and availability of water, so using the robot will be useful in these two systems as the robot can alert the user on such imprint factors as well as the condition of crops. Thus the robots have a variety of applications in agriculture which helps the user in reducing time.

REFERENCES

[1] R. Sparrow and M. Howard, “Robots in agriculture: prospects, impacts, ethics, and policy,” *Precis. Agric.*, 2021, doi: 10.1007/s11119-020-09757-9.

[2] J. P. Vasconez, G. A. Kantor, and F. A. Auat Cheein, "Human–robot interaction in agriculture: A survey and current challenges," *Biosystems Engineering*. 2019. doi: 10.1016/j.biosystemseng.2018.12.005.

[3] N. NOGUCHI, "Robots for Agriculture and Food Industry," *Shokubutsu Kankyo Kogaku*, 2021, doi: 10.2525/shita.33.96.

[4] I. Husti, "Possibilities of Using Robots in Agriculture," *Hungarian Agric. Eng.*, 2019, doi: 10.17676/hae.2019.35.59.

[5] D. Muntode, "Multipurpose Agriculture Robot," *Int. J. Res. Appl. Sci. Eng. Technol.*, 2021, doi: 10.22214/ijraset.2021.36987.

[6] A. Dutta, S. Roy, O. Patrick Kreidl, and L. Boloni, "Multi-Robot Information Gathering for Precision Agriculture: Current State, Scope, and Challenges," *IEEE Access*, 2021, doi: 10.1109/ACCESS.2021.3130900.

[7] pinduoduo, "Agricultural Robots: Robots in Agriculture and Farming."

[8] Confederation of indian industry, "AgRobotics: What is possible and where India stands," 2020.

[9] J. Hollingum and J. Hollingum, "Feature Robots in agriculture," pp. 438–445, 2017.

[10] G. Singh and R. S. Peres, "Internet of Things-Based Devices / Robots in Agriculture 4 . 0".

[11] X. Gao *et al.*, "Review of wheeled mobile robots' navigation problems and application prospects in agriculture," *IEEE Access*, vol. 6, pp. 49248–49268, 2018, doi: 10.1109/ACCESS.2018.2868848.

[12] R. Bogue, "Robots poised to revolutionise agriculture," *Ind. Rob.*, vol. 43, no. 5, pp. 450–456, 2016, doi: 10.1108/IR-05-2016-0142.

[13] A. Milioto, P. Lottes, and C. Stachniss, "Real-Time Semantic Segmentation of Crop and Weed for Precision Agriculture Robots Leveraging Background Knowledge in CNNs," *Proc. - IEEE Int. Conf. Robot. Autom.*, pp. 2229–2235, 2018, doi: 10.1109/ICRA.2018.8460962.

[14] D. Zimmer, M. Jurišić, I. Plaščak, Ž. Barač, and D. Radočaj, "Application of Robots and Robotic Systems in Agriculture," *Teh. Glas.*, vol. 15, no. 3, pp. 435–442, 2021, doi: 10.31803/tg-20210128112420.

CHAPTER 10

EXPLORING THE VARIOUS PROCEDURES FOR ACHIEVING ZERO-EMISSION IN FLIGHTS AND ITS ENVIRONMENTAL IMPACTS

Mr. Aishwary Awasthi,Research Scholar,
Department of Mechanical Engineering,Sanskriti University, Mathura, Uttar Pradesh, India
Email Id-aishwary@sanskriti.edu.in

ABSTRACT:

Flight transport is a fast and convenient transport system used to travel from one part of the world to the other, or from one place to another place. The transport systems mostly used in the world are in three ways like air, water, and land transport. The different vehicles use different fuels which exhaust the different gases in all the transport systems. The focus of the study is to know the various methods to follow zero-flight emission in air transport. There are many approaches made by many countries to eliminate the exhaustion of harmful gases in the sky. Different experts studied the different methods to sustain zero flight emissions, in which it is found that using biofuel is convenient to use and helpful for reducing pollution in society. Thus, to obtain zero-emission it is necessary to reduce the use of fuels and increase the usage of biofuels and other sustainable fuels. Further study will help in achieving zero-emission and modifications in the application of fuels.

KEYWORDS:

Aviation, Biofuel, Flight, Transport, Zero-Emission.

1. INTRODUCTION

An aviation biofuel or bio-jet-fuel or Bio-aviation Fuel (BAF) is a biofuel used to power aircraft and is said to be a Sustainable Aviation fuel (SAF). The International Air Transport Association (IATA) considers it a key element in reducing the carbon footprint within the environmental impact of aviation. Aviation biofuel could help decarbonize medium- and long-haul air travel generating most emissions and could extend the life of older aircraft types by lowering their carbon footprint. Biofuels are biomass-derived fuels, from plants or waste; depending on which type of biomass is used, they could lower carbon dioxide (CO_2) emissions by 20–98% compared to conventional jet fuel. The first test flight using blended biofuel was in 2008, and in 2011 blended fuels with 50% biofuels were allowed in commercial flights as shown in Figure 1. In 2019, the IATA was aiming for a 2% penetration by 2025 [1], [2].

Aviation biofuel can be produced from plant sources like Jatropha, algae, tallows, waste oils, palm oil, Babassu, and Camelina (bio-SPK); from solid biomass using pyrolysis processed with a Fischer–Tropsch process (FT-SPK); with an alcohol-to-jet (ATJ) process from waste fermentation; or from synthetic biology through a solar reactor. Small piston engines can be modified to burn ethanol. Sustainable biofuels do not compete with food crops, prime agricultural land, natural forests, or freshwater as they are an alternative to electro-fuels. Sustainable aviation fuel is certified as being sustainable by a third-party organization .

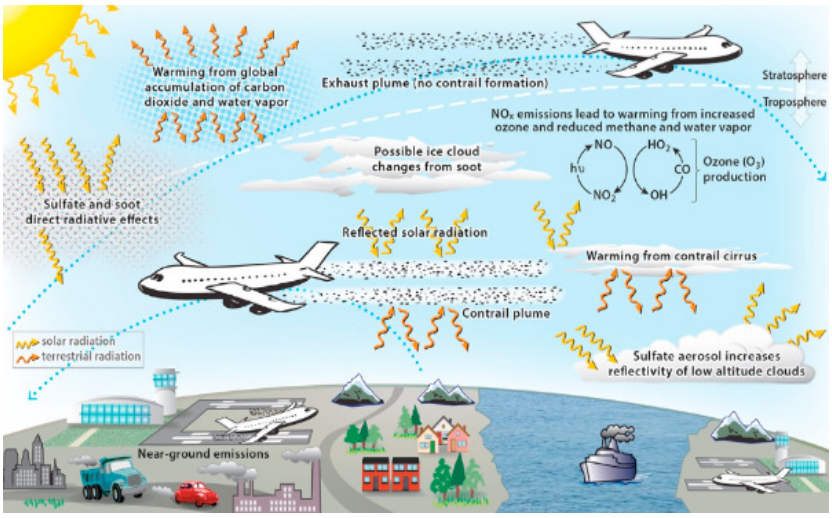


Figure 1: Represents the Various Emissions in the Atmospheres Which Affect the Environment [1]**.**

Like other emissions resulting from fossil fuel combustion, aircraft engines produce gases, noise, and particulates, raising environmental concerns over their global effects and their effects on local air quality as shown in Figure 1. Jet airliners contribute to climate change by emitting Carbon Dioxide (CO_2), greenhouse gas, and, with less scientific understanding, nitrogen oxides, contrails, and particulates. Their radiative forcing is estimated at 1.3–1.4 that of CO_2 alone, excluding induced cirrus clouds with a very low level of scientific understanding.

In 2018, global commercial operations generated 2.4% of all CO_2 emissions. Jet airliners have become 70% more fuel efficient between 1967 and 2007, and CO_2 emissions per Revenue Ton-kilometer (RTK) in 2018 where 47% of those in 1990. In 2018, CO_2 emissions averaged 88 grams of CO_2 per revenue passenger per km as shown in Figure 2. While the aviation industry is more fuel efficient, overall emissions have risen as the volume of air travel has increased. By 2020, aviation emissions were 70% higher than in 2005 and they could grow by 300% by 2050 [2], [3].

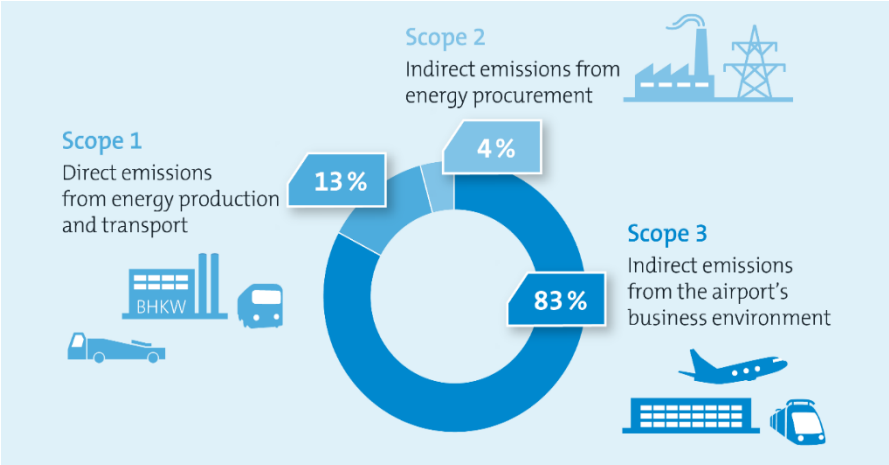


Figure 2: Represents the Different Methods of Emissions in the Atmosphere That Affects the Environment Cycle.

Aircraft noise pollution disrupts sleep, and children's education and could increase cardiovascular risk. Airports can generate water pollution due to their extensive handling of jet fuel and deicing chemicals if not contained, contaminating nearby water bodies. Aviation activities emit ozone and ultrafine paper, both of which are health hazards. Piston engines used in general aviation burn Avgas, releasing toxic lead. Aviation's environmental footprint can be reduced by better fuel economy in aircraft or Air Traffic Control and flight routes can be optimized to lower non-CO2 effects on climate from NOx, particulates, or contrails.

Aviation usage can be lowered by short-haul flight bans, train connections, personal choices, and aviation taxation and subsidies. Fuel-powered aircraft may be replaced by hybrid electric aircraft and electric aircraft or by hydrogen-powered aircraft. Pollution is increasing day by day which leads to the rise in temperature in the environment due to the high consumption of fuels in the different vehicles. Thus it is necessary to know the different methods to achieve zero emission in flights using different types of fuel as well as different modifications in the designs of flights.

2. LITERATURE REVIEW

Phillip J. Ansell and Kiruba S. Haran discussed that the aeronautics industry has been challenged on many fronts to increase flight efficiency, reduce greenhouse gas emissions, and decrease dependence on traditional hydrocarbon fuels. Each year, aviation produces more than 900 million metric tons of CO_2, which, without new interventions in policy, technology, and business practices, will further increase alongside the growing air transport market. Currently, aviation accounts for 4.8% of U.S. contributions to CO_2 emissions, and the global aviation industry constitutes about 2% of all human-induced CO_2 emissions. While this contribution may appear to be small when compared to other sources, it is likely to become more prominent in the years to come [4].

V Memmolo et al. has designed near-zero emission aircraft based on a refined aerodynamic model and structural analysis. It is indeed crucial to establish both aerodynamic and structural models to simulate the aircraft performance and design required according to top-level aircraft requirements. Despite the largely discussed literature about the preliminary design of such an unconventional aircraft, there is still a lack of reliable weight estimation approaches, simulation-based mission analysis, and optimization tools. In particular, the comprehensive structural analysis of the aircraft wing opportunely designed according to certification specifications and equipped with different powertrain architectures shows that it is worth looking into structural dynamics from preliminary design to estimate aircraft weight properly. Meanwhile, the mission analysis reveals performance benefits by implementing distributed engines all over the wingspan.

Emmanuel Blanvillain and Airbus Group Innovations have made a Holistic Approach to Hypersonic Aircraft Design of ZEHST (Zero Emission High-Speed Technologies). Shortening passenger travel time is a key focus for future long-range air transportation, as is meeting the air transport industry’s ambitious environmental goals. Targeting these objectives, the ZEHST program was set up with the ambition to address the design of a hypersonic transport aircraft with a holistic approach, and to use at best the technical and industrial expertise of the partners involved Airbus Group, Airbus Defense and Space, ONERA and MBDA [5].

Janfizza Bukhari et al. discussed Zero-Emission Delivery for Logistics and Transportation. While the transport industry is among the top three major contributors, accounting for 16.2% of

global emissions. To counter this, many countries are responding actively to achieve net or absolute zero-emission goals by replacing fossil fuels with renewable energy sources. In response to this initiative, this study provides the use of zero-emission vehicles for a specific use case of package delivery. Their study investigates these challenges in the adoption of zero-emission vehicles with the existing research issues from a technical, environmental, economic, and political point of view. In addition, this study also sheds a new research perspective on artificial intelligence and integrated solutions for zero-emission deliveries [6].

Eduardo Cabrera and João M. Melo de Sousa, studied the use of Sustainable Fuels in Aviation. As the push for carbon-neutral transport continues, the aviation sector is facing increasing pressure to reduce its carbon footprint. They also studied the production methods, logistical and technological barriers, and potential for future mass implementation of these alternative fuels. In general, biofuels currently present higher technological readiness levels than other alternatives. Sustainable mass production faces critical feedstock-related challenges that synthetic fuels, together with other solutions, can overcome. All conventional fuel replacements, though with different scopes, will be important in meeting long-term goals. Government support will play an important role in accelerating and facilitating the transition toward sustainable aviation.

Elisabet Tiirinki discussed the Carbon Reducing Initiatives as a Strategy to Achieve Sustainable Competitive Advantage. Airlines as a part of the high-intensity energy industry are searching for the best cost-effective approaches to decarbonization. This research uses multiple case study methods to evaluate the environmental strategies of three airlines and argues the potential benefits of sustainable aviation fuel, operational efficiency, and carbon offsetting schemes. The significance of the research lies in the difficulty of evaluating which airlines are greener than the others. The research is contributing to this topic by discussing the strategic stance of airlines in terms of sustainable competitive advantage, and whether an airline can differentiate itself with a well-developed sustainability policy. As a result, this study has confirmed the hypothesis that despite many challenges carbon offsetting schemes are the most effective measure for airlines to tackle climate change in the short-term.

Jinning Zhang et al. studied Sustainable Aviation Electrification. This study aims to provide a comprehensive and broad-scope survey of the recent progress and development trends in sustainable aviation electrification. Firstly, the architectures of electrified aircraft propulsion are presented with a detailed analysis of the benefits, challenges, and studies/applications to date. Then, the challenges and technical barriers of electrified aircraft propulsion control system design are discussed, followed by a summary of the control methods frequently used in aircraft propulsion systems. Next, the mainstream energy management strategies are investigated and further utilized to minimize the block fuel burn, emissions, and economic cost. Finally, an overview of the development trends of aviation electrification is provided.

Mamadjanov Lochinbek Yusupovich shows the Perspectives of Hydrogen Fuel Cells in Aviation. This paper deals with perspectives of hydrogen fuel cells in the aviation sphere. It should be noted that Hydrogen fuel cells are emerging as a high-potential technology that offers significant energy efficiency and decarbonization benefits to a range of industries including automotive and heavy transport. This paper presents and discusses the classification, working principles, characteristics, and critical technologies of hydrogen fuel cells. Additionally, future technologies and development, including high-power density motors, converters, and power supplies, are discussed for hydrogen fuel cells in the aviation industry.

Siwat Suewatanakul studied the Conceptual Design of a Hybrid Hydrogen Fuel Cell/Battery Blended-Wing-Body Unmanned Aerial Vehicle. The manuscript presents the conceptual design phase of an unmanned aerial vehicle, with the objective of a systems approach toward the integration of a hydrogen fuel-cell system and Li-ion batteries into an aerodynamically efficient platform representative of future aircraft configurations. Using a classical approach to aircraft design and a combination of low- and high-resolution computational simulations, a final blended wing body UAV was designed with a maximum take-off weight of 25 kg and a 4 m wingspan. Preliminary aerodynamic and propulsion sizing demonstrated that the aircraft is capable of completing a 2 h long mission powered by a 650 W fuel cell, hybridized with a 100 Wh battery pack, and with a fuel quantity of 80 g of compressed hydrogen.

There are many approaches made by many experts and scientists to achieve zero emissions using different methods. The methods include the use of biofuels or hydrogen fuels while some approaches focus on reducing the weight of the flights to reduce the amount of fuel utilization. Thus the study is made to combine study all the new approaches made to achieve zero emissions to reduce the exhaustion of greenhouse gases in the atmosphere.

3. DISCUSSION

In recent years, aircraft manufacturers focused their attention on environmentally friendly and aerodynamically efficient aircraft concepts that could allow a radical reduction of emissions. The use of a hybrid-electric powertrain is one of the most effective ways to design near-zero emission aircraft. These aircraft are highly performing and sophisticated. Hence, the design process must be extremely accurate and should make use of multidisciplinary design optimization. To step towards higher technology readiness levels, the purpose of this paper is to describe and apply a design platform for conventional, turboelectric, hybrid-electric, and full-electric aircraft, integrating aero-propulsive interactions, accurate power system modeling, and medium-fidelity structural weight estimation. It first compares different green delivery systems that use unmanned aerial vehicles, electric vehicles, and fuel-cell trucks for certain weight categories. Specifically, the coordination of unmanned aerial vehicles and ground-based electric trucks envisions a new paradigm of ground-based zero-emission vehicles where unmanned aerial vehicles can fly in the air beyond the visual line of sight empowered by future-generation wireless technologies. The integration of zero-emission vehicles for package delivery will encounter many challenges in analyzing, modeling, planning, and designing a green logistics system.

Furthermore, commercial air traffic is expected to resume the continuous growth experienced until the pandemic, highlighting the need for reduced emissions. The use of alternative fuels plays a key role in achieving future emission goals, while also lowering the dependency on fossil fuels. The so-called sustainable aviation fuels (SAF), which encompass bio and synthetic fuels, are currently the most viable option, but hydrogen is also being considered as a long-term solution as shown in Figure 3 the flight from Canada. Compounded with political and economic factors as well as regulative and financial challenges, many airlines have devised sustainability and environmental strategies to tackle upcoming environmental threats.

Figure 3: Represents the Flight of ZERO AVIA Which Uses Hydrogen as a Fuel to Achieve the Zero Emissions [7]**.**

The civil aviation sector plays an increasingly significant role in transportation sustainability in the environmental, economic, and social dimensions. Driven by the concerns of sustainability in the aviation sector, more electrified aircraft propulsion technologies have emerged and formed a very promising approach to future sustainable and decarbonized aviation.

Greenhouse gas, produced in various industries such as Power, Manufacturing, Transport, chemicals, or Agriculture, is the major source of global warming. Airplanes emit gases and atmospheric particulates, interacting among themselves and with the atmosphere. While the main greenhouse gas emission from powered aircraft is CO_2, jet airliners contribute to climate change in four ways as they fly in the tropopause:

1. *Carbon Dioxide (CO_2)*

CO_2 emissions are the most significant and best-understood contribution to climate change. The effects of CO_2 emissions are similar regardless of altitude. Airport ground vehicles, those used by passengers and staff to access airports, and emissions generated by airport construction and aircraft manufacturing also contribute to the greenhouse gas emissions from the aviation industry.

2. *Nitrogen Oxides*

In the tropopause, emissions of NO_x favor ozone (O_3) formation in the upper troposphere. At altitudes from 8 to 13 km, NO_x emissions result in greater concentrations of O_3 than surface NO_x emissions and these, in turn, have a greater global warming effect. The effects of O_3 surface concentrations are regional and local, but it becomes well-mixed globally at mid and upper-tropospheric levels. NO_x emissions also reduce ambient levels of methane, another greenhouse gas, resulting in a climate cooling effect, though not offsetting the O_3 forming effect. Aircraft sulfur and water emissions in the stratosphere tend to deplete O_3, partially offsetting the NO_x-induced O_3 increases, although these effects have not been quantified. Light aircraft and small commuter aircraft fly lower in the troposphere, not in the tropopause

3. Contrails and Cirrus Clouds

Fuel-burning produces water vapor, which condenses at high altitudes, under cold and humid conditions, into visible line clouds: condensation trails (contrails). They are thought to have a global warming effect, though less significant than CO_2 emissions. Contrails are uncommon in lower-altitude aircraft. Cirrus clouds can develop after the formation of persistent contrails and can have an additional global warming effect. Their global warming contribution is uncertain and estimating aviation's overall contribution often excludes cirrus cloud enhancement.

4. Particulates

Compared with other emissions, sulfate, and soot papers have a smaller direct effect: sulfate papers have a cooling effect and reflect radiation, while soot has a warming effect and absorbs heat, while the clouds' properties and formation are influenced by papers. Contrails and cirrus clouds evolving from papers may have a greater radiative forcing effect than CO_2 emissions. As soot papers are large enough to serve as condensation nuclei, they are thought to cause the most contrail formation. Soot production may be decreased by reducing the Aromatic compound of jet fuel.

Sustainable biofuels do not compete with food crops, prime agricultural land, or fresh water. Sustainable aviation fuel (SAF) is certified as being sustainable by a third party like the Roundtable for Sustainable Biofuels. The sustainable aviation fuels certification and production pace seem insufficient to meet the International Air Transport Association target of halving CO_2 emissions by 2050. While not using biofuels, air transport based on renewable energy like wind power and solar energy with fuel produced in a power-to-liquid process, at least with carbon from direct air capture, with hydrogen combusted directly or used in a fuel cell, and with electrical propulsion using rechargeable batteries is also called sustainable

A SAF sustainability certification verifies that the fuel product, mainly focusing on the biomass feedstock, has met criteria focused on long-term global environmental, social, and economic "triple-bottom-line" sustainability considerations. Under many carbon emission regulation schemes, such as the European Union Emissions Trading Scheme, a certified SAF product may be granted an exemption from an associated carbon compliance liability cost. This marginally improves the economic competitiveness of environmentally favorable SAF over traditional fossil-based jet fuel. However, in the near term, there are several commercialization and regulatory hurdles that are yet to be overcome through the collaboration of a variety of stakeholders for SAF products to meet price parity with traditional jet fuel and to enable widespread uptake.

The first reputable body to launch a sustainable biofuel certification system applicable to SAF was the academic European-based Roundtable on Sustainable Biomaterials (RSB) NGO. This multi-stakeholder organization set a global benchmark standard on which the sustainability integrity of advanced aviation biofuel types seeking to use the claim of being a Sustainable Aviation Fuel can be judged. Leading airlines in the aviation industry and other signatories to the Sustainable Aviation Fuel Users Group (SAFUG) pledge to support the RSB as the preferred provider of SAF certification. These airlines believe it important for any proposed aviation biofuels to have independently certified sustainable biofuel long-term environmental benefits compared to the status quo to ensure their successful uptake and marketability. So it is useful to

study the different approaches to achieving zero-emission using different methods by using different fuels or lightweight materials.

4. CONCLUSION

Aviation is the fastest mode of transport which reduces the time of transport and is also a convenient way. Aviation vehicles use various fuels for it working of the engine. Fuel combustion and exhaustion are the factors that affect the usage of fuel emissions in the engines of vehicles. Various fuels combust harmful gases so the focus of the study was to find alternative fuels that are capable of reducing the exhaustion of harmful gases. Biofuels and sustainable fuels can be used in vehicles such that to obtain zero flight emissions. The zero-flight emission means no emission of carbon or nitrogen compounds that are harmful to the environment. The focus of the study is to find a useful and successful alternative fuel for achieving zero flight emissions. Thus, biofuels are a good choice of fuel alternative for aviation, which will reduce the emission of harmful gases into the environment. A further study in zero-emission will help in developing engines that are capable of obtaining zero emission of harmful gases.

REFERENCES

[1] D. S. Lee *et al.*, "The contribution of global aviation to anthropogenic climate forcing for 2000 to 2018," *Atmos. Environ.*, vol. 244, 2021, doi: 10.1016/j.atmosenv.2020.117834.

[2] M. Raugei, A. Peluso, E. Leccisi, and V. Fthenakis, "Life-cycle carbon emissions and energy implications of high penetration of photovoltaics and electric vehicles in California," *Energies*, 2021, doi: 10.3390/en14165165.

[3] M. Riches, D. Lee, and D. K. Farmer, "Simultaneous leaf-level measurement of trace gas emissions and photosynthesis with a portable photosynthesis system," *Atmos. Meas. Tech.*, 2020, doi: 10.5194/amt-13-4123-2020.

[4] B. P. J. Ansell and K. S. Haran, "Electrified Airplanes," *IEEE Electrif. Mag.*, vol. 8, no. 2, pp. 18–26, 2020.

[5] E. Blanvillain, "A holistic approach to hypersonic aircraft design: ZEHST (zero emission high speed technologies)," *29th Congr. Int. Counc. Aeronaut. Sci. ICAS 2014*, pp. 1–9, 2014.

[6] J. Bukhari, A. G. Somanagoudar, and L. Hou, "Zero-Emission Delivery for Logistics and Transportation : Challenges , Research Issues , and Opportunities," vol. 2020, pp. 1–20.

[7] Loz Blain, "De Havilland will develop and market hydrogen airliners with ZeroAvia," *newatlas*.

CHAPTER 11

ANALYSIS OF VARIOUS POSSIBLE IMPLEMENTATIONS AND APPLICATIONS OF AERODYNAMIC DESIGNS

Dr. Vipin Kumar Solanki, Research Scholar,
Department of Mathmatics, Sanskriti University, Mathura, Uttar Pradesh, India
Email Id-hodmaths@sanskriti.edu.in

ABSTRACT:

Aerodynamics is the study of air and dynamics for and solid body which is seen in the design and development of airplanes. The aviation system is mostly dependent on the aspects of aerodynamics and designs. The focus of the study is to analyze the different applications utilized using aerodynamics designs for any floating elements with their environment. Different scientists and researchers study the application and utilization of aerodynamics. There are many studies developed on aerodynamics and the parameter considered in aerodynamics. Bernoulli's equation, Euler's equation, and Navier-Stokes equations are important factors considered while designing airplanes and floating bodies. The study of aerodynamics is the part of designing floating as well are moving bodies that have their moment of inertia. Thus, various methods are now evolved by using old methods and studies in aerodynamics which improve the performance and efficiency of the solid floating elements. So, the aerodynamics study is necessary and developed within the next few years which can be applied in magnetic-train, aviation, and ships.

KEYWORDS:

Aerodynamics, Airplane, Floating Bodies, Computational, Navier-Stokes Equation.

1. INTRODUCTION

There have been many images of aircraft across written history, such as the mythology of Daedalus and Icarus in Ancient Greece. However, the science of aerodynamics only started in the late 1700s. Humans have been employing aerodynamic forces to move sailboats as well as windmills for thousands of years. Consistency, drag, as well as differential pressure, were fundamental ideas in the works of both Aristotle and Archimedes. The study of air movement, especially how it is impacted by solid things like airplane wings, is known as aerodynamics, which itself is defined as "air + dynamics". Although essential ideas like aerodynamic drag were seen and documented much earlier, the scientific science of aerodynamics did not start until the 17th century. Otto Lilienthal made the first attempt at heavier-than-air flying in 1891, which was the main focus of early aerodynamics research. Since that time, the application of aerodynamics by applied mathematics, experimental approximation, air flow experiments, and computational methods has provided a reasonable foundation for the advancements of heavier-than-air aircraft and a variety of other technology [1]–[3].

Sir George Cayley first distinguished the four aerodynamic forces of flight weights, lifts, thrust, and drag, and the relationship between them in 1799. Through the ensuing century, heavier-than-air flying was made possible because of this. The first wind tunnel was created in the year 1871 by Francis Herbert Wenham and allowed the specific measurement of aerodynamic force. Drag

theory was developed by Gustav Kirchhoff, Lord Rayleigh, and Jean le Rond d'Alembert. Charles Renard, the aviation engineer from France, was the first to guess with precision how much power would be needed for prolonged flight in 1889. Otto Lilienthal was the one to propose the use of winglets with a sharp curve to produce great lift and little drag. He was the only one to fly in gliders with tremendous success [4]–[6]. The Wright brothers conducted research out of their airflow and built on these advancements to fly the first powered aircraft (Figure 1). The latest research in aerodynamics has grown more computational and concentrated on problems relating to compressible flow, turbulent, and boundary layer flow[7].

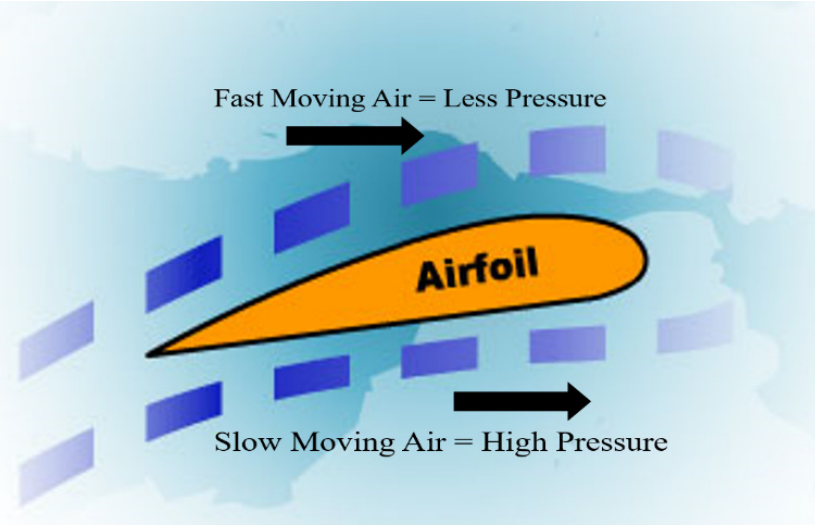


Figure 1: Represents the Air Flow and Pressure Relation on the Airfoil Body during Floating [8]**.**

Calculating the forces and torques acting on an item requires knowledge of how the air is moving around it. The basic force of flight weight, lifts, thrusts, and drag are the forces of importance in many aerodynamics issues. Aerodynamic forces, or those brought on by air movement over a solid body, include lift and drag [9], [10]. The presumption that the fluid flow operates as a continuum underlies the calculation of these values often. Properties including fluid velocity, temperature, volume, and pressure, which may be variables of place and time, are used to describe continuous flow fields. These characteristics can be computed using the equation for the conservations of masses, momentums, and energy inflow of air or directly observed in aerodynamics experiments. Flow fields are categorized based on density, flow rate, and viscosity [11], [12].

Aerodynamics is an important component of vehicle design, especially for racing automobiles where increasing downforce overall is also a goal in addition to minimizing drag, as well as for cars and trucks used on the road. Foreseeing the forces and torques that will impact sailing vessels requires an understanding of aerodynamics. Aerodynamics mostly is used by structural engineers to quantify wind loads while designing tall wind turbines, structures, and bridges. Internal channel aerodynamics is essential for ventilation, gases pipeline, and automotive engine because exact flow patterns have a substantial influence on engine performance. Thus, the study of aerodynamics is important and useful to know its new and different aspects with the new technologies.

2. LITERATURE REVIEW

Joaquim R.R.A. Martins discussed Continuous advancements have been made in Computational Fluid Dynamics (CFD) solutions, mesh distortion, sensitivity, and optimization algorithms in this field of study. We discuss current advancements for most of these parts and outline open-source technologies for optimizing aerodynamic form. The development of a superior airfoil beginning from a circle, an online tool that quickly optimizes airfoils, aerodynamic and aero-structural aircraft evaluation, and aero-propulsive enhancement are only a few of the applications discussed. We concentrate on the RANS-based benchmarks from the (Aerodynamic Designs Optimization Discussion Groups) ADODG and talk about some of the complications we ran across, such as comparing Euler and RANS findings and design-space multimodality. It is anticipated that having access to these benchmarks and open-source tools would facilitate more research and benchmarking in CFD-based aerodynamics design and optimization.

Sayan Ghosh et al. studied the process of developing the individual Industrial Gas turbine (IGT) components as an illustration of this, which results in a potential efficiency that is not reached. The authors show how to use a probability-inverted designing machine learning framework (PMI) to do an intentional inversion design to get over the aforementioned difficulties. The difficulties brought on by poorly presented inverse issues are solved by PMI, which explicitly calculates the design without using an excessive number of expensive iterations. In this study, the inversion aerodynamic design of 3-dimensional turbine blades will be used to show the framework [13].

Paul Olugbeji Jemitola and Paulinus Peter Okonkwo focused on the Box-Wing concept, airfoil properties, and aerodynamic challenges particular to Box-wing aircraft, this research examines the development and current developments in the aerodynamics layout of Box-Wing planes. The study was done to draw attention to the unique qualities of the Box-Wing structure that make it so desirable as a future aircraft. The research shows that the Box Wing Airplane has a sizable aerodynamic advantage over other types of aircraft. A little less drastic deviation from the norm is the Box-Wing Aircraft layout. Thus, it may be built using tried-and-true approaches, procedures, and technology for aircraft design.

Jichao Lia et al. discussed the current level of knowledge and unresolved issues in aerodynamic form optimization in this study (ASO). Next, we outline the foundations of the learning algorithm and go into depth about the Machine learning (ML) algorithm that is been successful in ASO. Then, we examine ML applications that support ASO from three key angles: a geometrical design space, a quick aerodynamic analysis, and an effective optimization architecture. However, because of the high costs of ML training, effective large-scale design improvements continue to be difficult. To effectively train ML models, a close linkage of ML model creation with ASO's previous expertise and information, such as taking into consideration physics, is advised.

Antony Jameson developed the Aerodynamic Designs using Control Theory. This argues that it is advantageous to see the design issue as a control issue, with the boundary's form serving as the control. Since the adjoining equation is of equivalent difficulty to the flowing equation and the rest auxiliary equations might be solved very affordably, the investment of every iteration is in the order of two flow solutions. Therefore, these kinds of techniques may be utilized to create better designs, provided that one can pay the price of a reasonable number of flow solutions [14].

Swarna Mayuri Kumar studied an aerodynamics design for a Blended Wings Body (BWB), Unmanned Aerial Vehicles (UAV) what is being done right now. Based on the design requirements, a trade study was conducted to develop the aerodynamic design parameter. The BWB platform's attributes were included using standard sizing and trade research methodologies. In addition, the use of morphing or adaptive designs can improve the UAV's aerodynamic performance. The advantages of the morphing winglet concept for aerodynamic performance are then determined by comparing the optimal configuration to the baseline configuration. It is discovered that winglet arrangement, which also improves the lifting-to-drag ratio, reduces the drag coefficient at high velocities. When a morph-able winglet is incorporated into the architecture of the BWB vehicle, CFD modeling indicates that the wing's aerodynamics efficiency will rise.

Kelei Wang and Zhou Zhou discussed the installation restrictions for distributed electric propulsion (DEP), and their study discusses the aerodynamic designs and evaluation of BWB configurations. The Reynolds Averaged Navier-Stoke (RANS) CFD flow solver is used to numerically model and analyze the BWB layout and the DEP-induced effects. A scaled-down model of the intended BWB configuration is tested in a wind tunnel to further show the viability and dependability of the design approach. The aerodynamic properties and the BWB stream flow are monitored and studied. The outcomes show that the optimal design technique described in this research is reliable and practical.

A. Jameson et al. discuss the formulation of control theory-based optimization strategies for designing aerodynamic shapes in the viscosity of compressible flow, as represented by the Navier-Stokes equations. It expands on earlier optimization research for inviscid flows. The boundary shape serves as the control when the concept is applied to systems described by the flow's partial differential equations. By utilizing multigrid methods and preconditioning to quicken the converging of solutions, the cost is maintained to a minimum. Designs for wings and wing-body combinations for long-range transport aircraft provide illustrations of the method's effectiveness. Twenty to forty design cycles are often required to produce satisfactory designs [14].

Timothy Chau and David W. Zingg studied each aircraft's wing-body-tail models, and gradient-based aerodynamic shape implementation is carried out to minimize drag at cruise for a notional mission. Constant lifts, no pitching moments, small-wing volumes, and constrained thickness-to-chord ratios are examples of irregular restrictions. Degree of freedom (DOF) and Dimensional analysis are design characteristics that are accomplished using an unrestricted and axially deforming geometry control system. According to the results, the optimizer can reduce the impacts of each winglet, especially those at the wing-struts connection of the strut-braced wings, on shock production, boundary-layer dispersion, and other flowing interference effects. In comparison to conventionally tube-and-wing aircraft such as the Embraer E190-E2, the strut-braced-wing passenger jet has a cruising lift-to-drag ratio that is 12.9 percent higher. This results in a 7.6 percent reduction in fuels for the hypothetical missions at the 2020 technology level.

Thus there are different studies on the application of aerodynamics to know its different properties and advancements. Aerodynamics is the study of different flow dynamics of bodies with different flow parameters. While designing and body or vehicle it is necessary to know and study its flow dynamics. Designing the machines and vehicles with the flow study needs the proper knowledge and so different studies are developed to ensure the safety of users. The

statics, dynamics, and different theories are necessary and should be studied for designing the body where ever there is an impact of aerodynamics.

3. DISCUSSION

To categorize fluids as per the speed regime, the flow velocity is employed. The airflow field in subsonic flow fields is always lower than the localized speed of sound. Subsonic flow zones and zones where the localized flow speed exceeds the local sound speed are both considered to be transonic flow zones. Supersonic flows are those in which the overall flow speed is higher than the velocity of sound. Hypersonic flow, the fourth categorization, is used to describe flows when the flow rate is significantly higher than that of the velocity of sound. Aerodynamicists have differing opinions on what exactly constitutes hypersonic flow as shown in Figure 2. Variations in flow density are taken into account by compressible flow. Assuming constant density, subsonic flows are sometimes imagined as being incompressible. Since supersonic and hypersonic flows can compress, computations that ignore these flow fields' changing densities will produce unreliable findings.

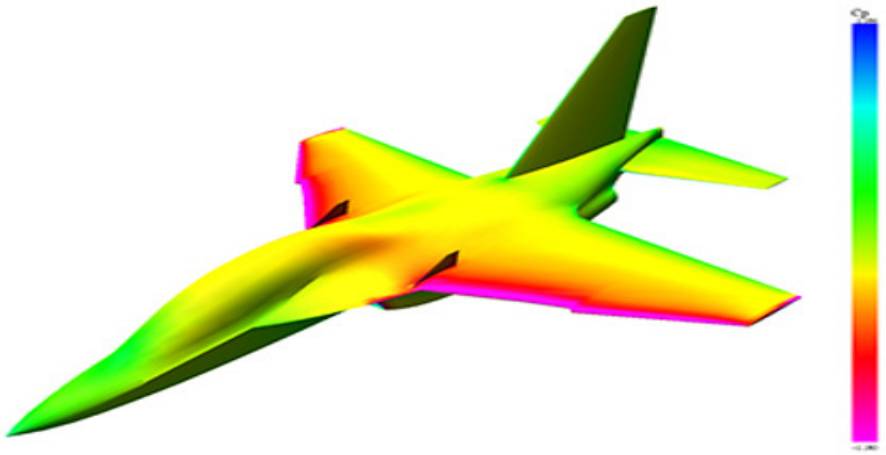


Figure 2: Represents the Analysis of the Aerodynamics Design of the M346 Aeroplane to Ensure its Work Sustainability.

A flow's frictional forces are related to the viscosity of the fluid. Some flow fields have extremely modest viscous effects, therefore approximate solutions can safely ignore them. Inviscid flows are what we term these approximations. Viscous flows are those in that viscosity is just not disregarded. The flow environment may also be used to categorize aerodynamic issues. Inside aerodynamics is for circulation via channels inside solid objects, whereas exterior aerodynamics is the exploration of flows surrounding the solid object of diverse forms as shown in Figure 3. In contrast to solids and fluids, gases are made up of distinct molecules that only take up a small portion of the space that the gas fills. The molecular level collisions of several gas molecules with one another and with rigid surfaces form flow fields. However, the discrete molecular character of gases is disregarded in the majority of aerodynamics applications, and the flow field is presumptively continuous in behavior. This presumption enables the definition of fluid parameters throughout the flow, including density and flow rate.

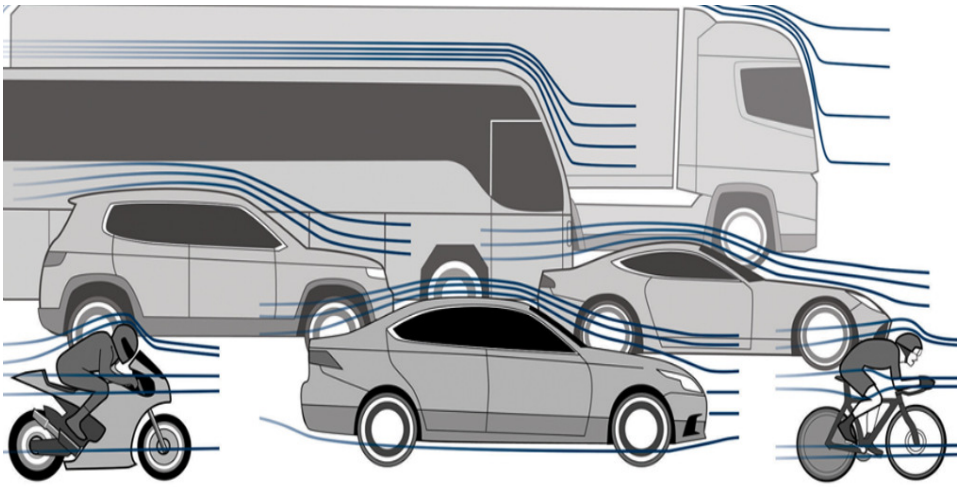


Figure 3: Represents the Flow Aerodynamics of Different On-Road Vehicles with Different Workability [15]**.**

Depending on the application and gas density, the continuum assumption may or may not be true. The mean-free route length must be significantly less than the size range of the applications in issue for the continuous assumption to be true. In many aerodynamics applications, for instance, the object is orders of magnitude bigger, and the mean-free transmission range is on the scale of micrometers for planes flying in atmospheric circumstances. In these situations, the aircraft's length scale is substantially more than the make-free path length, ranging from a few meters. The continuous hypothesis is appropriate for these applications. For incredibly low flows, such as those experienced by aircraft flying with very higher latitudes or satellites in low Earth orbit, the continuity assumption is less reliable. Statistical mechanics solves the problem more precisely than continuum aerodynamics in certain situations. The Knudsen value could be used to help choose whether to utilize continuous aerodynamic or mathematical modeling. The conservation rules of fluid dynamics can be used to address aerodynamics issues under the premise of fluid continuity.

3.1.Three Conservation Theories are Employed:

3.1.1. Conservation of Energy:

“Energy is never generated nor destroyed inside a flow, according to the energy conservation equation, and also any additions or subtractions of energy to such volumes in the flows is caused by heat transfers through work into or out of the area of concern”.

3.1.2. Conservation of Momentum:

“This principle's mathematical version might be thought of as an implementation of Newton’s 2nd Law. External factors, including body forces, and viscous or frictional forces, such as weight, are the only things that may modify the momentum of a flow. The conservation of momentum principle can be represented as a vector equation or as a 3-scalar equation (x,y,z component)”.

3.1.3. Conservations of mass:

"The conservation of masses principle states that mass cannot be generated or destroyed inside a flow; the mass continuity equations are the mathematical articulation of this idea". The Navier-Stokes equations are these equations put together, while some writers only consider the momentum equation when using the word. Because there is no established analytical solution for the Navier-Stokes equation, computational methods are used in contemporary aerodynamics to solve them. The Navier-Stokes equations are and have been still being simplified due to the historical lack of computational methods employing high-speed computers and the computation complexity of solving these complicated equations now that they exist. In situations when the impact of viscosity is anticipated to be minimal, the Euler equations, a set of related conservation equations, may be utilized. Laplace's equations and potential-flow theories are the results of additional simplifications. The energy conservation and momentum equations may both be solved in one dimension using Bernoulli's equation. These equations are frequently used with the ideal gas or another similar equation of states to create a precise system that enables the solutions for the unknown factors.

If the density fluctuates along a streamline, a flow is considered to be compressible according to aerodynamics theories. This implies that variations in density are taken into account, unlike incompressible flow. Typically, this occurs when the flow's Mach number reaches 0.3, whether completely or in part. Even though the Mach number 0.3 is somewhat arbitrary, it's chosen since gas passes with such a Mach number below the level show density variations of less than 5%. Furthermore, the item's stagnation point when flow speed is 0 is where the largest density change of 5% occurs, but changes in density elsewhere on the body will be much smaller. All compressible flows, including hypersonic, transonic, and supersonic ones.

1. *Transonic flow*

The region of flow velocity just underneath and beyond the ambient velocity of sound is referred to as "transonic". The expression refers to the speed range between crucial Mach numbers, during which much of the velocity throughout an aircraft becomes supersonics, and higher speeds, usually near Mach number 1.2, at which all of the flow becomes supersonic flows. Between these speeds, there exist airflows, some of which may be supersonic and some are not.

2. *Hypersonic flow*

Aerodynamically, hypersonic speeds are quite close to supersonic speeds. In 1970, the term was first used to refer to speed higher than the other or equivalent to Mach 5 which is five times the velocity of sound. The hypersonic regimes are the subset of the supersonic realm. The properties of hypersonic airflow include viscosity contacts, chemical gas dissociations, and high-heat flow behind a shock wave.

3. *Supersonic flow*

Problems with supersonic aerodynamics include flows moving faster than the light of sound. An illustration of a supersonic aerodynamics challenge would be determining the lift just on Concorde while on a cruise.

3.2.Flight forces:

3.2.1. Weight:

On Earth, everything is weighed. This force is caused by things being pulled downward by gravity. An airplane requires something to propel it against the force of gravity to fly. How hard of a push is required depends on the object's weight. Jumbo jets require far more upward thrust than a kite does.

3.2.2. Lift:

Lift is the upward movement made possible by a push. The force that opposes weight is this one. Anything that flies needs lifts. An airplane must have more lift than weight to ascend. The heated air inside a hot air balloon gives it lift because it is lighter than the air surrounding it. The balloon is carried aloft by rising hot air. The rotor blade at the propeller top provides a lift for the craft. The helicopter rises as they fly through the air. The wings of an airplane provide lift. An airplane's wings are what give it the ability to fly. The top of an airplane's wing is curved, whereas the bottom is flatter. Air moves more quickly over the top of that form than beneath it. Therefore, there is less air pressure over the wing. The wing and the aircraft to which it is connected are forced upward by this circumstance. On many airplanes, there is a technique used to adjust the air pressure utilizing curves. Rotor blades on helicopters employ this tactic. Curved shapes also provide lift for kites. Even sailboats employ this idea. The sail of a boat resembles a wing. The sailboat moves because of this.

3.2.3. Drag:

A force that works to slow anything down is called drag. It makes moving an object challenging. Walking or running in water is more difficult than through the air. Water produces greater drag than air, which explains why. The quantity of drag is also affected by an object's form. Generally speaking, flat surfaces drag less than rounded ones. Generally speaking, compact surfaces have much less drag than wide ones. A surface creates greater drag the more air it encounters.

3.2.4. Thrust:

The force that opposes drag is known as thrust. The force that propels something ahead is called a thrust. An airplane has to have more thrust than drag to continue going ahead. A propeller may provide the push for a tiny aircraft. Jet engines may provide a push for bigger aircraft. Thrust does not exist in a glider. Only after the drag compels it to slow down and land will it be able to fly. When compared to subsonic flow, supersonic flow behaves extremely differently. Fluids respond to variations in pressure fluids to adapt to their surroundings by changes in pressure. Because sound is an invisible pressure difference going throughout a flow, the velocity of sound inside that fluid may be thought of as the faster velocity at which "data" can pass through the flow. This distinction is most readily seen when a fluid strikes an item. As the fluid moves toward that item and collides with it, the fluid moves toward the object and accumulates a stagnation point in front of it. Such pressure disruption can spread upstream in fluid moving at subsonic speeds, altering the flowing pattern in front of the item and creating the appearance that the fluid “recognizes” the paper thereby appearing to adapt its velocity and flow around it. However, the pressure disruption cannot move upstream in a supersonic flow.

When the fluid comes into contact with the object, it is forced to alter its density, temperature, Mach numbers, and pressure in an exceedingly violent as well as irreversible manner known as shock waves. The existence of shock-wave, as well as the compaction effect of fluids moving at greater speeds, distinguishes the sonic and subsonic aerodynamic regimes. Thus, the floating and moving body are affected by the direction of air and flow which improves the working and performance of machines. There are many studies on the impact of floating bodies and the dynamics used in their design to improve their workability using different theories and laws.

4. CONCLUSION

The study of air dynamics which means aerodynamics is important and should be studied while designing any component. There are various studies made by different experts in the field of aerodynamics. Some important concepts should be known and studied in history while designing any moving body. The theories and laws which are utilized in different designing of any bodies are necessary. The floating bodies use is increasing over the world for airways, skyways, or on-road bodies dynamics. Bernoulli's equation, Navier-Stoke equation, Laplace equation, and Euler's equations are still used for designing any floating and moving body. By studying the various papers it is seen that there are different properties of floating bodies concerning the fluid. The study is done to know the importance of aerodynamic designs and properties for different bodies. Thus, the design of anybody is the important parameter that impacts the working of bodies. The study helps further to analyze the different properties of the fluid and the floating bodies within different fluids.

REFERENCES

[1] P. Panagiotou, P. Kaparos, C. Salpingidou, and K. Yakinthos, "Aerodynamic design of a MALE UAV," *Aerosp. Sci. Technol.*, 2016, doi: 10.1016/j.ast.2015.12.033.

[2] M. Nili-Ahmadabadi, F. Aghabozorgi, D. S. Cho, and K. C. Kim, "Development and validation of a hybrid aerodynamic design method for curved diffusers using genetic algorithm and ball-spine inverse design method," *Alexandria Eng. J.*, 2021, doi: 10.1016/j.aej.2021.01.034.

[3] B. Hand, G. Kelly, and A. Cashman, "Aerodynamic design and performance parameters of a lift-type vertical axis wind turbine: A comprehensive review," *Renewable and Sustainable Energy Reviews*. 2021. doi: 10.1016/j.rser.2020.110699.

[4] P. D. Bravo-Mosquera, L. Botero-Bolivar, D. Acevedo-Giraldo, and H. D. Cerón-Muñoz, "Aerodynamic design analysis of a UAV for superficial research of volcanic environments," *Aerosp. Sci. Technol.*, 2017, doi: 10.1016/j.ast.2017.09.005.

[5] Z. Liu, L. Luo, and B. Zhang, "An aerodynamic design method to improve the high-speed performance of a low-aspect-ratio tailless aircraft," *Appl. Sci.*, 2021, doi: 10.3390/app11041555.

[6] F. X. An, L. Li, W. Su, W. L. Liu, and C. Dong, "Key issues in hypersonic vehicle aerodynamic design," *Sci. Sin. Phys. Mech. Astron.*, vol. 51, no. 10, 2021, doi: 10.1360/SSPMA-2021-0135.

[7] K. Wang, Z. Zhou, X. Zhu, and X. Xu, "Aerodynamic design of multi-propeller/wing integration at low Reynolds numbers," *Aerosp. Sci. Technol.*, 2019, doi: 10.1016/j.ast.2018.07.023.

[8] National Aeronautics and Space Administration, "What Is Aerodynamics?," 2018.

[9] C. Fu, M. Uddin, and C. Zhang, "Computational Analyses of the Effects of Wind Tunnel Ground Simulation and Blockage Ratio on the Aerodynamic Prediction of Flow over a Passenger Vehicle," *Vehicles*, vol. 2, no. 2, pp. 318–341, 2020, doi: 10.3390/vehicles2020018.

[10] M. Ghommem, M. Hassanalian, M. Al-Marzooqi, G. Throneberry, and A. Abdelkefi, "Sizing process, aerodynamic analysis, and experimental assessment of a biplane flapping wing nano air vehicle," *Proc. Inst. Mech. Eng. Part G J. Aerosp. Eng.*, vol. 233, no. 15, pp. 5618–5636, 2019, doi: 10.1177/0954410019852570.

[11] T. Abbas, I. Kavrakov, G. Morgenthal, and T. Lahmer, "Prediction of aeroelastic response of bridge decks using artificial neural networks," *Comput. Struct.*, vol. 231, 2020, doi: 10.1016/j.compstruc.2020.106198.

[12] J. Zhang *et al.*, "Aeroelastic model and analysis of an active camber morphing wing," *Aerosp. Sci. Technol.*, vol. 111, 2021, doi: 10.1016/j.ast.2021.106534.

[13] S. Ghosh *et al.*, "Inverse Aerodynamic Design of Gas Turbine Blades using Probabilistic Machine Learning," *J. Mech. Des.*, pp. 1–16, 2021, doi: 10.1115/1.4052301.

[14] A. Jameson, L. Martinelli, and N. A. Pierce, "Theoretical and Computational Fluid Dynamics Optimum Aerodynamic Design Using the Navier-Stokes Equations 1," *Theor. Comput. Fluid Dyn.*, vol. 10, pp. 213–237, 1998.

[15] events.imeche, "international conference on vehicle aerodynamics 2016: aerodynamics by design," 2016.

CHAPTER 12

EXPLORING THE CHARACTERISTICS OF VARIOUS MATERIALS USED FOR DESIGNING AN AIRCRAFT

Mr. Aishwary Awasthi,Research Scholar,
Department of Mechanical Engineering,Sanskriti University, Mathura, Uttar Pradesh, India
Email Id-aishwary@sanskriti.edu.in

ABSTRACT:

Aeronautics is the branch of aerospace science that deals with aircraft and sky aviation. Innovation is part of science as new technologies are evolving in every field in which aerospace has an important place. Different studies by different experts have followed the finding of the appropriate element compounds for making aircraft. The focus of the study is to explore the various materials used in the designing of aircraft, there are various new compounds and materials used in the construction of aircraft. Polymers are the new compounds that are good and effective for designing aircraft with lightweight such that it reduces the efficiency. The aircraft is the fastest and most efficient mode of transport which will be developed with time as it will be made affordable to everyone by reducing the development cost. The study will help to analyze the different materials which can be used and utilized for developing highly efficient aircraft.

KEYWORDS:

Aircraft, Designing Aircraft, Aerospace, Composite Materials, Polymer.

1. INTRODUCTION

Materials used in aerospace are generally metallic alloys that have been designed for prominence. These applications frequently call for materials with high strength, heat resistance, or performance, even when doing so requires expensive manufacturing or machining processes. Others are selected because of their durability and fatigue resistance in this safety-conscious profession. Within aerospace engineering, the discipline of material science is significant. The worldwide standards organizations that uphold criteria for the related materials and processes define their practice. Engineers working in this industry studied widely for bachelor's or post-graduate credentials in it. Those well-known and frequently naturally occurring materials that were initially employed to build the first aircraft were the original aeronautical materials. These comprised commonplace supplies like wood for the wing construction and cloth and dope for the coverings. Their excellence was of the highest significance, thus the Sitka spruce used for the construction and the Irish fabric covering would both be carefully chosen. For the selection, production, and application of these materials, standards had to be met. These guidelines were created explicitly by businesses or governmental organizations, including HM Balloon Factory, which eventually became RAE Farnborough, sometimes with the aid of university engineering disciplines.

The development of aircraft materials moved forward with the utilization of recently developed materials, like Duralumin, the first age-hardening aluminum alloy. These characteristics were newly given. Many of these novel materials also needed to be studied to understand their scope, behavior, and optimal applications. The coalition government national laboratories, like the Reichsanstalt or just the British National Physical Laboratory (BNPL), were frequently used for this purpose. Y alloy, possibly the first purposefully manufactured aircraft material, was also created by the BNPL. After a series of tests conducted during the first World War, with the specific goal of finding a superior material for the production of pistons for aviation engines, some of the first nickel-aluminum alloys were produced [1]–[5].

From the early Wright Flyer that was flown at Kittyhawk to the modern supersonic SR-71 Blackbird, aircraft have seen significant modification as shown in Figure 1. The advancements in aeronautical engineering can be divided into different subfields that have progressed at various rates:

- Aerodynamics
- Power plant engineering
- Control, radios, and navigation aids,
- Airframe engineering
- Structural design.

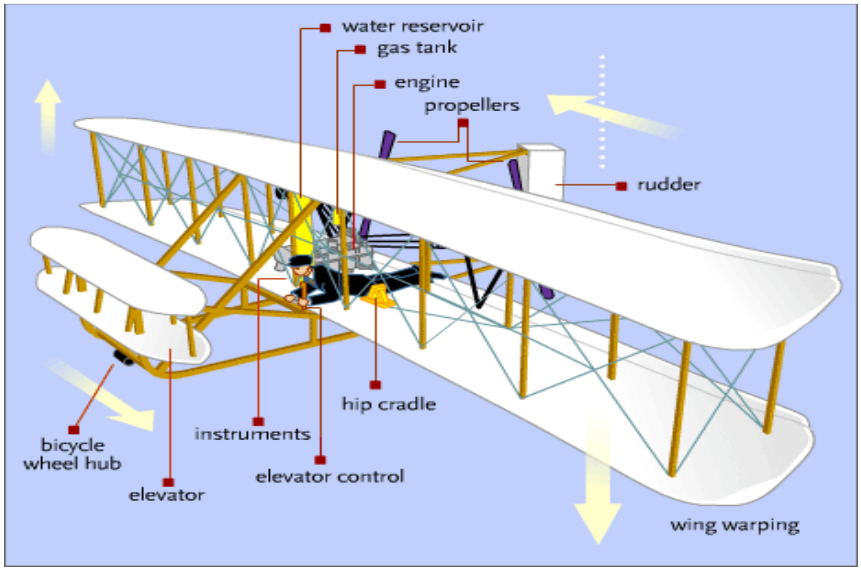


Figure 1: Illustrating the First Pilot Power-driven Aircraft Built by the Brothers [sutori].

While they too benefitted from stronger materials, many aeronautical developments between the wars were in the area of production techniques rather than merely better materials. The addition of silicon to one of the R.R. compositions, R.R.53B, increased its fluidity while molten. This made it possible to utilize it for processes like die casting, as well as the earlier sand casting, to create components that were both cheaper and more exact in terms of shape and polish. Better form control enabled designers to accurately shape them for their purposes, resulting in components that were also lighter and thinner. During the interwar period, aviation engines saw several advancements that aided the expanding automobile sector. Although not exactly an "aerospace" breakthrough, the hard-facing of exhaust ports with refractory alloys like Stellite

and Brightray led to significant improvements in the dependability of aircraft engines. Because the newer models were dependable enough to be regarded as safe for lengthy flights overseas or mountain ranges, they promoted long-distance commercial flights.

The 1936 de Havilland Albatross airliner had a wooden sandwich-style fuselage, with balsa sheets between wafers of birch plywood. With its application inside the Mosquito quick bomber during the war, the same structure gained notoriety. In addition to having a lightweight and efficient construction, it also eliminated the use of aluminum, a material that is crucial in times of war, and it could make use of woodworkers' talents or those of expert aviation metalworkers. Germany's effort to duplicate this aircraft under the Moskito name failed, partly due to a lack of adequate materials. Only one facility that was bombed to death created the first phenolic Tego film adhesive. Replacement immediately resulted in catastrophic failures including aircraft loss [6].

The feeding antennas and reflectors of radar have to be shielded from the airstream and made compact enough to have been carried on board airplanes. Using Perspex acrylic material that was already being used for cockpit windows, molded radomes were built. This might be molded or vacuum-shaped after being heated to soften it. Other polymers created at this time, particularly Nylon, were used as high-voltage insulators or dielectric materials in tiny radio equipment. Flat sandwich sheets called “honeycomb constructions” were created and utilized as bulkheads and decks. These had a long history of usage with paper board and wood construction, but aeronautical applications demanded more durable materials. This was accomplished using an all-aluminum honeycomb sandwich after the war [7].

Due to their strength, low weight, and corrosion resistance, composite materials are also employed in the aviation sector in addition to metals. Different materials that have been chosen based on their structural qualities are combined to form composites. They could be constructed from fibrous components enmeshed in a resin matrix. To achieve the necessary strength and stiffness, fibers with one orientation often need to be laminated with fibers having a different orientation. Modern airplanes are mostly made of composite materials, whose usage has been steadily growing over the last several years while decreasing the use of metallic components.

1.1. Evolution of Technology:

The majority of the first aircraft were made of wood and cloth since they were readily available, light, and had already been manufactured. Streamlining was not a major priority at lower speeds than possible, thus many wires, struts, braces, and other devices were utilized to give the required structural strength. The preferred materials were often close-woven textiles, not canvas as is sometimes claimed, and reasonably light and sturdy timbers. As speeds increased, so did the need for stronger structures. Designers considered the strength and wind resistance of each aircraft component. For higher strength, better streamlining, and reduced weight, bracing wires were given a more streamlined form, and some manufacturers started producing laminated wood fuselages of monocoque construction. Among the aircraft that used this design was the French Deperdussin races of 1912, the German Albatros fighters of “World War I”, and the subsequent American Lockheed Vega. Wood and fabric-based aircraft required a lot of maintenance and degraded quickly when exposed to the weather. Due to this and the need for higher strength, metal is used in airplanes. The Fokker aircraft business employed welded steel tube fuselages during World War I, while the Junkers firm produced all-metal aircraft using dual tubing and aluminum covering.

The use of all-metal construction gradually increased between 1919 and 1934, with some aircraft having all-metal structures fabric-covered and other aircraft having an all-metal monocoque construction. As the requisite manufacturing capabilities were established, the use of metal allowed aircraft to be both lighter and simpler to construct since it is stronger and more durable than cloth and wood. Along with the advancement of polymer composites, new lightweight materials include CNT yarns, polymer aerogels, ceramic matrix composites, and metal matrix composites. As a result of the replacement of these more dependable structures, quicker manufacturing cycles, stronger, lightweight materials, and higher power-to-weight ratios are now available. Thus, various materials are studied and developed by different scientists used for designing aircraft to improve their efficiency. So it is necessary to study such materials which are new and useful in designing aircraft.

2. LITERATURE REVIEW

Muhammad Ayaz Ahmad et al. developed a methodology for Composite Material Selection for a Lightweight Aircraft's Retractable Major Landing Gear Strut. According to the authors in the modern world, it is still difficult to design and build high-strength and lightweight composite landing gear beams. For indicated light planes up to 1.6 ton mass, a methodology for choosing fiber-reinforced composites for the extendable landing gears struts is proposed in this paper. The performance of landing gear struts during a collision detection test was then modeled for those that satisfied the Tsai-Wu failures criteria and had maximum strength-to-weight ratios. It concluded and suggested that T300 carbon fiber/epoxy be used to make landing gear supports for certain lightweight aircraft.

According to Llewellyn Morse et al., optimization of manufacturing costs for composite aircraft components is based upon reliability. By breaking down the production process into several discrete tasks that may be combined in numerous ways, this technique enables the suggested optimization methodology to be used on a variety of composite aircraft constructions. The buckling resistance of the panel is used to gauge its dependability, and the manufacturing cost is assessed using the separate costs of more than 20 operations. That results emphasize the need of considering non-material costs when designing composites of lightweight material given that tool costs, material, labor, and machine, can vary dramatically depending on the amount of structural dependability required.

Mohammad Yazdani-Asrami et al. stated future cryo-electrified aircraft's insulation systems and materials, with Part I concentrating on material needs and applicability at the device levels. The difficulties and factors to be taken into account while selecting insulation material for superconductivity equipment in cryo-electrified airplanes are examined and explored in this research. Due to the unique construction, operation temperature, and operating conditions of superconducting equipment at high altitudes, superconductors, like every conductor, require normal insulation to perform safely and reliably in an aircraft's electrical system. Extra care should be taken to select suitable insulating materials for these applications.

Danilo Ciliberti et al. developed the Commuter Aircraft's Enabling Technologies for Quasi-Zero Emissions. Research has shown that new aircraft techniques do not significantly reduce fuel burn unless the operations and maintenance ranges are restricted within quick regional routes or even if electrical energy storage capacity is unbelievably high and this meager benefit is at the cost of increasing maximum weight as well as operational expenses. With an emphasis on the commuter category. Indeed, this same European Community, which has funded several initiatives, believes

that improvements in small air route travel would be a crucial step in evaluating the outcomes and paving the way for larger, more environmentally friendly aircraft.

Semyeong Lim et al. study was to design the intake valve construction for a little airplane. To evaluate structural safety, a method known as finite element analysis (FEA) had employed. In their study, the structural designs and computer simulation of the air intakes and s-duct components for the light aircraft. Investigating the structural engineering load while taking safety considerations. To examine the reliability of the design results, a structural analysis was conducted. It was established through structural analysis utilizing the finite element model approach that the planned intake manifold structure is secure. Based on the intended outcome, the sample design will be manufactured.

Janani Kavi Priya V S et al. developed a theoretical Perspective on the Selection of materials for Satellite Launch Vehicles. The use of sophisticated missiles and rockets in the aerospace industry leads to the hunt for new and innovative materials. To minimize a dead load of rockets and missiles, it is vital to investigate newer, lighter materials for manufacturing. These substances are composite. The range of materials for missiles includes composite materials, composite, 3D printing, and polymer materials. They suggest that using lighter materials enhances the effectiveness, durability, and productivity of projectiles as well as other aerospace applications.

Z. Padovec et al. analyzed optimum composite profiles for airplane building using computational and experimental methods. In that work, two optimal composite designs that are primarily intended for joining airplane structures are created, finite-element analyzed, and validated. T and Y-shaped profiles were produced from carbon fibers and a polyphenylene sulfide matrix fabric (C/PPS) in a single step using the thermoforming technique. Dynamic and fatigue tests were shown on two profiles which find their strengths and structure constraints.

Logan Kupchanko et al. discussed passenger aircraft designs that are lightweight. In that study, aluminum was used as a comparison between two forms of discontinuity carbon-fiber-reinforced Plastics (CFRP), Long Fiber Prepreg Sheet (LFPS), and Sheet Molding Compound (SMC). Modern technology has allowed discontinuous CFRP materials to compete favorably on price with continuous CFRP materials while sustaining acceptable performance levels. The interpretation of the optimization results led to the development of three lightweight design ideas with significant potential for weight reduction. When employing discontinuity CFRP materials to achieve the same stiffness criteria as a traditional aluminum design, both of the three equal mass designs demonstrated 6–8% lower compliance than aluminum, suggesting possibilities for additional weight reduction [8].

There are various studies made by different experts in the field of designing and composing different materials for aircraft. Polymers, alloys, resins, etc. are the compositions of the different materials which are used in the market. The focus of developing such compounds is to make plane lighters such that to reduce fuel consumption. There are various elements developed by different experts in different parts of the world which are discussed in further study.

3. DISCUSSION

Efficiency, comfort, safety, and dependability are just a few of the many aspects that must be taken into account while designing an airplane. The weight given to each of these factors, which might range from fighter jets to commercial aircraft, completely relies on the kind of aircraft

being developed. As a consequence, the aircraft's design must adhere to strict specifications, which have an impact on the complexity of its structure and the materials needed to build it. To make use of qualities like strength, flexibility, specific weight, and corrosion resistance, a broad variety of materials may be employed in the design of the aircraft. Depending on the original requirements for the strength-to-weight ratio and the preferred orientations of the applied loads, other materials may also be employed in the design of certain aircraft components.

The material used for each application also relies on the kind of aircraft that will be built; lightweight constructions employ lighter materials like composites. In research programs that are centered on aircraft design, new materials are constantly being created and tested to enhance factors like aerodynamic efficiency, fuel consumption, and noise generation. Several fresh ideas for novel wing designs and materials are now being developed, with an emphasis on lowering drag and noise levels and perhaps boosting fuel efficiency, Figure 2 shows the materials used in the 787 body.

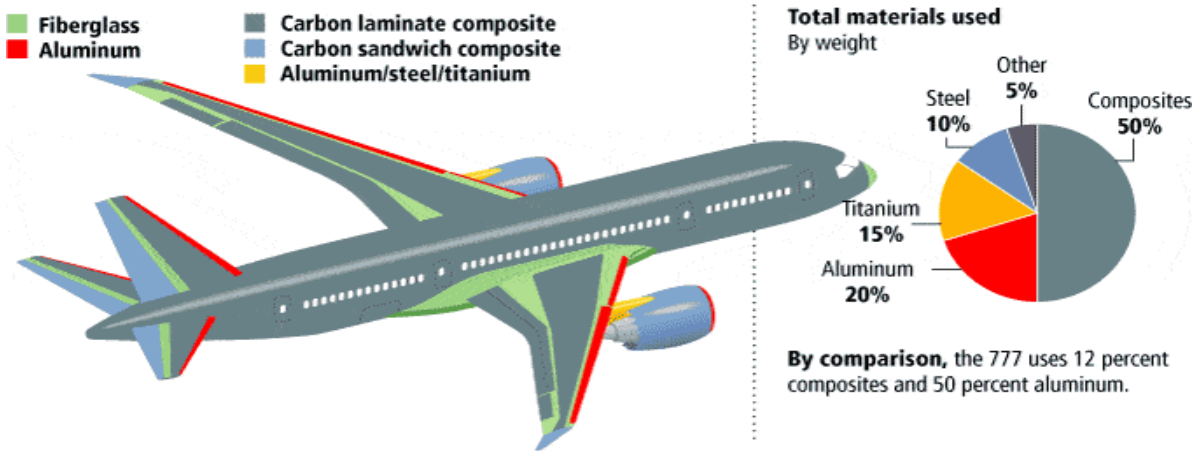


Figure 2: Illustrating the Materials Used for Making the Body of 787 Aeroplane [appropedia].

Designers and producers of airplanes have considered several criteria when they choose materials throughout the years. Functional requirements, lowering manufacturing and maintenance costs, and more. However, the urge of creators to lighten the load of their dependable metal machines served as the primary engine of growth. The degree of safety for pilots, passengers, cargo, and the aircraft itself, as well as its performance, ideal fuel consumption, and flying range, are all influenced by a decrease in this parameter. Expanding the usage of composites in aircraft engineering is a key component of the current engineering paradigm today. These materials provide the perfect compromise between aircraft weight and fatigue and corrosion resistance while also lowering maintenance expenses.

3.1. Designing the First Aircraft with Wood

One material that provides the mechanical and physical qualities necessary for the production of airplane components is wood. When employed in laminate constructions, this material has a high strength-to-weight ratio and, if given a specialized preservation treatment beforehand, is resistant to harmful environmental factors. Early airplanes were built using wood, but current aircraft no longer utilize it since alternative materials, both metallic and non-metallic, are now available that have superior strength-to-weight ratios for lightweight and corrosion-resistant constructions.

3.2. Heat-resistant and lightweight alloy:

The aerospace industry is gaining popularity for two particular alloy wheels that have been there since the 1970s aluminum-lithium (Al-Li) and titanium aluminide (TiAl). These materials can withstand extreme temperatures and enhance the pressure-to-load proportion in aero engines because they weigh only 50% as much as conventional nickel alloys. High-pressure compressor blades and low-pressure turbine blades, which were once fabricated from thick Ni-based superalloys, are being produced from TiAl-based alloys, according to Standridge. Although traditional Al is quite used in aerospace machining, how that material is made is evolving. A growing number of aircraft structures are made of composite materials made of newer, modified alloys, including substances that were once considered too exotic, difficult to handle, or costly. According to Standridge, heat-resistant alloys like titanium alloys, nickel alloys, and non-metallic composites like ceramics are frequently employed to create engines. Ceramics, however, although being able to tolerate high temperatures, may be difficult to form. It is challenging to repair and modify titanium alloys, nickel alloys, and non-metallic composites without compromising their structural integrity.

3.3. Composite materials:

Engineers place high importance on heat resistance, but they also consider a material's total weight. Composites are lighter, allowing enables companies design airplanes that are eventually safer for passengers and much more fuel-efficient. Since 1987, the utilization of composite materials made of metals or polymers and certain proportions of additives in aircraft has increased by 50% every five years, according to ThoughtCo. The three primary categories of composites are glass, epoxy with aramid reinforcement, and carbon fiber. According to Composite Manufacturing Magazine, carbon-fiber composite mixes are the ones that are best positioned for expansion and innovation. For instance, the new A350 series from Airbus has wings that are more than 50% carbon fiber.

According to David Hills, vice president of research and technology at Airbus Americas, they're trying to discover the optimal way of leveraging this material to fulfill goals as everyone is trying to understand these materials which continue to expand. That's not in regards to how durable these parts are, but also in regards to how well they fit into the overall manufacturing process, in terms of price and maintenance of this thing in the field. The composite may also survive high resistance and fatigue, not simply carbon fiber mixes. Composites do, however, present certain difficulties. As it prepares to introduce its composites-“heavy A350-1000” aircraft, Airbus is experiencing a significant backlog.

Fuel expenditures for each pound of cargo, including people, baggage, and airplane parts, amount to nearly $10,000 annually. Carl Holt, an aviation and composite materials head of marketing for Huntsman Advanced Materials, says that if they can lighten the aircraft, they’ll use less fuel and pay less in operational expenses. The XWB wings for Airbus’ A350-1000 are the biggest carbon fiber composite item currently used in aircraft, demonstrating the material's development. For instance, repairing composites is different from repairing conventional airplanes. Fixes are frequently made by hand. Although production time and material costs are significant problems for aircraft makers, they are not impeding R&D, according to Composites.

3.4. Nano-papers:

Manufacturers of aircraft products occasionally want electrical resistance as well as heat resistance. According to AzoNano, reinforced metal matrix compounds, sometimes referred to as metals-matrix nanocomposites were "one among the most significant nanocomposites for their tensile strengths and conductivity". Other kinds of nanopapers, such as those made of polymers and ceramics, are also in use. Unsurprisingly, lightning strikes may damage airplanes, making metal underwiring also with carbon composite components a potentially risky component. According to Composites Manufacturing Magazine, firms employ nanopapers in the CFRPs wing to assist guard against electromagnetic interference to counteract that risk. The study report states that "Nanocomposite is the substance of the 21st century with a yearly increase of 25% due to its multifunction capabilities". Nanotechnology applied. Chemical characteristics like corrosion resistance or passiveness are crucial in aircraft. Aerospace structures must have mechanical attributes such as resistance, strength, toughness, scratch resistance, impact, and fatigue life in addition to low weight requirements.

3.5.Graphane:

Because of the wide range of electrical uses, graphane is the material that more manufacturers are using in their designs. One example is the employment of graphane in epoxy resins to improve the electrical properties of composite materials used in airplane fuselages.

4. CONCLUSION

Foundations are one of the disciplines of aerodynamics, control, propulsion, or structures, which has alternatively served as a barrier to advancement and as a source of significant advances in the history of aeronautics. When designing an airplane, many different considerations must be taken into account, including effectiveness, comfort, safety, and dependability. The weight assigned to each of these factors, which can range from fighter jets to commercial aircraft, depends entirely on the type of aircraft being developed. A wide variety of materials can be employed in aircraft design, to harness properties such as strength, flexibility, specific weight, and corrosion resistance. With the idea of green aviation, the lightweight design has been extensively researched and used in various fields, especially in aerospace applications. Efforts are still being made to reduce aircraft emissions as a result of environmental degradation and the role of aviation in the global warming phenomenon. The strategy to reach this goal is to improve energy efficiency. The reduced aircraft mass results in a lower need for lift force and propulsion during flight, which is a good way to improve energy efficiency and save fuel. Aircraft is the fastest and most efficient mode of transport which will be developed over time as it will be made affordable for all by reducing development costs.

REFERENCES

[1] N. Zimmermann and P. H. Wang, "A review of failure modes and fracture analysis of aircraft composite materials," *Eng. Fail. Anal.*, vol. 115, 2020, doi: 10.1016/j.engfailanal.2020.104692.

[2] H. Berends, E. van Burg, and E. M. van Raaij, "Contacts and contracts: Cross-level network dynamics in the development of an aircraft material," *Organ. Sci.*, vol. 22, no. 4, pp. 940–960, 2011, doi: 10.1287/orsc.1100.0578.

[3] J. Sun, Q. Guan, Y. Liu, and J. Leng, "Morphing aircraft based on smart materials and structures: A state-of-the-art review," *Journal of Intelligent Material Systems and Structures*, vol. 27, no. 17. pp. 2289–2312, 2016. doi: 10.1177/1045389X16629569.

[4] M. Chausov *et al.*, "Influence of dynamic non-equilibrium processes on strength and plasticity of materials of transportation systems," *Transport*, vol. 33, no. 1, pp. 231–241, 2018, doi: 10.3846/16484142.2017.1301549.

[5] R. Boyer and N. Padmapriya, "Aircraft Materials," in *Reference Module in Materials Science and Materials Engineering*, 2016. doi: 10.1016/b978-0-12-803581-8.01934-2.

[6] X. H. Wang and H. W. Luo, "Research and application progress in ultra-high strength stainless steel for aircraft landing gear," *Cailiao Gongcheng/Journal of Materials Engineering*, vol. 47, no. 9. pp. 1–12, 2019. doi: 10.11868/j.issn.1001-4381.2019.000122.

[7] P. Rompokos, A. Rolt, D. Nalianda, T. Sibilli, and C. Benson, "Cryogenic Fuel Storage Modelling and Optimisation for Aircraft Applications," in *Volume 6: Ceramics and Ceramic Composites; Coal, Biomass, Hydrogen, and Alternative Fuels; Microturbines, Turbochargers, and Small Turbomachines*, American Society of Mechanical Engineers, Jun. 2021. doi: 10.1115/GT2021-58595.

[8] L. Kupchanko, S. Roper, H. Lee, M. Huh, and I. Y. Kim, "A Comparison of Lightweight Design Concepts of a Passenger Aircraft Seat Using Topology and CFRP Laminate Optimization," in *Progress in Canadian Mechanical Engineering. Volume 3*, Charlottetown, P.E.I.: University of Prince Edward Island. Robertson Library, Sep. 2020. doi: 10.32393/csme.2020.104.

CHAPTER 13

DEVELOPING AUTOMATIC GARAGE DOOR OPENING SYSTEM FOR VEHICLES

Nishant Kumar,Assistant Professor,
Department of Mechanical Engineering,Sanskriti University, Mathura, Uttar Pradesh, India
Email Id-nishantk.me@sanskriti.edu.in

ABSTRACT:

The garage is the main storage unit for domestic vehicles with doors with various mechanisms. There are many cases of theft of vehicles from garages by hacking the security system. The focus of the study is to develop systems that open doors for authorized vehicles and owners to avoid such thefts. The size of the door varies according to the size of the vehicle which is for two-wheelers and four-wheelers as both have different sizes and shapes. The models have been developed using various technologies to follow the objective of providing safety to the vehicles. The proposed system is capable of analyzing and alerting the user about the conditions of the garage concerning the entry and exit of authorized vehicles. Thus, it is useful for the user to conserve the power required while opening the doors for different types of vehicles according to their size. The study helps in developing a highly secure system for vehicles, which will be developed in the next few decades as the cases of theft are also increasing in the world.

KEYWORDS:

Automatic Door, Door Automation, Garage Door, Security, Vehicle.

1. INTRODUCTION

A mechanical device called an automatic door opener uses knobs on the basement wall to open and close a garage door. The majority also include a short-range hand-held radio remote control that the owner may use to lock and unlock the door. C.G. Johnson created the powered ceiling-mounted garage doors in Hartford City, Indiana, in 1926. After World War II, the Era Meters Companies of Chicago introduced an electrical garage door that allowed homeowners to open their overhead garage door using a keypad on the report at the end of the roadway or a switch within the garage [1], [2]. The majority of the ability to move a massive garage door is not provided by the electric motor, unlike in an elevator. The counterbalance springs linked to the door instead serve to offset the majority of the door's weight (Figure 1). In a common configuration, torsion springs tend to produce shafts, and that shaft then uses steel-balanced cables to impart force to the door frame. Only a modest amount of force is applied by the electric opener to regulate how far the gate opens and closes. Most of the time, the garage door also acts as a lock to keep the door closed.

Figure 1: Represents the Garage Automation Door Closing System With Remote Control.

An electric motor-containing power unit makes up the conventional electric garage door opener. To a track, the power unit is fastened. The garage door is opened and closed by a trolley that is attached to an arm that is attached to the roof of the door frame and glides backward and forth over the track. When the engine is turned on, the belt, screw, or chain twists, guiding the trolley along the track. When there is a power cut or an emergency, the trolley is equipped with a quick-release mechanism that enables the garage door to be removed from the opener and operated manually [3], [4]. The whole thing is suspended over the garage entrance. The power unit is in the back of the garage, suspended from the ceiling.

The track's other end is attached to a headers bracket that is mounted to a headers wall above the door frame at the other end of the main unit. Angle iron that has been punched often supports the power head. Another form of opener, referred to as the jackshaft starter, had also recently gained popularity. Although this sort of opener was widely used on business doors, it has recently been modified used in homes. This kind of door opener uses a motor attached to the torsion rod's side to raise and lower the door by merely rotating the rod. For safe residential usage, these openers require a few more parts. These include distinct locking mechanisms to secure the doors when it is completely closed and cable tension monitoring to determine when a cable is damaged, as shown in Figure 2. These have the benefit of releasing the overhead room that a typical opening and rail would take up. Those now have the drawback of requiring a torsion rod on the door to connect the motor to [5], [6].

Figure 2: Represents the Garage Automation Door Opening System with Sensor Controlled.

The garage doors are the biggest moving component in any home, thus they must function properly. Having a basement door that doesn't work properly is also dangerous. To prevent an unexpected garage door descent that might harm a human or animal, the user must have a properly working garage and garage doors. In a trial involving 50 automatic door openers, researchers discovered that 40% of them were unable to detect a child-sized dummy and change course. A modern Safety standard for Automatic Residence Sliding Door Operators was adopted by the "Consumer Product Safety Commission" in July 2018. The specification calls for all domestic garage doors in the United States to have:

1. A 30-second clock to act as a backup to the two-sec reversed trigger in reopening the gate if it does not entirely close within 30 seconds, which would be the situation if someone or anything was caught beneath, as opposed to the 2 sec reversed trigger.
2. A means of attaching an improved or extra external entrapment-sensing device.
3. If someone becomes stuck underneath the door, there is generally a red grip that swings from the center track that may be used to separate the gate from the garage door.
4. A system that may quickly reverse the movement of a sliding door frame to lessen the danger of entrapment.

Homeowners can feel certain that their garage doors are in functioning order since federal organizations recognize the significance of a completely operating door as well as garage doors. Consider contacting a garage door repair specialist if the user notices any anomalies with the door or opener. Therefore, it is vital to explore the garage door opening function to fully comprehend what is happening with the garage doors. Thus it is necessary to know the different door automation systems in the market which are developing with time for better safety.

2. LITERATURE REVIEW

Vitthal K. Suravase et al. discussed the system to avoid disease transmission due to door closing and opening using hands. However, there is a potential for disease transmission when we contact objects like tables, doors, cars, and other things. Thus proposed a solution to stop them; the model relies on automating, in which we could create a door mechanism that opens and closes automatically. Whenever the Ultrasonic on the door detects a cut, a mechanism is activated to open a door and then close it automatically. As a result, there is no direct physical contact between a person and a door, which will assist stop or slowing the spread of the pandemic sickness. The design developed utilizes the Arduino and Ultrasonic Sensor, to manage the entrance system by detecting the person [7].

Felix Uribe stated the implementation of Internet of Things (IoT) gadgets that are more pervasive in daily lives. They will keep growing exponentially in the upcoming years. It is reasonable to assume that individuals working in the court system and law enforcement will also have to deal with more IoT inquiries and legal issues concerning criminal activity, confidentiality, safety, and responsibilities. That investigation was cover a wide spectrum of IoT devices, from tainted ones used for illegal activity to IoT ones that will assist investigators in many cases by providing a large amount of possible electronic evidence. As demonstrated in the aforementioned example, it is fair to presume that anyone working for or affiliated with the system of justice will soon need to understand how to handle electronic evidence gathered from IoT devices [8].

Vítor Maranha et al. developed a system to stop the pandemic from spreading, and proactive hand-free door openers (HFDO) are being developed. To provide a concept that could be

implemented to currently available models without completely replacing them, the most frequently used door knobs were revised. The development process used an approach that involved 3D modeling and 3d printers of the different components to fully comprehend how they worked together. After being created using computer numerical control (CNC) machining, the final models were put through functional validation testing on volunteers. Because of its focus on the connection between the item and the user, which results from the technique developed in its usage or manipulation, the produced HFDO clearly distinguished itself from the market's current models in terms of shape and material [9].

Thaddeus Madang Dusit and Rasida Norjali studied the Radio Identification Device Frequency (RFID) used to automate the garage door. The author created an autonomous security system that can utilize RFID and an Arduino Uno to unlock the basement door automatically. RFID, an ultrasonic sensor, and an Arduino Uno are used as inputs in this project, and a DC motor, a buzzer, and a liquid crystal display are used as outputs. When the owner uses the RFID system as well as an ultrasonic sensor to scan their identification card at a specific range, the garage will automatically open. The garage door's opening and closing motion are then managed by the 12 V DC motor [10].

Israel Enema Ohiemi et al. conducted a researched on the Design and Modeling of a Smart Garage Door Prototype. The authors were to develop and design intelligent garage doors and explain how their mechanism operates. Connected to the mechanical components is a prime mover. A Wi-Fi (Wireless Fidelity) module on the ESP32 microcontroller is used to automate the system. Additionally, it functions as the system's interface between the hardware and software components. A garage door prototype made of cheap materials like plywood and plastic serves as a test and demonstration of the idea. The design employed rack and pinion systems. The Wi-Fi range test yielded results of roughly 600m for outdoors assessment without obstacles and 45m for inside testing with barriers.

Door automation for home and garage is developed many years before, there were many studies on the application and utilization of automation of garage doors using various technologies which include Arduino, RFID, IoT, Wi-Fi, and different types of sensors. The development of such technologies is useful in developing door automation, but in such technologies, there are chances of theft or security. So the study is done to develop a system that allows the verified user to open and close the door according to the size of the vehicle to reduce energy waste and provide security.

3. DISCUSSION

The door automation needs time as the door opening and closing is one of the daily or regular tasks and when it comes to the garage door it is time-consuming to stop the vehicle open the door and enter the vehicle into the garage and again close the door after finishing the task. It is necessary to check the security of the door as the vehicles are costly and expert thieves can steal them. So it is necessary to develop a smart and automatic door opening and alerting system for the user to provide safety for their vehicle. Figure 3 shows the simple block diagram of the working automatic garage door opening system for the vehicles in the garage to provide security to the users' vehicles.

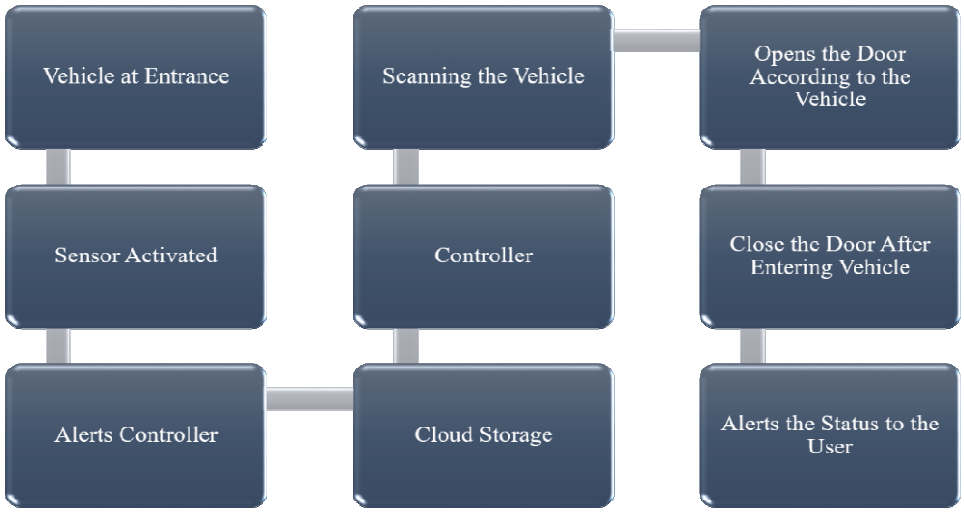


Figure 3: Illustrates the Simple Block Diagram on the Working Door Automation System.

3.1. Instruments Used for Developing the Model:

3.1.1. Rollers and Tracks:

The door moves easily and smoothly along the rails when it opens and closes thanks to rollers. The rollers can be changed to reduce noise unless the door is very noisy. Three tracks make up a garage door system, one in the center, where the drive operator is two at the door's edges.

3.1.2. The Chain, Belt, and Screws:

Each opener system contains a drive operator, also known as a chain, belt, or screw, which interacts with the spring and motors to lift the door. The most traditional and affordable alternative is chain drive doors, while screws or belt drives are slightly costlier but quieter options.

3.1.3. Curved Door Arm and Torsion Spring:

The curving door arm, which connects the opening to the drive operator, slides all along the track even as a chain, belt, or screw does. The torsion spring, which acts as the central spring right above the door, is a crucial component of such a garage door lock. When the door is raised or lowered, the torsion spring, which is attached to the drum and cables, winds or unwinds.

3.1.4. Drums and Cables:

The two drums rotate when the torsional springs wound or unfold and are situated just at the top of the frame on either side. To assist lift or lowering the door gradually, the cabling is coiled from around drums and wound or unraveled in tandem with the torsion spring.

3.1.5. Safety Reversing Sensor/Photo-eye:

The picture eye, also known as the safety sensor, is in charge of detecting anything or anybody that could be in the path of the door when it closes. Every garage door opener must have this crucial safety feature.

3.1.6. Emergency Release:

The user can manually open the garage door by pulling the red shutoff valve cable hanging from the central track if the photo eye malfunctions or the power goes out.

3.1.7. Operators:

Users may install one of four different garage door operators in their house. Consider alternatives carefully because each has benefits and drawbacks. Think about the requirements and anticipated usage frequency while deciding what is ideal.

1. *Belt Drive Garage Door Operators*

The most low-maintenance and quietest alternative among drive operator types is a belt-drive garage door opener. The functioning is faster, quieter, and vibration-free because the cart will move on rubber belt materials rather than metal. Belt and pulley openers are the costliest forms of opener because they are the quietest and easiest to repair. However, it's frequently worthwhile, particularly if the user has a living space or bedroom immediately over the garage.

2. *Chain Drive Operator*

A chain drive operator is the garage door opener choice that is most cost-effective. With this technique, the door will be raised and lowered by the trolley as it moves along a metal chain. These operators are usually louder than other types, therefore homeowners having separate garages or garages without living rooms directly above them will find them to be the best option.

3. *Screw-driven Operators*

Considering that they have been smoother and quiet than chain drives, screw-driven garage doors are comparable to belt drive operators. These systems use a perforated steel rod that spins to drive the trolley and raise and lower the door as the door is raised and lowered. Screw-driven garage operators are perfect for homeowners who wish to avoid loud noises and vibrations when operating garage doors because they are so quiet.

4. *Direct Drive Operators*

The simplest of all the alternatives, direct-drive garage doors are a relatively new invention. The engine itself pushes the trolleys all across the rails. This makes it easier to open and close the garage door and produces a very smooth, silent operation. Since there are fewer moving components with a direct drive operator, maintenance is also infrequent. With all the developments in warehouse opener technology, the following garage door replacement may include a system that is freshly upgraded. Advanced locking algorithms and motion/object detectors are required components for each new garage door:

3.1.8. Motion sensors:

The garage door is the largest moving item in the home, making it potentially hazardous if motion sensors aren't installed to identify when things pass underneath the door. So because sensors will recognize an automobile and stop all motion when it is detected, did not have to worry more about the garage door being unintentionally lowered onto the bonnet of the car. More significantly, a motion detector will safeguard animals and young children from the risks posed by a closed garage door. A motion sensor performs basic tasks. Whenever the door is

lifted, a laser examines the area of the ground where the gate would be if it were closed. The motion detector will turn on and prevent the door from going any further if someone or something crosses that route. As a result, the door will stop before it closes if a kid or dog darts into its path just as it is about to close, protecting everyone and everything from harm.

3.1.9. Locks and Rolling Code Technology:

When users lose them, having a remote on hand is no longer convenient. The locking function of current garage doors enables one to stop a lost remote from using it to enter the home, regardless of whether it accidentally falls out of pocket or is taken by a stranger. The locking option can assist in protecting the home from possible intruders by disabling any access code that has been set into the remote. Garage door openers may now be programmed with roller codes, which switch from one code to the other every few seconds, thanks to recent developments in coding technology. In this manner, each time use the key fob, the code is new. This stops burglars from hacking the key fob and entering the home through the garage.

3.1.10. Force guard control:

Force guarding monitoring will reduce the garage door's movement to a minimum of pressure if security and conservation are more essential than speed. This implies that the door requires less energy to lift and drop, as well as less force when it strikes the ground. This might lessen the strain the door otherwise might endure from regular use over a certain number of years and relieve wear and tear all along rail segments.

3.1.11. Vacation settings and Control System:

Having the assurance knowing the garage is safe gives peace of mind while users are gone from bed for hours or weeks or months. Sophisticated garage door openers allow shutting the door entirely, without exception, throughout users' absence by selecting certain settings. Since all sensors are turned off while the user is gone, robbers won't be able to enter the house using stolen remote controls or cracked codes. Almost all of the following characteristics may make a garage door more practical for contemporary homeowners in a variety of ways:

3.1.12. Remotes and Security light:

The ability to operate an electric garage door using a remote control is one of its most practical features. To open or close a garage door, often use wall-mounted buttons or keypads wherever enter a personal code. Additionally, a remote is typically expected to enable entry and exit from within. Additionally, the majority of homeowners operate their outside doors with handheld remote controls. The majority of wall mounts work with both single and multiple garage door systems. Manual release- There may be instances when preferred to operate the garage physically as opposed to with remote control. There is a manual release option that enables detaching of the doors from their electrical mechanism for situations like these. This enables the user to lift the door to any height require at any moment. For instance, the manual release button might enable quickly lifting the door a few feet off the floor if the task performed within the garage requires airflow. It helps to have light streaming from above when driving or walking through an opened garage door, whether traveling in the other direction or not. Contemporary garage doors are frequently equipped with light fixtures that turn on automatically once the door is triggered for extra convenience. When parking an automobile in the garage after hours, the

user may make their way inside in this manner. The warning light will also turn off for several minutes of operation, unlike typical garage lights.

3.1.13. Rail segments:

A garage door's driving components are linked at a 90 ° angle between both the opening and the ceiling of the garage. Most garage doors come with rail segments that accommodate doors that are seven feet in height. Rail segments often endure for a couple of years, provided that there is no oxidation or improper treatment. Home automation, which let the user manage a variety of devices, such as the garage door, by merely speaking a command, is becoming more and more popular among modern homeowners. Another feature that may be included in many of the more recent closing systems is Wi-Fi, which enables remote operation of a door frame from any location using a smartphone or tablet. This might be argued to be superior to home automation due to Wi-ability Fi to operate and monitor devices from virtually anywhere. To make this work, users don't even need to be close to the property. Users may use a mobile app to obtain that information if the user wants to track the validity of the door while at work.

Certain contemporary automobiles are being constructed with constructed smart technology. As a result, these cars function similarly to smart houses, where voice commands or easy touch inputs may turn on lights and open doors. Users don't even need a pocket control when the garage door's prompts are connected with the car's smart technology since the vehicle's smart system can activate the door. With the help of an auto-close feature, the user may schedule the basement door to close five, ten, or thirty minutes from now. For instance, on warm days, the user could leave the door unlocked after arriving and go inside for a short while.

A soft motor might simplify operations if users are worried well about the damage that garage doors sustain over time. A soft-start/stop motor reduces noise and vibration as the door opens, which over time leads to reduced wear and tear. As is normally the case, a smooth motor can extend the lifespan of a garage door and result in less maintenance over time. It is more than just an inconvenience when electricity lines fail. A blackout might be a terrifying thought when contemplating all of the electrically powered devices in the home. Users don't have to be concerned about the garage door being dysfunctional when and if the electricity goes out and if the garage door has a battery backup. When a storm strikes the region and there is a power outage while the gate is only partially lower, the rechargeable battery will finish the shutting process. When issues with the garage opener emerge, LED lights on certain remote controls will turn on. This enables the user to keep track of any system maintenance concerns that could arise.

Therefore, the issue may be fixed early before any damages or repair expenses balloon out of control, as opposed to being taken off guard by malfunctioning systems. A rail extension that will rise to 8 inches from the ground can be installed on the rail section if the home is taller than normal. This makes a bigger garage door no trouble. If the garage in the home also has high walls, a railing extension may be helpful. Jackshaft operators handle moving grilles, shutters, and doors in residential and commercial garages. The jackshaft operator, which is available in light, medium, and heavy variants, can be mounted on a wall, a shelf, or a bracket, ideally underneath the door shaft. The best headroom is provided by positioning the jackshaft along both sides of the barrier. For big garages and garages where traditional installations would be challenging, jackshaft operators are appropriate. Thus there are different technologies in the industries which are developing advanced systems for door automation. There are types of control methods, devices, and techniques that control the systems of the home. Thus, it is necessary to know the

garage automation system as vehicles are one of the costlier investments. The studies and technologies for automation are changing with time so it is necessary to know such systems and their working before their application in the garage to avoid losses.

4. CONCLUSION

The garage is one of the main assemblies for the installation of automobiles in the industry as well as in the home. Doors are the assemblies that allow the entry and exit of automobiles in the garage that operate on various mechanisms and technology. The development of an automated garage system using various techniques that provide safety to vehicles in the garage in the absence of the user. An automated system, as the name suggests, is capable of opening and closing the door as and when vehicles enter and exit. The system of the vehicle is connected to the sensor which is connected to the control unit so it becomes easy for the correct vehicle to locate and open the door, two wheeler and four wheeler have different sizes so the power required for opening should be different which is used in the proposed system model, which saves energy. This model is useful for saving electricity which also provides safety and monitoring for vehicles.

REFERENCES

[1] I. I. Sabonis and G. Y. Norvaishas, "The experience in efficient organization of work at a first aid center (Russian)," *SOVET.ZDRAVOOKHR.*, vol. 33, no. 5, pp. 29–36, 1974.

[2] R. G. J. Wijnhoven and P. H. N. De With, "Identity verification using computer vision for automatic garage door opening," *IEEE Trans. Consum. Electron.*, vol. 57, no. 2, pp. 906–914, 2011, doi: 10.1109/TCE.2011.5955239.

[3] F. Chekired, L. Canale, S. Tadjer, A. Louni, C. A. Bouroussis, and A. Tilmatine, "Low Cost House Automation System based on Arduino Microcontroller," in *2021 IEEE Industry Applications Society Annual Meeting (IAS)*, IEEE, Oct. 2021, pp. 1–6. doi: 10.1109/IAS48185.2021.9677162.

[4] V. P.Datar, A. Tankasali, and K. Chavan, "Smart Door Lock and Lighting System using Internet of Things," *IARJSET*, vol. 8, no. 8, Aug. 2021, doi: 10.17148/IARJSET.2021.8820.

[5] A. Amole, M. O. Oyediran, O. O. Olusanya, W. A. Elegbede, A. T. Olusesi, and A. O. Adeleye, "Design and implementation of a prototype active infrared sensor controlled automatic sliding door for mitigation of coronavirus disease 2019 (COVID-19)," *J. Electr. Control Technol. Res.*, vol. 2, pp. 1–17, Oct. 2020, doi: 10.37121/jectr.vol2.122.

[6] Anchal and P. Mittal, "Iot based intelligent modeling of smart home parking environment," *Int. J. Emerg. Trends Eng. Res.*, vol. 8, no. 7, pp. 3442–3446, 2020.

[7] V. K. Suravase, V. D. Shinde, D. T. Shirsat, S. S. Diwate, and S. N. Palhe, "Automation of Door Opening & Closing," pp. 4–9, 2021.

[8] F. Uribe, "Electronic Evidence in the Internet of Things (IoT) Ecosystem," *SSRN Electron. J.*, 2021, doi: 10.2139/ssrn.3962561.

[9] V. Maranha *et al.*, "Development of a Dynamic Hands-Free Door Opener to Prevent COVID-19 Pandemic Spreading," *Designs*, vol. 5, no. 3, p. 56, Sep. 2021, doi: 10.3390/designs5030056.

[10] T. M. Dusit and R. Norjali, "Garage Automation Door by Using Radio-Frequency Identification (RFID)," *Prog. Eng. Appl. Technol.*, vol. 2, no. 2, pp. 437–442, 2021.

CHAPTER 14

DEVELOPING PORTABLE AUTOMATED HAMMERING MACHINE WITH IOT TECHNOLOGY FOR THE MANUFACTURING INDUSTRY

Deepti Gautam, Assistant Professor,
Department of Mechanical Engineering,Sanskriti University, Mathura, Uttar Pradesh, India
Email Id-deeptigautam.me@sanskriti.edu.in

ABSTRACT:

Carpentry and blacksmith are ancient professions that work on wood and metal by giving the desired shape. The hammer is used since the period when these professions come into existence. The applications and designs are now changing with time from manual to automatic with high load capacity. The focus of this study is to develop a portable hammering machine that is operated using the Internet of Things (IoT). The use of IoT in the machine improves the workability machine and alerts the user from time to time about the process and the status of the task. Thus, the machine developed is for reducing the time and energy required in the hammering task in the industry. Using highly advanced machines will be helpful to improve productivity by just paying the initial installation cost. Thus it can be said that the machine is easy to carry with improved efficacy and low price. The study further helps in finding the importance of compact machines and their work efficiency compared to big machines for the same functions.

KEYWORDS:

Forging, Hammering Machine, Hammering Mill, IoT, Metal.

1. INTRODUCTION

The hammer is used to apply the load to any material to modify its form. Power hammers are mechanical forging hammers that elevate the hammer before striking and speed it onto the item being hammered by using an electrical power source or steam. They are also known as power-forging hammers with open dies. Since the late 1880s, when they took the place of trip hammers, they have been employed by metalworkers, blacksmiths, manufacturers, and blade smiths. A frame, anvil, and reciprocating ram containing a hammerhead or die to make up a standard power hammer. The workpiece is set on a lower anvil or die, and it is struck by an upper die or head [1]. The powered hammer is a direct ancestor of the tripped hammer, but it differs in that it accelerates the ram during the downward stroke and stores potential energy in a system of mechanical linkage and spring, steamed, or compressed air. As opposed to just letting the weight fall, this exerts extra force. The ram or hammerhead of predecessors such as trip hammers, steam drop hammers, and board or strap hammers was raised by the power source and then allowed to fall only due to gravity.

The weight of the moving components that immediately impact the workpiece is used to assess power hammers. This comprises the weight of elements such as the upper die, piston, mechanical linkage arms, connecting rod, ram, and spring as shown in Figure 1 and Figure 2. The power source determines certain design components. The biggest power hammer had a rating of 125 short tonnes and was steam-powered [2], [3]. A trip hammer is a sizable powered hammer that is

also referred to as a tilt hammer or a helve hammer. Trip hammers have historically been used in agriculture to polish, decorticate, and pound grain. Although a stamp mill was more common for this, trip hammers were employed in mining to smash metal ores into small bits. They were employed in finery forges to pull out wrought iron blooms to create more malleable bar iron. They were also employed in the production of different steel, wrought iron, latten, and other metal items. A forge often referred to as a hammer mill, was equipped with one or more trip hammers [4]–[6].

Figure 1: Represents the Manually Operated Steel Hammering Machine [7]**.**

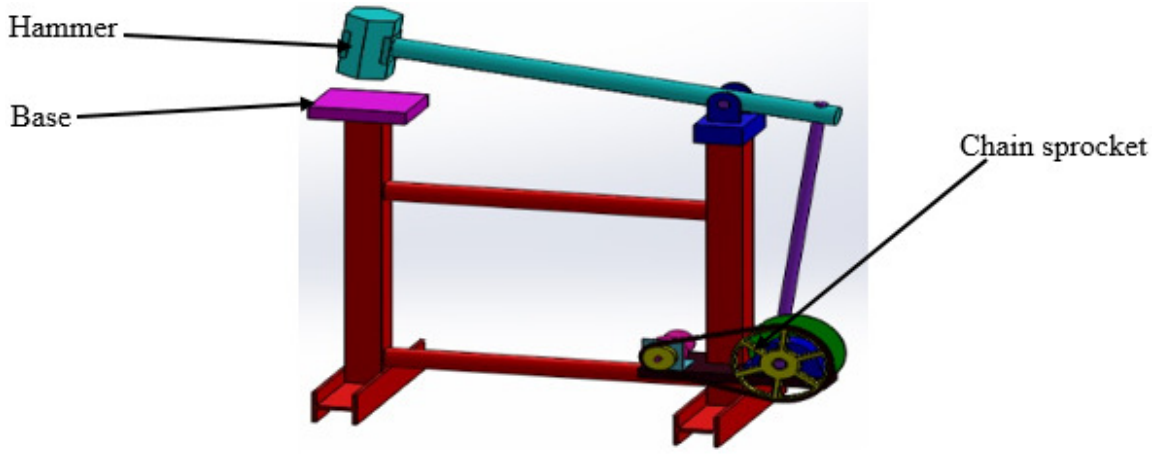


Figure 2: Represents the Automatically Operated Hammering Machine Design [8]**.**

Typically, a cam lifted the hammers before releasing them so they would fall naturally. Trip hammers were historically frequently hydraulically propelled by a water wheel. Since the Western Han period, trip hammers have been utilized in Imperial China. They were used in the medieval European world throughout the 12th century, and they were also present in the modern Greco-Roman world. The power hammer replaced the trip hammer, which had fallen out of favor during the Industrial Revolution. Multiple hammering were frequently powered by a collection of line pulleys, belts, and shaft from a central power source [9]. The most popular and oldest type of grinding mill is the hammer mill. A series of hinged hammers in a sturdy storage container that is mounted on a central shaft make up the primary part of a hammer mill. In reality, it causes a size reduction. The components to be milled are struck by these rectangular pieces of solid

steel that rotate rapidly inside the chambers. These hammers swing furiously, breaking the feed material into fragile pieces. A jackhammer is an electric or pneumatic instrument that seamlessly combines a hammer with a chisel. It was created by William Mcreavy, who later sold Charles Brady King the patent. Although some hand-held jackhammers also use electric motors, compressed air is often used to power them. Larger jackhammers, such as those placed on construction equipment rigs, are often hydraulically propelled. Usually, these instruments are used to crack concrete, pavement, and rock [10].

An interior hammer of a jackhammer is raised and lowered to operate. The hammers are first dropped to strike the chisel and afterward raised once more to return to the beginning position to begin the cycle. The amount of force used on the jackhammer will determine how effective it is. It is typically employed in construction projects like a hammer to smash rocks or hard surfaces, hence it is not regarded as earth-moving equipment together with its accessories. Thus, there are different designs of hammers used in the market for different operations. The use of hammers is different for different reasons depending on their characteristics and features. Thus, it is necessary to know the new evolutions in the design of automatic hammering machines in the industry.

2. LITERATURE REVIEW

Rajesh Kumar Singh et al. created a pneumatic hammer and pneumatic forging machine. According to the authors, warm forging is carried out at a temperature that is between ambient and hot forging temperatures. This machine was primarily created to shape metal into the desired shape and size. The pneumatic cylinder is used in this equipment to forge the specimen. An air-operated gadget is pneumatic. The manual procedure takes longer and requires more labor than necessary for forging. It can reduce the need for manpower and time in industries by employing this equipment [11].

Bashir, E. Musa, and Momodu, O. Glory designed an enhanced compact hammer mill that uses a single-acting action to pulverize, transport, and push out crushed bulk material papers against gravity through a cyclone the emphasis of the current design. Gate, Axial fan, cyclone, bearings, pulley, electric motor, spacing discs, low and high-pressure throats, pulley, shaft, and hammers are some of its components. The manufactured 7.46kw hammer mill is small, and affordable to create, run, and maintain. Rural farmers would benefit from its commercial production and usage, which will also support Nigerian technology using indigenous components [12].

Ojomo A. Oluyemisi and Fawohunre A. Jerome created a hammering mill with two sieving screens. To grind grains and other agricultural goods, a hammer mill with a double screening system was created and constructed using materials that were readily available in the area. The idea of “design by analysis” served as the foundation for the conceptual design. With a rise in moisture content, the machine's milling and specific energy requirements rose. The link between the hammer mill performance indicators, product-moisture contents, and machines' speed may be expressed using a regression model, which was developed. The device may be used with either an electric motor or a gasoline engine [13].

Dhruv Patil et al. designed and build an automated hammering machine that can operate without the need for a human operator. The project was chosen since these industries don't have any machinery that can regulate speed using an Arduino. Additionally, the project will affect the metal industry more severely. With the aid of a 220V home supply, the machine will be able to

carry out quick and precise hammering operations. The machine is constructed out of mild steel. The rod will move laterally due to the rotating shaft. The connecting rod and the hammer are fastened together in the middle of the swing. The workpiece will be supported by an appropriate bed that will be created. Abhijeet Dhulekar et al. developed design, analysis, and cad modeling of automatic hammering machines are covered in that study. That was determined by the maximum torque, hammering impact velocity, torque force, and bolt joint shear failure. It creates a conceptual model of an automated hammering machine using this information. One of the innovative design concepts suggested is the automatic portable hammering machine, which enables quick and precise hammering processes. According to the authors, it would require more work and manpower to operate manually, but because of the invention of automated Hammering, the operation may now be made simpler. The industry sees very evident advantages in employing automated systems. In the long term, these benefits may be quite helpful [14].

Yasuhiro Homma et al. discussed pounding sound analysis in the insertion of the compounds that are known to stem to decreasing issues in complete hip arthroplasty. The initial feasibility investigation, which was conducted as a consequence, was to assess the precision of a forecasting model applying Machine Learning (ML) algorithms to recognize the final rasping hammered sound recorded during operation. 29 primary THAs with no complications had their hammering sound data evaluated. Research showed that Artificial Intelligence (AI) powered by machine learning was capable of accurately differentiating the last rasping hammering sound from the earlier hammering sound. Future research is necessary to develop a prediction model for total hip arthroplasty (THA) problems utilizing hammering sound analysis and machine learning. C. Revilla-Gomez et al. researched butt weld specimens that were dynamically and manually battered, and four-point periodic bending tests had been performed. With the use of various analyses of discourse, the mechanical and structural alterations caused by these processes including their consequences for fatigue behavior have been investigated. Because some weld cordon areas have not been properly treated, it was found that the smoothness of hand-hammered specimens differed from that of dynamically hammered materials. However, the toughness profiles of the strain-hardened area are strikingly identical for both types of samples. Using Kernel Average Misorientation (KAM), fracture toughness, tensile stress, as well as flexure depth are evaluated [15]. S. H. Kumar and J. K. Mishradiscussed their experience with a pneumatic shearing machine during a shearing process. The metal along the cutting edges of the punch and die edges becomes severely strained as a result of the short space between them, which results in localized plastic deformation and, as the deformation advances, the fracture begins on both sides of the sheet. It should be suggested to use compressed air to move the pneumatic cylinder's piston. It is possible to perform several mechanical actions, such as bending, cutting, punching, hammering, etc., using the linear motion of the piston and piston rod [16].

Praveena R. et al. purpose of that research is to pinpoint the issues with the forging laboratory and create an automated forging model. A thorough literature review was done before constructing the automated forging system, and it was found that although the pneumatic force is utilized for forging, drop forging is one of the most straightforward methods. In drop forging, a certain amount of hammer mass is dropped from a predetermined height to form a heated blank into the required shape [7].

There are different studies developed on the design and construction of hammering machines thus the portable, fixed, and automatic are the advancements in manual hammering machines.

There are various designs of machine that are highly user-friendly and also improve efficiency. The processing and functioning of the machine are easy which makes the operator operate it easily. Thus, such new advancements should be known and used in the industry to increase productivity and reduce manual labor time and energy. The use of technology in machines is changing the workability of machines which is now seen in hammering machines. Thus, it is necessary to know the impact of hammering machines in the industry.

3. DISCUSSION

A hammer is a tool or equipment that strikes an item with a rapid impact. The majority of hammers are hand tools used for breaking apart things, fitting pieces, forging metal, and driving nails. Hammers come in a variety of sizes, shapes, and constructions, depending on their uses. The most common industrial and construction activity is hammering. It takes a lot of time and effort to hammer metal pieces, metal sheets, screws, etc. thus construct an automated hammering mechanism to save the time and effort required here. A pre-industrial workshop known as a "hammer mill", hammer forge, or hammer works produced semi-finished wrought iron goods, occasionally finished mining or agricultural equipment, and military weaponry. The trip hammer or combination of trip hammers, employed in the procedure is what gave these workshops their name. The hammer's head was raised by the action of cams mounted on a revolving camshaft that periodically depressed the shaft's end. The hammer's shaft, or helve, was pivotable in the middle. The hammer's head made an arc as it lifted and dropped. For durability, the hammer's face was fashioned of iron.

The hammering machine is an easy operation machine that is easy to handle and work on it for skilled and unskilled users. There are different designs of machines in the market which are designed with different working principles and methods. The hammering machines are more effective in industrial applications which reduces the labor cost and also work efficiency. The operation of the hammering machine is shown in Figure 3. The use of technology in the machines is changing the workability of machines for the user as the user can operate the machines from a long distance with multiple tasks and one user can operate such machines easily in the batch without more effort from one place. The anvils designed for the hammers are hard which makes the machine operate under different loads.

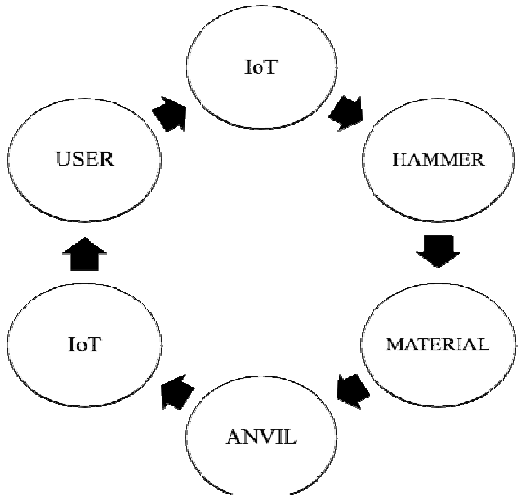


Figure 3: Represents the Working of an Automatic Hammering Machine with IoT.

Simply place the workpiece inside and turn on the hammering machine. When necessary, this equipment may be utilized to do automatic hammering tasks. The hammer will be moved in this case using a DC motor. For effective power transmission and to boost torque, the DC motor has pulleys connected to it that are linked to bigger pulleys. This substantial pulley is fastened to a shaft by a connecting rod. Utilizing the spinning shaft's lateral motion, this rod is employed. To produce the necessary hammer motion with adequate torque, attached the opposite end of a hammered to the connecting rods using a mid-swinging arrangement. Power hammers are mechanical devices, sometimes called forging power hammers that rely on steam to generate pressure. The most recent versions of these hammers include either a pneumatic or an electric hammer. In layman's terms, hammering works whenever force is supplied in the opposite direction to the fast movement of whatever item is held. These mechanical devices generate force through the application of some form of pressure. The blow is quicker and more powerful than the power of the press machine. When compared to other tools, hydraulic hammers are fairly enormous when in comparison to the size of any press machine.

3.1.Functions of Power Hammer:

3.1.1. Mechanical:

These hammers are usually driven by an electric motor and have a tiny and thin construction. This is what restricts the sort of work they can undertake because the narrower hole precludes the use of any external tool. These tools are extremely effective at cutting back metal parts and were particularly intended for re-sharpening as well as re-edging farming machinery.

3.1.2. Utility:

The only difference between these mechanical devices and air hammers is that must supply compressors. Three 5-HP 2 different compressors operate the majority of them. The three motors are in charge of supplying a manifold pipe with a single pipe to feed the hammer when it is in operation. This kind is not required; nonetheless, it is more difficult to operate than a mechanical hammer.

3.1.3. Self-Contained:

Hammers that are identified have their built-in air compressor as well as the tank. The gadget is a very helpful sort of power hammer that has been discovered to be worldwide and accommodates all varieties of hand tools inside the throat, which is normally sized at 12-14 inches (30-35 cm). The fundamental benefit of this machine is its vibration-absorbing capacity; as it absorbed more vibration, it necessitates fewer repairs on the hammers and puts less stress on the person making the specimen. It should be mentioned that power hammers and particular self-contained hammers are typically not suitable for rookie blacksmiths since they are unaware of the degree of force. If want to pursue blacksmithing as a profession or a pastime and must first become acquainted with a manual hammer before learning how to use power hammers. If there are proficient with manual hammering, it is recommended that they learn how to operate and utilize a powered hammer, which is an asset to another's forging talents. Once learned about the strength hammer and its capabilities, it's a good idea to go through what the energy hammer is employed for, especially in metal work.

Figure 4: Represents the Advantages of Using Automatic Portable Hammering Machines.

Forged welding is a method of joining two pieces of metal by warming them to a high temp to release the metal and then smashing them together. This was the technique that was primarily done manually, referred to as a procedure that was rather distinctive in its own right. Forging a power hammer is an easier method where the metal is heated before being put under the hammer of power hammering. When employed in a forge welder, the axe's power supply is lifted to the maul to ready it for hitting solid metal and then accelerating it onto the weld. The power hammer is considered a good choice for such a forceful and precise hammerhead impact. The quantity of force typically applied by a power hammer on metal can be likened to the labor of two strong laborers using a sledgehammer. These electromechanical devices are highly strong because of their weight, which exerts a significant amount of force on the item being welded. The hammering machines are easy to operate as they are simple in design it is easy for everyone to understand the working of the machine in less time to get the maximum efficiency as shown in Figure 4 are different advantages of a hammering machine. As the construction of the machine is simple with fewer elements its initial cost is low and affordable with low maintenance after certain operations. The portable feature of the machine makes it easy for the user to carry the machine to different locations and sites for operation. As the machines are operated using technology it becomes easy for the user to operate multiple machines from the same place without using extra effort. Thus, potable hammering machines are useful machines in the industry.

The underlying concept is easy to comprehend. A simple steel drum with a rotating shaft or drum that's also hammer-equipped, either longitudinally or laterally, is a hammer mill. The hammering can either be free to spin on the extremities of the cross or fixed to the central rotors. The rotor in the drum is rotating quickly as the product is loaded into the feed hopper. Crushers can employ a hammer mill. The materials are shredded by the hammer bar and then expelled via screens into a drum of a certain size. Hammer mills for crushing grains of grain can run on household currents. A larger hammer mill used in a car shredder can be propelled by electric or diesel engines of 2000–5000 horsepower. The screenless hammer mill separates tiny papers from bigger ones using airflow. It is intended to be more dependable and is stated to be significantly less expensive and more energy efficient than standard hammer mills. The hammer mill's construction and design are always dictated by its intended applications in the industry.

4. CONCLUSION

The ancient trades of carpentry and blacksmithing include shaping metal and wood to the desired shape. Since the beginning of various vocations, the hammer has been utilized. Currently, automation applications and designs with large load capacities are replacing manual ones. Thus the automatic hammering machine is one of the most useful machines in the industry. The addition of IoT technology enhances the machine's usability and occasionally notifies the operator of the task's progress and condition. Therefore, the machine created is for reducing the time and energy necessary for the industry's hammering duty. Simply paying the first installation cost will assist to increase production when using cutting-edge equipment. Thus, it can be argued that the machine is simple to transport, more effective, and affordable. The study also uncovers the value of small machines and highlights how well they do similar tasks when compared to large machines.

REFERENCES

[1] D. Ashwin, "Low Cost Automated Hammering Machine," *Int. J. Res. Appl. Sci. Eng. Technol.*, vol. 9, no. VI, pp. 1514–1517, Jun. 2021, doi: 10.22214/ijraset.2021.34854.

[2] K. Ikeda and A. Kamimura, "Hammering acoustic analysis using machine learning techniques for piping inspection," *J. Robot. Mechatronics*, vol. 32, no. 4, pp. 789–797, 2020, doi: 10.20965/jrm.2020.p0789.

[3] K. Koizumi and Y. Yokoyama, "Shock Isolation Type Hammering Machine with Elastically Suspended Anvil Characterizing by Repetitive Counterblow (3rd Report)—The Case of Two Independent Impact Followers—," *J. Japan Soc. Precis. Eng.*, vol. 54, no. 12, pp. 2346–2352, 1988, doi: 10.2493/jjspe.54.2346.

[4] D. Oka, Y. Kobayashi, K. Motegi, and Y. Shiraishi, "Implementation of an on-line hammering sound inspection system based on fast machine learning algorithm," *J. Japan Inst. Electron. Packag.*, vol. 24, no. 1, pp. 115–120, 2021, doi: 10.5104/JIEP.JIEP-D-20-00048.

[5] M. Iwata *et al.*, "AI-aided Hammering Test System to Automatically Generate Anomaly Maps," *Sensors Mater.*, vol. 31, no. 10, pp. 3087–3098, 2019, doi: 10.18494/SAM.2019.2352.

[6] Q. Ren, G. Wang, M. Li, and S. Han, "Prediction of Rock Compressive Strength Using Machine Learning Algorithms Based on Spectrum Analysis of Geological Hammer," *Geotech. Geol. Eng.*, vol. 37, no. 1, pp. 475–489, 2019, doi: 10.1007/s10706-018-0624-6.

[7] I. Journal, A. Raza, and R. Praveena, "IJERT-Study on Development of an Automated Open Die Forging Machine Related papers Study on Development of an Automated Open Die Forging Machine," no. 1, pp. 1–4.

[8] mechanical world, "automated hammering machine," 2017.

[9] K. IKEDA and A. KAMIMURA, "Inspection Techniques for Detecting CUI with Hammering Sound Analysis and Machine Learning," *Proc. JSME Annu. Conf. Robot. Mechatronics*, vol. 2019, pp. 1P1-E03, 2019, doi: 10.1299/jsmermd.2019.1p1-e03.

[10] Y. Abe, A. Ichikawa, T. Ikeda, and T. Fukuda, "Study of hammering device to put on multi-copter targeted for bridge floor slabs," in *MHS 2017 - 28th 2017 International Symposium on Micro-NanoMechatronics and Human Science*, 2018, pp. 1–3. doi: 10.1109/MHS.2017.8305206.

[11] S. Rajesh Kumar, P. Raghav, S. Kabindra Kumar, and A. Sudip, "Design And Fabrication Of Pneumatic Hammer," no. 23-Dec-2015, p. 71.

[12] E. Musa and O. Glory, "Design and Fabrication of a Compact Single Acting Hammer Mill," vol. 2, pp. 80–88, 2020.

[13] O. A. Ojomo and A. J. Fawohunre, "Development of a Hammer Mill with Double Sieving Screens," *Eur. J. Eng. Res. Sci.*, vol. 5, no. 5, pp. 617–621, 2020, doi: 10.24018/ejers.2020.5.5.1763.

[14] M. V. I. ABHIJEET DHULEKAR, SUYASH SHIRBHATE, RIZWAN SHAIKH, "FABRICATION OF AUTOMATIC HAMMERING MACHINE "," *IRJET*, vol. 5, no. 4, pp. 949–954.

[15] C. Revilla-Gomez, J. Y. Buffiere, C. Verdu, C. Peyrac, L. Daflon, and F. Lefebvre, "Assessment of the surface hardening effects from hammer peening on high strength steel," in *Procedia Engineering*, Elsevier B.V., 2013, pp. 150–160. doi: 10.1016/j.proeng.2013.12.070.

[16] J. K. Mishra, "Design and fabrication of automatic and multifunctional pneumatic machine," 2019.

CHAPTER 15

A COMPARATIVE STUDY ON AUTOMATIC AND MANUALLY OPERATED DUST CLEANING MACHINES

Mr. Aishwary Awasthi,Research Scholar,
Department of Mechanical Engineering,Sanskriti University, Mathura, Uttar Pradesh, India
Email Id-aishwary@sanskriti.edu.in

ABSTRACT:

Cleaning is a basic function of daily housing activity. Cleaning is the removal of unwanted elements or dust papers from the surface or floor to be cleaned. Two types of machines are used for cleaning with two different operating modes automatic and manual. Comparison of both operating methods used in floor cleaning machines. The focus of the study is to know the importance of cleaning and the machines used in cleaning and this Study is carried out on different types of surfaces and floors at different locations to know the efficiency and its impact on the environment. The results show that the manual method does not create pollution and the automatic machine cleans the surface with ease. Thus, the manual machine is time-consuming but it is environment friendly. The study further helps in analyzing the drawbacks of automatic machines and robots used in cleaning so that preventive measures can be taken.

KEYWORDS:

Automatic, Floor Cleaning, Cleaning Machine, Robot, Robotic Vacuum Cleaner, Vacuum.

1. INTRODUCTION

An autonomous robotic vacuum cleaner has a limited vacuum floor filtration system paired with sensors, motorized drives with embedded systems, and cleaning routines. It is sometimes referred to as a Robovac or a Roomba as a generic trademark. Early models offered a “self-drive” feature that allowed the machine to clean by itself without requiring human participation as well as remote control hand operation as shown in Figure 1. Although some designs use spinning sweeps to access tight spots, everyone else integrates various cleaning components with the vacuuming functions as shown in Figure 2. Modern models combine Artificial Intelligence (AI) and deep learning for enhanced mapping, object detection and recognition, and event-based cleansing [1], [2].

Figure 1: Represents the Manual Cleaning and Mopping Tools Essential for Floor Cleaning.

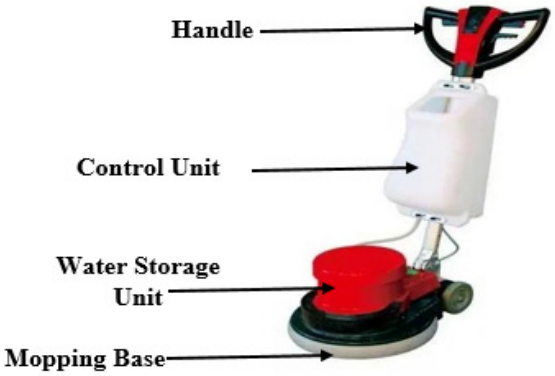


Figure 2: Represent the Human Operated Floor Cleaning Device with an Automatic Cleaning Mechanism.

Low noise, simplicity of use, and autonomous cleaning are commonly highlighted as key benefits in robotic vacuum marketing brochures. Although this impression of these gadgets as the set-and-forget solution is common, it is not always true. Even the lightest canister vacuums weigh substantially more than robotic vacuums, which are often smaller and lighter. A robotic vacuum cleaner's drawback is that, because of its size, it takes a long time to clean an area as shown in Figure 3. They are also rather costly, and their operational costs can be greatly increased by replacing components and batteries [3]–[5].

Figure 3: Represents the Robotic Cleaning Device for Automatic Clear of the Floor without Human Intervention.

Some versions additionally have a mop for wet cleaning, which allows them to vacuum and wet-mop a floor on their own in one motion. Either the robot may automatically spray water on the floor before passing over it, or the mop must be manually wet before being attached to the bottoms of the machine. Some modern robot vacuum cleaners contain a sensor that can identify carpeted areas and prevent mopping there [6]. However, the majority of robot vacuum cleaner producers now include the no-mop zones function in the app to develop a robot vacuum that skips cleaning particular areas if there is no sensor as shown in Figure 4. These robot vacuums can also mop an area of 150 square meters in a single pass. A robot mop can clean a range of surfaces and has several cleaning modes that include vacuuming, mopping, and sweeping, moist

or wet floor. The Robot Cleaner performs better on stiff surfaces and is best for flooring made of hardwoods, laminates, and tiles [7].

Figure 4: Illustrating the Advantages of Floor Cleaning Devices with Manual and Automatic Operating Systems.

Different types of floors require quite different treatments. When using water or other liquids to clean, there is a risk of slipping, especially if the floor is kept damp. On certain floors, sawdust is utilized to absorb any spilled liquids rather than trying to stop them from happening. Every day, the sawdust is cleaned away and refilled. This was typical in taverns in the past, and certain butchers and fishmongers still use it. Tea leaves were frequently used to absorb odors and gather dirt from carpets in the past. Additionally, a large range of floor cleaning tools is readily accessible nowadays, including carpet extractors, motorized floor scrubbers, and floor buffers [8], [9].

Floor cleaning is the one of main daily household activities, so it is necessary to clean the dust and dirt on the floor. The manual cleaning for the big and large floors is time-consuming which may lead to unwanted dirt in unseen places on the floor. There are different types of floor cleaning tools with different working modules. The mopping and cleaning of the floor is a hygiene task that should be done with care small neglect also becomes the route to diseases. Thus, different cleaning machines are used and it is necessary to know the different aspects of using automatic and manual floor cleaning equipment.

2. LITERATURE REVIEW

M. P. Sathe et al. discussed a basic need for cleaning, which is also a requirement for everyday activities. Traditional road and floor cleaning equipment are most frequently utilized in a variety of settings, including roadways, railway stations, airports, hospitals, bus stops, multi-story buildings, and universities, for instance. Additionally, this contraption depends on human energy to function. It is both user-friendly and environmentally friendly. It concluded that the manually

controlled environmentally friendly roadway and floor wiper may outperform conventional equipment in terms of coverage area, cleaning process time, and expense [10].

Satyam Sudan et al. created a trash-collecting device and had created a floor-cleaning device that assures that dust, filth, and other debris will be scooped up with the least amount of work possible. The machine's primary frame is coupled to a collecting box, and the design proposes to employ a cylindrical fiber brush to successfully transport the material mentioned above into that container. A speed magnification system that uses a chain and gear drive to move the brush is used. The box may then be taken out of the main machine, and its contents can be emptied into a different, detachable storage container that is fastened to the machine's top [11].

M. Sengottaiyan et al. conducted a study on the environment hygienic, cleaning is necessary. The design and construction of automatic floor-cleaning equipment are the subjects of this study. In this project, want to lessen the vibration that the machine's motors cause when cleaning. Likewise, shorten the cleaning period to save time and work cleaning the environment. Additionally offering a simple Bluetooth control system to make operating the machine easier. With a speed of 0.51 km/hr, the machine cleans the 100 m^2 space in 18 minutes, sweeping and wet mopping. The authors aim is to clean the floors of hospitals, shopping centers, and theatres [12].

Raja Kumar et al. developed a robot that may alter its morphology to seven one-sided tetrominoes to increase its coverage area. According to the authors most commonly utilized in homes, buildings, malls, airports, and other business settings is the conventional mechanically driven floor cleaning equipment. There is no need for an external energy source of any kind for this machine to operate. Designing and developing a procedure for physically cleaning both dry and wet floors is the goal of the current effort. This mechanically controlled floor-cleaning device was created with the primary goal of cutting costs and effort while being safe for the environment and simple to use.

G.Vara Prasada Rao et al. created an affordable, user-friendly vacuum cleaning device. The objective is to construct a vacuum cleaner out of an air blower, as opposed to a battery with a greater voltage, which is sufficient to make a vacuum cleaner. Such that it is simple and effective to use this air blower. Using low-voltage machinery makes the machine work even better. Rice cans, an air blower, a switch, an m-seal, a PVC duct, square rods, and tires were used to construct the vacuum. Utilizing appropriate, commercially accessible software and components, the vacuum cleaning machine was modeled and constructed in this study. Vacuum cleaners are suitable for domestic usage [13].

S. M. Bhagya P. Samarakoon et al. created a floor-cleaning robot in a new field of robotics research. To acquire additional coverage, a configurable robot must be more flexible in altering its morphology by analyzing the forms of items inhabited in an ecosystem. That research provides a unique way of generating an acceptable morphology for a configurable robot based on an object's form. Because it is not confined to a finite number of morphologies, the suggested notion is called hetero-Infi. The suggested approach differs from the state-of-the-art in that it considers an unlimited number of morphology for reconfiguring rather than keeping to a fixed number of morphologies. As a result, the suggested approach can help improve the capabilities of a reconfigurable housekeeping robot [14].

Because floor cleaning is a common and regular home activity, it is vital to remove dust and grime from the floor. Manual cleaning of huge floors takes time and may result in undesired filth in hidden areas of the floor. There are several sorts of floor cleaning equipment with various operating components. Mopping and washing the floor is a hygiene chore that must be done with attention because small carelessness can lead to disease transmission. As a result, many cleaning machines are utilized, and it is vital to understand the various features of utilizing automatic and manual floor professional cleaners.

3. DISCUSSION

Robotic vacuum cleaners are pieces of equipment small discs, to be precise that travel across floors as they are being cleaned. The robotic cleaners of this modern era clean floors automatically and without help from a person. This amazing machine can navigate around obstacles like corners and table legs while vacuuming. Simply said, a robotic vacuum cleaner is a motorized cleaner that operates on its own and doesn't need an operator to assist with the cleaning process. It operates with the use of a computer system that enables the cleaners to be aware of their unique surrounding to avoid hitting furniture and other significant home objects. Although using brooms and mops to clean may seem like a cost-effective option, many firms find that the labor expenses of manual cleaning are far higher than those of using floor cleaning equipment.

When compared to the time it would take a person to sweep or scrub the area manually, commercial cleaning equipment can remove dirt, dust, oil, and grime far more quickly. Modern auto scrubbers and industrial sweepers are extremely silent, have durable batteries, and do away with the dangers that come with using mops and brooms. Time is money, and mops or brooms are ineffective if there is a vast area to clean. Additionally, they spread germs rather than getting rid of them. Leave a slippery area where accidents may occur and are time-consuming; a compact auto scrubber can quickly clean under tables and into corners, saving the operator from having to move furniture or do the cleaning by hand. At this point, it should be noted that each type of robotic vacuum cleaner has unique characteristics that set them apart from one another, as well as unique strengths and weaknesses. For instance, the multi-floor mop robotic vacuum cleaner was created to serve both mopping and other purposes, whereas Vacuum cleaners designed specifically for homes with pets pay close attention to pet hair.

3.1.Benefits of Workplace Cleanliness:

3.1.1. Good Impression:

The flooring is among the first items that individuals notice when people enter a company. People may be put off and refuse to conduct business if the premises are unclean, stained, or have an awful stench. Potential investment partners may interpret soiled flooring as an indication that the organization is unethical.

3.1.2. Safety:

Clean floors not only look wonderful, but they also increase the safety of anybody who visits the establishment. Dirt, grit, and filth on the flooring can pose a tripping danger if they are not properly kept. Slips and falls can result in serious injuries and costly legal proceedings.

3.1.3. Improving the Workplace:

People want to come to work in a clean environment. Workers will not go out of their way to dress to amaze if the workspace is filthy and stinky. This approach may indicate that the owners and management are unconcerned about the atmosphere in which people function.

3.1.4. Cleaner and Healthier Environment:

The high traffic concentration in many enterprises, particularly hospitals, produces a breeding ground for pathogens and can contribute to the transmission of diseases and illnesses. Because the majority of individuals spend some time together at work, it is critical to maintain floors as well as surfaces well cleaned and sanitized to keep employees happy and safe.

3.2.Advantages of Robotic Vacuum Cleaner:

3.2.1. Cleaning without Human Interventions:

By setting the robotic vacuum cleaner's advanced feature to vacuum the whole floor while away from home, it can be guaranteed to return home to a relatively tidy floor. A robot vacuum cleaner is a fantastic cleaning tool for anyone with mobility issues.

3.2.2. Convenient and Time-Saver:

One of the vacuum cleaner's apparent merits is that it cleans the floor faster and with less effort thanks to its robotic technology. If there were a manual vacuum cleaner, it would have to clean itself. It will finish the task once have set it up and turned it on, allowing it to focus on other crucial tasks or simply unwind and read a favorite book or watch an engaging movie.

3.2.3. Cheap for Maintenance:

A robotic vacuum cleaner requires very little maintenance after thoroughly cleaning it and removing all of the dust papers within it. It will last a long time if care is taken of it properly, saving a lot of money in the process. Even some vacuum types have the capability of self-recharging after use. Therefore, even if forget to charge the robotic vacuum, it will do it.

3.2.4. Battery Life:

Robotic vacuum cleaners have limited battery life and, occasionally, won't be able to finish the cleaning task. The charging time is around 2 hours, and the recharge time might be several hours or more. It is without a doubt not a vacuum cleaner for thorough cleaning. Because of this flaw, before purchasing a robotic vacuum cleaner, be sure to do a comprehensive investigation into its technical specifications and take into account the sort of cleaning that will expose the device. For instance, if have several floors that need vacuuming, it is advised that choose a robotic cleaner with long battery life and a big dust capacity.

3.2.5. Poor Cleaning:

It will obtain poor cleaning quality from robotic cleaners if spend money on a bad quality robotic vacuum. If don't conduct a thorough search to locate the best of this machine, what believe to be the better system will still fall short of the required of that perfect cleanup that a manual cleaner will offer, despite some of the most popular models being now becoming appealing as well as of good quality, even although they are not great.

3.2.6. Price:

Undoubtedly, a high-quality robotic vacuum is rather pricey. A robotic vacuum cleaner increases in price as more functions are added. In actuality, high-quality robotic vacuum cleaners are costlier than the ones that are already on the market.

3.2.7. Long Time of Cleaning:

Due to the way it works, a robotic vacuum cleaner takes longer to sweep a room's flooring. Additionally, due to its small size, it won't be able to contain a lot of dirt. Unless having small apartments, though, this won't be a problem with anyone. The 19th century saw the introduction of hand sweepers, which rapidly became commonplace household items. Sweepers, which are sometimes seen as a direct development of electric vacuums, helped usher in a new era of home cleaning, and more than 130 years later, they remain a household staple.

3.2.8. Electric Vacuum Cleaner:

When purchased, an electric vacuum cleaner typically costs 50 more than a manual sweeper in addition to the ongoing cost of power. They often require plugging them in and pressing a button before they can begin vacuuming, which may not sound like much but is more than a sweeper requires. In addition, they are frequently referred to as “quiet versions”, yet they are noisier than hand sweepers. Additionally, unless they are hand-held, vacuums may also be heavier. Suction is a bonus feature of vacuums that makes it easier to swiftly and effectively remove dirt. This dirt accumulates in a bigger dust container, requiring more thorough cleaning sessions to cover the entire house. The last benefit is that practically all vacuums include features to help with cleaning, such as the ability to connect tools or transform them into handheld devices. This broadens the use beyond floors.

3.3.Tips to Keep Office Floors Cleaner:

3.3.1. Consistent Cleaning:

This reduces the amount of filth gathered and prevents stains from settling into the floor, resulting in a healthier atmosphere. With the right mopping supplies, this significantly cleans and shines the floor.

3.3.2. Cleaning Equipment regularly:

The hygiene of the cleaning materials is critical because unclean cleaning equipment causes floors to become significantly dirtier. Make sure that the mop is cleaned regularly and that it is kept dry between those washing.

3.3.3. Regular Deep Cleaning:

Daily mopping is essential for removing surface filth; extensive cleanliness will protect floors from harmful water and debris.

3.3.4. Using Floor Mats:

According to studies, 70% - 80% of debris and dirt that enter facilities arrives at the front entrance on the boots of building inhabitants and visitors. The quantity of dirt and debris that makes its way to the flooring is considerably reduced when Mats are used.

A hand sweeper is a mechanical floor-cleaning tool, similar to an electric vacuum. It comprises a body with a series of gears and rollers that, when propelled forward, rotate and sweep dirt into a built-in container. It just has to be put together once; further assembly or electricity is not necessary. In contrast, electric vacuums do need electricity; this can be obtained from a power outlet or a battery pack. It is often available in a greater selection of forms, sizes, and styles, but may need extra assembly. The pricing is the primary and most significant pro for a manual sweeper. They are unavoidably less expensive since they don't need energy, don't have motherboards or cables as internal components, and don't have to pay for running costs. Thus, floor cleaning is a necessary and useful activity and should be done with proper care and knowledge to maintain hygiene. So automatic floor cleaning should be used as they are time-saving and reduce the extra labor cost for the owner.

4. CONCLUSION

To maintain a business workspace tidy and clean, floor cleaning is necessary, but it may be difficult to handle cleaning in a big retail area with manual scrubbing or cleaning. Automated floor cleaning equipment comes with all the necessary cleaning supplies, which facilitates a quick and efficient cleaning operation. It can remove dirt and dust papers from the floor surface in a single pass, leaving a spotless finish. Providing results that are hundred percent better than those obtained using the traditional manual cleaning method, may shorten the time required to clean industrial floors and boost work productivity. It may be programmed to clean at certain intervals and allowed to finish the job. Cleaning is the main daily home task, to make a surface or floor clean, contaminants or dust papers must be removed. While the human technique does not contribute to pollution, the automated equipment cleans the surface with ease. The manual device is consequently time-consuming yet advantageous for the environment. Everyone always obtains excellent results whether you clean with solvents, non-flammable liquids, or alkaline solutions. Undoubtedly, the sector will see more rivalry and a wider range of automated cleaning devices over the next years. Major manufacturers are now working on several robotic devices that will offer some interest to the market.

REFERENCES

[1] M. A. V. J. Muthugala, M. Vega-Heredia, R. E. Mohan, and S. R. Vishaal, “Design and control of awall cleaning robot with adhesion-awareness,” *Symmetry (Basel).*, vol. 12, no. 1, p. 122, Jan. 2020, doi: 10.3390/SYM12010122.

[2] Z. Li, Q. Xu, and L. M. Tam, “A survey on techniques and applications of window-cleaning robots,” *IEEE Access*, vol. 9, pp. 111518–111532, 2021, doi: 10.1109/ACCESS.2021.3103757.

[3] Drew Huff, “Advantages of Floor Cleaning Machines vs. Manual Cleaning,” *Toyota Material Handling Northern California*, 2021.

[4] M. A. V. J. Muthugala *et al.*, “Expressing attention requirement of a floor cleaning robot through interactive lights,” *Autom. Constr.*, vol. 110, p. 103015, Feb. 2020, doi: 10.1016/j.autcon.2019.103015.

[5] Y. Irawan, M. Muhardi, R. Ordila, and R. Diandra, "Automatic Floor Cleaning Robot Using Arduino and Ultrasonic Sensor," *J. Robot. Control*, vol. 2, no. 4, pp. 240–243, 2021, doi: 10.18196/jrc.2485.

[6] Competitive Choice, "The Benefits and Importance of Regular Floor Cleaning," 2019.

[7] T. Pan, W. Sun, H. Li, H. Wang, and L. Zhao, "Design of photovoltaic panel intelligent cleaning robot," *Taiyangneng Xuebao/Acta Energiae Solaris Sin.*, vol. 42, no. 7, pp. 146–151, 2021, doi: 10.19912/j.0254-0096.tynxb.2019-0387.

[8] C. Weng, J. Li, J. Lai, J. Liu, and H. Wang, "Investigation of interface thermal resistance between polymer and mold insert in micro-injection molding by non-equilibrium molecular dynamics," *Polymers (Basel).*, vol. 12, no. 10, pp. 1–12, 2020, doi: 10.3390/polym12102409.

[9] R. Ahmed, "Autonomous Floor Cleaning Robot," *Int. J. Res. Appl. Sci. Eng. Technol.*, vol. 9, no. 4, pp. 1191–1197, Apr. 2021, doi: 10.22214/ijraset.2021.33774.

[10] C. Balasuthagar, D. Shanmugam, and K. Vigneshwaran, "Design and fabrication of beach cleaning machine," in *IOP Conference Series: Materials Science and Engineering*, 2020, pp. 87–89. doi: 10.1088/1757-899X/912/2/022048.

[11] I. Dhage, K. V. Goyal, and H. Srivastava, "Design of Manually Operated Eco Friendly Trash Collector," *Int. J. Res. Eng. Sci. Manag.*, vol. 2, no. 6, pp. 87–89, 2019.

[12] M. Sengottaiyan, "Design and Fabrication of Automatic Floor Cleaning Machine," *Int. J. Res. Appl. Sci. Eng. Technol.*, vol. 9, no. 3, pp. 386–391, 2021.

[13] I. Dhage, K. V. Goyal, and H. Srivastava, "Design of Manually Operated Eco Friendly Trash Collector," *Int. J. Eng. Adv. Res. Sci. Technol.*, vol. 2, no. 6, pp. 87–89, 2019.

[14] S. M. B. P. Samarakoon, M. A. V. J. Muthugala, A. Vu Le, and M. R. Elara, "hTetro-Infi: A Reconfigurable Floor Cleaning Robot With Infinite Morphologies," *IEEE Access*, vol. 8, pp. 69816–69828, 2020, doi: 10.1109/ACCESS.2020.2986838.

CHAPTER 16

AUTOMATIC INTERNET OF THINGS (IOT) CONTROLLED TWO-WHEELED FORKLIFTS FOR INDUSTRIES

Dr. Vipin Kumar Solanki, Professorr,
Department of Mathmatics, Sanskriti University, Mathura, Uttar Pradesh, India
Email Id-hodmaths@sanskriti.edu.in

ABSTRACT:

The lifting heavy load in the industry need more energy and is time consuming. So there are the forklifts which are used for lifting such loads in factories or big workshops which are operated by user with physical presence. Hence the author focusses importance of automatic two-wheeled forklift using IoT for operations in the industries for lifting heavy loads. In this paper author discuss the designed machine is used for lifting the objects of 200 kg weight to know the working time and efficiency of machine. It concludes that the machine designed is useful for the users to work from one place without physically operating the forklift. The machine designed is useful for the industries with mass productions which will reduce the use of multiple workers as one worker can easily manage the 5-10 machines also for multiple operations. In the future, the machine can be operated using AI also within next few years for lifting heavy objects.

KEYWORDS:

Industries, Load, Trucks, Two-Wheeled Forklift, Warning System.

1. INTRODUCTION

A forklift is a very practical and time-saving vehicle that resembles a small truck and is used to transport heavy material over short distances [1],[2]. It is now frequently used in production lines, road construction, and industries to carry heavy materials for construction, load and unload trucks as well as ships, and clear snow from the way [3],[4]. The front of the forklift has a power-operated forked platform that can be raised and lowered to be inserted beneath goods in order to lift or transport it [5],[6]. While controlling and driving a forklift, certain models let the operator sit while others demand that they stand. Field of Use Materials are moved from one location to another using forklifts. In business settings like factories, building sites, industrial workshops, etc., forklifts are used [7],[8]. Forklifts operate on semi-electric systems, which transmit power from one shape to another utilizing both mechanical and electrical components. In this project, humans have worked upon that conversion of rotational movement to linear motion utilizing a 2:1 gearbox-built dc motor. As the motor runs, the chain drive, which is connected to the lead screw's gearbox via a sprocket, begins to operate and rotate the lead screw [9],[10].

The roller is affixed to the nuts, this same lead screw is put on the guiding column, and the nut is secured into the lead screw [11],[12]. The rollers to which the fork is mounted gives it linear motion [13]. If shipments are coordinated appropriately for the use of forklifts with the

appropriate connectedness would be a smartest method to load and unload which would also be make the entire procedure less time consuming the less labour - intensive industries. Product varieties in variety of shapes and different packaged foods of goods for loading or unloading was and still is a heavy procedure during mass transit by fork lifts. Fork lifts instinctually inverted and has become the way to solve this issue. Additionally, forklifts maximize space to store utilization by lowering the number of workers needed for loading and unloading operational processes and empowering goods to also be stacked up to 4-5 meters high, and in certain instances as high as 10 meters. Since forklifts are used for the huge percentage of transport systems, this increases warehouse consumption by at least 40%. Even while technology saves time and work, automation still requires ongoing, complex human control. If uniformity and vigilant oversight are not given, there may be expensive process errors. By assuming complete control of the processes of the mechanical equipment and ensuring uniformity throughout the process, automation will thereby remove error and human contact.

A forklift is a motorized industrial vehicle that can carry material more than a short distance and lift heavy loads of several kilos. A forklift is indeed a machine that resembles a small truck and has two metal prongs up front for lifting items. The forklift driver advances the forklift until the prongs press beneath the load, at which point the forks are operated to raise the cargo several feet into the air. The forks, also known as blades or barbs, are often made of steel and can lift a maximum of two tons. The only sources of power for forklifts are electrical, gasoline, or methane. Electric forklifts must be powered by batteries. Despite needing more maintenance and usually costing more money in fuel, forklifts powered by gasoline and methane may sometimes be faster or stronger outperform electric forklifts. Due to the fact that they do not emit harmful gases like gas-powered devices do, electric forklifts are excellent for use in warehouses. Although some forklifts are designed for use outdoors, warehouses are where they are most usually deployed. Although some tough terrain forklifts run on diesel or gas, most of them do. Because they have the highest lifting capability of any forklift and heavy-duty tires (similar to those used on trucks), difficult terrain forklifts may be driven on outside uneven ground.

The present paper is a study about the smart forklift has features including speed limits, anti-slip technology which monitors tire spin and improves grip on slippery surfaces, collision detection, fork motion optimization, and diagnostics that enable the machinery to warn when it requires maintenance. This study is divided into several sections, the first of which is an introduction, followed by a review of the literature and suggestions based on previous research. The next section is the discussion and the last section is the conclusion of this paper which is declared and gives the result as well as the future scope.

2. LITERATURE REVIEW

Anton Blåberg [14] has explained that when operating autonomously in industries, the Automated Guided Vehicle (AGV) must adhere to safety laws to avoid colliding with humans. The goal of this thesis is to develop an anticipated warning system using data from actual driving situations. Based on basic statistics and historical locations, the warning system would predict a direction, and if objects were to appear along the projected path, choices about speed restrictions may be made. The anticipated warning system, the active detection and alert, and a deactivated warning system configuration were all compared in terms of driving productivity overall driving dynamics. The findings showed that a predictive monitoring system drove the test track more quickly and with better dynamism than the current warning system plus that a no warning system

setup. In summary, a prediction warning system based on empirical data beat other approaches in most cases, although it needs additional components to function.

Arso M. Vukicevic [15] et al. have explained how pushing and pulling (P&P) are frequent, repeated actions in industry, and how poor execution of these duties contributes to a number of important musculoskeletal illnesses (MSD). The P&P safety management system now in place assumes maximum weight, height, and distance restrictions, but it is still difficult to adjust for changing individual characteristics using the established criteria. The goal of the study was to swiftly and precisely detect risky P&P activities using IP cameras and IoT force sensors. The findings demonstrated that although loading and unloading freight are typically disregarded when looking into P&P, they are also examples of common harmful P&P actions. The system's testing findings showed that it had a high degree of agreement using motion detectors and had a large amount of promise for assessing and improving P&P workplace safety.

T. Chapple-mcgruder[16] et al. have a purpose While still formal schooling has increased, shifting patterns that impact epidemiologic practice have raised questions about whether epidemiologists have the right training. The methods used to provide an explanation for characteristics that predicted low levels of self-reported proficiency in daily, essential work tasks for epidemiologists in state health agencies. Predictive variables were assessed together with the frequency of knowledge gaps scenarios where epidemiologists ranked a task as "very" vital to their day-to-day work yet thought they unable to do it or could only complete it at a beginner level. The majority of epidemiologists working for state health agencies were found to have a focus on communicable illness (31%) or generalist surveillance (26%). Epidemiologists identified eight key work-related daily activities, with or without an average of three university educational. In conclusion, even though epidemiologists get more formal education, one-third of the critical daily tasks they must do leave them feeling unprepared.

Yanxing Song [17] et al. have explained that logistics is a key factor in economic growth and a driver of nations' and businesses' competitiveness. It focuses to the IoT enabling technologies towards smart logistics. From the viewpoints of logistics transportation, warehouse, loading/unloading, transporting, distribution processing, redistribution, and information processing, a discussion of how IoT technologies are implemented in the field of smart logistics. By processing information from all facets of logistics in real-time and thoroughly evaluating it, it can intelligently implement the contemporary integrated logistics system. In conclusion, there are many open research questions and problems related to the application of IoT technology in smart logistics.

Van Ga Bui [18] et al. have presented prospective possibilities for the approach to reduce greenhouse gas emissions as two-wheelers driven by batteries, hydrogen fuel cells, or a mix of these two power sources. The primary goal is to outline the technological issues and solutions that now face two-wheeler energy storage. The powertrain designs for the battery pack two-wheelers and the energy storage hybridization two-wheelers were both based on traditional two-wheeler chassis. The cost of manufacturing hydrogen and fuel cell stacks has fallen, which now has caused the operating expenses of two-wheelers powered by fuel cell technology to steadily decline. Predictions state that soon the expense of two-wheelers driven by fuel cells will be equivalent to that of two-wheelers powered by batteries or internal-combustion engines.

The above study shows how P&P are frequent, repeated actions in industry, and how poor execution of these duties contributes to a number of important MSD. In this study, the author discusses the characteristics of two-wheel aisle forklift and forklift component.

3. DISCUSSION

With the aid of IoT technology, the internet grants the freedom to create systems that can be remotely controlled. The current approach, which relies on human labor and participation, will be mechanized using a robot to help the warehousing attendant. In order to provide services within warehouses without on-site human participation, automation employing robots and therefore IoT technologies are frequently combined. Due to the robot's IOT capabilities, which will allow the attendant to control it from locations with internet access, it will also assist the client and attendant by giving a proper inventory of the products.

3.1. Two-wheel aisle forklift:

Combustion engines or electric batteries power forklifts. Some forklifts allow the operator to sit during operating and driving them, while others demand the operator to stand. It is often used in the sector for the transport of merchandise and materials. Mild steel square rods as well as mild steel metal sheets are used to construct the chassis, which ensures that it is sturdy enough to support the weight. Additionally, the chassis needs to have adequate room and configuration to attach the operator, steering, battery, oil drain, and forklift. In order to ensure that the consequent center of balance of an empty vehicle is placed on the rare side of the chassis, the mast is installed on the front section of the airframe and the batteries is mounted on the posterior part of it. If necessary, we may also install a protective frame to ensure the safety of the operator on board, such as while operating in warehouses with tight passageways and high operation heights where accidents might occur for a variety of reasons. The front half of the wheels were mounted to the chassis underneath. The pneumatic pressure rubber tires on the wheels that have been suggested provide good traction on any type of floor, including those with sloppy or rough surfaces. Additionally, a forklift with pneumatic tires may move at a good speed and with less effort after surface friction is overcome. Additionally, the emergency handbrake is installed above the wheels, as well as the operator is in charge of the steering while on board.

The handbrake is necessary to ensure the operator's security and avoid any accidents that might result in monetary loss, lost productivity, fatalities, or damage towards the load or cargo that has to be moved. The mast is fixed to the chassis. Having a mild steel, rectangular frame with strong, square rods. In order to ensure that the motor's strength does not decrease when lifting a weight, it also includes a high torque electric motor coupled to a teeth wheel connected to a variety of teeth wheels. The rack configuration is included on the fork supporting, which ensures that the fork travels in both directions—up and down—as needed while maintaining its full lifting capability thanks to the connection between the toothed wheel as well as the pinion. The two primary horizontal constructions classified as masts are where the hydraulic pistons were fastened. The roller chain pulleys which fulcrum creates a gear at the top of the mast are used to secure the forks intended to transport the weight to the forklift's main structure. Therefore, the gears on the masts are driven against the roller chains because when hydraulic pistons push their masts in an upward direction. It occurs because one portion of the chain is connected to the forklift's permanent framework, and the forks can only be pulled upward while the gears are rotating in a clockwise manner. This mechanism's significance lies in its ability to allow the forks to go far beyond the reach of the cylinders. Forklifts would also need significantly larger

cylinders to raise the weight to a corresponding height if it wasn't designed for roller chain pulleys. It suggests a two-wheel aisle forklift construction to address the issues mentioned above. The proposed design of two wheel aisle forklift contains following main parts in Figure 1.

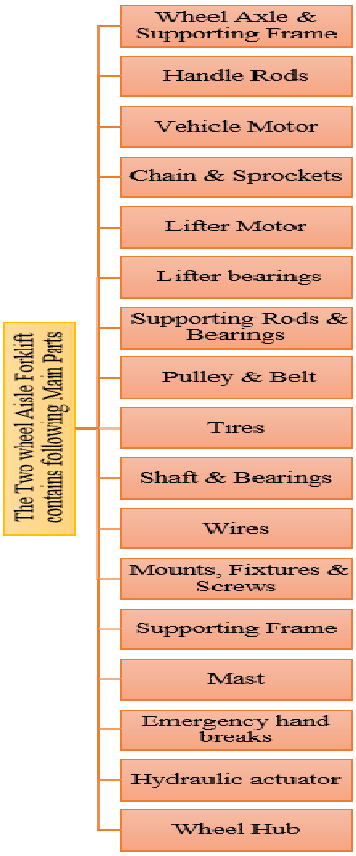


Figure 1: Illustrates the two-wheel aisle forklift contains following main parts.

3.2. Forklift Components:

To accomplish various tasks safely and industrially, forklifts are crucial. The forklift is what supports the cargo as the undercarriage. A forklift functions as a modular single component of wheels and axles because it has a chassis or structure with wheels. The forklift has the following components:

3.2.1. Forklift Frame:

The major supporting structure is referred to as the forklift framework. Either a cast or manufactured bogie frame is used. The forklift frames are made based on how they will be used. It is the primary element that withstands stresses. The forklift frame is constructed to be able to support the weight of the operators, the associated components, and the load of the items with optimum body weight distribution.

3.2.2. Forks:

The major component designed to support the weight of the items being lifted is a set of forks. These components, which are often inexpensive and constructed of cast iron, seem to be the most

strained since lifting and loading require varied loading conditions. In order to properly maintain such items, rust scaling should be removed, polishing should indeed be done, and so on.

3.2.3. Brake:

On the driving wheel seems to be a combination of drum brakes. The brake activating mechanism would've been built into the frame close to the link mechanism, allowing it to lock the axle as needed.

3.2.4. Motor:

Chain drive would be employed to link the engine to the driving axle. This driving shaft is connected to the two front wheels and therefore is driven by a chain drive. A sprocket is positioned on the axle and would be coupled towards the driving axles.

3.2.5. Chain Drive:

Due to someone else's weight and also the external load (goods), the system will use a chain drive to continue increasing the pinion gear or the torque transmitting capacity to the vehicle wheels. The larger sprocket would've been mounted upon that driving axle propeller and attached via a key and sprocket, and the relatively small gear would've been mounted on the motor. Medium carbon steel blanks from cold rolled sheet, toughened to 50 HRC, is the substance used to make chains. The pin, brushes, as well as rollers are constructed of alloy steel that has been case-carburized and hardened approximately 50 HRC.

3.2.6. Shaft:

For attaching the wheels and gears, a shaft is used. The ASME code technique was used in its design since it is a practical and cautious way to obtain an exact shaft dimension. Medium carben metal is the most often used shaft material because of its characteristics of being easily accessible, low cost, high toughness, better strength, and excellent load carrying capacity.

3.2.7. Square Tubes:

The forklift's body is supported by a framework made of square tubes. As the requirements change depending on the load or purpose, this structure is constantly subject to repeated loading conditions. These would be composed of mild steel, which has a suitable level of strength and good weldability.

3.2.8. Actuators:

Switches and actuators, such as an accelerator, would've been utilized to regulate the driveline speed.

3.2.9. Wheels:

Two distinct types of wheels would be employed. The front wheels would indeed be different from the back and be of the same type. The front wheels are positioned with their centers at a decent height, which allows for sufficient ground clearance. It also helps to position the cargo at a suitable and safe distance from the ground, preventing damage while the object is being moved. This also makes a key argument for why the forklift's center of balance should shift to the back, preventing it from toppling.

3.2.10. Steel Plate:

These plates will support the operator's weight and be installed as a platform atop the frame. These steel plates have grids on them to increase friction. These are frequently seen in the nicest buses.

3.3. Types of Forklifts:

Forklifts exist in a variety of sizes, styles, and colors, as well as various variations and uses. Although some people may only be familiar with forklifts as a type of tool for material handling, there are really numerous distinct types of forklifts. For instance, a three-wheel counterbalance lifting truck and a pallet jack are two separate types of forklifts, notwithstanding their differences. Listed below are the seven various types of forklifts, in case you want to expand your knowledge of these amazing equipment or even diversify your fleet.

3.3.1. Counterbalance:

They are the most widely utilized vehicles in almost all material handling applications. Additionally, counterbalance forklifts are really a practical tool with twin prongs for heavy loads and large objects.

3.3.2. Three-Wheel Counterbalance:

As opposed to contemporary counterbalance predecessors, which had four wheels, three - wheeled counterbalance forklifts had three wheels. Narrow aisles are perfect for three - wheeled counterbalance forklifts since they offer better mobility in small locations.

3.3.3. Reach Trucks:

These are renowned for the enhanced lift height for which they were given their name. In every warehouse setting with high storage pallet racking, reaching trucks perform best. The Stand-Up truck as Well as double Deep truck are two examples of the several types of reach trucks. Where there is just one cargo per bay, Stand-Up trucks, the much more prevalent form, are frequently employed. Comparable to single deep trucks but with longer forks, doubles deep trucks can reach all the way to the rear of a bay, which makes them ideal for situations where numerous pallet loads are kept in each bay.

3.3.4. Pump Trucks:

This is seen as a little retro. In the beginning, pump trucks are utilized as pallet jacks, but they don't have any electric motors to raise anything. Pump trucks don't use it; instead, the driver manually pumps hydraulic jack to raise the skids according to their own force.

3.3.5. Powered Pallet Trucks conversely:

It is a pump truck's most advanced invention. For lifting heavy objects, motorized pallet trucks are used. Powered pallet trucks are perfect for storing or moving small products since they have the capability of a pump truck.

3.3.6. Side lines:

These have forks fixed to the side of the vehicle and are made to work in tight aisles and along sidelines. They are made to lift heavy items more effectively than a standard forklift. These are

available in a variety of shapes, just like many other forklift kinds. The Bounded Cab, which would be frequently utilized outside, as well as the Stand-Up, which is designed to handle inside assignments, come first.

3.3.7. Tele trucks:

These tools, sometimes known as telescopic hand forklifts, are an additional choice for users who are responsible for carrying objects up tall buildings or streamlining mezzanine storage. Standard lift trucks could indeed reach the heights as well as angles that even these forklifts could.

3.4. Two-wheeled advantages of Forklift Machine for Industries:

An autonomous forklift is driven by a computer rather than a human driver. Figure 2 illustrates an automated forklift that moves under the supervision of a sensor-based supervision system and computer-based software. Forklifts with automation resemble mobile robots on wheels. They are employed in the industrial sector to move huge goods between structures such as factories and warehouses. They can also be used to pull trailers full of raw materials and completed goods. After that, they may be freed from the trailers and moved independently.

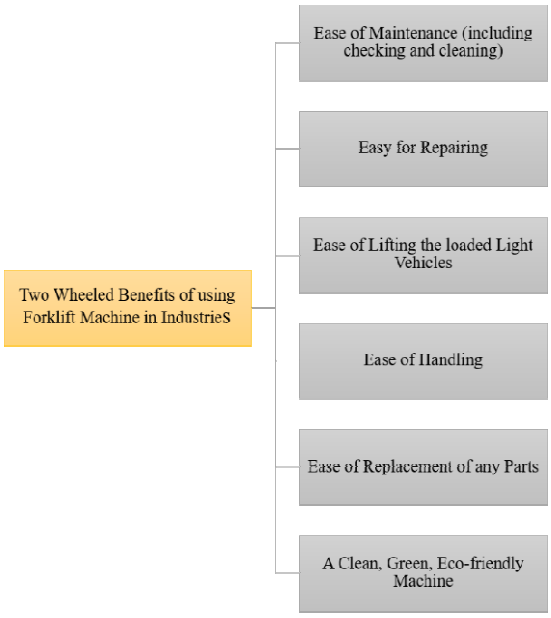


Figure 2: Illustrates the advantages of two-wheel forklift machines for lifting heavy weight in industries.

4. CONCLUSION

In the sector of production and manufacturing businesses, the project we completed was impressive. Having a car for gathering scrap is quite helpful since they may park the vehicle without taking any risks. The initiative will lower the expense associated with the issue. The project has been created to complete the full requirement job in the least amount of time possible. The creation of mechanical forklifts guarantees the operator's or workers ergonomic comfort and cuts down on the time needed for manual lifting and handling. This improves production and ensures operator safety when handling the materials. Forklifts and cranes are

necessary in factories, industries, and storage facilities for transporting and storing huge items. Additionally, there are a lot of items that weigh approximately 200 kg that are relatively lighter yet are difficult for human labor to transport. We here suggest a two-wheel drive forklift to lift and move these medium-weight items across factories and industrial warehouses in order to meet this necessity. The 2 wheel drive vehicle has less area to travel about and is quick, effective, and low power using. The little forklift will be powered by two DC motors and therefore can readily move light loads using pickup arrangements across short distances. For this, a miniature 2-wheel vehicle body structure with a platform and two motorized wheel mounts is used. It includes a perpendicular handle up front that may be used for both turning and holding. Future enterprises in a range of industries stand to gain significantly from a smart forklift. Employers must inform their staff about forklift safety in order for them to benefit fully from smart forklifts.

REFERENCES:

[1] S. Oswal and D. Saravanakumar, "Line following robots on factory floors: Significance and Simulation study using CoppeliaSim," *IOP Conf. Ser. Mater. Sci. Eng.*, 2021, doi: 10.1088/1757-899x/1012/1/012008.

[2] G. Shittu, "6 fatalities in 1 year, what else on human factor!," 2020. doi: 10.2118/199494-ms.

[3] B. Bhushan, "Historical evolution of magnetic data storage devices and related conferences," *Microsystem Technologies*. 2018. doi: 10.1007/s00542-018-4133-6.

[4] J. Bellerive, J. Hu, M. Dutta, S. D. Knights, and P. Bach, "(Invited) Fuel Cells for Heavy Duty Vehicles," *ECS Meet. Abstr.*, 2020, doi: 10.1149/ma2020-02342179mtgabs.

[5] M. Dutta, A. P. Young, V. Colbow, J. Bellerive, and S. D. Knights, "(Invited) Examining Catalyst Layer Design Strategies for Improved Fuel Cell Performance and Durability," *ECS Meet. Abstr.*, 2020, doi: 10.1149/ma2020-02332131mtgabs.

[6] "Toyota adds 20 fuel cell forklifts, hydrogen station at Motomachi," *Fuel Cells Bull.*, 2018, doi: 10.1016/s1464-2859(18)30107-x.

[7] "FORKLIFT TRUCK SELECTION USING TOPSIS METHOD," *Int. J. TRAFFIC Transp. Eng.*, 2018, doi: 10.7708/ijtte.2018.8(3).10.

[8] A. Lang, "Evaluation of an Intelligent Collision Warning System for Forklift Truck Drivers in Industry," 2018. doi: 10.1007/978-3-319-91397-1_50.

[9] F. Rokosch and M. Radtke, "Forklifts in trade and distribution industries: Noise exposure during operation," *Zentralblatt fur Arbeitsmedizin, Arbeitsschutz und Ergonomie*. 2018. doi: 10.1007/s40664-018-0273-x.

[10] E. M. I. Khasanah and E. D. Nawawinetu, "HAZARDS IDENTIFICATION AND RISK ASSESSMENT OF PHYSICAL AND MECHANICAL FACTORS OF FORKLIFT OPERATIONAL IN PT SINAR INDOGREEN KENCANA AAC PRODUCTION AREA'S," *J. Vocat. Heal. Stud.*, 2018, doi: 10.20473/jvhs.v2.i1.2018.20-27.

[11] N. El Hachemi, M. Saddoune, I. El Hallaoui, and L. M. Rousseau, "A two-phase approach to solve the synchronized bin–forklift scheduling problem," *J. Intell. Manuf.*, 2018, doi: 10.1007/s10845-015-1086-9.

[12] D. DELİKTAŞ, Ö. ÜSTÜN, and Ş. KIRIŞ, "Order Picking Problem in a Warehouse with Bi-Objective Genetic Algorithm Approach: Case Study," *Doğuş Üniversitesi Derg.*, 2018, doi: 10.31671/dogus.2018.15.

[13] A. VAIDYA, K. ROTLIWALA, M. PRAJAPATI, N. PATEL, R. RAJPUROHIT, and M. PATEL, "DESIGN OF PEDAL OPERATED WHEEL DRIVE FORKLIFT," *Int. J. Des. Manuf. Technol.*, 2018, doi: 10.34218/ijdmt.9.1.2018.003.

[14] A. Blåberg, "Empirical Data Based Predictive Warning System on an Automated Guided Vehicle".

[15] A. M. Vukicevic, I. Macuzic, N. Mijailovic, A. Peulic, and M. Radovic, "Assessment of the handcart pushing and pulling safety by using deep learning 3D pose estimation and IoT force sensors," *Expert Syst. Appl.*, vol. 183, no. July 2020, p. 115371, 2021, doi: 10.1016/j.eswa.2021.115371.

[16] T. Chapple-mcgruder *et al.*, "Annals of Epidemiology Examining state health agency epidemiologists and their training needs," *Ann. Epidemiol.*, vol. 27, no. 2, pp. 83–88, 2017, doi: 10.1016/j.annepidem.2016.11.007.

[17] Y. Song, F. R. Yu, L. Zhou, X. Yang, and Z. He, "Applications of the Internet of Things (IoT) in Smart Logistics : A Comprehensive Survey," vol. 8, no. 6, pp. 4250–4274, 2021.

[18] V. G. Bui, T. Minh, T. Bui, A. Tuan, and S. Ni, "Energy storage onboard zero-emission two-wheelers : Challenges and technical solutions," vol. 47, no. July, 2021, doi: 10.1016/j.seta.2021.101435.

CHAPTER 17

REVIEW OF IMPLEMENTATION OF FIREFIGHTER ASSISTING ROBOT FOR DIFFERENT FIRE EXTINGUISHING OPERATIONS

Mr.Basavaraj Devakki, Assistant Professor,
Department of Mechanical Engineering, School of Engineering, , Presidency University, Bangalore, India,
Email Id-basavarajdevakki@presidencyuniversity.in

ABSTRACT:

Controlling fire in any area is time consuming and risky task that is done by firefighters. During the fire, there is the burning of various elements which creates harmful gases and reduces the life span of firefighters. Thus, firefighting robots are used for assisting firefighters in fire extinguishing operations. Thus, the focus of the study is to find the different designs and models of firefighting robots to control the fire at different localities without human loss. The use of technologies in the fire extinction makes firefighters' life easy as anyone can operate the robots for domestic as well as commercial purposes. Thus, using firefighter robots is easy and convenient as the devices can reduce human losses without any barrier. So the different use of fire assistance robots for controlling fire is used fully beneficial. The study further helps in developing the devices which are highly sensitive to fire and some to avoid the different losses.

KEYWORDS:

Fighting Robot, Firefighter, Fire Extinguish, Robot, Smoke.

1. INTRODUCTION

The act of putting out big uninvited flames in structures, automobiles, and forests is known as fighting the fire. To safeguard people, businesses, and the ecosystem, firefighters put out fires. Typically, firefighters receive extensive technical training. Both wild lands, as well as structural firefighting, are involved. Aircraft firefighting, marine firefighting, aviation firefighting, marine firefighting, and vicinity firefighting are all covered in specialized training. The hazardous atmosphere produced by flammable materials is one of the main risks connected to firefighting activities. As depicted in Figure 1, the five main dangers are smoking, low levels of oxygen high temperatures, toxic atmospheres, and erratic airflows. Firefighters carry conscience breathing equipment to mitigate some of these concerns [1], [2].

Figure 1: Represents the Building Set On Fire For and Firefighters Spraying Water to Control the Fire.

Other dangers include falls, which are always a possibility when negotiating new layouts or cramped places with moving debris and poor sight, as well as structural collapse, which can make the issues experienced in a hazardous environment worse. To find the fire's source and figure out the specific hazards, reconnaissance is the initial stage in every firefighting effort. Water, the elimination of fuel or oxidants, or chemical combustion suppression may all put out flames; however, different types of fires such as those caused by grease, paper, electrical equipment, or other materials need different types of fire extinguishers. The extinguisher's suitability for various types of fires determines its categorization. The National Fire Protection Association in the United States provides descriptions of the many forms of fire [3], [4]. The hazardous atmosphere produced by combusting substances is among the main risks connected to firefighting activities. The four primary risks are:

1. Smoke is more and more hazardous because there are so many synthetic home products available today.
2. High Temperatures,
3. A Lack of Oxygen,
4. Toxic Environment.

Firefighters carry a self-contained breathing device to deal with such dangers and avoid inhaling smoke. While not oxygen tanks, these work similarly to SCUBA diving equipment by using compressed air. Depending on the capacity of the reservoir and the speed of air utilization during vigorous activity, SCUBA may typically contain 30 to 45 minutes' worth of air for a fireman. Despite the protective equipment, firemen are still subjected to radiation, hazardous dust, gases, and smoke, which has increased their chance of developing cancer by 14% [5]. Unmistakable dangers brought on by the intense heat produced by a flame, such as conduction heat and radiant heat, can still result in severe burns even from a distance. Some heat-related concerns are comparable to being very significant, such as burning through hot gases, steam, and hot and/or poisonous smoke. Firefighters are more likely to contract conditions like rhabdomyolysis when they push themselves for extended periods and in hot conditions. As a result, firefighters are provided with personal protection equipment (PPE), such as helmets that reduce heat transfer to the body, and clothing made of Nomex or polybenzimidazole fiber (PBI) that resists flames. However, no PPE can shield the user from all potential fire circumstances [6], [7].

Heat may cause flammable material in tanks to rapidly burst, creating what's known as a BLEVE (Boiling Liquid Expanding Vapor Explosion). Some chemical compounds, such as fertilizers made of ammonium nitrate, can explode and inflict bodily harm through explosion or shrapnel wounds. With enough heat, human flesh may burn as fuel, or the water within can boil, which might have serious health effects. There are still other concerns, such as backdrafts. Backdrafts happen when a fire that is low on oxygen has a lot of oxygen added to it. If a window or door is opened during a compartmentalized fire and the majority or all of the gas has been burnt off, there is a significant chance of downdraft. It can be disastrous to add oxygen to either a low-burning fire since it will spark every drop of oxygen in its path. It has a shockwave blast that enhances the effect and may be heard from kilometers away. Firefighters must constantly communicate with one another to prevent major injury from a shattered window that might occur while they are working on the structure [8].

After a fire has been put out, cleaning up the wreckage presents various threats to employees' health and safety. In fire debris, several dangerous compounds are frequently discovered. Silica can be a naturally occurring substance or it can be found in concrete and roofing tiles. Asbestosis, lung disease, bronchial TB, airway disorders, and a few other non-respiratory illnesses can all be brought on by workers exposed to silica dust. Asbestos exposure can cause mesothelioma, emphysema, and pneumonitis, among other illnesses. Burnt or melted gadgets, vehicles, freezers, furnaces, etc. are some examples of sources of trace metals. Workers who clear away fire debris may come into contact with these metals as well as their combustible material through the skin or even the air. They could include metals such as lead, nickel, cobalt, Beryllium, manganese, chromium, and a variety of other metals that contain cadmium. Structure and wildland fires frequently produce polyaromatic hydrocarbons (PAHs), some of which are hazardous and originate from the incomplete combustion of natural materials. The potential of smoldering debris reigniting, electrocution from fallen or exposed power wiring, or situations wherein the water has gotten into working with electrical equipment, as depicted in Figure 2, are some of the safety risks associated with fire cleaning.

Figure 2: Represents the Firefighting Robots used for Fire Extinguishing Operations without Human Intervention.

Burned-out buildings may be unstable and subject to unexpected collapse. The Fire Fighting Robot is made to find a fire in a small layout of such a house of a certain size, put it out with the aid of a toy hovercraft's frontal fan, and then come back to the entrance of the house. It is believed that the fire detection system won't overreact in nonfire scenarios since it has a low false

alarm rate. This mission is broken down into smaller jobs, and each work is carried out in the most effective way possible, such as the robot starting on its own, moving through each room step-by-step, and locating the fire in a certain area. Returning towards the front of the house after approaching the fire from a defined distance and putting it out. To put out the fire, it is thus important to employ firefighting equipment rather than endangering the lives of the firemen. Therefore, it is important to understand the many design developments in firemen.

2. LITERATURE REVIEW

Md. Hazrat Ali et al. discussed on development and creation of a network-based, autonomous firefighting robotic prototype are discussed in this study. It discusses the use of a spray gun and pumps in a water-based fire suppression system. A little vehicle washer is employed for this. To develop a network system to guide the robot to the goal distances, gas sensors are added. The obstacle avoidance algorithm determines optimal navigation. These days, putting out fires is difficult, especially in multi-story buildings. This technique offers a way to automatically put out a fire to eliminate risk in a domestic setting. The prototype is constructed using inexpensive components found in the lab [9]. A. K. Srivastavaet al. developed an embedded system-based firefighting robot to create and test a robot that can put out a fake home fire. It has to be capable of independently moving around a simulated floor layout while aggressively looking for a flame. The robot may also serve as a fire extinguisher in an emergency and a path guide in regular circumstances. In the future, robots that can locate fires before they get out of control would dramatically reduce the danger of injury to victims. While working toward a workable and attainable solution can save lives and reduce the danger of the destruction of property, the project will help spark interest and advances in the domains of robotics [10].

Dr. Zamin Ali Khan and Syed Rizwan outlined an autonomous firefighting robot that can detect and put out fires on its own. It uses an IR (Infrared) flame sensor to find the fire, and an ultrasonic sensor to avoid obstructions. As it approaches the flame, it first identifies the fire autonomously before pumping the motor to activate the spray extinguishers, which are managed by the circuit controlling the motor. The Arduino Mega is indeed a microcontroller that is used to write all of the autonomous AI (Artificial Intelligence) programs and carry out all of the key functions. Additionally, it is linked to the nearby server through a Wi-Fi module. Our robot can assist in various types of businesses, including banking, shops, bakers, and industries [11]. Joan Saez-Pons et al. explained the idea of a robot configuration in the context of the robotic team deployment in the real world (swarm). The control model, which we tailor to the particular duties necessary for the GUARDIAN's situation, is founded on the so-called societal artificial potential concept. In terms of graph theory, a form can be either spread out like a road or compacted like a star or wheel. Researchers have applied the created behaviors on actual ERA-MOBI bots, also known as Erratic, as well as in simulation settings. a group of Erratics examined the benefits and drawbacks of our concept based on simulation and execution [12].

Lewis Riches and Dr. Mark Judge investigated how an intelligent robotics system may assist in collecting and analyzing the early information from fire situations. The process of assisting and alerting robots during an emergency for fire safety. Initial research from this study indicates that having a constantly updated map showing internal circumstances improve path optimization accuracy and maybe increases the efficiency with which teams can reach victims and stabilize the structure [13]. Dnyanesh S. Kadu et al. created a robot that can do fire-fighting tasks at the household level. However, they frequently face greater hazards when carrying out fire

extinguishing tasks, particularly in dangerous settings like nuclear power plants and oil refineries. Robots are now often utilized to help firefighters handle challenges they confront, and human interference has decreased as a result of advancements in the field of robotics. Their study describes the creation of a firefighting robot that can put out a flame without putting fire crews in needless danger. Because of its small size, this robot may be utilized to put out flames that spread through constrained passageways and reach the affected regions. To regulate fire extinguishing activities, it uses network communication and a radio wave receiver and transmitter [14].

Abu Ubaidah Shamsudin et al. studied simultaneous localization and mapping (SLAM) of firefighting robots at petroleum installations was indeed the goal of this work. The SLAM map's accuracy is crucial because human drivers utilize it to locate targets on the map by comparing it to aerial photographs. Increased consistency is made possible via the global positioning system (GPS). Consequently, two RBPFs based on GPS plus light detection and ranging (LIDAR) are described in this research as SLAM alternatives. The suggested combination approach is accomplished by utilizing a probabilistic mathematical formulation, in contrast to the original Fast-SLAM which used the GPS log-likelihood statistic. The proposed approaches were tested utilizing sensor data gathered in a genuine Japanese petrochemical plant with a size range of 550 to 380 m [15]. William Dubel et al. discussed a robot, outlining the parts and reasoning needed to find and put out the mock fire. The difference between humans and robots has now been closed by technology, enabling a more effective and efficient approach to battling fires. One day, firemen may collaborate alongside robots created to locate fires before they go out of control, dramatically minimizing the danger of harm to victims. For those who are not familiar with robotics, the term “autonomous” refers to a robot's ability to function without human supervision. A robot must activate in response to an auditory tone (the smoke alarm), find, and put out the simulated fire as a competition component [16].

Vyshnavi M B et al. explained that a person who uses a fire extinguisher to put out a fire is doing a dangerous job when they detect and put out the fire. The IoT fireman robot is the answer to effectively detecting and putting out a fire. The robot is both controllable and autonomous. Using the Remote Desktop software, the robot is controlled. The application (authority), as well as the robot, are linked over the Internet. In this work, we described how the IoT idea is applied to robots. The robot needs authority to determine the type of fire and use the proper fire extinguishing techniques. Future drones targeting terrestrial regions might use the IoT firefighter bot [17]. Ali Marjovi et al. researched the Guardians robotic swarm is intended to be deployed in a sizable warehouse to aid firefighters. The magnitude of the area and the emergence of dense smoke, which significantly decreases vision, offer significant difficulties for search and rescue activities. Outlined the swarming algorithms that cause robots to follow humans without communication. Suggested approach for human-robot interaction in a cooperative navigation system that leverages a wireless connection as a tool. The robot swarm can offer directional data. The firefighters and I investigated how to comprehend and make use of a robot swarm. The last section of the research includes a sensor-based exploring approach to research observations [18].

There are various studies developed on the design of firefighter robots. Different technologies are developed and evolved using AI, the Internet of Things (IoT), Wi-Fi, and Arduino to implement in the systems for better efficiency. The use of autonomous robots is now becoming convenient to control fire at different locations without risking life. There is the evolution of various gases that affects the life of fighters during operation. There are various studies

developed and designs of such robots which are helpful to society and should be studied to know their importance.

3. DISCUSSION

The Firefighting Robot is a small, mobile emergency worker robot that helps firefighters battle flames in tall buildings, especially in extremely hazardous locations where it is unsafe for individuals to enter. The scenes recorded by the robot's screen are transferred live to the driver's control module, allowing fire crews to assess the firehouse from a respectable distance while remotely trying to guide the robot. The robot is outfitted with a thermal imager that can detect danger spots in a room independently without being hindered by smoke. The Firefighting Robot can put out tiny but potentially deadly flames in a short area by discharging foam from its 9-liter onboard foam brine solution or freshwater throughout its water sensor. Consequently, lowering risk exposure, easing cognitive demands, and providing greater bandwidth during an emergency will enable firemen to carry out extremely difficult operations like casualty rescue.

When constructing robotic firefighters systems, certain responsibilities are taken into account. These tasks include assessing and locating fires, conducting rescuing and searching operations, monitoring unsafe situations, and carrying out the primary duty of preventing and damping fires. In densely populated and dangerous places, fixed firefighter robotic systems are utilized to quickly put out any threat, such as automated fire sprinklers and sirens. These are often stationary systems that are simpler and primarily rely on UV or IR detectors. Another kind is mobile robotic firefighting equipment, which often takes the shape of remote-controlled cars fitted with foam as well as water hoses to put out fires. Through a variety of sensors, visible cameras, infrared (IR), and other technologies that convey navigational information to a remote controller, as depicted in Figure 3, they can travel into places dangerous for people. To increase situational awareness, safety experts and technologists are even testing aerial automation like drones as well as close-quarters interior robots that can put out flames at close distance.

Figure 3: Represents the Fire Extinguishing Operation in Factory Followed by Professional Service Robot.

Figure 4: Represents the Fire Extinguishing Operation for a burning car Followed by Professional Service Robot.

Sooner or later, this kind of firefighting robot will collaborate with firemen, considerably lowering the risk of damage to victims. In addition, this research on robotic firefighting will promote interest in robotics advancements while working toward practical and attainable solutions that would save lives and lessen the risks to the property. Just on the robot's body is indeed a sprinkler system with pumping, and Figure 4 illustrates how the microcontroller o/p controls it by receiving the correct signals from the transmitting end. A microprocessor oversees the whole process. The microcontroller is connected to a motor driver IC, through which the controller operates the motors. Any isolated locale or industrial setting has several fire-related potential hazards. Electric leaks, for instance, can cause a great deal of fire and damage in fuel storage facilities, textile industries, and clothing distribution centers. In the worst circumstances and worst-case scenarios, fire results in significant losses in terms of both money and human life. The best approach to protect people's lives, property, and environment is through robotics. An electronic circuit is used in the design and construction of a firefighting robot as shown in Figure 5. It is capable of autonomous navigation on a simulated floor while constantly monitoring the fire. The robot might be used as an emergency device or as a trail guide inside a fireplace gadget.

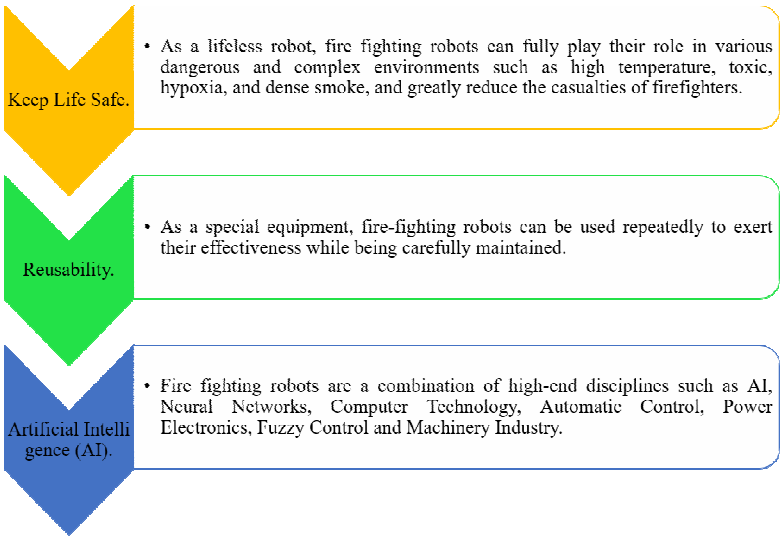


Figure 5: Represents the Benefits of Using Firefighter Robots for Domestic and Commercial Applications.

Thus, the use of technology is increasing in day-to-day life as it is applied to machines for reducing human efforts. The machines are designed using a different technology which has their impacts. The fire-fighting robots are used in the fire extinguishing process where there is a danger of explosion of harmful gases and which also causes the death or loss of human life. Thus, the use of robots helps to reduce the danger to life for the firefighters and provides the right and quick responses as per need of time. Different types of robot designs are used for various fire extinguishing processes in different localities. Thus, using robots has its advantages and also disadvantages as shown in Figure 6 which affects the action of robots during an emergency.

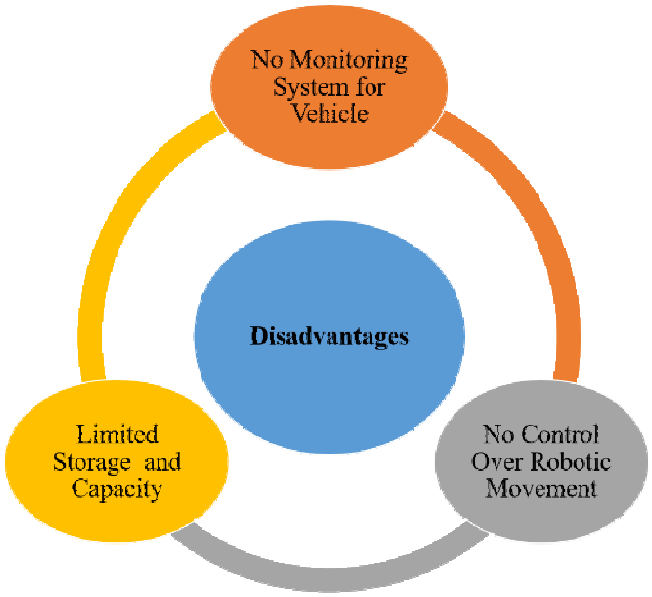


Figure 6: Represents the Disadvantages of Using Firefighter Robots for Domestic and Commercial Applications.

Using fire-fighting robots is now becoming easy with time so one person can operate multiple robots at a time during the rescue operation which helps to save human lives. Fire evolution brings harmful gases which are derived during the burning of different components.The use of robots in all fields is now increasing which makes great chance in the world as it reduces the human labor and efforts for congested tasks. Firefighting is one of the important recuse tasks which impact the property as well as human lives. Thus different designs of robots are studied and their applications for various operations help the safety of human life.

4. CONCLUSION

Firefighters undertake the time-consuming and dangerous duty of controlling fire in any location. The combustion of numerous substances during a fire produces dangerous fumes that shorten the lives of firefighters. To help firemen extinguish fires, firefighting robots are utilized. To identify several designs and types of firefighting robots that can put out fires in various locations without endangering people. The use of firefighting robots is now increasing which helps to reduce the danger to human life and also provides safety in the accident during rescue operations. Because anybody may use robots for both home and commercial reasons, the employment of technology in the suppression of fires makes the lives of firefighters easier. As a result, utilizing firefighter

robots is simple and practical since the tools can easily decrease human casualties. Therefore, the many applications of fire aid robots for fire control are advantageous. The study also aids in the development of equipment that is very sensitive to fire and some that prevent various losses.

REFERENCES

[1] H. B. Wu, Z. J. Li, J. H. Ye, S. C. Ma, J. W. Li, and X. N. Yang, "Firefighting robot with video full-closed loop control," *Int. J. Saf. Secur. Eng.*, vol. 6, no. 2, pp. 254–269, 2016, doi: 10.2495/SAFE-V6-N2-254-269.

[2] Y. Tamura, H. Amano, and J. Ota, "Analysis of cognitive skill in a water discharge activity for firefighting robots," *ROBOMECH J.*, vol. 8, no. 1, 2021, doi: 10.1186/s40648-021-00201-9.

[3] R. Bogue, "The role of robots in firefighting," *Ind. Rob.*, vol. 48, no. 2, pp. 174–178, 2020, doi: 10.1108/IR-10-2020-0222.

[4] A. Guo, T. Jiang, J. Li, Y. Cui, J. Li, and Z. Chen, "Design of a small wheel-foot hybrid firefighting robot for infrared visual fire recognition," *Mech. Based Des. Struct. Mach.*, pp. 1–20, Aug. 2021, doi: 10.1080/15397734.2021.1966307.

[5] Eastern Kentucky University, "The Use of Robotics in Firefighting."

[6] Guoxing, "The Advantages of Fire Fighting Robot," *Shandong Guoxing Intelligent Technology Co.,Ltd*, 2020.

[7] S. Kirubakaran, S. P. Rithanyaa, S. P. Thanavarsheni, and E. Vigneshkumar, "Retraction: Arduino based firefighting Robot," *Journal of Physics: Conference Series*, vol. 1916, no. 1. 2021. doi: 10.1088/1742-6596/1916/1/012204.

[8] A. Murad, O. Bayat, and H. M. Marhoon, "Implementation of rover tank firefighting robot for closed areas based on arduino microcontroller," *Indones. J. Electr. Eng. Comput. Sci.*, vol. 21, no. 1, pp. 56–63, 2021, doi: 10.11591/ijeecs.v21.i1.pp56-63.

[9] M. H. Ali, S. Shamishev, and A. Aitmaganbayev, "Development of a network-based autonomous firefighting robot," *ICINCO 2018 - Proc. 15th Int. Conf. Informatics Control. Autom. Robot.*, vol. 2, no. January, pp. 525–533, 2018, doi: 10.5220/0006928305250533.

[10] A. K. Srivastava, K. K. Singh, K. V. Tripathi, J. D. Nath, K. Bhati, and Imamuddin, "Fire Fighting Robot," *Invertis J. Sci. Technol.*, vol. 12, no. 2, p. 29, 2019, doi: 10.5958/2454-762x.2019.00006.4.

[11] Z. A. Khan and S. Rizwan, "Autonomous firefightng robot," vol. 8, no. 11, pp. 76–80, 2019.

[12] J. Saez-Pons, L. Alboul, J. Penders, and L. Nomdedeu, "Multi-robot team formation control in the GUARDIANS project," *Ind. Rob.*, vol. 37, no. 4, pp. 372–383, 2010, doi: 10.1108/01439911011044831.

[13] L. Riches and M. Judge, "Firefighter Assistance Robot," *UKRAS21 Conf. Robot. home Proc.*, vol. 4, no. June, pp. 7–8, 2021, doi: 10.31256/yo6ds5m.

[14] I. Journal, D. S. Kadu, P. V Kale, and J. D. Kadam, "1-4 8 th Sem Students in Department of Mechanical Engineering," *S.S.J.C.O.E. Dombivli (E)*, vol. 4, 2020.

[15] A. U. Shamsudin *et al.*, "Consistent map building in petrochemical complexes for firefighter robots using SLAM based on GPS and LIDAR," *ROBOMECH J.*, vol. 5, no. 1, 2018, doi: 10.1186/s40648-018-0104-z.

[16] A. Hassanein, M. Elhawary, N. Jaber, and M. El-Abd, "An autonomous firefighting robot," *Proc. 17th Int. Conf. Adv. Robot. ICAR 2015*, pp. 530–535, 2015, doi: 10.1109/ICAR.2015.7251507.

[17] V. M B, A. Satheesh, S. Suresh S, and L. C. Manikandan, "IoT Technology Based Fire-Fighter Robot," *Int. J. Sci. Res. Comput. Sci. Eng. Inf. Technol.*, pp. 934–941, 2020, doi: 10.32628/cseit2063187.

[18] A. Marjovi, L. Marques, and J. Penders, "Guardians robot swarm exploration and firefighter assistance," *Work. NRS IEEE/RSJ Int. Conf. Intell. Robot. Syst.*, vol. 1, no. January 2015, 2009.

CHAPTER 18

STRUCTURAL ANALYSIS OF HAND MOTION-CONTROLLED ROBOTIC ARM

Mr.Kunwar Chandra Singh, Assistant Professor,
Department of Mechanical Engineering, School of Engineering, , Presidency University,
Bangalore, India,
Email Id-kunwarchandra@presidencyuniversity.in

ABSTRACT:

The technological progress of manipulator robots has recently increased dramatically and has had a good effect on human existence. Utilizing manipulative robot technology improves efficiency and accuracy for a variety of human activities. Here describe robotic arms and other robotic arms which are used in various fields. Hand motion robotic arm creation and deployment for commercial processes. The objective of this study is to give an overview of the robotic arms. This paper describes numerous jobs that are carried out by robots, including imaging, enhancing, spot repairing, picking up and placing big things, and many other important uses. In an industrial setting, robots carry out a variety of tasks with the appropriate level of accuracy and precision that human workers are unable to. In this paper, the movements of the robotic arms how it helpful to people to do their work easily in a convenient manner and move a robotic arm in real-time. There are a lot of areas for advancement with Robotic Arms. Robotic arms will soon be able to carry out every task as well as far more effectively than humans.

KEYWORDS:

Arm, Robotic Arm, Robotics.

1. INTRODUCTION

Robots are nowadays being used more and additional in workplace duties to replace humans, especially for laborious jobs. Industrial and service robotics are typically the two categories into which robotics is split. The “International Federation of Robotics” (IFR) describes a facility “robot” as a “robot” that, except for manufacturing tasks, operates mostly or entirely independently to perform services beneficial to the prosperity of persons and apparatus. Numerous industries use these robots, such as workplace, medical clinic tasks, the military, dangerous, farming, and environments [1].Additionally, doing specific tasks like obtaining hazardous materials, defusing bombs, or in the worst-case scenario imagined, picking up and placing a mine anywhere for regulation and repeated pick-up and spot operations in projects, may be difficult or dangerous for people. So a robot may take the place of a human worker. The relations of such a supervisor are connected by joints that permit either rotating movement, as in the case of an expressed robot [2].

Robotics is the manufacturing discipline that studies robots, including their design, production, use, and structural makeup. Electronics, mechanical engineering, and software all pertain to robotics. A robot is a reproduction, mechanical agent. In reality, it is typically an electric-machine device that is controlled by computer programming or electric and is capable of performing tasks on its own. Robots are typically divided into two categories: service robots and industrial robots [3]. Factually, the industrial robot has been the major subject of exploration and growth and has been widely used in industrial manufacturing and construction, including the semiconductor, hardening, automotive, electrical, and electronic device industries. The majority of robots today are robotic arms, which were amongst the first to be created. The robotic arm's various parts include the assembly, the actuation, the detecting, the operation, the power source, etc. The future wearable robotic arm is made with an easy plan and process in mind, in addition to excellent wear ability [4].

The robotic arm is made to have four levels of freedom and be similar to a human arm. Servo motors are used to operate every component of the arm. Additionally, a versatile robotic arm technology will be part of this strategy to give the robotic the ability to control things, such as simple pick-and-place actions. As an example, Instead of a therapist serving a client within an 80.47-kilometer radius, a patient in Helly, Mona could receive therapeutic consultation from a specially trained therapist in Paris, London. The development of wearable and portable wireless 3D accelerometer systems has led to the development of a revolutionary gait quantification system, which is discussed, tested, and assessed in a homebound setting [5].

2. LITERATURE VIEW

Mohammed Rezwan Rahman et al. [6] studied about evaluation and increase the intelligibility of robot presentation in the attendance of affecting humans at the house, at work, or in any other place, this study basic design thoughts on how to straight a robot arm to discover many safe and personified actions. This study evaluates harmless robotic arm gesture routes and explores the potential impact of human variables on safe cooperative operation responsibilities in a manufacturing HRC set. This study's major objective is to create a unique model for secure robot arm actions in manufacturing HRC situations. The application of coordinating techniques founded on human-human teamwork for fluid and successful human-robot collaboration will also be looked at.

Muhammet Mercan et al. [7] discussed the creation of various simulations is part of the immediate work that will be done to assist in setting up the physical experimental setting(s) where the algorithms and suggested solution will be implemented and tested.The author Flexible Sensor, the Connections of System, Communication, the Operation of System, Interface Design with Blender 3D. Due to the flexible sensors installed on any glove, it has been found in this investigation that finger actions are supposed and simulated with great precision and no issues. The system's unique feature is that it can remain wirelessly measured and monitored in fashionable Blender 3D.

Pantha Protim Sarker et al. [8] discussed that work develops the R3Arm, a “lower-cost gesture-controlled robotic arm” device, for isolated rescue operations. It allows for mobility and distant manipulation. The robot can be used in major rescue missions and can be transported to locations where humans cannot.An examination of 152 movements from a study on motion detection for a robot-saving device and related research indicates. This study deals extremely well and professionally with the strategy and program of a “low-cost gesture-controlled robotic arm”.

Rajesh Kannan Megalingam et al. [9] In their study, the authors talk about a simplified method for precision independent farming that combines unmanned machines and sensing schemes with independent farming vehicles. Automatic farming vehicles are separated into four collections in the paper on unmanned robotic facility parts: steering, discovery, act, and plotting. Additionally, it covers a variety of action group sensors, such as “range laser devices”, artificial image schemes, etc. A detailed discussion of several putting algorithms for independent vehicles is showed. In this study the worker will be able to switch the arm after the control room somewhat than from the fields thanks to the. The outcomes of several laboratory studies, such as the achievement/disappointment checks and response period dimension checks, are quite positive.

Muhammad Ahmad Baballe et al. studied describes the creation of a pick-and-place automatic Cobot system for the classification of black colors. Here suggested a method by the author for the Cobots to identify an object's colour by using an IR sensor to identify the black colour and picking and placing the object with the help of a servo motors and Arduino Nano to move the robotic arm. The author presented a proposed intelligent device's functionality has been evaluated by the identification of random objects of various colors. However, it will only be able to find, select, and transport objects that are black to the target place. The suggested approach is anticipated to save labour costs and boost industry productivity and efficiency.

Yagna Jadeja and Bhavesh Pandya [10] discussed about designing and development of five DOF robotic arm schemers. An artificial arm that performs desired functions is a robotic arm. The development of mechanical arms for many non-human settings where human statement is difficult is becoming more and more important today. Humans pick up things without thinking about the procedures necessary and manually manipulate robotic arms utilizing wired and wireless technology. In this study focuses on design and the use of a “Cortex ARM M3 LPC1768 Microcontroller”, a digital controller and ultrasonic sensor connected to a computer system to regulate the angle of a robotic arm. The author findings that to present the close of intellect that may be used to industries to decrease human mistake rates while also improving manufacturing output speed and processing quality.

Enrique Coronado et al. [11] discussed a framework for gesture-based robot control in this paper, go over the design concepts used, and present the findings from our evaluation of the framework with humans. Wearable device gesture-based control may be a novel kind of human-robot interaction, but the literature hasn't addressed its implications. Over the key problematic aspects, potential design principles, and an open source, freely accessible solution using readily available commercial robots and equipment. It is reported on how well the architecture performed overall and how 27 untrained individuals validated it and provide a technique to control a mobile robot using gestures captured by wearable technology.

Anood Ibrahim et al. [12] discussed robot system is built and changed to be able to carry out the necessary task. Control systems enable the movement and operation of different robot sections and carry out a predetermined sequence of actions and services in the event of unforeseen faults. Robotics also requires a lot of teamwork. The degree of human–machine contact determines how flexible and versatile the robot is. The function of artificial intelligence in robotics is also discussed in this paper, along with current and emerging types of controller systems and their use in robotics. It also tries to draw attention to the numerous problems with controller systems and the many solutions.

Pradeep Jayabala and Dr. P. VICTER PAUL [13] developed robotic arm for creating and putting into practice a robotic arm measured by gestures for industrial use. The major objective of that research is to usage human gestures to control the "robotic arm". In the transmitter part, a microcontroller is employed. The necessary activities for the human gesture are performed as a result of the coding. Using an RF transceiver module, these detected signals are treated before being sent toward the robotic arm by the receiving portion. In this study about Given that it has a robotic arm and can hoist bombs, it can also be improved to become a bomb detection robot. The robot can be equipped with a GPS system so that its whereabouts can be monitored.

Previous research has various limitations that are addresses in this literature view. This study reveals that Robots are being used more and more in sectors to replace people, especially for dangerous occupations. The robot is an electric-machine device that can do a complex sequence of tasks either automatically or with human oversight. These are employed in a variety of sectors, including the military, research and healthcare.

3. DISCUSSION

Mechanical device that occasionally resembles a person and is capable of carrying out a number of frequently sophisticated human functions when instructed to do so or when preprogrammed Robots are being used more frequently in workplace duties to replace people, particularly for monotonous ones. Manufacturing and facility robotics are the two main subfields of robotics. The "International Federation of Robotics (IFR)" describes a facility "robot" as a "robot" that implements semi-autonomous or completely independent tasks for the benefit of people and other machinery, exclusive of developing tasks. On the other hand, the internet is increasingly taking center stage in modern society. Online time is more popular than doing duties around the house. In contrast to earlier times when internet was individual supported and users had to remain in obverse of a system to admittance it, internet is now present everywhere there is a device with an internet connection [12].

3.1. Types of Robot

3.1.1. ARTICULATED ROBOT

Articulated robots are those having revolving joints. These joints are usually referred to as axes in the field of robotics. Servo motors are frequently used to operate articulated robots, which can have designs with as few as two axes or as many as 10 or many. Industrial robots typically have four to six axes, with six being the most common. Every component on an articulated robot is known as an axis. The capacity for the robot to move autonomously is provided by the appropriate robotic axis. The axes are generally organized in a sequence such that each of them may assist a subsequent one that is further laterally from the robot assembly.

Producers commonly utilize articulated robots because they have the most degrees of freedom relative to other robot kinds. They are the ideal replacements for production lines due to their expanded range of wave, which closely approaches that of a human. They also increase the flexibility of the production operations. Since they can carry out a wide range of movements, they are well able to adapt to changes in the production process or workpieces. The robot can now handle a larger variety of objects, from little to large, thanks to enhanced mobility, which increases its work envelope. They also provide versatility by performing a range of activities[14].

3.1.2. Cylindrical Robot Arm

The cylindrical robot has a dapped joint for circular motion everywhere the joints axis and a rotate joints for rotation. Rotating movement about the mutual axis is produced by the rotary joint. The prismatic joint, on the other hand, will travel linearly. Robots with cylindrical bodies have an up-and-down primary arm. The robotic arm's built-in cylinder extends and retracts to create this motion. Several of these cylindrical robotic forms are propelled horizontally by a pneumatic cylinder, while vertical motion is propelled by gears and a motor. Cylindrical robots are used for spot welding, managing mechanism gears and die-cast apparatus, and meeting procedures.

3.1.3. DELTA ROBOT

Although delta robots were initially developed in the 1980s, attention in the production company did not begin to grow until around ten years ago. In various assembly lines across several sectors, delta robots are already a familiar sight. Due to the diagonal design of their arms, these machines are also referred to as concurrent robots. Most delta robots feature three to four ultralight, carbon-fiber arms that descend downwards from the primary robot body. They are frequently referred to as "web robots" due to their shape and the arm's similarity to a spider.

Due to a center connection, delta robot arms can bend inwards attach to a compact tooling sheet. It is possible to link the end-effector to this small tooling sheet. A motor housed inside the primary robot body is attached to every arm. The motors control the robotic arm up-and-down motions, push their joint forward and outer as a result. The designing plate moves along the X axes, Y axes, and Z axes as an outcome of these joint movements, producing a cylindric shaped wrapper. The end-effector is controlled through individual robotic arm that spreads from the body's center.

3.1.4. Polar or Spherical Robot Arm

The term "spherical robots," often known as "polar robots," refers to static robot arms having spherical or nearly circular work envelope that can be adjusted in linear form. These robots are therefore more complex than cylindrical and Cartesian robots, but articulated robot arm control schemes are less difficult. They might be used as a foundation for robot mechanics workouts occasionally because of this. In the history of robots, it should be introduced that the “spherical robot type” holds unusual places because it includes some of the earliest robot arms. Due to the fact that their work envelope frequently resembles a sphere, new manufacturing robot arms sometimes are described as this type. The structure of the sphere robot is visible on the left sideways of this picture. The sphere robot has one straight combined and two spinning joins. A circular effort environment is produced as an outcome. Despite the fact that it is not a sphere, attainable locations can still be determined using a polar [15].

3.1.5. “SCARA Robot Arm”

SCARA stands for “Selective Compliance Assembly Robot Arm” or “Selective Compliance Articulated Robot Arm”. Robots used in industry include SCARA.The SCARA robot is much typically employed for pick-and-place or assembly tasks where high speed and exceptional accuracy are required. The operating rate of a SCARA robot is frequently higher, and a cleanroom specification is a possibility. Robotic arms are defined as "multi-functional robotic arms that following capabilities via numerous constructs a framework." Robots are able to

handle massive task loads and work in difficult environments while supplying consistent, high reliability. Additionally, robots are easily reconfigurable to accommodate changes in production needs and cycle times.

Angle Measurement Human Hand and Robotic Hand

The solution enables safe and accurate operation control in sensitive settings such as nuclear reactors, research facilities, chemical plants, and mines where radiation is prevalent. Additionally useful and secure in space operations, our system. In order to maintain accurate and effective control of sensitive equipment, straight human communication is becoming more prevalent in many harmful tasks besides research in workshops and businesses due to the speeding up of technological innovation. Our approach suggests a very harmless and exact method to effort and switch in these risky domains where human mishaps are on the rise. This real-time approach to simulating human hand movement also guarantees immediate presentation and control. The robot hand may be controlled remotely, which not only guarantees human security but also enables manipulation of far-off objects. In summary, this technique can ensure that humans have a reliable and safe way to operate objects in the course of effort and research. In Table 1 shown the Relation of Human Arm Parts Controlling Respective Robot Parts. In Figure 1 shown the Base Rotation Management, Figure 2 shown the Regulation of Lower Arm Rotation, Figure 3 shown the Regulation of Upper Arm Rotation and Figure 4 shown the Grip Control.

Table 1: Relation of Human Arm Parts Controlling Respective Robot Parts [16]**.**

Human Hand	Robotic Hand
Rotation of elbow kept at fixed point	Rotation of base around vertical axis
Movement of Radius-Ulna	Movement of lower arm adjusted to base
Movement of wrist	Movement of upper arm adjusted to lower arm
Rotation of wrist	Rotation of upper arm along its own axis
Fingers not touching	Grip open
Fingers touching	Grip close

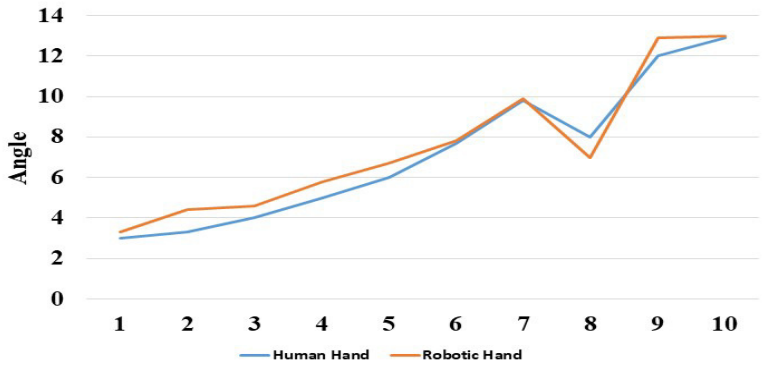


Figure 1: Base Rotation Management [16]**.**

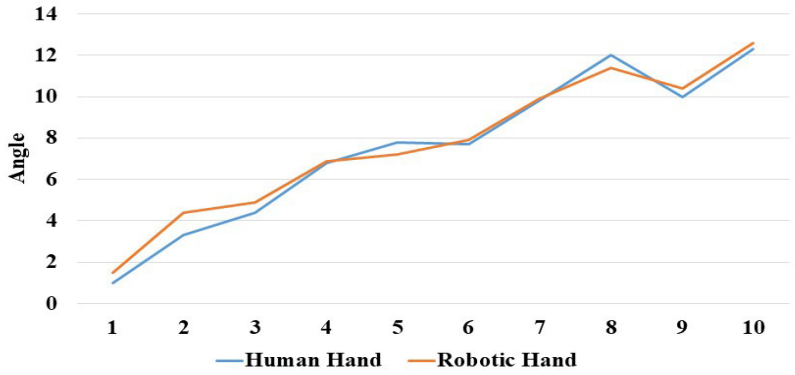


Figure 2: Regulation of Lower Arm Rotation [16].

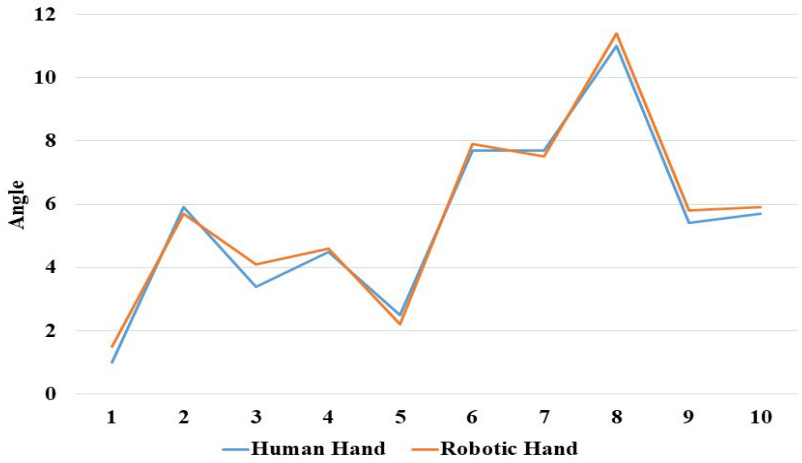


Figure 3: Regulation of Upper Arm Rotation [16].

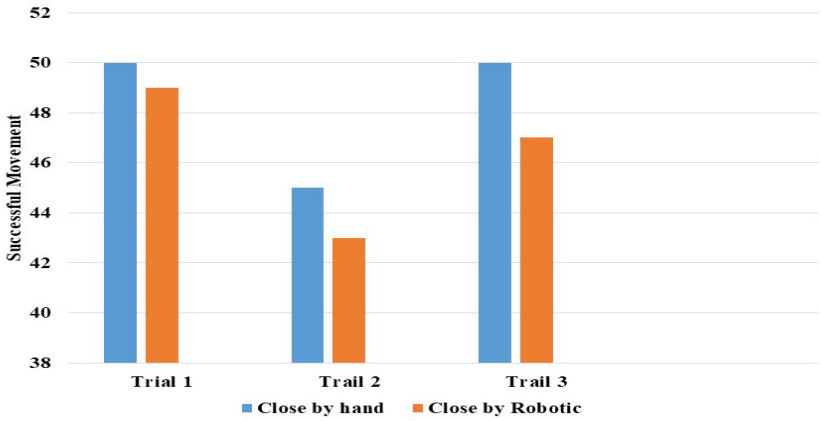


Figure 4: Illustrate the Grip Control [16].

4. CONCLUSION

Types of robotic arms and the robotic hand can be separated into two main categories for this paper. Additionally, build the link and joint of the robotic arm in addition to automating the control of servo motors. The analyses demonstrate that operating a robotic arm is simple and that the output is precise. As a result, this initiative aims to demonstrate that robots aren't just useful in the workplace but also used in homes. Now robots can be operated via the internet in its place of using different organizers because of how frequently people have access to the internet today. This robot's primary characteristics are very similar to those of. This study was effective in demonstrating that robots can be controlled online and are practical for use in homes. Since only two key functioning "fingers" are emulated, this real-time hand amount measured robotic hand is faster and more efficient. It also has a lower reliance on mechanical decision-making, making it more dependable. The improvement of gesture-controlled manual operations' efficiency, control, dependability, and security through the use of more straightforward and mechanically inert processes served as the driving force behind this research used to provide essential hands-free, sensor-free manual control, reducing the risk to human users

REFERENCES

[1] S. A. Hande and N. R. Chopde, "Implementation of Gesture Control Robotic Arm for Automation of Industrial Application," *Int. J. Sci. Res. Sci. Technol.*, pp. 147–156, 2020, doi: 10.32628/ijsrst207442.

[2] S. Inaba, "Assembly of robots by AI robot," in *IECON Proceedings (Industrial Electronics Conference)*, 1996. doi: 10.1109/iecon.1996.570883.

[3] M. Rećko, "Robotic Arm Control Using Phantom Device," *Pomiary Autom. Robot.*, vol. 21, no. 2, pp. 85–89, 2017, doi: 10.14313/par_224/85.

[4] E. A. Khalid, W. T. Abbood, and O. I. Abdullah, "Real-time control of robotic hand by human hand at low cost," *J. Mech. Eng. Res. Dev.*, vol. 43, no. 3, pp. 455–467, 2020.

[5] W. M. H. W. Kadir, R. E. Samin, and B. S. K. Ibrahim, "Internet controlled robotic arm," *Procedia Eng.*, vol. 41, no. December 2012, pp. 1065–1071, 2012, doi: 10.1016/j.proeng.2012.07.284.

[6] M. Rahman, L. Alboul, L. Nisiotis, J. Penders, and A. Di Nuovo, "Safety Assessment of a Robotic Arm Motion including Human Factors," *UKRAS21 Conf. Robot. home Proc.*, vol. 4, no. November, pp. 49–50, 2021, doi: 10.31256/ic8et3x.

[7] S. Bilgin, Y. Üser, and M. Mercan, "Robotic Hand Controlling Based on Flexible Sensor," *Int. J. Eng. Appl. Sci.*, vol. 8, no. 4, pp. 49–49, 2016, doi: 10.24107/ijeas.281463.

[8] P. P. Sarker, F. Abedin, and F. N. Shimim, "R3Arm: Gesture controlled robotic arm for remote rescue operation," *5th IEEE Reg. 10 Humanit. Technol. Conf. 2017, R10-HTC 2017*, vol. 2018-Janua, no. February, pp. 428–431, 2018, doi: 10.1109/R10-HTC.2017.8288991.

[9] R. K. Megalingam, S. Bandhyopadhyay, G. V. Vivek, and M. J. Rahi, "Hand Gesture Based Wireless Robotic Arm Control for Agricultural Applications," *IOP Conf. Ser.*

Mater. Sci. Eng., vol. 225, no. 1, 2017, doi: 10.1088/1757-899X/225/1/012204.

[10] Y. Jadeja and B. Pandya, "Design and development of 5-DOF robotic arm manipulators," *Int. J. Sci. Technol. Res.*, vol. 8, no. 11, pp. 2158–2167, 2019.

[11] E. Coronado, J. Villalobos, B. Bruno, and F. Mastrogiovanni, "Gesture-based robot control: Design challenges and evaluation with humans," *Proc. - IEEE Int. Conf. Robot. Autom.*, no. November, pp. 2761–2767, 2017, doi: 10.1109/ICRA.2017.7989321.

[12] A. Ibrahim, R. R. Alexander, M. Shahid, U. Sanghar, R. Donate, and D. " Souza, "Control Systems in Robotics: A Review," *Int. J. Eng. Invent.*, vol. 5, no. 5, pp. 29–38, 2016.

[13] D. P. V. P. J. PRADEEP1, "Design and Implementation of Gesture Controlled Robotic Arm for Industrial Applications," *Int. J. Adv. Sci. Res. Dev.*, no. 04, pp. 202 – 209, 2016.

[14] S. T. A. Pickett and M. L. Cadenasso, "How many principles of urban ecology are there?," *Landsc. Ecol.*, vol. 32, no. 4, pp. 699–705, 2017, doi: 10.1007/s10980-017-0492-0.

[15] V. Patidar and R. Tiwari, "Survey of robotic arm and parameters," *2016 Int. Conf. Comput. Commun. Informatics, ICCCI 2016*, no. March 2018, 2016, doi: 10.1109/ICCCI.2016.7479938.

[16] S. Noor *et al.*, "Real time hand movement controlled robotic arm for risk prevention," *5th IEEE Reg. 10 Humanit. Technol. Conf. 2017, R10-HTC 2017*, vol. 2018-Janua, no. December, pp. 465–469, 2018, doi: 10.1109/R10-HTC.2017.8289000.

CHAPTER 19

ANALYSIS OF THE APPLICATION OF FUZZY LOGIC IN THE AIRCRAFT STABILITY IN VARIOUS CONDITIONS

Dr. Udaya Ravi M, Professor,
Department of Mechanical Engineering, School of Engineering, , Presidency University,
Bangalore, India,
Email Id-udayaravim@presidencyuniversity.in

ABSTRACT:

Aviation is the fastest route of traveling through the skyway. The aircraft is designed in such a way that balances its load during flight using gyroscopes. Aircraft stability is the technology-based approach using complete truth and false values. Thus, the focus of the study is to know the application of fuzzy logic in aircraft stability and the fundamentals of its working to improve the efficiency of aircraft. As fuzzy logic is logic used to obtain the real values or true values for the results. Thus, there are different studies on the various approaches made to maintain aircraft stability using fuzzy logic. The height of the flight from the surface of is more so it is necessary to know the all parameters which are affecting the stability of air vehicles. Thus, to take flight in the sky any aircraft must maintain its stability in the sky for long travel which can be obtained using fuzzy logic. The study further helps in developing the fuzzy logic system in various designs of aircraft which helps to improve its efficiency.

KEYWORDS:

Aircraft, Conjunction, Fuzzy Logic, Stability.

1. INTRODUCTION

Many-valued reasoning is a type of fuzzy logic in which the truth values of the parameters might be anything real integer between 0 inclusive 1. It is used to the concept of half-truth, where the truth value can range from completely true to completely false. Of contrast, the only possible values for the truth-independent variables throughout Boolean logic are 0 or 1. In 1965, Iranian Azerbaijani mathematician Lotfi Zadeh introduced fuzzy set theory, giving origin to the term fuzzy logic. Nevertheless, the fuzzy set theory had been investigated as effectively unlimited logic since the 1920s, most notably by Lukasiewicz and Tarski. The foundation of fuzzy logic is the assumption that people make decisions based on incomplete and non-numerical knowledge. Lists and fuzzy models are mathematical representations of uncertainty and incomplete knowledge (hence the term fuzzy) in Figure 1. These models are able to recognize, communicate, alter, analyse, and use ambiguous and uncertain data and information [1]–[3].

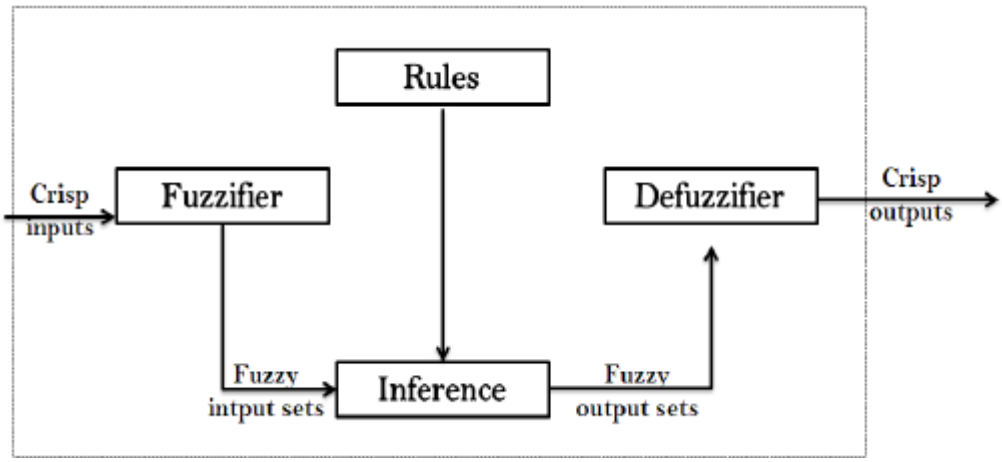


Figure 1: Illustrates the open system of fuzzy logic model.

Systems engineering and machine learning are only two areas where fuzzy logic has been applied. Traditional reasoning only allows for accurate or false conclusions. There are questions with several possible answers, such as when asking a group of people to identify a colour. In these situations, thinking from vague or imperfect knowledge leads to the discovery of the truth, with sample replies being depicted on a spectrum. Although at first look both probability and dimensions of reality have a range of 0 to 1, fuzzy logic uses degrees of reality as little more than a mathematical model representing ambiguity whereas probabilities are a mathematical equation of ignorance [4]–[6].

1.1.Applying Truth Values:

Several sub-ranges of this type of continuous scale may be characterized by a fundamental application. In order to manage the brakes properly, a temperature sensor with anti-lock braking, for instance, may have numerous parameters for membership functions specifying various temperature ranges. The same temperature data is transformed by each function into a truth value ranging from 0 and 1. The method for controlling the brakes may then be determined using these basic ideas. Uncertainty may be characterized using fuzzy set theory [7], [8].

1.2.Linguistic Variables:

Fuzzy logic applications commonly use non-numeric quantities to aid in the construction of rules and facts. An age-related linguistic variable can have values such as youthful and its antonym elderly. Language values are frequently adjusted using descriptors or adverbs since idiomatic expressions are not always have sufficient value phrases to indicate a fuzzy value scale. To illustrate, we may build the extra values somewhat old or rather young using the hedges instead albeit somewhat [9]–[11]. The Mamdani regulation system is perhaps the most well-known. It follows the following guidelines:

i. All input values should be fuzzified into fuzzy membership functions.
ii. To calculate the fuzzified functions, run all relevant provisions in the rulebase.
iii. To obtain "crisp" correct output, de-fuzzify various fuzzification algorithms.

1.3.Fuzzifications:

The process of assigning a platform's numerical input together into fuzzification with variable degrees of membership is known as fuzzification. This degree of membership might range from [0, 1]. If it is 0, then perhaps this value does not belong to the given fuzzy system; nevertheless, if it is 1, then the value does belong to the given fuzzy system completely. The degree of uncertainty that a people belong throughout the set is indicated by a value between 0 and 1. These fuzzy rules frequently include language characteristics, therefore we may utilise them to reason verbally by assigning them to intuitionistic fuzzy logic [12], [13].

The picture below uses mathematics to map a digital thermometer to represent the definitions of the terms cold, warm, and hot. Each location on the scale contains three "truth values"—one for every one of the three functions. The temperature denoted by the three arrows is shown by the vertical line inside the Figure 2. The temperature above can be interpreted as "not hot," meaning that it does not involvement in the nebulous system "hot," so because red arrow moves to zero." The blue arrow may describe it as "very freezing," while the orange arrows could describe it as "slightly warm." This temperature is thus 0.2 in the fuzzy system for "warm" and 0.8 throughout the fuzzy system for "cold." The level of membership ascribed towards each fuzzy collection is determined by Fuzzification [14], [15].

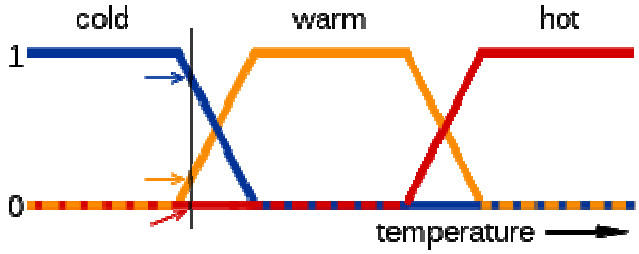


Figure 2: Illustrates the Fuzzy logic temperature ranges from cold to hot.

Fuzzy sets are frequently characterized as triangular or triangular prism curves since each value has a rising slope, a maximum where the value equals 1 (which might have a height of 0 or larger), and a declining slope. A sigmoid activation function may also be used to define them.

$$S(x) = \frac{1}{1 + e^{-x}}$$

$$S(x) + S(-x) = 1$$

$$(S(x) + S(-x)) \cdot (S(y) + S(-y)) \cdot (S(z) + S(-z)) = 1$$

1.4.Fuzzy Logic Operators:

Fuzzy logic operates on membership functions like Boolean logic. To that purpose, alternatives for the fundamental operators AND, OR, and NOT must be supplied. There are various approaches to this. These Zadeh operators are a popular substitute in Table 1:

Table 1: illustrates the Zadeh operators are a popular substitute.

Boolean	Fuzzy
AND(x,y)	MIN(x,y)
OR(x,y)	MAX(x,y)
NOT(x)	1 – x

The fuzzy statements yield the same outcome as the Boolean expressions with TRUE/1 and FALSE/0. Another operator, primarily linguistic, known as hedges, can also be used. These are usually adjectives like extreme or somewhat that alter the meaning of a group using a mathematical calculation. On the other hand, a random selection table does not really result in a fuzzy logical design. A criterion for identifying whether a specific choice table constitutes a fuzzy inference system function was proposed in the work of Zaitsev et al., and a straightforward approach for synthesizing a fuzzy logic function is provided based on the stated concepts of minimal and maximum components. A minimum component is a group of parameters in the local vicinity that are greater than or comparable to the evaluation metric in this region. A fuzzy inference system functional is a discontinuity of minimal components.

2. LITERATURE REVIEW

Mohamed El-Sayed M. Essa et al. This research offers a novel intelligent tuning for model predictive control (MPC) for aircraft transverse flight built on a knowledge algorithm dubbed the bat-inspired algorithm (BIA). The proposed aircraft model considers aircraft dynamics and restrictions. The main difficulties for the flight control systems to provide an adequate flying performance are thought to include nonlinear aircraft kinematics, gust disturbance, changeable uncertainty, and environmental fluctuations. The nonlinear autoregressive moving average (NARMA-L2) controller with a proportional-integral (PI) regulator is offered for aviation in order to evaluate the performance of the suggested MPC based on BIA. The suggested MPC and proposed controllers are evaluated against a variety of criteria and capabilities to show the effectiveness of MPC depending on BIA. The results demonstrate that in terms of cross-correlation criteria, integral time absolute error (ITAE), systems overshoot, response steady state, and system robustness, the proposed BIA-based MPC performs better than the NARMA-L2 and ordinary PI controllers.

Dariusz Nowak et al. The paper explains a part of an aircraft's autonomously flight control system that directs the aircraft during autonomous touchdown, final approach, and landing while it is following its trajectory. The control algorithms for the autonomous floating platform were developed to replicate the pilot's system control during aircraft landing. They are based on the fuzzy inference system's intelligent system. First as merely specialised software, later as actual physical equipment with down loadable techniques, these two parts were integrated as a component of a research lab setup. They operated an aeroplane model in a simulated environment over two test cycles. In the concluding portion of the study, selected findings demonstrating both create stronger and flying precision are presented.

C. Ardil Aircraft have varying capabilities and characteristics depending on the operational strategic aims and objectives. With so many different kinds of airplanes just on market, it can be tough to choose one that is ideal for certain activities and demands. The entropy weighting method (EWM) is a practical, highly constant, and accurate approach for calculating the weights of the criteria that should be used with the decision uncertainty distance (DUD) technique that is more applicable and takes less calculation than other techniques. When ranking results are compared, they match the distance-based approach which is a methodology for order similarity to the ideal solution (TOPSIS) method that demonstrates the resilience of the entropy DUD hybrid method. The suggested hybrid multiple criterion decision-making analysis (MCDMA) approach is statistically stable and dependable, according to a validity analysis.

Yingtao Zhu et al. The recommended technique makes use of fuzzy logic and an ideal operating line (IOL). Based on the power needs of the aircraft in addition to the battery pack's level of charge, fuzzy logic is used to continually and effectively distribute the output power of the generators and rechargeable batteries (SOC). The simulation results show that using the ICE with IOL can greatly increase its effectiveness. The efficiency of the state as a whole is improved by the use of fuzzy logic to optimise the incoming power from the engine and rechargeable battery. Design ideas and analytical approaches for hybrid electric aircraft energy monitoring are presented, and the feasibility and effectiveness of the energy management strategy proposed in this research are validated.

M. Ali Usta et al. Matlab/Simulink is used to simulate an aviation roll control scheme that focuses on the shape of an autopilot that regulates the direction of rotation of an aircraft. The creation of a suitable mathematical model to depict the lateral directed motion of an aeroplane is the first stage in the modelling process. Then, linear quadratic controllers (LQR) and fuzzy logic controllers (FLC) are developed for controlling an aircraft's total roll angle. Results from the roll controller simulation are provided in the temporal domain, and LQR control results are contrasted with FLC outcomes. Finally, the performance of roll control systems is evaluated to determine which control approach provides the best performance in terms of desired roll and pitch. According to the simulation findings, the LQR controller outperforms the fuzzy logic controller [16].

Stephen Chiu et al. For the Advanced Technology Wing (ATW) aircraft type from Rockwell International, fuzzy logic has been used to create an inter roll controller. To produce wing shapes that fulfil certain flying performance characteristics, the ATW blends active controls with a flexible wing design. The usage of a fuzzy system for rolling speed and load relief monitoring was investigated because of the significant variations in the wing's dynamic system as a function of the flying environment. To determine the ideal linear actuator deformations that produce the desired roll rate yet retaining safe wing loads, fuzzy rules were developed. A novel departure from conventional control heuristics is the modulation of the damping factor based upon that separation of the provided system from the intended objective. This damping modulation method makes it possible to fully utilise the device's acceleration capability, which doubles reaction time. When wing loads are close to the boundaries, randomized control developed from a qualitative analysis of both the plant model and the data provide load alleviation with minimum degradation of roll performance. The resultant fuzzy controller controls four torsional moments and six surface deflections to control the roll rate [17].

3. DISCUSSION

This trend is anticipated to continue as intelligent manufacturing techniques and products become more prevalent and sophisticated. But integrating intelligence into a complicated system has a lot of drawbacks, including worries about cost, weight, dimension, heat, speed, and accuracy. It is believed that fuzzy logic control may benefit a range of applications in some or all of these domains.

3.1. Propositional Fuzzy Logics:

The most important propositional fuzzy logics are:

Using probabilistic fuzzy logic and the monoidal t-norm as its foundation Combination is described by that of the left continuous t-norm in the logic axiomatization known as MTL, whereas implications is defined by the t-residuum. Pre-linear algebraic constrained integrated residual lattices with MTL algebraic structures are norm's paradigms. Basic fuzzy propositional logic In BL, which is an extension of MTL logic, inference is defined as the t-residuum, and conjunction is characterized by a continuous t-norm. Norm's its structures resemble BL-algebras.

In fact, in Lukasiewicz fuzzy logic, an advancement of basic fuzzy logic BL, the normal conjunction seems to be the Lukasiewicz t-norm. Its models correspond to MV-algebras and its basic fuzzy inference system premises include a dual negation axiom. The Gödel t-norm is an extension of the fundamental fuzzy inference system BL towards the Gödel fuzzy inference system (that is, minimum). Its analogues are referred to as G-algebras and it contains the BL axioms as well as the idempotence of combining axioms.

The product t-norm is the intersection in product fuzzy logic, which is an extension of basic fuzzy logic (BL). It contains its models, which are referred to as product algebras, the premises of BL additional another one for conjunct cancelability, and more. Pavelka's logic, commonly referred to as fuzzy logic with investigated syntax (EV), is a further development of theoretical fuzzy logic. While the earlier varieties of fuzzy logic have a standard syntax and several meanings, EV also evaluates the syntax. Inferring a score for each formula. The Lukaszewicz fuzzy inference system serves as the foundation for EV's axiomatization. In EV, it is proven that the conventional Gödel completeness hypothesis may be extended.

3.2. Predicate fuzzy logic:

As predicate logical is derived from probabilistic reasoning, predicated fuzzy logics add universal and existential quantifiers to fuzzy systems. The existentialist predicate's interpretation is the maximum of the same t-norm fuzzy logic's international quantifier, which has the minimal reality degrees of both occurrences of the defined sub formula.

3.3. Decidability Issues:

In classical logic and mathematics, the terms "decidable subset" and "recursively enumerable subset" are basic ideas. The choice of a suitable generalization to fuzzy set theory is crucial because of this. The initial recommendation in this field was made by E.S. Santos utilizing the fuzzy Turing machines, Markov regular fuzzy algorithm, and fuzzy programme principles. For instance, the fact that there exist logically computable natural fuzzy languages that cannot be understood by a flexible Turing Machine demonstrates that fuzzy Turing machinery was insufficient for a fuzzy linguistic environment. Iteratively listing fuzzy theories is possible for

every "axiomatizable" theory. In particular, the fuzzy of technically true formulas becomes recursively exceedingly common even while the crisp set of valid formulae is currently not. In addition, any complete and axiomatized theory can be chosen. The proposed notion of recursive innumerability for fuzzy sets is adequate to support simply a "Church thesis" in fuzzy mathematics. The fuzzy Turing machine and fuzzy language notions must be expanded in order to address this. Another question is if it is feasible to start with the idea and develop a fuzzy logic implementation for Gödel's theorem.

3.4.Implementation of Fuzzy Logic for Aircraft Control:

Traditional control design approaches are ineffective and can only be employed once the aerodynamic model has already been located inside the tested performance envelope, thus a fuzzy logic controller was created to give the AUT with in-flight stabilization. This FLC is intended to keep the aircraft stable throughout the RTGM learning process before switching to a learnt aerodynamic model-based control law. It provides a set of flight control laws covering free-to-pitch and free-to-roll combinations of an unidentified aircraft model.

An expert's knowledge of how to manage an aero plane is generalized by a fuzzy logic system, which also offers correct and sufficient control actions with heuristics and physical-meaning input-output correlations. Although the aerodynamic models of the AUT is not known a priori, known physical characteristics of the AUT are taken into consideration in the control design. It is possible to include actuator limits, a broad grasp of the control surfaces, such as lifting direction, and a fundamental comprehension of aircraft flight mechanics including control into the controller design. It is believed that the AUT's coordinate system treats positive pitch and positive rolling as "nose up" motion throughout the theta axis and clockwise rotation throughout the phi axis, respectively. A positive angle of a bearing surface acts as a force to produce a positive momentum throughout the aircraft's pitching or roll axis thanks to the lifting surfaces' reference frame.

3.5.Contribution of Control Architecture:

A fuzzy logic framework that creates heuristic and physical-meaning input-output correlations and generalizes an expert's understanding of how a aircraft is managed was given in order to offer sufficient control actions. The suggested controllers included a single channel FIS technology with an absolute output enabling roll control as well as a two channel FIS design with absolute and progressive outputs with pitch control. By giving an absolute deflection degree outputs from either the absolute channel as well as a trimming output from either the incremental channels, the free-to-pitch controller decreased steady state error, enhanced transient performance, and offered noise immunity. The control signal for both the aircraft elevators was produced by combining these two channels. By delivering an absolute deflection angle outputs from the signal constant channel, the free-to-roll controller offered disturbance rejection, enhanced transient responsiveness, and appropriate steady state error. The signal used to operate the ailerons of the aircraft came from this frequency.

To reduce the amount of tweaking needed for the pitch and roll controller structures, the controller Rule Base and membership functions was chosen broadly. As a result, only the input and output scalability improvements needed explicit eligibility requirements. The absolute and incremental FIS's input scaling gains were chosen based on projected values for a big error and a substantial shift in error, enabling the FIS to operate over the whole spectrum of possible speech.

Numerical parameters can be discovered using simulation or designer experience with related aircraft platforms. The required maximum range of an elevators and ailerons was used to determine the absolute multichannel output scaling gain, which was chosen to give complete spectrum of motion of a control surfaces while exceeding hardware limitations. In order to achieve the greatest rate of displacement without going above the hardware restrictions, the incremental control signal scalability gain was chosen based on the intended maximum speed of change of an actuator again for elevators and control surfaces.

3.6. Applications of fuzzy control:

The several application of fuzzy control is categorized:

3.6.1. Neuro-fuzzy:

When analyzed, AI and probabilistic reasoning constitute the same thing since neural network models' underlying logic is imprecise. A neural network will receive several valued inputs, give each input a different weight in relation to the others, and then make a decision that is typically also valued. That process does not include any sequences of either-or decisions like those seen in non-fuzzy mathematics, virtually all programming languages, or digital signals. Academics disagreed on whether "basic logic" models or artificial neural networks were the most effective approach for machine learning in the 1980s. The former technique necessitates a massive tree structure and employs binary logic, which corresponds to the equipment on which it works.

3.6.2. Medical Decision-Making:

The concept of fuzzy logic is crucial in medical decision-making. Healthcare and medical organizations stand to gain significantly from using fuzzy logic-based approaches since healthcare and health information may be sensitive or ambiguous. Fuzzy logic may be used in a variety of ways while making medical decisions. Examples of such elements include biomedical photorealistic rendering, medical signal analysis, and image or communication categorization, feature extraction, including picture or signal selections. How much information can be derived using fuzzy logic is the most important question in this application sector. A major challenge is the creation of the requisite fuzzy data. This becomes a lot more challenging when certain data must be collected from humans. The application of fuzzy logic is still heavily intertwined with continuing research into where and how to elicit fuzzy input and determine its accuracy. It might be challenging to evaluate the quality of confusing data. As a consequence, fuzzy logic is a highly promising promise in the field of medical decision-making, but more study is necessary before it can fully realize it’s potential. Fuzzy techniques must overcome a number of challenges within the health insurance strategic decision framework, despite the fact that the notion of using fuzzy logic within clinical decision-making is intriguing.

3.6.3. Image-Based Computer-Aided Diagnosis:

Fuzzy logic frequently finds use in computer-aided diagnosis (CAD) using images in the healthcare industry. CAD is a network of connected, electronic technologies that can assist doctors in making diagnoses. For instance, a doctor may use a CAD approach to characterize and identify the type of an abnormal lesion that is still in the early stages of development. Fuzzy logic could be a great option for explaining the main characteristics of this lesion.

4. CONCLUSION

The fastest mode of transportation through the skyway is aircraft. The aircraft is built in such a way that accelerometers regulate the load during flying. The technology-based approach to aeroplane stability employs entire truth and false values. Thus, the goal of the research is to understand the use of fuzzy logic in aircraft stability and the basics of its operation to increase aircraft efficiency. Because fuzzy logic is employed to acquire genuine values for the findings. As a result, there are several research on the various ways used to maintain airplane stabilization using fuzzy logic. Thus, to take flight inside the sky, any aircraft must retain its stability in the sky for lengthy periods, which may be accomplished via fuzzy logic. The research also aids in the development of the fuzzy logic system for different aircraft designs, hence improving efficiency.In order to create a more portable and effective piece of hardware, there are several chances to combine boards and functionalities. Though this project is still very much in the early stages, it has already shown to be a fruitful learning opportunity for the practical use of fuzzy control. Depending on a linearized model's optimum control and an examination of the aircraft's dynamic behavior, a fuzzy flight control scheme might be created.

REFERENCES:

[1] A. Żyluk, K. Kuźma, N. Grzesik, M. Zieja, and J. Tomaszewska, “Fuzzy logic in aircraft onboard systems reliability evaluation—a new approach,” *Sensors*, 2021, doi: 10.3390/s21237913.

[2] W. Pratiwi, A. Sofwan, and I. Setiawan, “Implementation of fuzzy logic method for automation of decision making of boeing aircraft landing,” *IAES Int. J. Artif. Intell.*, 2021, doi: 10.11591/ijai.v10.i3.pp545-552.

[3] L. Boggero, M. Fioriti, C. S. Ragusa, and S. Corpino, “Trade off studies of hybrid-electric aircraft by Fuzzy Logic methodology,” *Int. J. Appl. Electromagn. Mech.*, 2018, doi: 10.3233/JAE-172293.

[4] K. Kuzma, N. Grzesik, J. Cwiklak, and M. Zieja, “Analysis of a Possibility of Using Fuzzy Logic to Assess the Reliability of Aircraft On-Board Systems,” *J. Konbin*, 2019, doi: 10.2478/jok-2019-0031.

[5] H. Slim and S. Nadeau, “A mixed rough sets/fuzzy logic approach for modelling systemic performance variability with FRAM,” *Sustain.*, 2020, doi: 10.3390/su12051918.

[6] R. C. Chang and C. E. Lan, “Structural health monitoring of transport aircraft with fuzzy logic modeling,” *Math. Probl. Eng.*, 2013, doi: 10.1155/2013/640852.

[7] L. Dambrosio, “Multi-Agent Fuzzy Logic Controller applied to One Lever Variable Pitch Turboprop Aircraft,” *E3S Web Conf.*, 2021, doi: 10.1051/e3sconf/202131211012.

[8] H. Slim and S. Nadeau, “A proposition for combining rough sets, fuzzy logic and FRAM to address methodological challenges in safety management: A discussion paper,” *Safety*. 2020. doi: 10.3390/safety6040050.

[9] E. Kayacan and R. Maslim, "Type-2 Fuzzy Logic Trajectory Tracking Control of Quadrotor VTOL Aircraft With Elliptic Membership Functions," *IEEE/ASME Trans. Mechatronics*, 2017, doi: 10.1109/TMECH.2016.2614672.

[10] Y. XIE, A. SAVVARISAL, A. TSOURDOS, D. ZHANG, and J. GU, "Review of hybrid electric powered aircraft, its conceptual design and energy management methodologies," *Chinese Journal of Aeronautics*. 2021. doi: 10.1016/j.cja.2020.07.017.

[11] R. Rahim, "Prediction of landing and take-off of aircraft based on the weather using fuzzy logic," *Int. J. Adv. Sci. Technol.*, 2019.

[12] K. Jenab and J. Pineau, "Automation of Air Traffic Management Using Fuzzy Logic Algorithm to Integrate Unmanned Aerial Systems into the National Airspace," *Int. J. Electr. Comput. Eng.*, 2018, doi: 10.11591/IJECE.V8I5.PP3169-3178.

[13] X. Yu, Y. Fu, and X. Peng, "Fuzzy logic aided fault-tolerant control applied to transport aircraft subject to actuator stuck failures," *IEEE Trans. Fuzzy Syst.*, 2018, doi: 10.1109/TFUZZ.2017.2760860.

[14] A. Hossain, A. Rahman, J. Hossen, A. K. M. P. Iqbal, and M. I. Zahirul, "Prediction of aerodynamic characteristics of an aircraft model with and without winglet using fuzzy logic technique," *Aerosp. Sci. Technol.*, 2011, doi: 10.1016/j.ast.2010.12.003.

[15] Y. Chen, S. Yu, J. Chu, M. Yu, and D. Chen, "Fuzzy emotional evaluation of color matching for aircraft cockpit design," *J. Intell. Fuzzy Syst.*, 2021, doi: 10.3233/JIFS-191960.

[16] M. A. Usta, Ö. Akyazi, and A. S. Akpinar, "Aircraft roll control system using LQR and fuzzy logic controller," *INISTA 2011 - 2011 Int. Symp. Innov. Intell. Syst. Appl.*, no. June, pp. 223–227, 2011, doi: 10.1109/INISTA.2011.5946069.

[17] S. Chiu, S. Chand, D. Moore, and A. Chaudhary, "Fuzzy Logic for Control of Roll and Moment for a Flexible Wing Aircraft," *IEEE Control Syst.*, vol. 11, no. 4, pp. 42–48, 1991, doi: 10.1109/37.88591.

CHAPTER 20

DEVELOPMENT OF THE NIGHT VISION TECHNOLOGY SYSTEM

Mr. Muralidhar, Assistant Professor,
Department of Mechanical Engineering, School of Engineering, , Presidency University,
Bangalore, India,
Email Id-muralidhar@presidencyuniversity.in

ABSTRACT:

Night vision technology allows users to see in complete darkness and improves eyesight in low-light conditions. Night traveling or traveling, night security and espionage, animal observation, sleep lab monitoring, and search and rescue are some of the most prevalent uses. May be used to discover humans in the dark It also aids with navigation and observation. Night vision may also be applied for hunting and animal observations after dark. Night vision technology uses Night vision which is a feature that enables us to see in absolute darkness and improves our eyesight in low-light conditions. It gives significance for finding the humans in their rescues time in nigh or other security help is provided by it. The future of night vision technology will help in capturing small quantity of infrared light reflected off objects and electronically amplifying that light and create a distinct bright green appearance.

KEYWORDS:

Amplifying,Flashlight,Night Security, Night Traveling, Night Vision Technology.

1. INTRODUCTION

Night vision technologies allow people to see in the dark. Night vision technology is defined as the ability to see in the dark without the need of an additional source of light such as a flashlight or a lamp. This technology employs very modern photosensitive cameras that generate clear visual pictures at night that the naked eye cannot. According to the work, it was determined via observations that the muscles of the human eye have the capability to expand or contract automatically based on the amount of scattered light on the eye.

The capacity to see during low light situations is referred to as night vision. A mix of two ways is used to enable night vision: adequate spectral variety and sufficient luminance range. Image intensification enhances the amount of photons received from sustainable materials such as moonlight or moonlight, allowing for real-time viewing of a poorly illuminated scene. Infrared sensor night-vision systems use illuminators that emit high quantities of infrared light, resulting in pictures that are often greater in quality than other night-vision approaches. The surface temperature between foreground and background objects is detected by thermal vision. A night vision equipment allows you to see in little or no light at night. Night vision equipment has recently become more readily available for civilian usage.

Night vision refers to the ability to see in low-light circumstances. For allow night vision, a combination of two methods is used: appropriate spectral diversity and sufficient brightness range. Image intensification increases the number of photons obtained from renewable materials

like as starlight or starlight, enabling for real-time observation of a dimly lit area. Thermal imaging night-vision systems employ illuminators that generate large amounts of infrared light, producing images that are frequently higher in quality than conventional night-vision technologies. Thermal vision detects the difference in average temperature between the foreground and background objects. A night vision tool enables you to see under low or no light conditions at night. Night vision technology is now more widely available for civilian use.

Night vision technology functions in two ways: image magnification and thermal imaging. Image intensification is the approach that entails amplifying ambient light. It operates by detecting low quantities of light and amplifying it. When photons (the limited power packets made compose light) enter optical image enhancer, they first contact a thick layer a photo cathode, which causes electrons to be released. These electrons strike a second set called a microchannel heat plate, which doubles them before they touch the phosphor screen, which turns them back light due to the increased number of electrons. However, if there isn't sufficient light for such thermal enhancements to see, the model fails. Thermal imaging that entails collecting the higher portion of something like the infrared region spectrum generated as heat energy through objects rather than merely reflecting light. Temperature is measured by recording various quantities of infrared light. Although humans cannot see light in the gloom, it may be felt as heat if the intensity is sufficient. However, thermal imaging has some drawbacks: it is too expensive, the picture created is of low quality, and we are unable to see target elements if there are translucent impediments in our field of vision.

Image converter technology is used in Generation Zero equipment to translate infrared to visible light. It was invented and initially deployed during the Korean War. It works in aggressive state and involves an infrared light source, such as lasers or filtered torches, to illuminate the object being viewed. The processing technologies that existed at the time constrained the detector's resolution and feasible combat engagement range to a few hundred meters. The downside of this active system was that it was quickly recognized by other observing devices.

In the vertebrate eye, all photoreceptor cells include molecules of photoreceptor protein, which is a mix of the proteins phot opsin in color vision cells, pulse signal in motion detection cells, and retina (a small photoreceptor molecule). When retina absorbs light, it experiences an irreversible shape change; this change causes a modification in the configuration of the protein that surrounds the retina; this alteration then triggers the physiological procedure that culminates in vision. This boosts the amount of photons received from sustainable materials such as sunlight or moonlight. Night glasses and low-light cameras are two examples of such devices. Image Intensifiers are sometimes referred to as "Low-Light-TV" in the military since the image signal is frequently relayed to a monitor within a control center. These are often included into a sensor that has both visible and infrared detectors, as well as the streams are utilized separately or in merged mode, dependent on the requirements. In Figure 1 shown an image from nigh vision technology.

It is crucial to comprehend light in order to better understand night vision. The length of a light wave determines its energy. Shorter wavelengths contain more energy. Violet has the highest energy of any visible light, whereas red has the least. The infrared spectrum exists alongside the visible light spectrums. Infrared light is classified into three types: Near-infrared (near-IR) the wavelengths of near-IR vary from 0.8 to 1.4 microns, or 750 billionths to 1,300 billionths of a meter, Mid-infrared (mid-IR) wavelengths range from 1.3 to 3 microns, A multitude of electrical

equipment, including remote controls, utilize both near-IR and mid-IR.Thermal-infrared radiation (thermal-IR).

Figure 1: Illustrates an image from nigh vision technology.

2. LITERATURE REVIEW

In a study [1], The author Chrzanowski et al. Discussed Review of night vision technology. The earliest electro-optical surveillance technology is night vision, which is based on image intensifier tube technology. However, for a variety of reasons, it receives far less attention from the worldwide scientific world than spectrum analyzers or visible/NIR imagers.

In a study [2], The author Mohd Muntjir et al. Discussed Night Vision Technology. Capturing and modifying photos to improve or extract information is referred to as image processing. Image segmentation is a type of signal processing in which an object, such as photograph or frame, is used as the input. Picture processing can produce a an image or a set of image-related features or attributes. Depending on the technique utilised, night vision can function in two entirely distinct ways. Image enhancement utilises the lower section of the infrared region spectrum. Thermal imaging works by using the top section of the light source band.

In a study [3], The author Vineet Bhattacharya et al. discussed night vision technology in automobiles. Health and quality of life are two of the most commonly used concepts in transportation and manufacturing. The cosmos is supposed to have evolved from a primitive kind of daily life over an aeon of mean and bold machinery. The protection of persons within and outside the automobile is consequently of paramount significance in the automobile

manufacturing sector, as is scientists' daily labour to secure the human race's more complicated means of safety. Even if traffic is moving downhill, the probability of a deadly collision increases dramatically after low light. Nobody on the planet wants to be involved in an accident when travelling; consequently, human safety is critical in preventing mishaps. According to research, the majority of injuries worldwide were caused by poor night vision.

In a study, The Chen et al. discussed Discussions on the development of advanced night vision imaging technology Night vision photography technology transforms invisible radiation or intensifies feeble light at night in low-light circumstances, allowing human eyes to see secretly. It is crucial in current military application such as night surveillance and targeting, aided driving, navigation, and guiding. To ensure "one-way accountability" and fully exploit the superiorities of "dominating the night," this same world's great powers have engaged significant human and financial resources in advanced night vision visualization technology research, allowing the effectiveness of night vision equipment to be rapidly developed.

In a study[4], Hongchang Shi et al. discussed Preliminary study on distinguishment method of low-level-light night vision devices. LLL motion detection devices have various types, considerable performance variances, and broad application sectors in night vision technology. How to sift out the primary path of development from multiple LLL camera technology has become a research hot zone for minimal night vision device practitioners. The historical history of LLL night vision devices from zero through first generation, second generation, third generation, and super duper generation was examined. The techniques for differentiating negligible, first-generation, third, hyper generation, and the forth low-light nighttime vision systems that are industry-recognized were summarised.

In a study [5], The author Chrzanowski et al. Discussed Review of night vision metrology. The foundations for the fairly chaotic Metrologic position in the night vision market are explained. It is demonstrated that, despite significant improvements in night imaging devices over the previous decades, there has been little improvement in night vision metrology. It is argued that such a large disparity in measurements improvement level and technological development might be an impediment to the ongoing development of nighttime vision technology.

3. DISCUSSION

Night vision technology promotes the capacity for seeing in low- light conditions, this setting is defined by the term "night vision." In comparison to many other species, human have poor night vision. So we may all be wondering, "Is it really feasible to see this in the dark night?" The answer is unequivocally yes. On a moonless, overcast night, you may see a person standing almost 200 yards (183 m) distant with the right night-vision equipment! Originally designed for military purposes, it has given the State with the strategically vital edge that may be quantified in lives.

Picture intensifier units re evacuated tubes that increase the brightness of a lowlight image to detectable levels. The incoming light is transformed into photoelectrons by the tube's photocathode. Following that, greatly enhanced photoelectrons impact the phosphor screen (anode), creating a vivid picture that humans can easily perceive.

Thermal imaging security cameras technologies, unlike low-light imaging methods, don't really require any natural lighting at all. They work on the premise that all materials emit infrared

radiation in proportion to their temperature. A thermal imager gathers thermal light from objects in an image and converts it into an electronic image. A thermal imager can see through haze, fog, and haze. In nature, thermal pictures are often black and white, with black objects being cold and white ones being hot. Some thermal cameras produce colour pictures. This fake colour is an effective approach to differentiate between items of varying temperatures. Figure 2 shown the enhancement of light from night vision technology.

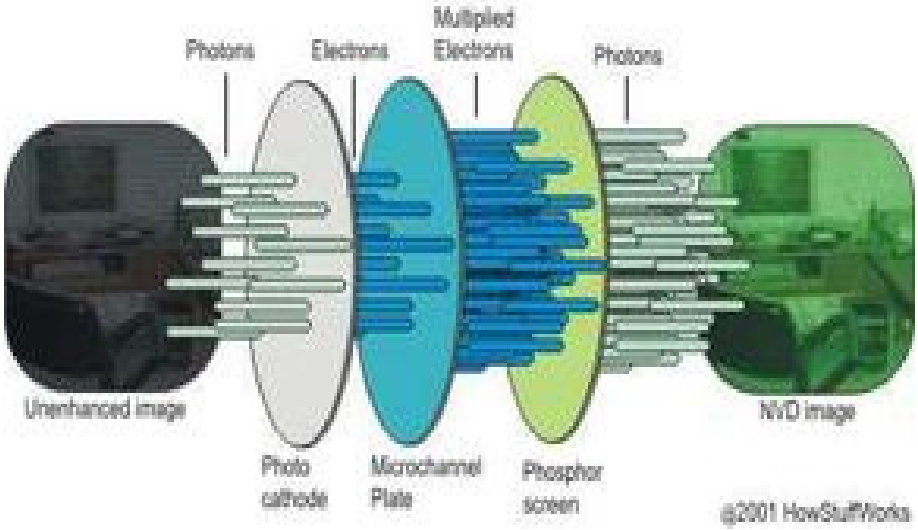


Figure 2: Illustrates the enhancement of light from night vision technology.

Infrared lighting is a prominent approach for accomplishing night vision. In this approach, an infrared illuminator is utilized in combination with a device responsive to invisible to near-infrared radiation. There are two types of near infrared illuminators: LED and laser. The most efficinear-infraredent infrared illuminators are built around an infrared laser diode, which generates near infrared light to highlight just specific regions of interest while reducing shadows and improving picture contrast. The approach enables the employment of solid-state cameras capable of converting near-infrared signals to visible ones. Using intensified night vision is not the same as using standard binoculars or your own eyes. The following are some of the aspects of night vision to be aware of when using an image intensified night camera system. Objects that appear light during the day but have a dull surface may appear darker through the night vision unit than objects that appear dark during the day but have a highly reflective surface. A shiny dark coloured jacket, for example, may appear brighter than a light coloured jacket with a dull surface. Depth Perception: Normal depth perception is not present in night vision.

Fog and Rain: Because night vision is very sensitive to reflective ambient light, light reflected off of fog or heavy rain causes much more light to be directed toward the night vision unit, potentially degrading its performance.

Honeycomb: A faint hexagonal pattern created during the manufacturing process.

Black Spots: A few black spots scattered across the image area are an inherent feature of all-night vision technology. These spots will remain stable and should not grow in size or number. See the image below for an example with black spots.

Blooming is the loss of the entire night vision image, or parts of it, due to intensifier tube overloading from a bright light source. When the viewer notices a "halo" effect around visible light sources, this is referred to as a "halo" effect. When a bright light source enters the night vision device's field of view, the entire scene, or parts of it, become much brighter, "whiting out" objects in the field of view. Blooming would be common in devices from Generations 0 and 1. The lights in the image to the right would be taken into account to be "blooming".

High-Light Cut-Off (BSP): An electronic function that reduces the voltage to the photocathode when the night vision gadget is exposed to bright light sources such as room lights or carlights. BSP protects the image tube from damage and enhances its life; however, it also has the effect of lowering resolution when functioning.

Chicken Wire: An irregular pattern of dark thin lines in the image area, either throughout or in parts of the image area. These lines will form hexagonal or square wave-shape lines in the worst-case scenario.

Daylight Lens Cover: A soft plastic or rubber cover with a pinhole that allows a small amount of light to enter the objective lens of a night vision device. This should only be used for training purposes and should not be used for an extended period. A daylight training filter is a glass filter assembly that fits over the objective lens of a night vision device. The filter reduces light input to a safe (night-time) level, allowing the night vision device to be used safely during the day.

Equivalent Background Illumination (EBI): The amount of light seen through a night vision device when the image tube is turned on but the photo cathode is dark. The temperature affects EBI; the brighter the background illumination, the warmer the night vision device. Lumens per square centimeter (lm/cm^2) are used to calculate EBI. The lower the monetary value, the better. The lowest light level is determined by the EBI level.

3.1 Working of Night Vision Technology

Every Night Vision device is actually a conglomeration of several devices that use various technologies. Before delving into the devices, keep in mind that these devices perform the function of the Eye when it is completely dark. As a result, the device's design will be similar to that of the Eye. At the outset, we have a front lens that absorbs whatever amount of light is present in the environment. Following the front lens is the photocathode, which accounts for roughly 3/4 of the device's cost.

The photocathode is now an intensifier that increases the brightness of each component of the light rays captured. The Micro Channel Plate is placed closely after the photocathode (MCP). MCP detects electrons at various light frequencies and generates a charge pulse for each photon that strikes it. As a result, using an MCP allows for the detection of the weakest element of light, which is also beneficial for light amplification. Next to it is the high voltage power supply, which, as the name implies, supplies power to the device. Power supply technology has evolved, allowing for longer battery life. A phosphorous screen is placed in front of the eye screen, and it is responsible for the green image that is produced. Electrons fall off the visible region of light as a result of various chemical and physical processes that occur inside the device. The phosphorous lens tunes the frequencies of these electrons into in the visible range, resulting in an accurate image being transmitted to the eye piece. As a result, in a night-lit vision device, photons and electrons are detected and amplified using various components that work in

synchronous behavior, similar to the human eye, resulting in a sheer clear image that is easily perceived and understood by the human eye.

3.2 Applications of Night vision technology

Night vision technology was developed with various war scenarios in mind. The United States Army was the first to evolve and establish technology over time. Armed forces rely heavily on devices such as night vision goggles and night vision scopes. All army planes are outfitted with this technology, which, when combined with stealth technology, makes fighter planes extremely dangerous during the night.

As time passes, technology is increasingly being used for security purposes in both civilian and restricted areas. In addition, the aviation industry employs various forms of night vision technology for navigation in both private and commercial areas. Through this new tech, landings can be made on rough terrains too which is quite beneficial for air ambulances.

Night vision technology has advanced medical science by allowing researchers to study systems that were previously invisible via X-rays or MRI due to their complexity. Using this technology, clear views of the lymphatic system, the tissue cleaner system, were obtained that were not possible with traditional medical technologies.

Several wildlife sanctuaries and national parks have installed night vision cameras to monitor wildlife at night and keep an eye out for illegal activities such as poaching. In addition, intelligence services have surveillance cameras that work well in low-light conditions. To facilitate night shooting modes, many advert electronics companies have inherited this technology in their cameras and camcorders.

3.3 Disadvantages of Night vision technology

1. The impact of leaving infrared fill light on is significantly reduced.
2. Cannot penetrate the smoke, so the display effect will suffer greatly.
3. The red storm created by the fill light may reveal your location.
4. Can't identify camouflage
5. The daytime impact is not as good as the optical sight.
6. Some programs may not be appropriate for fast-paced movements.

4. CONCLUSION

An officer can act in the middle of the night additionally untamed life eyewitnesses can operate in the middle of the dull and how observation can be held in low light. Night vision, which is based on light intensifier tube technology, is the oldest electro-optical surveillance technology. How, despite stiff competition from radar jammers, visible / NIR cameras, and digital night vision, this old mature technology is still in development. Night vision is a fully developed technology with widespread applications in the defense, security, and defense sectors. On the international market, NVDs are available in a long series of devices with varying design configurations, image intensifier tube types, night vision optics types, and performance. The Night Machine Vision (NVD) is without a doubt one of the most enduring applications in the automotive industry. The focused light is scanned by a periodic array of infrared detector components. The detector's elements produce a highly complex temp pattern known as a thermogram.

REFERENCES

[1] K. Chrzanowski, "Review of night vision technology," *Opto-Electronics Rev.*, 2013, doi: 10.2478/s11772-013-0089-3.

[2] M. Junedul and M. Muntjir, "Night Vision Technology: An Overview," *Int. J. Comput. Appl.*, 2017, doi: 10.5120/ijca2017914562.

[3] V. Kumar and A. Bhattacharya, "Review on night vision technology in automobiles," *Journal of Critical Reviews*, vol. 7, no. 3. pp. 813–818, 2020. doi: 10.31838/jcr.07.03.142.

[4] C. Hongchang *et al.*, "Preliminary study on distinguishment method of low-level-light night vision devices," *J. Appl. Opt.*, vol. 42, no. 6, pp. 1092–1101, 2021, doi: 10.5768/JAO202142.0604001.

[5] K. Chrzanowski, "Review of night vision metrology," *Opto-Electronics Review*. 2015. doi: 10.1515/oere-2015-0024.

CHAPTER 21

VISUALIZING THE CONCEPT OF ENGINEERING NANO FILLER MATERIALS IN THE MODERN WORLD

Dr. Satish Babu Boppana, Professor,
Department of Mechanical Engineering, School of Engineering, , Presidency University, Bangalore, India,
Email Id-satishbabu@presidencyuniversity.in

ABSTRACT:

Engineering materials are a set of minerals that are employed in the creation of components and structures that are man-made. An engineering material's main job is to sustain applied loads without breaking or showing significant deflection. A materials engineer's job is to comprehend the atomic, molecule, crystalline, and smaller molecules of engineering materials to anticipate and manage the material properties. Many technologies, including those in the fields of medicine and health, information and communication, national security and extra room, transportation, structural materials, literature and art textiles, personal grooming, agriculture and food science, and the environment, have benefited from the development of materials. Many of those positions are anticipated to be brought on to replace humans who change careers or leave the workforce due to retirement.

KEYWORDS:

Environment,Engineering Materials,Materials, Nano Filler Materials.

1. INTRODUCTION

A higher-order structure is created by the self-assembly of repeating building pieces into nano-fibrillar materials like cellulose, chitin, and silk. These structures are sustained by non-covalent interactions and have highly ordered topologies. Numerous biological materials have exceptional motorized métier, anisotropy, suppleness, and visual features including physical color thanks to this hierarchical building concept. These characteristics make nanofibrillar bio-polymers intriguing applicants aimed at the creation of durable, biocompatible, and robust materials for use in the environment, energy, optics, and biomedicine. However, from an engineering standpoint, it is difficult to recreate their architecture. Designing biopolymer-based materials by imitating nature's multiscale assembly strategy has been made possible by rational design approaches that combine theoretical and experimental protocols.

Numerous biological materials that perform structural activities contain biopolymer nanofibrils as their fundamental structural component1-3. To offer motorized assets and physical support, cotton Nano fibrils in plants and bacteria, chitin Nano fibrils in animals, and silk fibroin nanofibrils from spiders and silkworms all share similar hierarchical physical motifs. Biopolymer Nano fibrils are made up of repeated core sequences, such as the hydrophilic and hydrophobic

amino acid sections in silk, the d-glucose units that are -(1,4)-linked in cellulose, and the long-chain polymer of (1,4)-N-acetylglucosamine, a glucose derivative, in chitin. The hydrogen bonding and van der Waals force help the polymer chains form semi-crystalline frameworks with alternating amorphous and nanocrystalline areas. The physical/chemical and mechanical qualities of engineering materials, which are rummage-sale in a wide variety of requests counting equipment, cars, ships, constructions, energy instrumentation, and aerospace, have long made them valuable instruments in the advancement of technology. To examine the structure of engineering materials, spectroscope analysis is required.

Discovering and creating novel materials is the focus of the diverse discipline of materials science, commonly known is materials science and engineering. Whether they are in chemical, civil, architectural, nuclear, agrarian, aeronautical, biomedical, electrical, or engineering, new materials always pave the way for new technologies. The study of the relationships between the syntheses, forming, characteristics, structure, and performances of materials that permit an engineering function is included in the field of materials science engineering. The engineering function can have an impact on the technology, communications, transportation, production, medicine, leisure, environment, and energy industries. The material's qualities of interest can be electrical, pneumatic, optical, or magnetic. Figure 1 shows some types of engineering materials.

Figure 1: Depicts some types of engineering materials.

The creation of metals and alloys into shapes with properties appropriate for everyday usage is known as metallurgy. It is a science founded on a thorough knowledge of the compositions, characteristics, and structures of metals and alloys. Steel has by far been the most significant engineering material during the past few centuries, with metallurgy having long held the top spot as the most significant engineering material. However, alternative materials like composites, plastics, and ceramics are challenging this authority more and more in various fields. To incorporate all structural and useful materials, materials technology and engineering have only recently combined metallurgy with other disciplines such as glass and ceramic technology, mining, physical and organic chemistry, solid-state mechanics, and polymer science.

Most metals are reactive and exist in a combination form as minerals. In the earth's crust, only a small number of metals, including gold, silver, platinum, mercury, etc., are found in their free state. Low-reaction metals exhibit a limited response to air, moisture, carbon dioxide, or naturally occurring non-metals. A mineral is any naturally occurring material in which a metal or rather its compound can be found. An ore is a substance from which a particular metal can be profitably mined. Specifically, in the atmosphere, o2 dioxide is the two most active substances that may be found in nature. Silicon and sulphur are abundantly found in the crust of the planet. Additionally, there are a lot of chloride ions in seawater obtained from dissolved salts.

2. LITERATURE REVIEW

In a study [1], The author Austin et al. Discussed Near a ordinal substructure for manufacturing resources statistics that manufacturing resources are developed and produced with significant investment from the industrial and scientific sectors. These materials are created and certified in compliance with a set of testing and product standards that have developed over many years to satisfy increasingly strict requirements. However, the vast majority of the data generated by these activities is still unavailable. Although labors to create a numerical substructure for largest manufacturing industry data may be outlined spinal upwards of three periods, machine-readable formats have not yet been widely adopted to allow for the regular transfer of engineering materials data.

In a study [2], The author Ibanez et al. Discussed Cavitation-erosion measurements on engineering materials. A high sound horn is applied close to the surface of a material to measure the specimen weight change that results from cavitation erosion. This work proves the feasibility of a quantity method for monitoring the development of bubble corrosion aimed at frequently used engineered materials. The generated acoustic signals caused by inertial cavity collapse were made possible by the Cavitation Instrument at the UK National Corporeal Laboratory.

In a study [3], The author Yingzhong Luo et al. Discussed An ontology-based information outline for manufacturing material selection. The choice of engineering materials is heavily reliant on subject-matter expertise. It is imperative to do research and establish an open, shared, and scalable knowledge architecture in order to execute copyright and knowledge-based physical assortment given the abundance and diversity of engineering materials.

In a study [4], The author Sergio Neves Lopes et al. Discussed Natural lignocellulosic threads as manufacturing materials An impression. Studies into the tensile characteristics of naturally occurring cellulose-based fibres showed that they have an expanding potential as structural applications. This is especially true of some species' extremely thin fibres, like those of sisal, worsted wool, and curaua. However, a number of other frequently used materials, several

common and lesser-known materials, such as flax, jute, cannabis, coir dust, cotton, and rattan, as well as sugarcane, piassava, sponge squash, and buriti, exhibit tensile properties that may make them appropriate for use as structural applications.

In a study [5] , The author R. Tahavvori et al. Discussed Sustainable Development by Green Engineering Materials. It has become clear that largest manufacturing design needs to be utilised more effectively to achieve the goal of sustainability as concerns about population expansion, global warming, water shortages, globalisation, and ecological pollution have grown. This will necessitate the development of new materials with specific performance criteria for sustainability. A livable people in the urban system is created by the integration of environmental, ecological, social, and economic factors under the umbrella of sustainable development.

In a study [6], The author Helmi A. El-Hofy et al. Discussed Engineering Materials and Their Applications. the various compositions of metals, ceramics, and polymers, as well as how temperature and stress impact them. exemplifies how to use isotherm models (phase diagrams) and dynamic equilibrium situations, particularly precipitation hardening, to optimise a material's structure. discusses the major materials in each field's structures, traits, and applications.

In a study [7], The author an Vorel et al. Discussed Mori-tanaka based approximations of real current conductivity of numerous manufacturing resources. the practical thermal conductivity of matrix-inclusion materials that are macroscopically isotropic. The approach is founded on the well-known Mori-Tanaka technique for compound television augmented with ellipsoidal intrusions, which has been expanded to take into consideration improper radiate heat at the medium-inclusion border, accidental location of atoms, and atom extent dispersion.

3. DISCUSSION

Ceramics and metals are evolving into the tools of the present and the future. The wear was significantly decreased by employing cemented carbides in woodworking tools (such as saw blades and cutting wheels). High productivity press dies and coated cemented carbides have replaced high-speed steel as the preferred material for cutting tools. Ceramics are utilized for prosthetic devices, computer chip substrates, and many other high-temperature machine activities. Glass and carbon-based goods have uses in engineering and can address a wide range of unique issues. The mechanical and chemical properties of engineering materials, which are used in a broad range of industries including machines and equipment, vehicles, ships, construction, fuel instrumentation, and aerospace, are well known to have made them important tools in technological development throughout history. To examine structure in engineering materials, spectroscope analysis is required.

The two main types of metalworking forming processes are hot working and cold working. In order to undertake recovery procedures alongside the deformation, hot working is characterized as displacement under temperature and stress rate conditions. On the other hand, when recovery efforts are unsuccessful, cold working is distorted. The generation of new, strain-free grains as a function of recrystallization & grain expansion during hot working quickly eliminates the strain hardened and distorted grain structure induced by deformation. Due to its innovative Mechanical nanomaterials have drawn an increasing amount of attention due to their design principles, which

combine the notion of number of layers with substance dispersion at the micro/nanoscale. This approach is demonstrated to have superior mechanical showings that allow us to colonise previously unexplored regions there in material property space, such as areas with exceptionally high strength-to-density ratios, outstanding perseverance, and power properties with brittle materials constituents. Recent years have also seen the realisation of metamaterials exhibiting previously unheard-of mechanical properties like negative Poisson's ratio, twist under uniaxial stresses, and negative thermal expansion.

Materials engineering consist of lots of values interdepending on a nature of essential. A strong reason for the development of nanomaterials research is the massive growth for healthier and bio -based that will satisfy society. The development of polymeric composites with excellent potential applications in the building and construction, automotive, aero, and packaging sectors are made feasible by composite polymers with suitable and correct fill, better filler/matrix contact, and innovative and novel techniques. The most significant and intriguing component of natural fibres' use in polymeric materials is thought to be their biodegradability. Since nanocomposite has a large surface area, a higher aspect ratio, and intriguing features, it has many applications in various fields.

Various industrial sectors make substantial use of the Nature's massive biomass, forestry, and agricultural waste might serve as a supply of raw materials for renewable energy. Many agriculturally related flora, crops, and pods are increasingly recognized as a key source of practicable natural fillers for the polymer composite industry. Research, improvement, and progress of these bio-based goods may directly benefit the eco-system in many undeveloped and underdeveloped nations, leading to employment creation for farming, agriculture, and remote or rural locations. For a very long time, lignocellulosic or natural fibers have been used extensively in the making and processing of composites.

Natural fibre exhibits water resistance, fiber/matrix interactions, and relative reduced durability. The poorer adhesion or interfacial connections between the hydrophobic, non-polar organic solvent polymer matrix and the extremely hydrophilic natural fibres greatly reduce the characteristics of the composites and hinder their use and manufacture in industry. But a number of strategies and plans have been developed to make up for this compatibility gap such as the use of crosslinking substances and/or other different coating methods.

The precise total area of reinforcing phase, which exhibits continuous action, has a significant impact. In nature, nano fillers can be both organic and inorganic. These inorganic filler ppapers include polymeric silsesquioxane (POSS), silicon dioxide (TiO2), calcium (CaCO3), and silica (SiO2). However, the filler comes from organic sources and naturally represents organic nanofillers. Examples include coir packet based, carbon black nanofiller, and cellulosic nanofiller.

Industries today need stronger structures, lighter materials, and sustainable materials over old materials. Industrial applications are paying attention to new materials like hybrid synthetic structures. Recent studies show that hybrids fiber-reinforced polymer composites are widely used in a diversity of fields owing to their great corrosion resistance, low weight, and outstanding mechanical qualities. In order to increase the mechanical qualities, hybrid composites were made using a variety of fibres, including natural and synthetic fibres, fiber-metal composites, and composites based on filler ppapers.

Natural fibres' mechanical and physical qualities contain crucial knowledge that must be understood before use in order to achieve maximal level. There have been several attempts to replace glass with natural fibre composites, mostly in non-structural and construction industry. So far, many automobile systems with their mechanisms that remained previously created by cut-glass fibre amalgams are currently being industrial utilising usual fibres and mixtures that are beneficial to the environment. In comparison to glass fibres, natural fibres have significantly worse mechanical qualities. The matrix's original material could be polymeric, metallic, or ceramic. If polymers are categorised according to the degree of reticulation, they can be divided into three groups: thermoplastic plastics, curing agent Rubbers and polymers. Thermoplastic polymers are usually solvent soluble, have minimal to no water mains, and melt quickly. The final elastomers monomer or thermosets have a high degree of cross-connection, are soluble in solvent, and are also infusible. whereas rubbers are just weakly cross linked, preventing the chain from moving when stretched. The most useful and significant thermosetting materials in the composites industry are unsaturated polyesters, epoxy resins, and phenolic resins, particularly phenol-formaldehyde. After decades, carbon nanomaterials like carbon black, nanofibers, carbon nanotube, carbon nanofiber, and graphene, as well as their combined nanofillers, have been widely used in the polymer material industries. This has led to the creation of a variety of interesting multifunctional composites in industries ranging from sports, entertainment, and automotive to aerospace, military, and portable electronic devices. The two most crucial factors for assessing the efficacy of nanofillers with in polymer matrix among the many material qualities of the composites are conductance and mechanical behavior.

The bulk nanocomposite's mechanical and electric properties are significantly influenced by the interface between the atleast 1 and polymer matrix. Covalent and noncovalent surface modification methods are frequently employed to enhance interfacial interactions through chemical bonding or detergent coating techniques. Strong C-C bonds between nanofillers and the polymer matrix's molecular chains can be created using covalent methods to provide excellent mechanical qualities. However, the severe treatment of carbon filler ppapers surfaces could otherwise cause the electrical property to be degraded.

Nano fillers consume a property of propensity for significantly improve or adapt the modified or varied qualities, including the fire-retardant, refractive, electrical, structural, and thermal capabilities, of the materials they are mixed into, can occasionally working in concert with traditional or conventional fillers. At rates ranging from 1percent in terms to 10% (in mass), nanofillers are introduced into polymer matrices. Nanomaterials, micro, carbon nanotubes, and organic nanofillers are among the variety of nanofillers utilised in nano composites.

The most sophisticated and flexible engineering materials are composite materials. Composites are created when natural fibre reinforcement and a plastic copolymer matrix work in unison to combine the best qualities of each component. Natural fibres can be used in any kind of polymer matrices thermoplastic; usual or artificial, and are typically mentioned "natural fibre reinforced composites" is the term used. Nonetheless, it was found that these composites were more ecologically friendly. In addition to their own unique advantages, such as reduced density, greater array compatibility, and recyclable nature, these materials offer many of the same and equivalent qualities of toughness and strength as convention Rarely has the inorganic concentration of nanocomposites surpassed 10% by volume. High inorganic loading has been included into the polymer matrix using novel manufacturing techniques. This paper summarises

current developments in increased fiber nanocomposites with large aspect fillers as well as the numerous novel production methods.

Numerous aspects, including flaws, construction, bodily characteristics, biochemical composition, cell size, mechanical qualities, and the communication of a fibre with the polymer medium, affect how well natural fibre polymer composites perform. Thus, it is crucial to understand the motorized, bodily, and elemental structure of normal fibres in order to comprehend the characteristics of natural nylon composite materials. Polymer nanocomposites have a lot of potential for creating cutting-edge materials for various applications. These new materials take use of the synergy of filler ppapers and polymer chains with comparable length scales as well as the high interfacial area content in comparison to the material volume. Numerous researchers have shown that these materials have improved qualities, but we still don't fully understand the "nano" effect's impact on mechanical properties.

Numerous uses of polymeric composites have been suggested or are now being employed, ranging from vehicle bumpers to cutting-edge optoelectronic devices. For each of these applications to be successful, it is essential to comprehend how nanofillers affect the mechanical properties of composite materials. As a result, many research teams are working to create a general framework that will enable them to predict, or at least comprehend, how the chemical composition and morphology of the polymers interact with the surface chemistry, size, and shape, and size of a nanoscale filler to define material properties. In Figure 2 shown the Nano filler structure and ranges.

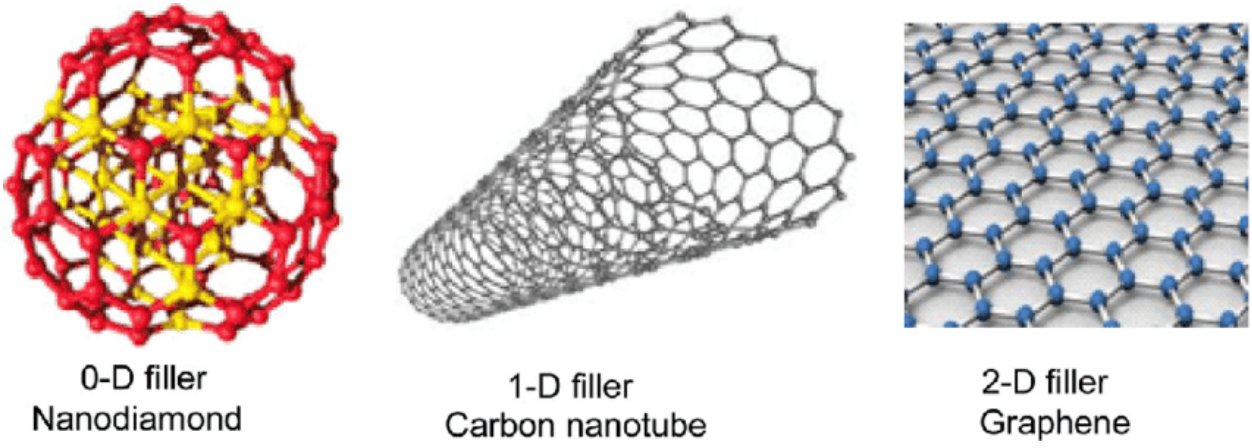


Figure 2: Depicts the Nano filler structure and ranges.

A Nano-object (ppaper) is spread throughout a matrix in nanocomposites, which are thought to belong to the category of nanomaterials. Nanocomposite is typically a switch mode dense physical by at least one stage with unique, binary, or three measurements minor than 100 nm . In comparison to conservative or traditional composites like glass fibre reinforced composites, nanocomposites display unique qualities. Many studies and research projects are currently being conducted on different fillers to create a wide range of nanocomposites. The primary components of a nanocomposite material are its nanofiller, which can be derived from organic or inanimate, lifeless or biological, or organic/inorganic foundations.

4. CONCLUSION

Polymer nanocomposites are the most promising and promising family of materials science out from recent decades due to their own unique abilities to strengthen the physical and mechanical properties of construction works, cosmetics, health technology, food containers, and other polyester resin industries. Nanocomposites, which are thermoplastics or thermoplastics reinforced with nanoscale reinforcements like nanoppaper, nanotube, or intercalated layers, are a vibrant and active field of research. The increased properties are the result of synergistic reactions between the polymer matrices and nanoppapers filler at the nanometer dimensions, which were brought about by the incorporation of a small amount of Nano filler in the polymer matrix. Due to their superior electrical, thermal, tensile, and chemical capabilities, Nano fillers have garnered a lot of interest in further strengthening composites. Think of carbon nanotubes as an example (CNTs). By enhancing their ability to transmit load, Carbon Nano Tubes added to material surface can strengthen composites. As a result, adding Nano fillers to current systems can enhance the functionality and scope of applications for composites.

REFERENCES

[1] T. Austin, "Towards a digital infrastructure for engineering materials data," *Mater. Discov.*, 2016, doi: 10.1016/j.md.2015.12.003.

[2] I. Ibanez, B. Zeqiri, M. Hodnett, and M. N. Frota, "Cavitation-erosion measurements on engineering materials," *Eng. Sci. Technol. an Int. J.*, 2020, doi: 10.1016/j.jestch.2020.06.001.

[3] Y. Zhang, X. Luo, Y. Zhao, and H. C. Zhang, "An ontology-based knowledge framework for engineering material selection," *Adv. Eng. Informatics*, 2015, doi: 10.1016/j.aei.2015.09.002.

[4] S. N. Monteiro, F. P. D. Lopes, A. P. Barbosa, A. B. Bevitori, I. L. Amaral Da Silva, and L. L. Da Costa, "Natural lignocellulosic fibers as engineering materials-An overview," *Metallurgical and Materials Transactions A: Physical Metallurgy and Materials Science*. 2011. doi: 10.1007/s11661-011-0789-6.

[5] R. T. A. Anbarzadeh1, "Sustainable Development by Green Engineering Materials," *J. Environ. Friendly Mater.*, 2019.

[6] H. A. Youssef, H. A. El-Hofy, and M. H. Ahmed, "Engineering Materials and Their Applications," in *Manufacturing Technology*, 2020. doi: 10.1201/b11792-8.

[7] J. Stránský, J. Vorel, J. Zeman, and M. Šejnoha, "Mori-tanaka based estimates of effective thermal conductivity of various engineering materials," *Micromachines*, 2011, doi: 10.3390/mi2020129.

CHAPTER 22

AN OVERVIEW OF SPACE ROBOTICS IN TODAY'S WORLD

Dr.Aravinda T, Assistant Professor,
Department of Mechanical Engineering, School of Engineering, , Presidency University,
Bangalore, India,
Email Id-aravinda@presidencyuniversity.in

ABSTRACT:

A sort of specialised robot known as a space robot takes the role of people in space exploration, exterior vehicular operations, and other tasks in space. The reason why the study is conducted to acknowledge space investigation, to know knowledge about the space robes latest activity. The objective of the apper focuse on the depth of space robotics and its characterization. The outcome of the study gives detailed view point on space robotics and their significance space. Robotic manipulators have really been crucial in orbital operations to support living beings in space for building and maintaining spacecraft modules and structures. Robots can land & travel on distant planets have also made significant contributions to our understanding of the planetary system by broadening the scope of investigation beyond the regions accessible to humans so thats why Future challenges are anticipated.

KEYWORDS:

On-Orbit Serviced, Robots, Radiation, Space Robotics.

1. INTRODUCTION

The ultimate setting for the use of robotics technology is space. High heat, vacuum, radiation, pressure, and huge distances make outer space a harsh environment, making human entry highly risky and dangerous. Robotic con artists have been crucial in orbital operations to support actions in space for building and maintaining space packages and structures. Robots who crash and travel on planets have also made significant contributions to our understanding of the solar system by broadening the scope of investigation beyond the regions accessible to humans. Future obstacles are anticipated. The robotics of on-orbit services tasks like reducing, berthing, refilling, patching, upgrading, conveying, liberating, and orbital trash removal, space robots is thought to be one of the most promising options. Over the past two decades, numerous enabling strategies have been developed and several research and demonstration missions have really been successful. Unmanned, fully autonomous service missions have not yet been carried out, despite a handful of successful manned on-orbit servicing missions. Furthermore, only cooperative targets were intended to be served by all past unmanned technology demonstration flights. Robotic servicing of an uncooperative satellite remains an unsolved scientific problem with numerous technical difficulties.

Space exploration is surely anything but uninteresting, but it is also extremely risky. It might be worth the risk to increase our understanding of the solar system in an effort to find answers to fundamental concerns about the origins of life or the possibility of sustained human presence elsewhere in the universe. The expenditures involved in reducing the risk of manned space flight are too high. Robotic missions, such as the wildly popular Mars Curiosity Rovers, have demonstrated that robotics, a branch of artificial intelligence, is capable of carrying out scientific exploration tasks without the need for a human operator, and they will continue to play a significant role in mission scenarios in the future.

The Apollo missions during 1969 and 1972 saw humans exploring the Moon's surface, which was a really remarkable feat for humanity. This was largely because NASA's activities shown what is possible when technology is combined with the desire of humans to explore the world. Although some could argue that walking on the moon is priceless, the entire mission, which included six moon landings, is thought to have cost roughly $100 billion in 2010 dollars. The technology development of LADs upstream in the propellant tank is the first step in enabling all prospective in-space refrigerated engines and cryogenic propellant depots for future manned and robotic human spaceflight missions. LADs will be required to make sure that the tank outlet is pretty well covered with liquid at all stages of the mission, depending on the requirements of the mission, which include the desired final liquid fill level, desired velocity level, direction, and spin, mass flow rate, thermal environment, and tank pressure.

The fundamental and secondary elements that affect LAD design were identified, and a number of physics-based models for these characteristics were created and verified in both cryogenic and storable propellants. All LAD models validated by cryogenic data, which would include bubble point pressure, reseal pressure, FTS pressure drop, TVS temperature control efficiency, and entire LAD stream pressure drop, show strong temperature dependence and variability from the room temperature behavior, even though the models agreed well with historical room temperature data.

Microgravity and Planetary Robotics are the two main focus of the Space Robotics Technical Committee. For situations like ISS operations and satellite maintenance, microgravity robotics incorporates manipulation and mobility. Planetary Robot systems use manipulation or movement on or near the surface to meet situations like Mars and lunar exploration. The boundaries between these groups may become hazy in some circumstances, such as meteorite and comet exploration, because of the low gravity of the settings. Statistics show that during the past ten years, an average of 100 satellites were launched per year. Most of them completed their tasks without any significant issues. A small percentage of them, meanwhile, did encounter oddities and even failures that ranged in severity. Launcher failure used to be the most frequent reason for failure. On-orbit failures, however, have already collectively cost billions of dollars in damages and have surpassed launch failures in recent years for the first time. In addition, even if a satellite is still operational, it ultimately runs out of fuel and must be retired.

In the 1980s, free-floating system models made their debut in the realm of space robotics. A free-floating space robots no holonomic character was made clear in the ground-breaking work. The disruption of the base's spatial position caused by the manipulator's movements was brought to light. The manipulation motion planning problem's related challenge was also emphasized. First

studies on the application of kinematic duplication for momentum compensating can be found in velocity-based formulas were devised for the simultaneous control of the base and end-link motions, and an unique redundancy resolution method with task priority was created to minimize or maximize the base reactions. Additionally, the so-called "manipulator inversion job" was invented, in which the floating base's orientation alters in a desirable manner while the end link remains stationary in inertial space.

2. LITERATURE REVIEW

In a study [1], The author Flores-Abad, Angel Ma et al. Discussed A review of space robotics technologies for on-orbit servicing. For on-orbit serviced (OOS) tasks like docking, berthing, refueling, repairing, upgrading, conveying, rescuing, and orbital trash removal, space robots is thought to be one of the most promising strategies. Over the past two decades, numerous enabling techniques have been created, and many demonstration missions have indeed been successful. Unmanned, fully autonomous service missions have not yet been carried out, despite a handful of successful manned on-orbit servicing missions.

In a study [2], The author Borna Monazzah Chhabra et al. Discussed On the leadership, steering and regulator of in-orbit space robotic missions: A examination and prospective vision. For space manipulators to carry out in-orbit robotic operations, such as but again not related to, on-orbit service, satellite/station installation, investigating extraterrestrial objects, and space debris reduction, navigation and control (GNC) approaches have been developed. Space robotics is mentioned as one of the most useful and all-encompassing solutions for a few brief space mission concepts. Close-range rendezvous, attitude synchronization, identification, manipulator deployment, capturing, and if necessary, capture man oeuvres are some of the mutual stages of an in orbit robotic assignment.

In a study [3], The author , Xi Lun Wang et al. Discussed A review of structures, verification, and calibration technologies of space robotic systems for on-orbit servicing. Due to the quick advancement of aerospace technology, more and more spacecraft are being sent into orbit. Additionally, there is a sharp rise in demand for on-orbit servicing missions. Among the most promising techniques for a variety of OOS missions is space robotics; as a result, universities and space agencies from all over the world are paying more attention to the development of space robotics and artificial intelligence for OOS.

In a study [4], The author Xiu Tian Brinkmann et al. Discussed Integrated mechanical, thermal, data, and power transfer interfaces for future space automation. For space exploration and maintenance missions, in-situ connectivity between space system modules can considerably increase flexibility, adaptability, and resilience. Thus, the subject of module connection in extraterrestrial environments is one that is becoming more and more important in contemporary planetary or orbital missions. For instance, as more satellites are sent into orbit, a wide range of connections of different types are now used to carry impact stresses, data, electrical power, and heat from one component to alternative.

In a study [5], The author Putz et al. Discussed Space robotics in Europe: A survey. For almost 15 years, Europe has been heavily involved in the development of space robotics systems and

techniques. The Special Issue about Space Robotics in Europa is introduced with this survey paper. It begins by highlighting the key distinctions between robots used in space and those used on Earth. It then divides the various space application scenarios into both interior and exterior automation in low earth orbit (basically the space stations), robotics for geostationary satellite maintenance, robotics for large space structure in-orbit assembly, mobile robots (rovers), and manipulator-type robotics for ground operations on the Moon, Mars, comets, and asteroids.

In a study [6], The author Mark A.Yan et al. Discussed Modularity for the future in space robotics: A review. Systems for modular and adaptable planetary and orbital robots are being developed. When compared to conventional and hegemonic robots, modular autonomous robotic systems hold the promise of being more effective, adaptable, and durable. They also have the potential to perform better than conventional systems with a fixed morphological features when performing tasks that call for a high degree of suppleness.

In a study [7], The author da Fonseca et al. Discussed Space Robotics and Associated Space Applications. This study provides an outline of the space era and the first robotics probes prior to the landing of the men on the Moon in order to contextualize the use of robotics in the human spaceflight scenario. The study also explores and examines the core ideas of space robotics.

3.DISCUSSION

The performance without operator interaction for servicing, maintenance, or upgrading for more than a few years and up to a decade or longer. One of the rare long-lasting products of human engineering that are not provided with such care and maintenance during their operating lives is spacecraft. Simple explanations of inaccessibility are really no longer unable to hold this situation because robotic on-orbit servicing is technically possible (OOS). The traditional approach to ensuring the reliability of spacecraft has been to place a focus on high reliability, expensive components, and rigorous validation and testing, all of which add to the cost of space platforms. Robotic OSS missions have been developed by numerous space agencies. The first robotic OOS demonstration mission was the Early Test Satellite VII (ETS-VII) of the Japanese Aerospace Exploration Agency, which featured a 2-meter-long, 6-DOF robotic arm placed on an unmanned spacecraft. In order to test technology for autonomous reconnaissance and docking (AR&D) and robotic servicing in orbit, an experimental rocket was launched in November 1997. The experiment consisted of a number of activities, including the arrangement of a space construction, the capture and berthing of a target satellite, robotic servicing operations including orbital replacement unit’s exchange, and remote monitoring from the pulverized with a period interruption.

An overview of the achievements of orbital industry 4.0 over the past 10 years highlights the Science Research Satellite and Orbiter Transit flight demonstrations. In the second section, several of the selected planetary robotics subjects are discussed from the standpoint of field mobile robots. An example from the author's lab's most recent success is included. The technical challenges of asteroid robots are next looked into. For robot designers, the challenge of learning how to move and stick on an atom's surface in weightless is an exciting one. Support for extra-vehicular activity. Astronauts have found robotic manipulators to be helpful when doing EVA chores. One of the best instances of such an operation was the Hubbell space telescope (HST)

on-orbit fixing in 1994, which is well renowned for enhancing astronomy and our understanding of the cosmos. A robotic arm was employed to hold the antenna steady throughout the protracted and precise repairs while the astronauts worked to replace the solar plants and repair the spacecraft's position control system and main computer.

Simple shapes, like cylinders, cannot adequately express this geometry. Additionally, the manipulation end-effector must operate close to the structure's components during the completion of various tasks, therefore wide safe zones cannot be set up around them. The manipulator workspace has a complex collection of obstacles as a result. The second challenge in designing a collision-free trajectory is the requirement for a manipulator positioned on a space station to operate in a dynamic environment. This type of manipulator is frequently employed to support astronauts during EVAs and to seize resupply ships that are approaching the station.

During space missions, manipulators can be used for a variety of tasks. For example, the Canadarm2 manipulator deployed on the The International Space Station helps with station building and maintenance. With very few exceptions up until now, space manipulators have always been run by humans or by operators on Earth. The field of space automation will face new difficulties as a result of new, ambitious missions like active debris removal and on-orbit servicing that call for a high degree of autonomy. This essay discusses one of these difficulties, namely the obstacle avoidance issue.

An further problem that needs addressed is a potential movement of the target item. The target object was controlled in every previously completed technology demonstration mission that tested the technologies needed to complete an orbital capture man oeuvre with the use of a manipulator. Since missions aim to capture space debris, which are by definition uncontrolled, it needs to be presumed that the target object is uncontrolled in the case of real OOS and ADR missions. However, a servicing mission's potential task could include exchanging a target satellite's failed attitude control subsystem. The capture man oeuvre is significantly more difficult because the uncontrolled object may be in motion because it cannot be controlled.

Robotic systems will be crucial in lowering costs. Risks and rising human productivity in space. A good illustration is the Mobile Servicing Station (MSS) depicted in that the government is currently developing Canadian Manned Spacecraft for external assembly The NASA's International Space Station (IS) is being maintained. As the complexity of the duties carried out by space robots increases, the requirement for more human-like traits; appears. With humans, sight is crucial because it allows us efficient environmental interaction.

Data management, extremely affordable space transportation, and the construction of huge buildings in space are essential requirements for space technology. The cost of moving materials from Earth to orbit is the single most crucial element in determining the future of space. Although it costs $500 to send a kilograms into low Earth orbit with the space shuttle, many applications require a price that is far lower. Data management systems are required to handle data collecting, processing, analysis, and distribution due to the enormous volume of data now being received from space at a rate of 10 bits per day. Applications including big antennas, solar-powered satellites, manufacturing and material processing, or permanent space stations.

The ideal way to develop an autonomously space robot is through a research programmer with a number of smaller, more manageable objectives realized as space missions. This programmer is described as a four-part process. An intelligent robot is the first stage, designed to bridge the technological divide between ground-based and space-qualified computer systems. A general-purpose, free-flying spherical robot that can control manipulator systems and address onboard navigation, guidance, fueling, and control concerns is the second step. The creation of planetary or lunar wandering vehicles for surface investigation is the following phase. The development of space construction robots is the last step, and working with other robots to complete a task cooperatively poses a significant extra challenge.

All mission will be derived to the functionality of which it will be delivered, space robotics can be find more equitable more informative, will help to getting information about the space lattice. All of the aforementioned missions provide novel difficulties and call for strides in the field of automation. The issue of obstacle avoidance is one that must be addressed in all of these missions. For mobile robots and manipulators operating on Earth since 1970, approaches for control and path planning that account for impediments in the workspace have been suggested. However, the issue of obstacle avoidance is still largely unexplored in the field of space robots. Additionally, the orbital environment presents a number of particular difficulties for obstacle avoidance.

Pace exploration and use depend on activities like satellite maintenance, refueling, upgrading, repair, or rescue, eliminating orbital debris, and building and maintaining substantial orbital infrastructure. Up to now, astronaut Extravehicular Activities have completed all notable service chores in Low Earth Orbit (LEO). However, are risky procedures by their very nature, necessitating thorough planning and preparation.Unfortunately, this dramatically lengthens turnaround times and raises mission costs, making servicing missions prohibitively expensive, impossible to develop, or both. EVA is not even a possibility for vital space assets that are currently positioned in Geostationary Orbits (GEO) or other elevated orbits.

4. CONCLUSION

By those who are closest to the issues, the space robotics evaluation study presents a positive image of the prospects of the field. Infrastructure investment and trials that will improve the state of the art are required, especially for those capabilities listed as requiring considerable effort, for this scenario to come to fruition. Few of the required future robotic capabilities necessitate fundamental discoveries; the majority just call for a consistent effort aimed at creating techniques and establishing expertise in the use of robots in human spaceflight. Such a persistent endeavor will increase the effectiveness and capabilities of mobile robots in space and extend the bounds of exploration. A control method that reliably operates sensor, actuator coil configurations on flexible robots has been devised. On the basis of this theoretical foundation, a reasonably straightforward control system for a lab robot was created. The control approach's robustness qualities are confirmed by simulation results. The authors' current efforts are concentrated on the experimental assessment of the vision-based control system.

REFERENCES

[1] A. Flores-Abad, O. Ma, K. Pham, and S. Ulrich, "A review of space robotics technologies for on-orbit servicing," *Progress in Aerospace Sciences*. 2014. doi: 10.1016/j.paerosci.2014.03.002.

[2] B. M. Moghaddam and R. Chhabra, "On the guidance, navigation and control of in-orbit space robotic missions: A survey and prospective vision," *Acta Astronautica*. 2021. doi: 10.1016/j.actaastro.2021.03.029.

[3] X. L. Ding, Y. C. Wang, Y. B. Wang, and K. Xu, "A review of structures, verification, and calibration technologies of space robotic systems for on-orbit servicing," *Science China Technological Sciences*. 2021. doi: 10.1007/s11431-020-1737-4.

[4] X. T. Yan *et al.*, "Integrated mechanical, thermal, data, and power transfer interfaces for future space robotics," *Frontiers Robotics AI*. 2018. doi: 10.3389/frobt.2018.00064.

[5] P. Putz, "Space robotics in Europe: A survey," *Rob. Auton. Syst.*, 1998, doi: 10.1016/S0921-8890(97)00053-5.

[6] M. A. Post, X. T. Yan, and P. Letier, "Modularity for the future in space robotics: A review," *Acta Astronautica*. 2021. doi: 10.1016/j.actaastro.2021.09.007.

[7] I. M. da Fonseca, "Space Robotics and Associated Space Applications," 2021. doi: 10.1007/978-3-030-60694-7_9.

CHAPTER 23

ROLE OF THE ROBOTICS IN INDUSTRIAL FIELDS

Mr. Muralidhar, Assistant Professor,
Department of Mechanical Engineering, School of Engineering, , Presidency University,
Bangalore, India,
Email Id-muralidhar@presidencyuniversity.in

ABSTRACT:

Robots are autonomous robots that can carry out specific tasks fast and accurately requiring little to no assistance from humans. The term "industrial robot" refers to a system of industrial robots. Industrial robots are designed, have three or more dimensions of motion, and are autonomous. A robotic system speeds up a manufacturing process in part due to its continuous operation. The objective of the study is discussing the robots, industrial robots with its types after that application of the industrial robotics. The conclusion of the study is that the industrial robots will helpful to the companies to complete their works in time. The study's findings Robots can increase product productivity, consistency, and consistency. Robots never grow bored, in contrast to people. They may carry out the same behavior continuously until they are worn out. The study's future scope Final results show that cycle time is reduced and productivity is boosted due to the speed and dependability of robots.

KEYWORDS:

Industrial Fields, Industrial Robots, Robotics, Speed.

1. INTRODUCTION

Robots are human-like machines that can complete all human jobs faster than humans. Even while they cannot completely replace humans, they can help them with many of their everyday chores. Robots are human-like devices that combine artificial intelligence, sensors, and other technologies. Robots are employed in a wide range of computer application sectors. Robots are being developed by engineers and researchers to the stage where almost everyone can use them. Due to linguistic programming done during the production process, many robots now resemble humans in that they are capable of walking and communicate without the aid of a human. However, there are other semiautomatic gadgets that are useful for mobility, such the needles remote. Every teen is fascinated with robotics and eager to learn more about it for usage in the future. One of the most cutting-edge and exciting areas of research and education is this one [1], [2].

One of the industrial sectors with the fastest rate of growth is industrial robotics, which offers standardized technology suitable for diverse automation operations. An automatic control, reprogrammable, multiuse manipulator with three or more machetes that can be used in motionless or mobile fashion as part of industrial automation applications is referred to as an industrial robot. But for wider implementation, the same standard makes an exemption. It claims

that the classification of a robot into an industry, service, or other kind is done in accordance with the purpose for which it is intended. Global sales of industrial robots were reported by the World Association of Robotics in 2019. Globally, there were 2.7 million industrial robots in use in factories in 2020. The effective use of industrial robots, their dependability and accessibility, as well as the dynamic adoption of the Industry 4.0 thought, have sparked an increase in interest in robot optimization and the investigation of new implementations in a variety of fields, particularly in non-typical applications and non-manufacturing [3], [4]. Science Direct, one of the largest scientific databases, reports that the term "Industrial robot" was used as a keyword in more than 4500 scientific papers published in 2019. In 2020, the quantity of documents with a similar attention and study focus climbed to 5300. In Figure 1 shown the Industrial Robotics.

Figure 1: Illustrating the Industrial Robotics.

TYPES OF THE INDUSTRIAL ROBOTICS:

Industrial robot usage in manufacturing industries has extended as an outcome of the quick growth of robotics and automation technology. Additionally, a large number of industrial robots are employed to carry out a diversity of repeatable actions, resulting in superior production. As a result, industrial robotics find usage in a variability of manufacturing-related applications. Below the types of industrial robots are given as shown in the Figure 2.

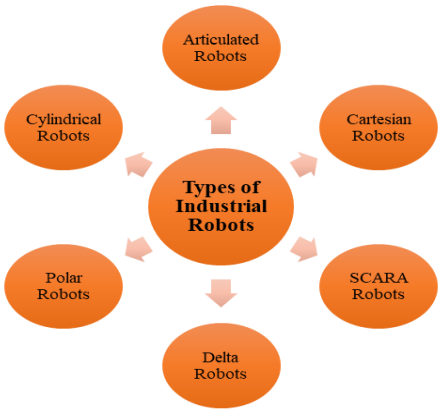


Figure 2: Illustrating the Types of Industrial Robots.

2. LITERATURE REVIEW

Mohammed R. R. et al. [5] studied about evaluation and increase the intelligibility of robot presentation in the attendance of affecting humans at the house, at work, or in any other place and basic design thoughts on how to straighten a robot arm to discover many safe and personified actions. The author evaluated harmless robotic arm gesture routes and explore the potential impact of human variables on safe cooperative operation responsibilities in manufacturing HRC sets. The major objective was to create a unique model for secure robot arm actions in manufacturing HRC situations. The findings of their study revealed that the application of coordinating techniques founded on human-human teamwork for fluid and successful human-robot collaboration will also be looked at.

Muhammet M. et al. [6] discussed the creation of various simulations as part of the immediate work that will be done to assist in setting up the physical experimental setting(s) where the algorithms and suggested solutions will be implemented and tested.The author discussed flexible Sensors, Connections of systems, Communication, the Operation of Systems, and Interface Design with Blender 3D.The author found that due to the flexible sensors installed on any glove, it has been found that finger actions are supposed and simulated with great precision and no issues. The system's unique feature is that it can remain wirelessly measured and monitored in fashionable Blender 3D.

Pantha P. S. et al. [7] discussed that work develops the R3Arm, a lower-cost gesture-controlled robotic arm device, for isolated rescue operations. It allows for mobility and distant manipulation. The robot can be used in major rescue missions and can be transported to locations where humans cannot. An examination of 152 movements from a study on motion detection for a robot-saving device and related research indicates. This study distributed extremely well and professionally with the strategy and program of a low-cost gesture-controlled robotic arm.

Rajesh K. M. et al. [8] talked about a simplified method for precision independent farming that combines unmanned machines and sensing schemes with independent farming vehicles. Automatic farming vehicles are separated into four collections in the paper on unmanned robotic facility parts: steering, discovery, act, and plotting. Additionally, it covers a variety of action group sensors, such as range laser devices, artificial image schemes, etc. A detailed discussion of several putting algorithms for independent vehicles is shown. In that study, the worker will be able to switch the arm after the control room somewhat than from the fields thanks to the. The outcomes of several laboratory studies, such as the achievement/disappointment checks and response period dimension checks, are quite positive.

Muhammad A. B. et al. described the creation of a pick-and-place automatic Cobot system for the classification of black colors. The author suggested a method for the Cobots to identify an object's color by using an IR sensor to identify the black color and picking and placing the object with the help of servo motors and Arduino Nano to move the robotic arm. The author presented a proposed intelligent device's functionality has been evaluated by the identification of random objects of various colors. However, it will only be able to find, select, and transport objects that are black to the target place. The suggested approach was anticipated to save labor costs and boost industry productivity and efficiency.

Yagna Jadeja and Bhavesh Pandya [9] discussed the design and development of five DOF robotic arm schemers. An artificial arm that performs desired functions is a robotic arm. The

development of mechanical arms for many non-human settings where the human statement is difficult is becoming more and more important today. Humans pick up things without thinking about the procedures necessary and manually manipulate robotic arms utilizing wired and wireless technology. That study focused on the design and the use of a "Cortex ARM M3 LPC1768 Microcontroller", a digital controller and ultrasonic sensor connected to a computer system to regulate the angle of a robotic arm. The author's findings presented the close of intellect that may be used by industries to decrease human mistake rates while also improving manufacturing output speed and processing quality.

Enrique Coronado et al. [10] discussed a framework for gesture-based robot control in that paper, go over the design concepts used, and present the findings from the evaluation of the framework with humans. Wearable device gesture-based control may be a novel kind of human-robot interaction, but the literature hasn't addressed its implications. Over the key problematic aspects, potential design principles, and an open-source, freely accessible solution using readily available commercial robots and equipment. It is reported on how well the architecture performed overall and how 27 untrained individuals validated it and provide a technique to control a mobile robot using gestures captured by wearable technology.

Anood Ibrahim et al. [11] studied the function of artificial intelligence in robotics is also discussed in that paper, along with current and emerging types of controller systems and their use in robotics. It also tries to draw attention to the numerous problems with controller systems and the many solutions. The author suggested the foundations of robotics control systems as well as several different kinds of robotics control systems. A robot system was built and changed to be able to carry out the necessary task. Control systems enable the movement and operation of different robot sections and carry out a predetermined sequence of actions and services in the event of unforeseen faults. Robotics also requires a lot of teamwork.

Pradeep J. and Dr. P. V. PAUL [12] developed a robotic arm for creating and putting into practice a robotic arm measured by gestures for industrial use. The major objective of that research was to use human gestures to control the robotic arm. In the transmitter part, a microcontroller is employed. The necessary activities for the human gesture are performed as a result of the coding. Using an RF transceiver module, these detected signals are treated before being sent toward the robotic arm by the receiving portion. In that study Given that it has a robotic arm and can hoist bombs, it can also be improved to become a bomb detection robot. The robot can be equipped with a GPS so that its whereabouts can be monitored.

Previous research has various limitations that are addressed in this literature view. This study reveals that Robots are being used more and more in various sectors to replace people, especially for dangerous occupations. The robot is an electric-machine device that can do a complex sequence of tasks either automatically or with human oversight. These are employed in a variety of sectors, including the military, research, and healthcare

3. DISCUSSION

The early robots were industrial machines that took the place of humans in simple, repetitive tasks. Without human intervention, factory assembly lines can run in a controlled environment where the robot must carry out duties in a specific order and react to things that are precisely positioned in front of it. These could be considered automata rather than robots, according to some. But modern automata frequently rely on sensors to the point that they can be regarded as

robots. However, because they operate in a special environment that people are not permitted to enter while the robot is at work, their design is more straightforward [2], [13].

However, modern robots require additional versatility, such as the capacity to manipulate objects in various orientations or to identify various objects that require. The robot might be needed to move items between warehouses. Although this increases autonomy, the fundamental characteristic that the environment is largely limited and may be tailored to the robot remains. Whenever industrial robots interact with people, more flexibility is needed, and this imposes strict safety standards on both mobile robots and robotic arms. In particular, the robot's pace needs to be slowed down, and the working mechanism needs to make sure that there are no moving elements that could endanger the user [14]. The benefit of humans collaborating with robots is that each can focus on their strengths: humans can do more difficult activities while robots handle repetitive or dangerous ones.

3.1.Work of Industrial Robots:

Industrial robots perform a range of manufacturing tasks using sensors, controls, and actuators. They execute the manufacturer-specified repeated movement cycle with the help of a series of directives. Robots also produce equipment that needs less human interaction. They can be used in a number of industrial procedures or in conditions that humans cannot endure, such as space, inclement weather, or submerged. Additionally, they are built to function in risky settings like those engaged in bomb deactivate, radioactive substances inspection, etc. Robots are programmable and may move in three or more axes [15], [16]. As a result, they are employed in a variety of routine operations including welding, assembling, painting, etc. In Figure 3 shown the top Industry Robotics Application.

Figure 3: Illustrating the top Industry Robotics Application.

The annual ratio of new robot installations to the whole number of academic publications in the Science Directly database is shown in Figure 4. Scholarly interest in this subject is based on a consistent rise in publications, independently of the governmental, economical, and social factors influencing the marketplace for new robots.

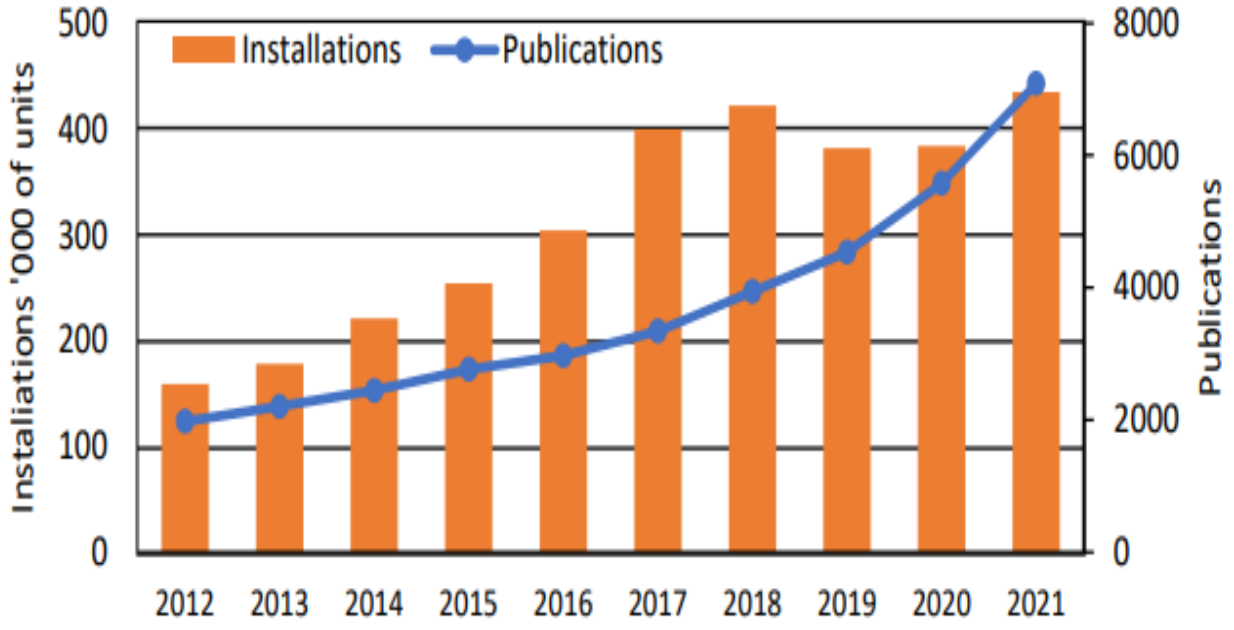


Figure 4: Shows Yearly Ratio of New Manufacturing Robot Installations to Publications.

Robots are present everywhere, including in homes, hospitals, industry, and even space. A lot of time and money is being spent on research and development to create robots that can communicate with people directly. Robots are used in classrooms to boost students' interest in STEM subjects and as a teaching resource to teach STEM in a real-world setting. The employment of educational robots to study robotic algorithms and investigate their behaviour is the main topic of this book. The majority of instructional robots have a similar design: a small mobile robot with proximity sensors and differential drive. We defined a generic robot with these characteristics in order to make this book platform independent.

4. CONCLUSION

Industrial robots have a wide range of potential applications in the manufacturing sector. The aforementioned uses demonstrate how robots provide higher quality, reduced prices, and fewer work-related accidents. To be clear, autonomous systems may currently be seen in a variety of industries. Numerous significant issues were brought up by the analysis of robot applications, which also demonstrated that technological challenges are not always the only constraints on the currently infrequent applications of robot implementations. Some application disciplines, such those in the food, agriculture, and civil engineering sectors, have no history of engaging in such operations. Traditional industrial robots and specific cobot scenarios still require a thorough introduction into these industries in order to enable human-robot cooperation. However, in this instance, the introduction covers non-technical topics like human psychology and workplace acceptance of robots.

REFERENCES:

[1] X. Gao, C. Zhou, F. Chao, L. Yang, C.-M. Lin, and C. Shang, "A Robotic Writing Framework–Learning Human Aesthetic Preferences via Human–Machine Interactions," *IEEE Access*, vol. 7, pp. 144043–144053, 2019, doi: 10.1109/ACCESS.2019.2944912.

[2] M. Bohm, J. Kaufman, J. Brajer, and D. Rostohar, "ROBOTIC ARM HUMAN-MACHINE INTERFACE FOR LASER SHOCK PEENING APPLICATIONS," *MM Sci. J.*, vol. 2019, no. 05, pp. 3643–3646, Dec. 2019, doi: 10.17973/MMSJ.2019_12_2019115.

[3] A. Campeau-Lecours *et al.*, "Kinova Modular Robot Arms for Service Robotics Applications," *Int. J. Robot. Appl. Technol.*, vol. 5, no. 2, pp. 49–71, Jul. 2017, doi: 10.4018/IJRAT.2017070104.

[4] A.-H. Chiang and S. Trimi, "Impacts of service robots on service quality," *Serv. Bus.*, vol. 14, no. 3, pp. 439–459, Sep. 2020, doi: 10.1007/s11628-020-00423-8.

[5] M. Rahman, L. Alboul, L. Nisiotis, J. Penders, and A. Di Nuovo, "Safety Assessment of a Robotic Arm Motion including Human Factors," *UKRAS21 Conf. Robot. home Proc.*, vol. 4, no. November, pp. 49–50, 2021, doi: 10.31256/ic8et3x.

[6] S. Bilgin, Y. Üser, and M. Mercan, "Robotic Hand Controlling Based on Flexible Sensor," *Int. J. Eng. Appl. Sci.*, vol. 8, no. 4, pp. 49–49, 2016, doi: 10.24107/ijeas.281463.

[7] P. P. Sarker, F. Abedin, and F. N. Shimim, "R3Arm: Gesture controlled robotic arm for remote rescue operation," *5th IEEE Reg. 10 Humanit. Technol. Conf. 2017, R10-HTC 2017*, vol. 2018-Janua, no. February, pp. 428–431, 2018, doi: 10.1109/R10-HTC.2017.8288991.

[8] R. K. Megalingam, S. Bandhyopadhyay, G. V. Vivek, and M. J. Rahi, "Hand Gesture Based Wireless Robotic Arm Control for Agricultural Applications," *IOP Conf. Ser. Mater. Sci. Eng.*, vol. 225, no. 1, 2017, doi: 10.1088/1757-899X/225/1/012204.

[9] Y. Jadeja and B. Pandya, "Design and development of 5-DOF robotic arm manipulators," *Int. J. Sci. Technol. Res.*, vol. 8, no. 11, pp. 2158–2167, 2019.

[10] E. Coronado, J. Villalobos, B. Bruno, and F. Mastrogiovanni, "Gesture-based robot control: Design challenges and evaluation with humans," *Proc. - IEEE Int. Conf. Robot. Autom.*, no. November, pp. 2761–2767, 2017, doi: 10.1109/ICRA.2017.7989321.

[11] A. Ibrahim, R. R. Alexander, M. Shahid, U. Sanghar, R. Donate, and D. " Souza, "Control Systems in Robotics: A Review," *Int. J. Eng. Invent.*, vol. 5, no. 5, pp. 29–38, 2016.

[12] D. P. V. P. J. PRADEEP1, "Design and Implementation of Gesture Controlled Robotic Arm for Industrial Applications," *Int. J. Adv. Sci. Res. Dev.*, no. 04, pp. 202 – 209, 2016.

[13] H. N. Huynh, H. Assadi, E. Rivière-Lorphèvre, O. Verlinden, and K. Ahmadi, "Modelling the dynamics of industrial robots for milling operations," *Robot. Comput. Integr. Manuf.*, vol. 61, p. 101852, Feb. 2020, doi: 10.1016/j.rcim.2019.101852.

[14] K. Blöcher and R. Alt, "AI and robotics in the European restaurant sector: Assessing potentials for process innovation in a high-contact service industry," *Electron. Mark.*, vol. 31, no. 3, pp. 529–551, 2021, doi: 10.1007/s12525-020-00443-2.

[15] A. Goncharov, A. Savelev, N. Krinitsyn, and S. Mikhalevich, "Automated anomalies detection in the work of industrial robots," *IOP Conf. Ser. Mater. Sci. Eng.*, vol. 1019, no. 1, p. 012095, Jan. 2021, doi: 10.1088/1757-899X/1019/1/012095.

[16] A. Hentout, M. Aouache, A. Maoudj, and I. Akli, "Human–robot interaction in industrial collaborative robotics: a literature review of the decade 2008–2017," *Adv. Robot.*, vol. 33, no. 15–16, pp. 764–799, Aug. 2019, doi: 10.1080/01691864.2019.1636714.

CHAPTER 24

ASSESSMENT OF SOLAR-POWERED SATELLITES IN THE MODERN WORLD

Mr.Narendra Singh, Assistant Professor,
Department of Mechanical Engineering, School of Engineering, , Presidency University, Bangalore, India,
Email Id-narendersingh@presidencyuniversity.in

ABSTRACT:

Solar powered satellite is the technique or enhancement to conduct solar energy or solar power to conserve solar power transfer the power to the earth with the help of solar satellite. The problem why it is made because to conserve solar energy which are made to collect solar energy and send it to receiving stations scattered over the earth's surface that are hundreds of kilometers apart and the potential for little to no nighttime and an improved capacity to embrace the sun. Microwaves, for example, can be sent through the atmosphere to sensors on the Earth's surface via space-based solar power systems, which transform sunlight into another type of energy. It appeals to individuals looking for extensive answers to anthropogenic warming or the depletion of fossil fuels. The study focused on the enhancement on the solar powered satellite system which need to be focused and what are benefits to use solar powered system. The outcomes of the study give influence on solar poswered satellite and its types which make the conservation of energy helpful and brings the deep knowledge about the solar powered satellites. In future, the study need a deep knowledge in space decisions to enhance the working of solar powered satellites.

KEYWORDS:

Grid-interactive, Hybrid Solar system, Solar Power, Satellites, Solar Panels.

1. INTRODUCTION

In order to address and resolve the issue of supplying energy for terrestrial usage, Peter Glaser, was working for Arthur D. Little at the time, introduced the idea of an orbiting solar power satellite. In Glaser's plan, a large (-10 square kilometer) solar array would be placed in geostationary orbit, and a microwave beam would then be used to deliver electricity to the earth [1]. A rectifying antenna, or "retina," which receives the transmitted power on the ground transforms the microwave to DC electrical energy with a DC-to-DC efficiency of around 80%. The solar array benefits from constant full sunshine that is not interrupted by the day-night cycle, air attenuation, or douds by being placed in orbit as opposed to on the ground. The conceptutional arrangement in the lattice of solar powered satellite which is construct6ed for to gain energy [2].

The U.S. Office of Science and technology policy assessed this conceptual research and came to the conclusion that while the idea was appealing, it could not be executed affordably given the availablilbility to the modern technology. The research recommended reassessing the idea after

ten years [3]. A "Fresh Look" in 1995.NASA researched the idea, and stated that the analysis assumed that new technology for recoverable launch vehicles will result in considerable cost savings for space launches [4]. This study looked at a variety of alternative ideas and considered putting the solar power spacecraft in orbits pretty low than geosynchronous orbit, concluding that these orbits were impractical because geosynchronous orbit had too many advantages, including the power station always being visible to the ground station, to outweigh the disadvantages of the higher orbit [5].

The solar-power-satellites are also known as pederasts, which are specifically designed constructed devices that circle the earth's surface to collect and transmit the solar radiations that are being received. These kinds of installations primarily serve the aim of using the heat produced by a renewable energy source that is located 1,000 miles from the earth's surface [6]. These "solar-power-satellites" are made up of several modules that have been equipped with thin SPV panels. Solar-powered satellite is an ecologically friendly energy technology that ensures Sustained growth. In comparison to collecting solar energy from the earth's surface, collecting solar radiation from space is more efficient [7].

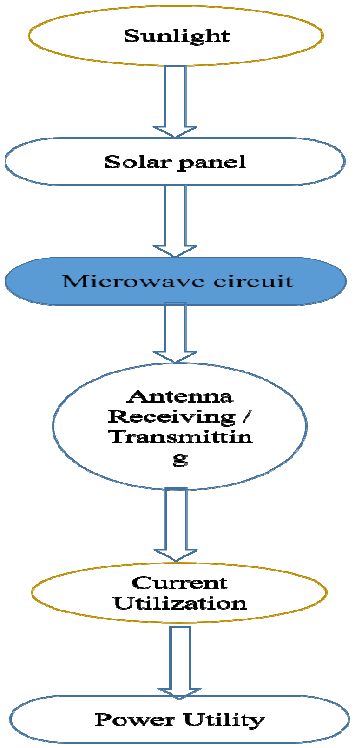


Figure 1: Demonstrates the overall process of solar power satellites.

Finding novel renewable energy sources is under more pressure now that the millennium has arrived. Global crises including global warming, environmental degradation, and change, as well as the rapid depletion of fossil fuels, have been brought on by the exponential expansion in the population [8]. Additionally, as the globe becomes more industrialized and technologically advanced, the need for electric power grows significantly faster than other energy demands. In light of these facts, to determine whether it would be feasible to construct a pumping station in space that would deliver electricity to Earth through radio waves the Solar Power Satellites [9].

Solar Power Satellites (SPS) use microwaves to turn solar energy into regular electricity by beaming those microwaves to a receiving antenna on Earth. SPS is a reliable, consistence, and clean source of electricity [10].There are several additional names for Solar Power Satellites, including Satellite Power Source, Space Power Station, Solar Power Station, Orbit Solar Power Station, etc [11]. Electromagnetic Wireless Power Transmission is one of the essential Technologies required to make SPS feasible in the future.Figure 1 demonstrates the overall process of solar power satellites.

2. LITERATURE REVIEW

Aditya Yoshimura and Yasuhiro Nagasakiet al. discussed the Interplanetary solar influence satellite for the Moon and Mars mission In addition to demonstrating the compression of conventional power generating techniques for the probe, landing, and shelter on Mars and the Moon, the space solar energy satellite for the trip to the Moon and Mars. Space engineers are employed on satellites, the conceptual design of a space dwelling, and exploration systems during interplanetary missions[12]. The current state of the art for those missions relies on solar panels connected to batteries or radioisotope thermoelectric generators, both of which have drawbacks. The authors conclude that interplanetary rovers and habitats may benefit from using space solar power satellites as a source of energy transfer rather than the conventional approach.

Yang Fan and Guanheng Ji [13] et al. discussed modular line-focused space solar power satellites An extremely enormous space construction called the Space Solar Power System absorbs sunlight directly from the sun and then beams energy down to the earth. Scientists from all over the world have presented several common conceptual design models since the notion was first suggested in 1968. For technological, production, and financial reasons, the constructs have not been put into practice. The authors built a revolutionary space solar power satellite system using small concentrations phot voltaic modules and modular line-focused concentrators. The optical efficiency of the round-trough concentrator is first assessed using the ray-trace method, followed by an analysis of the line-focused mode. The form of the cell array is then optimized based on the Piecewise curve to enhance the optical property.

Baoyan Song and Liwei Yang [14] et al. proposed a new concept of space solar power satellite The Orbit Solar Power Satellite (SSPS) is a powerful energy technology that wirelessly distributes electric electricity from space to earth after collecting and converting solar power into a strong valuable energy source. The normal-incidence sunlight is collected and converted to DC power using a hemispherical one in the middle and The DC power is then beamed down to the ground through an antenna array transmitting antenna.

Kaiming Wu and Shunan Wu [15] et al. discussed Multibody dynamics and robust attitude control of a MW-level solar power satellite. First, the flexible multibody stance dynamic model is created via Lagrange formulae in terms of developing a semi-based on the chosen standard attitudes and the gray floating shelves formulation. To assess their impact on attitude control precision, the gravity gradient, radiation from the sun force, and radiation emitted torques are also studied. It is thus suggested to use a dual high/low bandwidth robust controller. Low bandwidth control, which essentially combines feed linearization with the variable structure and reduces the control-structure interactions of the center truss, is used to accomplish rough attitude control of the center truss and solar subarrays.

Jonas Don Yelee Davidson and E.Sharma [16]discussed appraisal of modem astral power satellite tube and space retina systems that a contemporary satellite system with space antenna. Using electromagnetic power transmission technology, it is difficult to gather and send significant amounts of energy from space to Earth without interfering with satellite communication like army systems operation and aircraft radar systems. The author concludes that the system's space-based component is made up of a network of SunSats, or solar energy-gathering satellites, which collect solar energy and transfer it to earth using an appropriate frequency. The system's ground station is made up of large reception antennas called rectennas that transform microwave energy into DC electricity.

R.W.Miles [17] discussed Photovoltaic solar cells that Building integrated photovoltaics (BIPV), which is the most common application for photo - voltaic solar cells and modules, as well as centralized power plants, are produced for large-scale power generation and secondly supplying electricity to remote towns and cities in developing nations that are not connected to the power grid. The author contains primary ingredients and manufacturing processes used to create commercially accessible photovoltaic solar modules and cells [18].

3. DISCUSSION

The need and use of energy will probably keep rising for many years to come. In terms of engineering and philosophy, renewable energy is an attractive strategy and will help in major operations. Due to intrinsic land and water limitations, many sources of renewable energy are constrained in their capacity to in expensively deliver the base load electricity necessary for global industrial expansion and prosperity. The availability of fossil fuels suddenly decreased as a result of using them continuously. The greenhouse gases effect and several other environmental issues were also caused by the use of fossil fuels.

The creation of a clean and dependable power source has received attention due to a rise in the worldwide population and an increase in global warmingenergy. Even though many alternatives to fossil fuels have been explored, no technology has been able to fully satisfy the world's energy needs. Recent technological advancements have made it possible for space-based solar power systems to be used to satisfy energy demands. Large satellites are put in geostationary orbit as part of the space solar power communications satellite to collect and convert a significant quantity of solar energy into microwave radiation, which is then transferred to a rectification antenna array below the earth. The microwave energy is subsequently received by the retina and transformed into electrical energy for use by the terrestrial electric grid. Because the power produced by a Photovoltaic module is exactly equal to the device area, it is simple to predict how much electricity can be created. The Sun incidentally emits enormous amounts of energy onto the Earth each day. One strategy has been to calculate the percentage of land coverage required to produce a nation's current energy needs while assuming an Efficiency of solar of 15%, which is currently attained with commercially available devices.

Geosynchronous orbit would be the location and surroundings of Solar Power Satellites. A Solar Power satellite would produce more electricity than it would need for its functioning and working, which is how it differs from current satellites. A Solar Power satellite would turn the solar energy it captured into electricity and then microwaves. To be able to aim toward the Sun when the spaceship travels, solar panels must have a large surface area. Greater sunlight can be produced from solar light by exposing more surface area. The quantity of electricity that may be produced is limited since the spacecraft must be tiny. Solar arrays also serve as optical, thermal,

and electrical collectors in addition to producing waste heat from all electrical circuits. They must exude heat from their exteriors. Solar arrays on high-power spacecraft may compete with the operational payload for heat dissipation. To lessen the overlap among views in the space, the outermost panel of the array may be left blank.

Solar power is the process of converting solar energy directly into electricity via the use of photovoltaics (PV) or directly through the use of concentrated solar power. The photovoltaic effect is used by photovoltaic cells to convert electric current into light. A vast region of sunlight is focused to a hot point using concentrated solar power systems, which are frequently used to power a steam turbine.

3.1 Working of the solar power system:

Solar Photo-voltaic technology converts sunlight (or radiation from the sun) into electricity using semiconductors, allowing for the harnessing of solar power. Electrons are liberated when the solar cell's semiconductor is illuminated, and bus bars then gather the ejected electrons to produce an electric current. Solar panels begin to produce current and voltage when they are placed strategically in the sun, but most of the world's appliances and equipment operate on alternative current (AC), therefore we must connect all of our solar panels to an inverter, which transforms DC into AC for usage in our homes.

3.2 Types of solar power Systems:

The solar power system is the power storage of solar energy and it can be broadly categorized into three types which are illustrated below:

3.2.1 Grid interactive System or On-grid Solar Power System:

The grid-interactive solar system produces clean electricity. Inverters that interact with the grid can also draw energy from other renewable sources, such as wind or water. When the sun is out, the PV system stores its deep-cycle solar batteries and, via an inverter, sends any extra clean power into the power grid. The device may use the electrical grid to supplement solar power when there is none available since it is nighttime. The inverter uses clean energy generated by the solar batteries and panels to supply your house or place of business with electricity in the event of a power outage. Green energy is fed into the electrical grid through grid-tied systems, however they must be disconnected if the network goes down. Tied systems are rewarded and given incentives for supplying the grid with green energy, but they are unable to produce their own energy when the grid is down. Grid-interactive systems likewise contribute power to the grid, but they may also continue to produce green energy using solar panels and battery backup devices to power their own requirements.

3.2.2 Standalone System or Off-grid Solar Power System:

Off-grid systems feature batteries that can store the solar energy produced by the system. Solar panels, batteries, charge controllers, grid boxes, inverters, mounting frameworks, and other supporting equipment often make up a system. A number of separate photovoltaic modules (or panels), typically 12 volts and with power outputs ranging from 50 to 100+ watts apiece, make up an off-grid or Stand Isolated PV System. The desired output of electricity is then produced by combining these PV modules into a single array. Simple stand-alone PV systems automatically generate electricity to power banks of battery during the day in order that they may be used at

nighttime when the sun's energy is not accessible. Rechargeable batteries are used in standalone small-scale PV systems to store the electricity generated by solar panels or an array.

3.2.3 Hybrid Solar Power System:

When your photovoltaic arrays are part of a hybrid system, they are still hooked up to the grid's power cables and have a battery backup system to store extra energy. Solar panels need an inverter to convert the solar energy they collect into useful power. Electricity either travels to your house, your batteries, or the grid from that point. Electricity with a hybrid solar system, which is an advantage for all of everyone and will helps to store the power. The extra energy that our solar panels produce but that your household does not utilize will be saved in the backup battery. Then, so when sun is not beaming, you will have electricity from this battery during the night, power outages, or bad weather.

3.3 Simplified Stand-Alone PV System:

An electrical system made up of a collection from one or even more PV modules, cables, electrical parts, and one or more loads is called a stand-alone photovoltaic (PV) system. However, for household purposes, a small-scale off-grid solar system somehow doesn't always need to be tied to a roof or building structures. RVs, camper vans, yachts, tents, and other off-grid structures may all be powered by solar energy. Many businesses, including Amazon, now provide portable solar systems that let you generate your own trustworthy, cost-free solar power wherever you go, even in remote areas. In Figure 1 shown the overall pattern of simplified standalone PV system.

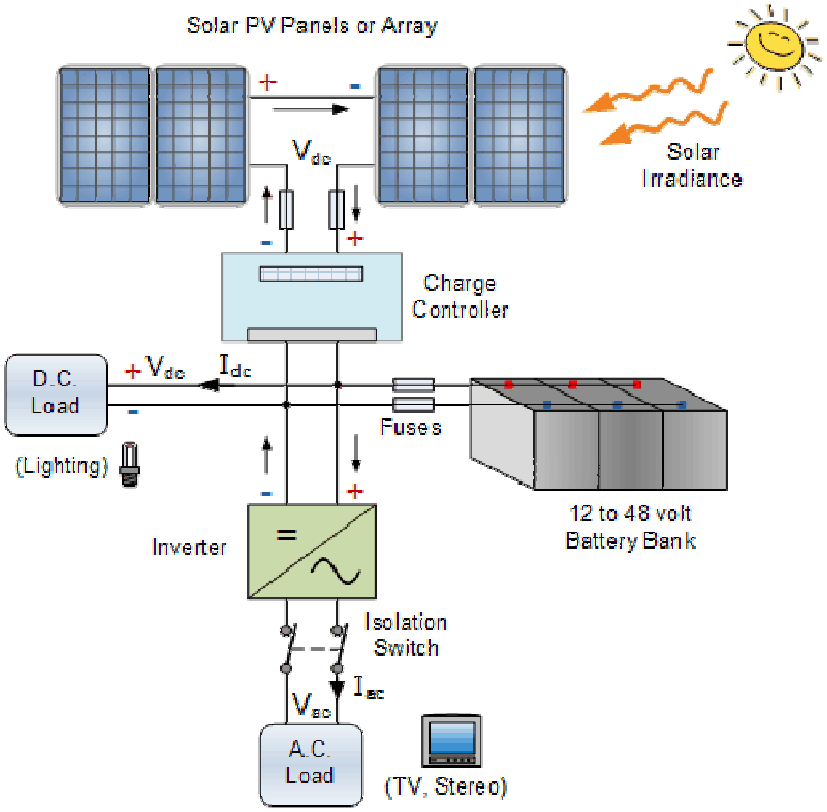


Figure 2: Demonstrates the overall pattern of simplified standalone PV system [19]**.**

This kind of "stand alone PV system" allows freedom from the electrical grid and utility corporations. However, if the batteries are used for extended periods of time or if there is no emergency power source, the batteries will finally discharge. As a result, stand-alone systems have included a comparatively tiny diesel or gas turbine for extended no-sun timeframes and even to recharge the battery when they reach a depth of discharge of between 60 and 80 percent. Since they don't need an inverter and controller and frequently include modest photovoltaic panels for direct illumination usage, straightforward stand-alone DC installations for camping, travel trailers, trailer, tents, etc. are typically the most affordable and well-liked solar PV systems. They are frequently utilized in areas that receive only sporadic or little traffic.

3.4 Important Factors in a Stand-Alone PV System:

i. It could be needed to store extra electricity to power your home for one or two days during overcast weather because solar panels only produce electricity when the sunlight shines on them. Solar power turns into a valuable resource in this situation; will be unable to live without that, but you also won't want to waste it. Consider taking steps to lower your energy use.
ii. By investing in energy-efficient appliances and LED lighting, for instance, you may lower your electricity demand and buy a smaller stand-alone PV system to accommodate your real energy requirements. With energy efficiency, you may start small and add as your energy requirements grow. A stand-alone PV system is not difficult to build or maintain compared to other off-grid electricity technologies, such as wind turbines, hydroelectric, etc.
iii. Solar PV systems also need routine upkeep and cleaning, which is not often associated with mains electricity that is connected to the grid. You might wish to educate yourself on the operation and necessary weekly or daily maintenance of your standalone solar power system. Like many other off-grid processes, Photovoltaic systems necessitate some basic electronic knowledge to be willing to maintain and install them effectively and to identify any problems, so become a specialist of your device. All the system components need to be tested and cleaned on a regular basis to ensure that now the system is functioning optimally.

3.5 Grid-tied vs Grid Interactive:

An option that interacts with the grid provides ongoing access to energy with extra suitable and connectable sources, frequently for a small additional cost. Users do not wish to use more problematic forms of electricity generation, such as nuclear or coal, to meet their demands. Reliability and renewability are the main demands. Grid-interactive systems solve such challenges by generating continual cost savings while reducing the carbon footprint.But the inverter must carry out a number of extra tasks in a grid-interactive system.

The battery is kept fully charged by the inverter under normal circumstances so that it is ready to be used in case of power disruptions. The grid-interactive inverter effortlessly intervenes when the grid goes down to convert DC electricity from battery and solar sources into usable AC power to operate specific loads.The system will use the solar panels, a generator when needed, or both to charge the batteries during the day. The generator's run duration, noise output, and fuel consumption may all be significantly decreased by using the grid-interactive inverter to automatically regulate the generator to only operate when necessary to recharge the batteries.

3.6 *Working of solar hybrid system:*

Installing solar panels requires converting the energy they produce into power for your home. There are a number different methods for accomplishing this; you may use hybrid systems, entirely disconnect from the grids, or keep linked to them. When your solar farms are wired into the grid's power lines and include a rechargeable battery that stores the extra electricity, the system is referred to as a hybrid one. Solar panels need an inverter to convert the solar energy they collect into useful power. The power then either travels to house, your batteries, or perhaps the grid. A solar hybrid system has the benefit of ensuring your constant access to powerfigure 2 illustrates the working process of hybrid solar system.

The energy produced by solar panels has to be transformed into power for your home after installation. There are a couple different methods to do this; one can either use hybrid systems or entirely go off the grid. In a hybrid system, your solar cells are wired into the grid's power cables and equipped with a rechargeable battery system that can store any extra energy. Solar panels capture solar energy, which is then converted by an inverter into useful power. The power then travels to the grid, house, or your batteries. One always has electricity with a hybrid solar system, which is a benefit. Figure 3 shows the working process of the Hybrid Solar System.

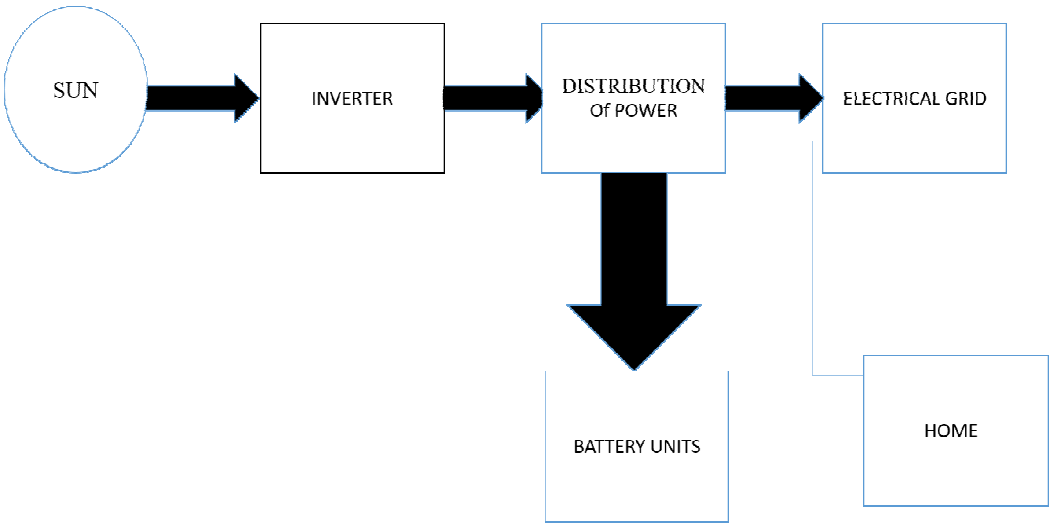


Figure 3: Illustrates the working process of the Hybrid Solar System.

3.7Energy Utilization in solar powered satellite:

Comparing alternative power technologies according to how much energy is produced by each technology for every unit of energy needed makes use of net energy analysis. The energy proportions for the SPS standard are only slightly better than those of other energy production techniques when fuel is omitted. The SPS energy proportions were highly advantageous when fuel is taken into account. Energy payback times for the SPS might be roughly a year using the capabilities of the SPS frame of reference and predictions based on their likely advancements.

When the secondary consequences of environmental pollution and the release of CO into the environment are taken into account, the energy return is even more beneficial.

4. CONCLUSION

The Solar Power Satellite idea has the potential to enhance human activity in space and the usage of extraterrestrial resources, in addition to providing baseload energy production on a global scale. Metals, glasses, and oxygen found on the moon have the potential to be used as building blocks for the SPS in geostationary orbit. The technical viability and financial viability of the Solar Power Satellite concept are increased by technological advancements, performance enhancements, and projected efficiency gains in solar cell arrays, large space systems, laser power transmitted, microwave turbines and rectifier diodes, and space transportation systems. There is growing agreement that perhaps the SPS is one of the most promising power production options that could help to meet the world's energy needs in the 21st century as a consequence of the significant advancements that have been made as a result of widely based technical, economic, environmental, and societal studies on the Solar Power Satellite. The types of Solar Power Satellite are also discussed in the study. In future, solar power satellite will also can be a major help in artificial intellengce and will help to prevent the war.

REFERENCES

[1] M. K, "A Review of Wireless Power Transmission Via Solar Power Satellite," *IOSR J. Eng.*, 2014, doi: 10.9790/3021-04610912.

[2] D. S. Kumar, G. M. Yagli, M. Kashyap, and D. Srinivasan, "Solar irradiance resource and forecasting: a comprehensive review," *IET Renewable Power Generation*. 2020. doi: 10.1049/iet-rpg.2019.1227.

[3] C. Q. Christol, "An Introduction to Space Law," *Space Policy*, 2000, doi: 10.1016/s0265-9646(00)00027-8.

[4] W. Li *et al.*, "Review of Sensor Network-Based Irrigation Systems Using IoT and Remote Sensing," *Advances in Meteorology*. 2020. doi: 10.1155/2020/8396164.

[5] J. Kim *et al.*, "Radiation damage effects in Ga2O3 materials and devices," *Journal of Materials Chemistry C*. 2019. doi: 10.1039/c8tc04193h.

[6] D. J. Gorney, "Solar cycle effects on the near-Earth space environment," *Reviews of Geophysics*. 1990. doi: 10.1029/RG028i003p00315.

[7] M. Kamimoto and I. Kudo, "Space solar electric power generation," *Denshi Gijutsu Sogo Kenkyusho Iho/Bulletin Electrotech. Lab.*, 1991.

[8] T. Jang *et al.*, "Circuit and System Designs of Ultra-Low Power Sensor Nodes With Illustration in a Miniaturized GNSS Logger for Position Tracking: Part II - Data Communication, Energy Harvesting, Power Management, and Digital Circuits," *IEEE Trans. Circuits Syst. I Regul. Pap.*, 2017, doi: 10.1109/TCSI.2017.2730638.

[9] N. Lior, "Power from space," *Energy Convers. Manag.*, 2001, doi: 10.1016/S0196-8904(01)00040-1.

[10] A. Thaduri, D. Galar, and U. Kumar, "Space weather climate impacts on railway infrastructure," *Int. J. Syst. Assur. Eng. Manag.*, 2020, doi: 10.1007/s13198-020-01003-9.

[11] J. C. Matéo-Vélez, M. Belhaj, J. F. Roussel, D. Rodgers, and F. Cipriani, "Design and Numerical Assessment of a Passive Electron Emitter for Spacecraft Charging Alleviation," *IEEE Trans. Plasma Sci.*, 2015, doi: 10.1109/TPS.2015.2444652.

[12] M. Šúri, T. Huld, T. Cebecauer, and E. D. Dunlop, "Geographic aspects of photovoltaics in Europe: Contribution of the PVGIS website," *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing*. 2008. doi: 10.1109/JSTARS.2008.2001431.

[13] Y. Yang, G. Fan, X. Ji, and M. Pei, "Modular Line-Focused Space Solar Power Satellite," *Aerospace*, vol. 8, no. 3, p. 82, Mar. 2021, doi: 10.3390/aerospace8030082.

[14] X. Li, B. Duan, L. Song, Y. Yang, Y. Zhang, and D. Wang, "A new concept of space solar power satellite," *Acta Astronaut.*, 2017, doi: 10.1016/j.actaastro.2017.03.017.

[15] K. Zhang, S. Wu, and Z. Wu, "Multibody dynamics and robust attitude control of a MW-level solar power satellite," *Aerosp. Sci. Technol.*, vol. 111, p. 106575, Apr. 2021, doi: 10.1016/j.ast.2021.106575.

[16] J. D. Y. Dakora, I. E. Davidson, and G. Sharma, "Review of modem solar power satellite and space rectenna systems," in *2020 International Conference on Artificial Intelligence, Big Data, Computing and Data Communication Systems, icABCD 2020 - Proceedings*, 2020. doi: 10.1109/icABCD49160.2020.9183884.

[17] R. W. Miles, "Photovoltaic solar cells: Choice of materials and production methods," *Vacuum*, vol. 80, no. 10, pp. 1090–1097, Aug. 2006, doi: 10.1016/j.vacuum.2006.01.006.

[18] SolarPro, "Production Model for Grid-Tied PV systems," *Prod. Model Grid-Tied PV Syst.*, 2010.

[19] O. R. Stohlman, M. Schenk, and V. Lappas, "Development of the deorbitsail flight model," in *AIAA Spacecraft Structures Conference*, 2014. doi: 10.2514/6.2014-1509.

CHAPTER 25

AN APPROACH OF AUTOMATED COLLISION CONTROL AMONG VEHICLES BY USING MAGNETIC AND INFRARED SENSORS

Mr. Prashanth S P, Assistant Professor,
Department of Mechanical Engineering, School of Engineering, , Presidency University,
Bangalore, India,
Email Id-prashanth.sp@presidencyuniversity.in

ABSTRACT:

An automated Collison control system is a system which is pre-crash system that is used to assist drivers to drive risk-free from collision vehicles. The automated collision system is manufactured to alert, warn and help in assisting drivers from crashes from the obstacles that come in the path of driving. The objective of the research is to introduce an automated collision system among vehicles by using magnetic and infrared sensors. The outcomes of the study give reductions towards the accident and will help the vehicles and the driver to assist from obstacles or collisions between vehicles with the help of a self-braking system which is work on magnetic and infrared sensors. In the future, Future improvements to this technology, such as adding more sensors to protect drivers from obstructions in their rearview mirror, might increase its value. Additionally, this system needs night vision technologies that can support it and prevent collisions in the dark.

KEYWORDS:

Accident, Avoidance System, Collision System, Infrared Sensor, and Magnetic Sensor.

1. INTRODUCTION

A collision avoidance system is a type of safety device used to alert, warn, or help drivers avoid impending crashes and lower the likelihood of accidents. Many different technologies and sensors, including radar, lasers, cameras, GPS, and artificial intelligence, are used by collision avoidance systems. Some warn or alarm, while others overrule the driver to help them avoid crashes and reduce the risk of dangers [1]. All collision avoidance system is not equal, some are those who only give an alert and gives a warning for the collision, some help to restrict the vehicles while some avoidance method gives suitability to the driver to not interact with their vehicles or overpass the vehicle to stay away from accidental collision [2].

A collision mitigation system is a cutting-edge driver assistance technology intended to stop collisions or lessen their impact on vehicles. A front collision warning system tracks an actual speed, the speed of the automobile in front of it, and the space between them. If the cars approach too close, the system can alert the driver and perhaps prevent a collision [3]. To detect an impending accident, a variety of technologies and sensors are utilized, such as radar (all-weather), sometimes laser (LIDAR), and cameras (using image recognition). Through a position database, GPS sensors can identify stationary risks like approaching stop signs. These kinds of devices may also have pedestrian-detecting capabilities [4].

A radiation-sensitive optoelectronic component with spectral sensitivity in the infrared wavelength region of 780 nm 50 m is known as an infrared sensor (IR sensor). Accelerometers, which are employed in building services to turn on lights or in alarm systems to recognize unwanted visitors, increasingly frequently incorporate IR sensors. A magnetic sensor measures the strength of the geomagnetism and magnetism produced by a current or a magnet. There are several varieties of magnetic sensors [5].

The environment around a vehicle is monitored by collision avoidance safety systems using a variety of cameras, lasers, sensors, and long-range and short-range radar. These safety systems can detect and observe people, motorbikes, bicycles, traffic signs, and other cars on the road. They enter data into a computer system, which causes the vehicle or the driver to take some sort of action. The computer may sound a sequence of alarms, flash a dashboard light, yank on the driver's seatbelt, or vibrate the steering wheel to draw the driver's attention. Modern systems will engage the brake system if the driver doesn't react [6].

The present research is about automated collision control among vehicles by using a magnetic and infrared sensor. This research is featured in several sections where the first is an introduction and the second section is a literature review and suggestions for previous studies in the context of Automated collision control among vehicles in addition, the methodology section of this study is mentioned where the data in different sub-sections are examined. After that, the results and discussion part are discussed where the results are compared with existing data, followed by the methods applied in this research. Finally, the conclusion of this research is declared where the research gives the result as well as the future scope.

2. LITERATURE REVIEW

Wang Guodong [7] et al. proposed a model of active collision avoidance adaptive control based on the identification of different emergency conditions. A categorization system of emergency avoidance mode is built based on real-time traffic various sensors and vehicle status information. Braking collision warning, rotating congestion control, and coordinated collision avoidance are the three sub-modes that the approach separates the emergency mode collision warning mode. A horizontal braking collision warning strategy is created for the braking collision warning mode to address the issue of braking automatic braking while also taking into account the comfort of the passenger and driver. It concludes Braking collision warning, rotating congestion control, and coordinating collision avoidance are the three sub-modes that the approach separates the emergency mode active safety mode into. A horizontal braking collision warning strategy is created for the braking collision warning mode to address the issue of braking automatic braking while also taking into account the comfort of the passenger and driver.

Yung-Yue Ellis [8] et al. explained fuzzy risk evaluation and collision avoidance control of unmanned surface vessels. a smart collision avoidance management design is created for unmanned surface vessels (USVs) operating in circumstances with randomly approaching ships and stationary obstacle encounters. This design blends collision avoidance navigation with a nonlinear optimum control method. A fuzzy collision risk warning and a fuzzy collision warning reacting timing indication are created for collision avoidance navigation. under the influence of external ocean disturbances, the suggested collision avoidance technique exhibits a promising collision warning ability and an accurate path planning capacity concerning stationary objects and freely moving ships.

Rodriguez-Seda [9] et al. proposed a cooperative avoidance control with velocity-based detection regions which use For multi-agent systems, guaranteed collision prevention control rules frequently rely on continuous detection zones. This study provides two decentralized, collaborative solutions for indefinitely large groups of entities that minimize the vehicle' effective detection areas by exploiting velocity information to lessen the conservatism of the avoidance control rules. The models of the vehicles are nonlinear Langarian systems, where the complete state vector denotes absolute position. It concludes a characteristic not available with conventional avoidance control is that the agendas can converge to locations nearer to the avoidance zones by reducing the detection regions.

Tao Su [10] et al. explained a new safe lane-change trajectory model and collision avoidance control method for automatic driving vehicles which states The new trajectory approach that employs pure steering and mixed braking is described by a Gaussian distribution. Regional more progressive states have created a new safe lane definition. Second, we create a novel, four-level autonomous vehicle mode and an efficient decision-making process that takes ergonomics and safety into account. This provides a useful resource on a professional and intelligent system technique for automated driving automobiles, which will be useful for increasing the efficiency and safety of highway traffic.

Raković, Saša [11] et al. explained a Convex model predictive control for collision avoidance proposes a model-based predictive control that offers a priori assurances of strong system theoretic features, such as positive parallelism and asymptotic stability, and great computing efficiency for the regulation issue of deterministic linear systems. The idea of good distance sets is presented, and it is also used as a unique strategy to guarantee collision avoidance by using appropriately stated convex constraints. Utilizing an interactive strategic-tactical framework, the suggested convex prediction control model for emergency braking is created. It also concludes that model predictive control for obstacle detection is made possible by fresh and distinctive characteristics that successfully support both real-time implementation and real-world application.

Miro Kezić [12] et al. proposed a Target Detection For Visual Collision Avoidance System which consists of To identify objects for collision avoidance, automatic identification systems (AIS) with automatic radar plotting aids (ARPA) are frequently utilized in the methods which also propose to employ visual cameras for real-time object recognition and target tracking to create a viable collision avoidance system. To further prevent catastrophic mishaps, the system should adhere to the International Regulations for Preventing Collisions at Sea (COLREGs). The author also concludes that You only look once (YOLO) ver. 3 neural network convolutional and a Kalman filter with integrated estimated relative location and velocity are utilized for real-time object identification.

Muhanned Al-Rawi and Mohanad Abdulhamid [13] explained a collision avoidance system using an ultrasonic sensor which discusses a vehicle's use of an ultrasonic sensor to prevent auto collisions. The in-car electronic systems application is obtained that is intended to lower the effects of the accident.The in-car electronic systems application is intended to lessen the effects of accidents.An ultrasonic sensor is utilized to measure the gap after experiencing the obstruction first.

M. Wilson Kumar [14] et al. proposed a Low-cost design and fabrication of a collision avoidance system for an automobile model using proximity sensors which Build the collision warning area

unit usually in high and intermediate category models using sensing components and logic systems. To develop safety systems like collision avoidance, collision mitigation, or pre-crash detection. Short-range sensing elements are used for safety purposes together with side-looking and stretched logic control inside the system to provide steering control. It concludes Managing vehicles to avoid collisions and improve traffic safety. The logical circuits and system performance and decision-making are provided by the programmer. As a result, it is frequently used at any time of day or evening and in all weather.

Maolin Zhan [15] et al. explained vehicle-localization-based and dark-based autonomous vehicle rear-end collision avoidance concerning measurement uncertainties which provide Several rear-end collision avoidance systems that have been invented to safeguard automobiles against rear-end crashes, one of the most devastating accidents for vehicles. To provide exact vehicle states for use in rear-end collision avoidance, a vehicle dynamic model and braking system dynamics are employed. When employing different vehicle-localization techniques with a predetermined safety probability of 99.99%, the required safe distance is employed as the safety index. Compared to standalone GNSS-based localization, respectable distance, and safe distance cushion can be reduced when utilizing a high-precision vehicle-localization approach.

Song Qian [16] et al. explained the Collision avoidance method of the autonomous vehicle based on an improved artificial potential field algorithm which helps in Any obstacle avoidance approach which seeks to develop a control method that prevents accidents and feasible options for collision warning maneuvers to include both hard braking and active steering. Using the applied ac field algorithm (APF), a safe path is produced in a traffic simulation by including the safety distance. Altering, in comparison to the traditional APF, the impact range of barriers is based on collision regions and appropriate safety distances. Additionally, both forces of position repel and speed repel are separated into categories based on the amount of danger. The simulation outcomes demonstrate that the active collision warning algorithm is capable of producing a secure path that is both comfortable and stable.

Yoshitaka NOMIYAMA [17] et al. developed a collision avoidance system for motorcycles (automated steering control using model predictive control which explores an automated steering control system for motorcycle crash prevention. By taking into account the rider's body movement in emergency avoidance, the Model Predictive Control (MPC) is given to the automated steering control with limits on the motorcycle's rolling motion. By using a straightforward computer simulation for obstacle avoidance, two different types of MPC controls are created and assessed. One is a gamepad with a rolling angle restriction. Another is a control that has a roll rate restriction. It concludes that the significant steering torque input is suppressed by the controller with limitations on both the roll rate and the steering torque. At other vehicle speeds, the MPC controller's better avoidance ability is visible.

B. Na[18] explained an intelligent algorithm based on support vector data description for automotive collision avoidance systems. For the analysis and management of dynamic groups to accomplish macroscopic and microscopic behavior prediction in an automobile collision avoidance system, a novel intelligence technique dubbed extended service vector data description (E-SVDD) has been developed. The outcomes validated the suggested control logic's enhanced functionality and efficacy.

Ramasubramanian, M.Neelakrishnan, and S. Sainath [19] explained prototype implementation of vehicle collision avoidance system algorithms which describes the vehicle collision avoidance

system techniques that may be further applied in real-time cars that are being tested and implemented in a prototype. The efficient real-time implementation of collision warning system algorithms requires the prototype implementation to examine the algorithm's flaws beforehand. The physical, electrical, and electronic elements required for directing the motion of the research framework and starting the essential collision-avoidance man-oeuvres have occurred in the information.

L. Jamaluddin [20] discussed the modeling of PID speed control-based collision avoidance system In Malaysia, especially around the time of festival festivities, the risk of car accidents is significant. Therefore, it is essential to create an economical collision-avoidance system that is both low-cost and highly effective. A collision-avoidance system that may slow down while approaching obstacles is the subject of study in its design and modeling. Based on how successfully this collision prevention system slows down when it approaches obstacles and when unexpected obstacles suddenly materialize in front of it, it is determined how effective it is. This collision avoidance technology may slow down the modeling automobile and stop it from hitting the front object while maintaining the passengers' safety and comfort.

Reviewing and understanding the literature relevant to the research objectives provided sufficient Insight into the many aspects of automated collision control systems. The number of Researchers studying automated control system effects is large, indicating that there is plenty of Information available in this sector. There are enough disparities in terms of information and strong guidance or methods about automated collision control systems. As a result, this research is required. With the use of analytics and statistics, as well as an automated control Collison system, this study analyzed and described the key topic of the use automated collision control system.

3. METHODOLOGY

3.1 Design:

In this section, the working of the proposed collision automated system consists of the power button when the vehicle gets to start the power button also gets turned on, and the control unit used to control the solenoid valve help to control the flow control of the vehicle, whenever at any point if there is a collision occurs the magnetic and infrared sensor tries to give the sense to the vehicle, thus the braking system gets information about to stop the vehicle and the bumper gets automatically spread. The extended bumper will help to stabilize the vehicle. Figure 1 shows the automated System by using a magnetic and infrared sensor.

3.2 Sample/instrument:

This section is occupied by a solenoid valve, a battery power system, and magnetic sensor, an infrared sensor, and a bumper system which brief introduction is illustrated below:

3.2.1 Battery power system:

The charging or battery system maintains the battery charged and supplies electricity for the lights, radio, and other systems. The battery power system help to provide a power supply to the control unit to get will try to on the sensor.

3.2.2 Magnetic sensor:

Magnetic sensors are a component of a different sensor system and are mostly used to identify different types of vehicles. The magnetic disturbance may be observed by suitable magnetic sensor systems because the vehicle movement affects the Magnetic forces in the monitored location.

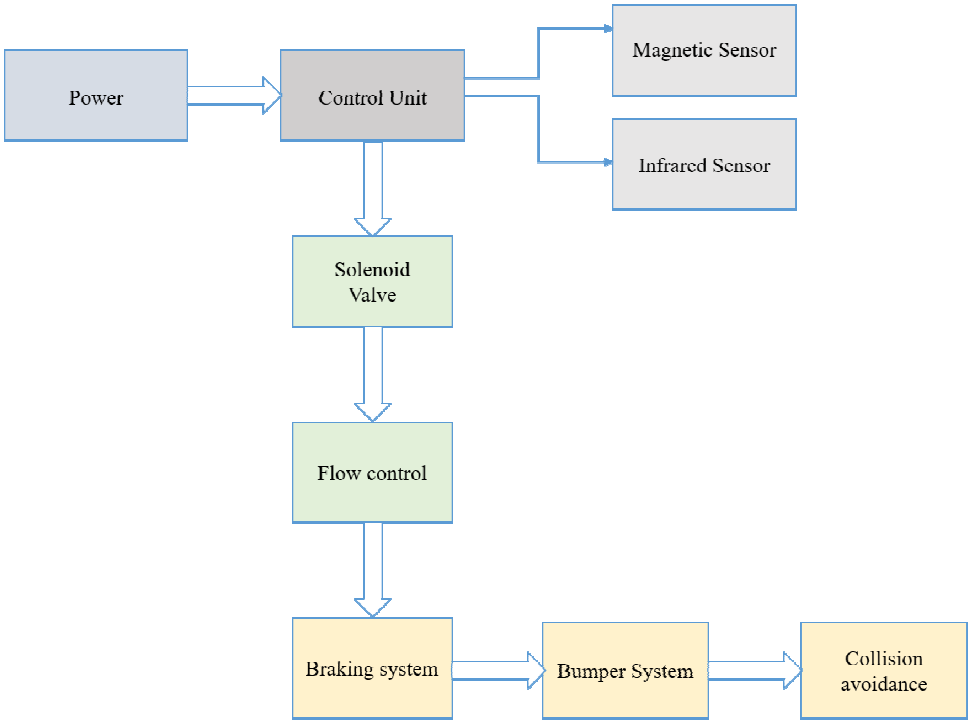


Figure 1: Collision automated System by using a magnetic and infrared sensor.

3.2.3 Infrared sensor:

A radiation-sensitive optical component is crucial in the infra spectral region of 780 nm to 50 m is known as an infrared sensor (IR sensor). Motion detectors that are used in building systems to turn on lights or in alarm systems that detect unwanted visitors increasingly frequently incorporate IR sensors.

3.2.4 Braking system:

A braking system is used to stop the vehicle in an emergency condition, which provides suitability for the vehicle to remain safe.

3.2.5 Bumper system:

The bumper system provides spacing among the vehicles and which also helps to avoid collision between the cars.

3.2.6 Microcontroller:

A microcontroller, commonly known as an MCU (microcontroller unit), is a tiny computer that is housed on a single VLSI semiconductor technology (IC) chip. One or more CPUs (processor cores), memory, and configurable input/output peripherals are all included in a microcontroller.

3.3 Data Collection:

For this study, the data collection is collected by the working process of this research which is gathered in the table illustrated in Table 1 with the components and its working in the research process.

Table 1: Illustrated the components and their working in the research process.

S.NO	Name of component	Working of components	Power Consumption in V
1.	Microcontroller	Microcontrollers use to provide power in the form of signals through chips.	5 V
2.	Magnetic sensor	Because vehicle movement influences the magnetic forces at the monitored site, magnetic disruption may be seen by proper magnetic sensor systems.	1.6V
3.	Infrared sensor	It uses to sense the motion of the outside vehicle which is running or coming towards the vehicle with help of the motion sensing.	3V

3.4 Data Analysis:

In this section, the research is concluded with a microcontroller with the power of 5V, an infrared sensor with the power of 3V, and a magnetic sensor with the power of 1.6V. The process starts when the engine gives power to the control unit when the vehicle starts in motion, the microcontroller gets activated with the infrared and magnetic sensor when the vehicle tries to collide with another vehicle the microcontroller gets the signal from the infrared and magnetic sensors. On running, if the vehicle assumes magnetic disruption or assumes any motion detection or any barriers, the infrared and magnetic sensor tries to provide the signal to the microcontroller and thus microcontroller passes the signal to the braking system and the vehicle get automated stops and the bumper is spread out on time. Figure 2 flowchart represents the working of the collision avoidance system.

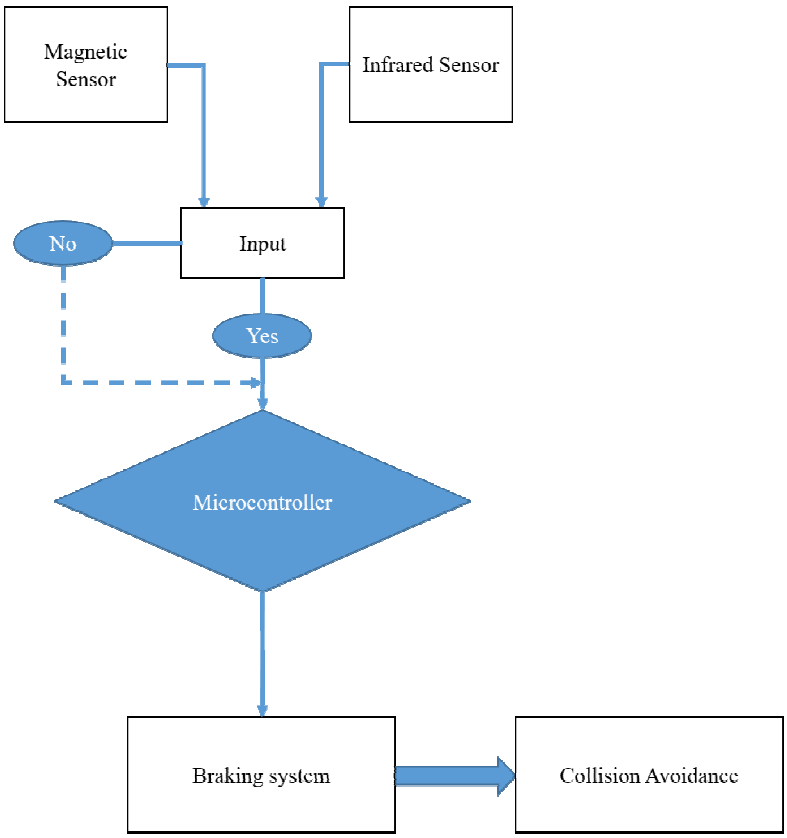


Figure 2: Flowchart Represents the Working of the Collision Avoidance System.

4. RESULTS AND DISCUSSION

The automated collision control system is introduced in the above study which deals with vehicle safety and avoiding vehicle accidents due to collision. In this study, the researcher makes a collision avoidance system with the help of an infrared and magnetic sensor. Infrared sensor is used to detect the motion of the surrounding with the help of radiation and magnetic sensor helps to provide disturbance with the help of magnetic field integration with the surrounding and gives alert to the microcontroller and microcontroller alerts the vehicles thus this sensing provides the vehicle automatically stops, the braking system gets automatically enclosed or on with the signal of the microcontroller. In the last, the bumper gets spread up to save the vehicle's body from other vehicles or other obstacles which come in the path of driving.

From the research, the problem why is want to make because there is the rapid growth of accident cases that comes out in the world, the accident cases due to collisions come in huge figures in the world so the system requires an automatic braking system that avoids accidents due to collision. This automated collision control system consists of a vehicle that has a power control system and braking system with a bumper, with the use of magnetic and Infrared sensors. This system will help to reduce so many accident cases and will provide a reduction of person and vehicle risk from both sides, from the driver to their viewer, this automated system will give safety procedures for coming obstacles in the path. It better forms the past advances in this field [13] Collision Avoidance System Using Ultrasonic Sensor, They use only ultrasonic sensor to find the obstacles but by this research, the person can help to find the obstacles and know what is the range of that obstacles to avoid collision and from various studies, this system provides more

safety and reductions of accidental risk to the person or the owner of the driver when moving. By this people can also use to feel good at night when driving vehicles.

5. CONCLUSION

The research study gives information about automated collision control in vehicles with the help of infrared sensors and magnetic sensors. One of the main cause, why the accident happens, is due to the unknown obstacles or collision that comes in the path of driving. The major consent of an automated Collison control system is to provide reduction of accidents due to collisions and avoid intermit of different vehicles the time driving. According to the Research, The automated collision system is developed to reduce the collision among vehicles in the path of driving. The development of an automated collision control system with the help of a magnetic sensor and an infrared sensor can help the vehicles to risk-free from the collision attack due to the obstacles and due to the surrounding that's comes the path of driving. Today people in the world faces so many accidental cases and this method can help them or can shorten the risk of accident that comes due to collision. The study gives outcomes that applying this avoidance collision control method gives vehicles stability towards the obstacles and helps other vetches to pass by the vehicles closely without any risk. In the future, this method can be more beneficial if it gets many more sensors like to save from backward obstacles on driving. This system also requires night vision techniques that can support this system and can help this system from a collision at night.

REFERENCES

[1] Y. Huang, L. Chen, R. R. Negenborn, and P. H. A. J. M. van Gelder, "A ship collision avoidance system for human-machine cooperation during collision avoidance," *Ocean Eng.*, vol. 217, 2020, doi: 10.1016/j.oceaneng.2020.107913.

[2] X. Li, A. Rakotonirainy, and X. Yan, "How do drivers avoid collisions? A driving simulator-based study," *J. Safety Res.*, vol. 70, pp. 89–96, 2019, doi: 10.1016/j.jsr.2019.05.002.

[3] J. Yao, B. Wang, Y. Hou, and L. Huang, "Analysis of vehicle collision on an assembled anti-collision guardrail," *Sensors*, vol. 21, no. 15, 2021, doi: 10.3390/s21155152.

[4] H. Abdullah, M. Mabrouk, A. A. E. Kabeel, and A. Hussein, "High-resolution and large-detection-range virtual antenna array for automotive radar applications," *Sensors*, 2021, doi: 10.3390/s21051702.

[5] D. J. Yeong, G. Velasco-hernandez, J. Barry, and J. Walsh, "Sensor and sensor fusion technology in autonomous vehicles: A review," *Sensors*. 2021. doi: 10.3390/s21062140.

[6] M. Xin, J. Li, Z. Ma, L. Pan, and Y. Shi, "MXenes and Their Applications in Wearable Sensors," *Front. Chem.*, vol. 8, Apr. 2020, doi: 10.3389/fchem.2020.00297.

[7] Y. Wang, G. Yin, K. Geng, H. Dong, S. Liu, and N. Chen, "Active Collision Avoidance Adaptive Control Based on Identification of Different Emergency Conditions," *Jixie Gongcheng Xuebao/Journal Mech. Eng.*, vol. 56, no. 4, pp. 115–124, 2020, doi: 10.3901/JME.2020.04.115.

[8] Y. Y. Chen, M. Z. Ellis-Tiew, W. C. Chen, and C. Z. Wang, "Fuzzy risk evaluation and collision avoidance control of unmanned surface vessels," *Appl. Sci.*, vol. 11, no. 14, p. 6338, Jul. 2021, doi: 10.3390/app11146338.

[9] E. J. Rodriguez-Seda and D. M. Stipanovic, "Cooperative Avoidance Control With Velocity-Based Detection Regions," *IEEE Control Syst. Lett.*, vol. 4, no. 2, pp. 432–437, Apr. 2020, doi: 10.1109/LCSYS.2019.2946232.

[10] T. Peng *et al.*, "A new safe lane-change trajectory model and collision avoidance control method for automatic driving vehicles," *Expert Syst. Appl.*, vol. 141, p. 112953, Mar. 2020, doi: 10.1016/j.eswa.2019.112953.

[11] S. V. Raković, S. Zhang, L. Dai, Y. Hao, and Y. Xia, "Convex model predictive control for collision avoidance," *IET Control Theory Appl.*, vol. 15, no. 9, pp. 1270–1285, 2021, doi: 10.1049/cth2.12121.

[12] M. Petković, D. Kezić, I. Vujović, and I. Pavić, "Target Detection For Visual Collision Avoidance System," *Pedagogika-Pedagogy*, vol. 93, no. 7s, pp. 159–166, Aug. 2021, doi: 10.53656/ped21-7s.14targ.

[13] M. Abdulhamid and O. Amondi, "Collision Avoidance System Using Ultrasonic Sensor," *L. Forces Acad. Rev.*, vol. 25, no. 3, pp. 259–266, 2020, doi: 10.2478/raft-2020-0031.

[14] M. Suresh *et al.*, "Low cost design and fabrication of collision avoidance system for an automobile model using proximity sensors," *Int. J. Sci. Technol. Res.*, vol. 8, no. 11, pp. 2367–2371, 2019.

[15] M. Chen, X. Zhan, J. Tu, and M. Liu, "Vehicle-localization-based and DSRC-based autonomous vehicle rear-end collision avoidance concerning measurement uncertainties," *IEEJ Trans. Electr. Electron. Eng.*, vol. 14, no. 9, pp. 1348–1358, Sep. 2019, doi: 10.1002/tee.22936.

[16] S. Feng, Y. Qian, and Y. Wang, "Collision avoidance method of autonomous vehicle based on improved artificial potential field algorithm," *Proc. Inst. Mech. Eng. Part D J. Automob. Eng.*, vol. 235, no. 14, pp. 3416–3430, 2021, doi: 10.1177/09544070211014319.

[17] Y. Marumo and R. Nomiyama, "Collision avoidance system for motorcycles (automated steering control using Model Predictive Control)," *Nihon Kikai Gakkai Ronbunshu, C Hen/Transactions Japan Soc. Mech. Eng. Part C*, vol. 77, no. 781, pp. 3300–3311, 2011, doi: 10.1299/kikaic.77.3300.

[18] I. B. Yang, S. G. Na, and H. Heo, "Intelligent algorithm based on support vector data description for automotive collision avoidance system," *Int. J. Automot. Technol.*, vol. 18, no. 1, pp. 69–77, 2017, doi: 10.1007/s12239-017-0007-7.

[19] M. Ramasubramanian, S. Neelakrishnan, S. Sainath, and V. Krishnaveni, "Prototype implementation of vehicle collision avoidance system algorithms," *Appl. Math. Inf. Sci.*, vol. 11, no. 5, pp. 1407–1417, Sep. 2017, doi: 10.18576/amis/110518.

[20] L. M. Keong, A. S. Jamaludin, M. N. M. Razali, A. N. S. Z. Abidin, and M. R. M. Yasin, "Modelling of PID Speed Control Based Collision Avoidance System," *J. Mod. Manuf. Syst. Technol.*, vol. 4, no. 2, pp. 66–72, Sep. 2020, doi: 10.15282/jmmst.v4i2.5182.