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Handbook of Trends in Engineering Technology And Research

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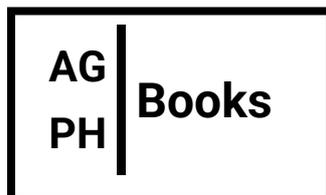
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About the Book

There are continuous advances made every day in the field of engineering and technology which are trying to usher us into a new technical era. This book is an attempt to cover some of these emerging trends in different fields such as manufacturing, artificial intelligence, robotics, education, transportation, environment etc. and provide an updated review on the ongoing research and developments in the same fields. The research papers selected for this book present a wide literature survey dealing with the information about the scientific principles and applications of the technology.

Because there is so much hype surrounding emerging technology and disruptive technology, it can be challenging for the business leaders to make the right decisions about the investments. This is especially true in situations where the most exciting technologies are still in the process of being developed in laboratories, academic institutions, and early-stage startups. Even though the landscape of technology is always shifting, businesses still need to have a solid understanding of which technologies will be responsible for the most significant economic shifts and digital disruptions in the next decade.

Students, professors, entrepreneurs, tech savvy or a layman, anyone can benefit from this book as the language used is simple and the information presented is in an educative and systematic fashion which keeps the readers interested while going through the content. All the reference papers included in this book are from credible sources and special care has been taken to include the latest advances keeping in tune with the purpose of this book.

Preface

In the coming years, many fundamental activities and interactions, such as the ways in which we travel, work, as well as communicate with one another, are expected to undergo significant changes brought about by a variety of emerging technologies, which are also expected to see significant improvements as a result of these changes. People, businesses, and the economy as a whole stand to benefit significantly from the introduction of new technologies such as blockchain, artificial intelligence, quantum computing, smart factories, cobots, additive manufacturing, cloud computing, vehicular adhoc, and virtual and augmented reality, amongst others. Emerging technologies are going to have a significant impact not just on the most prosperous firms of the future but also on the educational, security, environmental, medical, and transportation sectors.

This book presents review works by a number of authors in the field of engineering and technology which are going to shape our future. A vast literature survey has been included to detail the working, mechanism and the applications of the technology in different fields. This book is suggested for anyone who is interested in keeping themselves updated about the latest developments, especially engineering students and aspiring future entrepreneurs.

Modern gadgets and digital technologies influence every sphere of life today, hence it is today necessary to keep in touch with the advances in the field. Keeping this in mind, this book has been designed so that everyone be in touch with the latest advances and utilize the emerging technologies to the fullest while further contributing in their development and management.

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CONTENT

| Sr. No. | Chapter and Author | Page No. |
|----------------|--|-----------------|
| 1. | <p>A Comprehensive Review on Emerging Technologies to Reduce the Risk of Growing Environmental Concerns</p> <p>Dr. Rahul Ratnakar Mahamuni</p> | 1-10 |
| 2. | <p>A Literature Survey on The Emerging Trends in The Telecommunications</p> <p>Tilak Mukherjee</p> | 11-20 |
| 3. | <p>A Comprehensive Review on The Emerging Technologies in The Field of Robotics and Automation</p> <p>Dr.Nitin K Kamble</p> | 21-30 |
| 4. | <p>A Comprehensive Literature Survey on Research and Innovation in Robotics and Automation</p> <p>Dr. Sandeep S Sarnobat</p> | 31-39 |

| | | |
|----|--|-------|
| 5. | <p style="text-align: center;">A Review on the Machinability Characteristic of Stainless steel in various machining operations</p> <p style="text-align: center;">Vineet Dubey and C.K. Dixit</p> | 40-55 |
| 6. | <p style="text-align: center;">Potential Model for Binding Energy of First and Second Row Diatomic Molecules</p> <p style="text-align: center;">A. K. Pandey and C.K. Dixit</p> | 56-65 |
| 7. | <p style="text-align: center;">Micropolar Fluid Model for Blood Flow through a Small Tapered Tube</p> <p style="text-align: center;">Dr. Rajendra Kumar Tripathi</p> | 66-74 |
| 8. | <p style="text-align: center;">A State of Art Review on The New Innovations and Research in Education</p> <p style="text-align: center;">Dr. Ramakant Sharma and Dr. Mayank Sharma</p> | 75-84 |

| | | |
|-----|--|---------|
| 9. | A Comprehensive Literature Survey on The New Emerging Technologies in Education Dr. Mayank Sharma and Dr. Ramakant Sharma | 85-96 |
| 10. | A Comprehensive Review on The General Concepts and Applications of Artificial Intelligence Dr Ishwarya M.V, Jayashree Ananth and Dr M.Suresh Anand | 97-108 |
| 11. | Using Acridine Orange Dye/ PVA Composite Films for Flexible Laser Filters Debopriyo Ghoshal | 109-113 |
| 12. | A Review to Understand the Advancements and Challenges in Wireless Technology Nishtha Saroha | 114-125 |

| | | |
|-----|---|---------|
| 13. | <p style="text-align: center;">A Comprehensive Review on The Activities Of 5th Generation Mobile Communication System</p> <p style="text-align: center;">Vishakha Tomar</p> | 126-135 |
| 14. | <p style="text-align: center;">A State of Art Review on Advancements in Vehicular Embedded System Technologies</p> <p style="text-align: center;">Mr. D. Karthik Prabhu</p> | 136-146 |
| 15. | <p style="text-align: center;">Concepts of Cloud Computing and Its Applications</p> <p style="text-align: center;">Dr. Arvind Kumar Shukla, Dr. Rajdeep Singh and Dr. C K Dixit</p> | 147-167 |
| 16. | <p style="text-align: center;">Corrosion– Major Cause of Deterioration of Reinforced concrete</p> <p style="text-align: center;">Dr. Sanjeev Kumar Verma</p> | 168-176 |

| | | |
|------------|--|---------|
| 17. | A Schematic Review on non- Conventional Manufacturing Process Birajashis Pattnaik | 177-186 |
| 18. | A State of Art Review on The Design and Applications of Flexible Microstrip Antennas Dr. Jacob Abraham | 187-196 |

A Comprehensive Review on Emerging Technologies to Reduce the Risk of Growing Environmental Concerns

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Abstract

The ecosystem is important for sustaining of life on Earth. When we degrade the environment with the human-made garbage, it leads to significant environmental challenges for the world. Nevertheless, many of us aren't paying notice to the issues generated in the environment, that is going to be a big concern for the generations to come. Due to high levels of pollution, there's an alarming growth in environmental difficulties preparing the way for the loss of the natural resources. This paper takes a deep look at the environmental concerns and numerous developing technologies in the area of the environmental science in order to remedy the issue.

Keywords: Ecosystem, Natural Resources, Environmental Concerns.

1 Introduction

Environmental pollution has a substantial influence on our life expectancy, but it also has a negative impact on our quality of life because of diseases such as cancer and heart disease. Toxic air is a severe

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threat to human health (WHO 2018). In general, Ireland's air quality is decent, however there are isolated problems all around the nation. According to the “European Environment Agency” (EEA), air pollution from fine particulate matter (PM2.5) was responsible for 1,300 premature deaths in Ireland alone in 2017.

Not only is noise an irritation, but it is also harmful to one's health. There are an estimated 12,000 premature fatalities in Europe each year as a result of long-term exposure to the environmental noise from the road traffic, rail, air, and industrial. Climate change has the potential to cause a broad variety of health problems. Climate change may have a significant influence on mental health as well as physical health. The ecosystems on which humans depend for our health and well-being are threatened by a decline in biodiversity as well as the loss of species. Food and pharmaceutical manufacture are among the industries worst hit by the storm. A person's well-being may be adversely affected by chemical exposure. Poor mental as well as physical health outcomes are linked to a lack of green as well as blue areas that are free of pollutants and pesticides. Inequality in society is a major problem. The 2019 EU Green Deal acknowledges these challenges of unfairness and emphasises the need of a just transition to a more sustainable society.

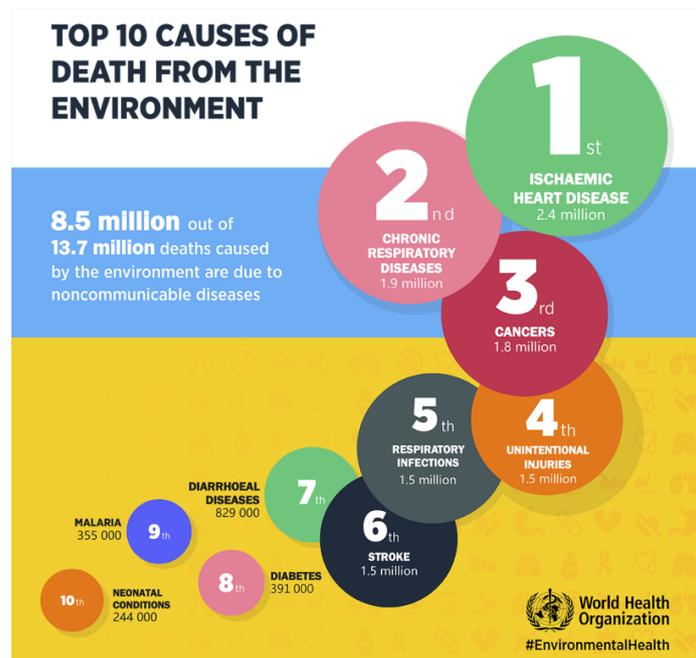


Figure 1 Effects of Environmental Pollution on health

One of the most significant contributors to the nation's fine particulate matter emissions is the use of solid fuels for space and water heating (PM2.5). Nitrogen oxides are another important air contaminant from a health perspective (NOx). It is estimated that each year, 300 new instances of lung cancer in Ireland are brought on by exposure to radon. In Ireland, road traffic noise is by far the biggest source of irritation and sleep disruption.

Dr. Rahul Ratnakar Mahamuni

Drinking water contamination and the presence of lead in the supply are still major health issues. Agriculture, waste water discharges, physical habitat characteristics such as excess fine silt (hydromorphology), as well as pressures from forestry operations are the primary factors affecting water quality in Ireland.

An important factor in the global spread of antimicrobial resistance is the widespread and inappropriate usage, abuse and misuse of the antimicrobial agents, especially antibiotics. For several generations to come, the ecosystem as well as human health will be affected by the existence of persistent anthropogenic substances in the environment.

2 LITERATURE REVIEW

(Çetin et al., 2021) It is widely accepted that digital technology is a key facilitator of the circular economy in many sectors. However, to date, there have been few research on whether digital technologies may be used in the physical environment to support the circular economy. The built environment is one of the most resource- and energy-intensive businesses in the world, and this research examines how digital technology might help create a circular economy in this industry. An iterative method is used to gather data: “(1) framework development based on principles of resource regeneration, reduction, slowed and closed loops; (2) expert workshops to understand the use of digital technologies in a circular built environment; (3) a literature and practise review to further populate the emerging framework with the relevant digital technologies; as well as (4) the final mapping of the digital technologies to the framework. A new Circular Digital Built Environment framework is developed in this research. In order to support a circular economy in the built environment, it identifies and maps 10 enabling digital technologies. (1) artificial intelligence, (2) robotics, (3) additive manufacturing, (4) building information modelling, (5) digital twins, (6) digital platforms/marketplaces, (7) blockchain technology, (8) the GIS, (9) material passports/databanks, (10) the internet of things”. Starting from this paradigm, researchers and practitioners alike may begin to explore a new study route at the convergence of the digital technology, the built environment, as well as the circular economy.

(Usman & Ho, 2021) COVID-19 (coronavirus disease) is a worldwide health disaster that is still spreading throughout the world today. To address this challenge, tens of thousands of articles have been written as well as published. Environmental studies articles were subjected to a bibliometric analysis with the purpose of identifying current and upcoming research trends in the age of COVID-19. Bibliometric analysis may be used to analyse the production and trends in an area of study. For this, the “Web of Science” Core Collection's "Science Citation Index Expanded" (SCI-EXPANDED) database was queried for papers in nine environmental-related topic areas. On the basis of a bibliometric analysis of 495 relevant publications, it was possible to identify a wide range of important research indicators that have made major contributions to this topic throughout the years. To show where new research opportunities may have arisen because of the epidemic, this bibliometric analysis is heavily weighted. Environmental quality evaluation and its role in COVID-19 environmental transmission have been the subject of a substantial amount of study, it has been discovered. As a result of COVID-19's favourable environmental consequences, several environmental risks, like increased exposure to the disinfectants as

Handbook of Trends in Engineering Technology and Research

well as antimicrobials, inadequate waste management, as well as food insecurity, have been worsened by COVID-19. Researchers have also been looking at ways to conserve the environment while developing post-COVID-19 communities and structures. This bibliometric analysis enabled for the representation of the environmental studies research agenda throughout this epidemic.

(Xue et al., 2020) The development of the renewable energy (RE) is becoming more crucial as a result of the ever-growing need for energy and the detrimental environmental effect of fossil fuels. There are significant differences between the risk management challenges faced by conventional energy projects and those faced by renewable energy (RE) projects. Using Citespace software, researchers were able to compile a comprehensive overview of China's research on renewable energy project risk management from 1997 to 2018. Risk management in the renewable energy has evolved from RM practise to a technology-driven integrated solution throughout time. Knowledge gaps and potential future research areas were identified and explored in light of the current trend.

(Lefers et al., 2020) Sustainability and environmental consciousness are becoming more prevalent across the world, yet population expansion and climate change need technical changes to assure global food as well as resource security. The establishment of specialised and regionally focused agriculture in these severe conditions has just lately begun, despite desert regions having long been recommended as suitable places for solar power production. Most plentiful resources in coastal areas of the Middle East as well as North Africa (MENA) are constant sunshine and salty sea water. Future greenhouse designs that combine transparent "infrared-collecting solar panels" with low-energy salt water cooling have enormous untapped promise in the MENA coastal areas. For salt-tolerant plants & algal biomass, these greenhouses may be used to grow crops that are important to regional agriculture in this severe climate by combining these technologies. Future designs for controlled environment agriculture won't compete with municipal fresh water supplies and can be easily incorporated into local food chains for humans, cattle, and fish. The marginal land in these situations might be used for biomass production, renewable energy generation, as well as the circular carbon economy if the right technology is implemented. The purpose of this approach is to shift the focus from seeing these surroundings as extreme to seeing them as having enormous untapped potential for growth.

(Farkas et al., 2020) Multiple pathogen detection approaches are becoming more important because of the wide variety of enteric viruses in the environment. For long-term surveillance and source tracing of aquatic enteric viruses, quantitative developing digital "polymerase chain reaction" (PCR) as well as isothermal amplification methods are well suited. Using culture and PCR-based detection, quick viral risk assessment may be achieved, particularly in host tissues that can support many viral strains. Although viability tests may give a better knowledge of viral survival than using PCR alone, additional research is needed to determine the efficacy of these assays in waste as well as environmental water samples. Certainly, new sequencing-based technologies, like as biosensors, may be used in the near future to evaluate viral risk in the aquatic environment, providing vital information on the ecology and variety of viruses.

Dr. Rahul Ratnakar Mahamuni

(Zhang et al., 2020) Sustainable growth has been hampered by the lack of resources and environmental contamination, which have become major global concerns. It has been shown that remanufacturing is a cost-effective technique that improves energy and material use, and reduces environmental pollutants. As part of a thorough literature analysis of remanufacturing technology advancements, researchers concluded that remanufacturing in energy, environment, as well as economy has made significant progress in recent years, and we reviewed the remanufacturing trend. It is important to understand how LCA may be used to remanufacturing assessment in the first place. LCA-based remanufacturing evaluation methodologies have been reviewed. Based on LCA, a methodology for analysing energy, environmental, and economic impacts of remanufacturing was developed. The energy, environmental, and economic aspects of remanufacturing were all taken into consideration while compiling the data for these assessments. Also discussed was remanufacturing's combined assessments of energy, environmental, and economic impact. With the use of LCA, the remanufacturing process was outlined in detail to help better understand and implement LCA and encourage remanufacturing. Remanufacturing as well as new technologies were presented at the conclusion of the study as a way to keep up with the manufacturing industry's tendency toward remanufacturing innovation. Furthermore, the limits of LCA were explored.

(Moya et al., 2019) Based on scientific investigations spanning the previous 30 years, this study examines the current state of the art for plant systems and their impact on “indoor environmental quality” (IEQ). Biophilic workplaces and interactions with plants have been demonstrated in certain studies to modify human attitudes as well as behaviours, boost productivity and enhance general well-being. In addition to cooling the surrounding environment, evapotranspiration from plants is a useful tool for regulating air temperature & humidity levels. As a passive acoustic insulation solution, indoor flora may also be employed. Emerging technologies, such as living wall systems and biofiltration, have the potential to enhance a home's overall comfort level. VOC pollutant elimination is different in green systems than in traditional HVAC systems, according to many research reports. Under regulated settings, the root zone of potted plants may be a good place to remove volatile organic chemicals. So in order to determine the genuine pollutant removal processes and the overall impact on IEQ, it is imperative that the complete capacity of the plants in real-life situations be understood. It would be necessary to study the impacts of green systems in conjunction with mechanical aspects like heating, ventilation, as well as air conditioning.

(Linkov et al., 2018) Emerging technologies provide a challenge to traditional risk assessment and management systems. A complementary approach to the early-stage assessment as well as management challenges of the high-uncertainty technologies, like synthetic biology, nanotechnology, and artificial intelligence, can sometimes be warranted even though the existing risk-based paradigm has been crucial for the assessment of many chemicals, biologicals, radiologicals, and nuclear technologies. Risk governance, according to this study, should use quantitative experimental data as well as qualitative expert knowledge in order to describe and balance the risks as well as the benefits, costs, and social consequences of developing technologies. Multi-stakeholder efforts are required to drive an emerging

technology risk governance process that incorporates various sources of information, examines numerous endpoints and outcomes, and compares the performance of emerging technology to currently available conventional products in a specific context. Even in the early phases of technology's development, this approach may be useful for policymakers as well as decision makers to analyse the potential influence of such innovations on human as well as environmental health.

3 CURRENT TRENDS IN ENVIRONMENTAL SCIENCE

a. Air quality and health

Toxic air is a severe threat to human health (WHO 2018). The air quality in Ireland is usually acceptable, however there are a number of contaminants that are generating worry in certain areas of the nation. Fine particulate matter (PM2.5) pollution continues to be a major problem in Ireland because of the continuous use of solid fuels for home heating. This pollutant is the most harmful to Irish citizens' health and, as a result, the most significant impediment to good air quality in the country.

For the whole EU as a whole, the "European Environment Agency" estimates that 538,014 premature deaths were caused by PM2.5 air pollution in 2017. Ambient air pollution from "polycyclic aromatic hydrocarbons" (PAH) caused by solid fuel burning is also a significant issue in our cities and villages, and researchers are now over the EEA's PAH reference threshold. Due to the continuous use of fossil-fuel powered transportation, notably diesel, nitrogen dioxide (NO₂) levels in the metropolitan areas should be addressed. In 2019, we found NO₂ levels over the EU limit at a Dublin urban traffic monitoring site, and subsequent monitoring in Ireland shows that transportation-related emissions are a far larger issue than previously thought.

b. Noise exposure and health

Noise is a health hazard, not just an irritation, according to recent analyses of the consequences of noise. Long-term exposure to the environmental noise from the railroads, road traffic, aviation, as well as industry causes to 48,000 new instances of heart disease as well as 12,000 early deaths per year in Europe, according to the "European Environment Agency" (EEA). The "European Environment Agency" (EEA) believes that long-term noise exposure affects 22 million individuals with chronic high levels of irritation and 6.5 million people with chronic high levels of sleep disruption. People in lower socioeconomic categories are more likely to experience noise disturbance than those in higher socioeconomic groups, according to a recent study in Europe.

c. Climate change and health

There is little doubt that climate change is the most significant environmental issue we face today. Meanwhile, efforts are being put towards reducing the causes of the climate change, as well as preparing society for the effects of climate change and reducing its related hazards. Climate change has the potential to cause a broad variety of health issues, including:

Dr. Rahul Ratnakar Mahamuni

There is a clear correlation between increased floods and an increase in the risk of infectious illnesses (e.g. through contamination of the water supplies). Flooding is a major source of anxiety for those who live in flood-prone areas. As a result, toxins held in soil or river sediments might be released back into the ecosystem when a flood occurs. Increasing temperatures as well as the melting of the polar ice caps can release contaminants like mercury back into the ecosystem, as well as causing rising sea levels and consequent floods. Global pollutant exposure will rise as a consequence of discharges of pollutants like mercury, which are highly mobile & persistent. Heat waves and increasing temperatures may also have a disastrous impact on vulnerable groups, like the elderly.

Increased exposure to UV radiation might lead to a rise in skin cancer rates. Pests and illnesses that were previously absent from Ireland's landscape, like cholera and other water-borne diseases, will become more common as a result of the country's changing climate. Because of rising quantities of ozone in the atmosphere, climate change might enhance the dangers presented by respiratory ailments (an air pollutant that is exacerbated by sunlight). Local air quality may also be affected by the increased risk of forest fires. Climate change may have a significant influence on mental health as well as physical health. Those who live in places susceptible to floods are especially affected by these impacts. The growth of "eco-anxiety" amongst the general people has also been recognised as a consequence of a growing sense of concern about the effects of climate change as well as the magnitude of the danger humanity face.

d. Chemicals and health

In recent years, our knowledge of the health and well-being effects of chemicals has grown dramatically. Even while chemicals are vital to contemporary civilization, they are frequently employed without properly examining or comprehending the unintended consequences they have on the environment as well as human health, resulting in the intractable as well as long-lasting environmental issues that may not be solved for many generations.

More than 1.6 million lives were lost worldwide in 2016 owing to chemical exposure, according to the "World Health Organization" (WHO). This is based on a small number of chemicals whose effects on health have been well studied. Approximately 0.4 fatalities per thousand people in Europe each year are attributed to the chemical exposure (this specifically excludes the effects of the ambient air pollution from the combustion sources). Approximately 2,000 people in Ireland die each year as a result of smoking.

Chemical exposure may have a detrimental impact on quality of life in addition to causing early mortality. Nearly 1.9 million newborns in Europe are born each year with the mercury levels over prescribed limits, resulting in long-term impacts on cognitive development and ability to learn. Some chemicals have well-established risks, but there is mounting evidence that the dangers of combining chemicals are larger than their separate dangers. There is a lack of information on how dangerous toxic compounds are. The WHO estimates that the chemical production will double by 2050 compared to 2010.

Handbook of Trends in Engineering Technology and Research

Chemicals in daily items are a hot topic in Ireland right now, thanks to the country's growing sensitivity to the issue. According to a 2020 Eurobarometer special research, 88% of Irish people are concerned about the effect of chemicals in everyday things on their health, whereas 89% are concerned about the impact on the environment. Residents in Ireland also believe that the government is not doing enough to protect the environment, while 67% of those surveyed believe that people themselves are not doing enough.

e. Biodiversity loss and health

Clean water, shelter, clean air, food, as well as fuels for heating are all services given by the natural ecosystems that are crucial to human well-being. More than a million animal and plant species are now at risk of extinction, according to a 2019 study from the "Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services" (IPBES). According to IPBES' Chair, "the health of ecosystems on which humanity and all other species rely is degrading more quickly than ever." It is clear that we are destroying the underpinnings of the economies as well as livelihoods as well as their health, food security, and quality of life throughout the globe.

The loss of biodiversity may have a wide range of health consequences. As an instance, 75 percent of food crops rely on the animal pollination in order to produce appropriate amounts of healthy and nutritious meals, which is dependent on a stable environment. Natural resources are used in the production of several of the pharmaceuticals. 70% of cancer medications are derived from natural sources or synthesised to look like natural sources. Our ability to get medicinal supplies may be harmed as a result of declining biodiversity and the disappearance of species.

Increased numbers of particular species may transmit infectious illnesses because of the imbalances in ecosystems caused by a reduction in biodiversity. In order to safeguard the ecosystems on which human health and well-being depends, we must confront these trends in the biodiversity loss.

f. Access to and use of green space and health

Better health outcomes, such as enhanced mental as well as physical well-being and a decline in obesity, are linked to easy access to the green and blue areas. Obesity rates were greater in metropolitan areas with less green space than in those with more green space, according to new study out of Ireland. A surprising finding from this study was that those who lived in areas with a lot of green space had a greater risk of obesity, however no specific cause was given. The absence of walkways, security concerns, and other variables may be to blame for these results, but additional investigation is required.

There has never been a greater pressing need for access to high-quality green space in cities, where urbanisation is on the rise. Ireland is expected to have one of the fastest rates of urbanisation in the EU, growing at a pace of more than 5% per year by 2050. A healthy as well as sustainable lifestyle for these residents would be facilitated by the availability of accessible and acceptable high-quality green spaces in these metropolitan regions. In addition to improving one's mental health, these places may foster a stronger feeling of belonging and community, both of which benefit society as a whole. Another area

Dr. Rahul Ratnakar Mahamuni

where social injustice is a problem is access to the green space, with the lower socioeconomic level residents having less access to the green space in their neighbourhood.

g. Sustainability, individual choices and health

A clean environment has both beneficial and negative implications on human health and well-being, and people are becoming more conscious of these effects as they become more aware of their own individual choices. What we do in our houses and gardens, how we dispose of our garbage, how people ventilate the homes, as well as how much noise people make are all indicators of their values and attitudes toward the community, environment, health, as well as well-being.

What people do in their houses and gardens, how they dispose of their garbage, how people ventilate the homes, as well as how much noise people make are all indicators of their values and attitudes toward the community, environment, health, as well as well-being. Live Green, a collaborative public information resource, provides guidance and recommendations on how we may take action to create healthier and more sustainable decisions. One of the most important ways humans can enhance the health as well as well of the general public is to encourage people to adopt more sustainable lifestyles and consumption habits. "Our Sustainable Future" is Ireland's national policy for sustainability and lays out sustainability concerns and how they may be addressed to guarantee that the quality of life as well as general well-being can be enhanced and maintained in the future decades.

Residents, companies, schools, and other institutions benefit from a dynamic, inclusive, and active community. The "Public Participation Networks" (PPNs), which seek to increase public participation in decision-making as well as governance, have as one of their primary goals the sustainability of local communities.

h. Social inequity in exposure to pollution

It is imperative that future policies take into account the increasing disparity in exposure to environmental stresses across different social groups. These problems are aggravated by the fact that those of lower socioeconomic position are less able to withstand the impacts of pollution. Because of this, people may have fewer options for where they want to live and are unable to relocate to a new place, and they may also find it more difficult to get medical treatment (e.g. they may not have a private health insurance). Other factors that may have an effect on their local environment include a reduced desire or capacity to criticise or participate in local decision-making processes.

As part of the "2019 EU Green Deal", that emphasises the need for a fair transition to a more sustainable society, no one is left behind and protection is given to the most vulnerable in the population, these inequality concerns have been recognised.

4 CONCLUSION

Emerging environmental issues include the anthropogenic climate change (also known as "global warming"), the depletion of the stratospheric ozone (also known as the "ozone hole"), the acidification

of the surface waters (also known as "acid rain"), the destruction of the tropical forests, the depletion as well as extinction of the species, as well as the steep decline of the biodiversity. However, despite the fact that all of these issues present themselves in the physical world (the environment), their origins - as well as the possible solutions to these issues - are inextricably linked to human values, attitudes, beliefs, requirements, aspirations, expectations, as well as behaviours. As a result, the symptoms of the ecological disaster can always be regarded solely as physical problems that require solutions from environmental "specialists." Rather, the symptoms of the environmental crisis are inherently human problems, as well as they are closely connected to the argument of what it means to be a human.

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A Literature Survey on The Emerging Trends in The Telecommunications

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Abstract

Improving telecommunications security and decreasing customer churn are two of the most pressing issues facing the telecom industry today, as well as optimising network load as well as infrastructure. These problems are dealt with head-on by the top ten trends in the telecommunications industry, which also serve to improve the overall efficacy of enterprises involved in the telecommunications industry. The global link that has been fostered by the COVID-19 outbreak provides telecommunications companies with a number of alternatives to build new products and grow their consumer base. In order to manage the growing number of people and things that are connected in smart industries, cities, homes, and automobiles, there is a growing need for cloud and 5G technology solutions. These solutions are needed to handle the flow of data generated by these connected environments.

Keywords: Telecommunications, Global Connectivity, 5G Technology, Infrastructure Optimization.

1 Introduction

The contemporary telecommunications sector is confronted with a wide range of difficult business issues. As a result of fierce rivalry from Over-the-Top (OTT) service providers, industry has seen its income streams in fundamental sectors like telephony and text messaging plummet over the last several

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years. A digital revolution of the telecom business is needed to remain competitive in 2022. In order to get better from the COVID-19 disaster and confidently position themselves for future, they are using technologies like "Mobile Edge Computing" (MEC), IoT, as well as 5G. Customer-focused, efficient, and profitable services need to be progressively transitioned away from conventional offerings.

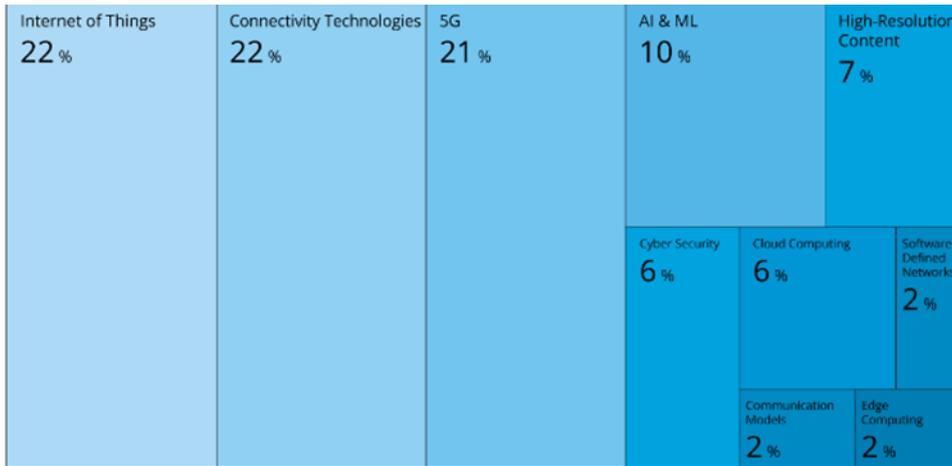


Figure 2 Growth in Telecommunication Technologies

A similar transformation is taking place in the telecom business as cloud computing has in data storage. Thus, cloud-hosted telephony is now widely used by many businesses. The cloud simplifies data as well as voice delivery, allowing an organisation to work with a single vendor for both types of services. We should expect further development, innovation, and opportunity for communication services as the digital revolution continues. The telecommunications industry is undergoing a major structural shift. In doing so, they're creating a new digital ecology of value, a linked market, and a technological change that's all their own. In this digital age, providers are attempting to implement high-performance networks in order to meet the needs and desires of their clients.

2 LITERATURE REVIEW

(Khan et al., 2022) Electronics and biology have come together to create bioelectronics, which has opened up promising new avenues for the development of medicinal therapies. New nanoelectronics plus soft, biocompatible materials have been proved to be useful in healthcare activities such as physiological sensing as well as medicine distribution as well as monitoring the heart and brain. Wired connections are required for electrical control on the majority of bioelectronic devices now in use. Bioelectronics that provide non-invasive control, biotelemetry, as well as wireless power transmission (WPT) are being developed as an alternative as wireless technology grows in popularity. In this review article, wireless bioelectronics and their applications for organ-specific therapies, such as diseases and dysfunctions, are discussed in detail. Key antenna properties, including materials, radiation characteristics, integration with other devices, and experimental setup are the focus of this paper. Wirelessly mediated

Tilak Mukherjee

bioelectronics, despite recent success, still faces significant problems that must be overcome for commercialization, and also for the ever-expanding and developing therapeutic targets of the future.

(Menaka et al., 2021) Nearly three-quarters of the planet's surface is covered by water. The oceans are still a mystery because of all the amazing things that go on under the surface of the water. Water pollution, oil and gas extraction and exploration, natural disaster mitigation, marine safety, naval military operations and the detection of improvements to the aquatic environment all benefit from "Underwater Wireless Communication" (UWC). A new age known as the "Internet of Underwater Things" (IoUT) has been established to help with these applications. Research, commercialization, and undersea military applications may all benefit from IoUT's scientific advancements. It's also a key aspect of the next 5G & 6G telecommunications networks. As we move forward to the next generation of mobile networks, we can expect a significant leap in performance over the current 4th generation systems, especially in the areas of 5G and high-capability networking. These improvements will be made possible by advances in 5G and 6G connectivity networks, which are expected to provide even greater coverage with lower latency, better security and lower power consumption. In order to overcome the challenges of 5G networks, new technologies including optical wireless communication (OWC) are being used. In order to overcome difficulties of 5G networks, new technologies such as OWC are being used. Compared to other wireless technologies, OWC is a better fit for 5G network operations. Using the OWC technique to develop 5G, 6G, & IoUT networks would be the best as well as most effective option, according to this article.

(Fahad A. Rida, 2021) Since bandwidth restrictions made it impossible to communicate with the medical team or patients while providing care to patients in distant locations, these technologies have been used to treat and monitor remote health care patients. Power consumption and sending large amounts of data between medical professionals and patients are strictly prohibited. "Direct-spread spectrum" (DSP) is used by wireless sensors, notably 3G mobile wireless, to communicate massive data, like multimedia, between patients as well as physicians at any time and anyplace. The "wireless sensor network" uses binary transmission as well as multipath to reduce the power consumption of the transmitter as well as receiver sensors. The precision of the measurement is dependent on the bandwidth of the unit used to determine the time of arrival (TOA). Because of the MPC's delay and the decrease in the number of copies of the original signal, the TOA predictions are constantly changing as they are sent to the receiver. The TOA is skewed in favour of positive values because of the delay introduced by transporting signals over obstacles.

(Jijo et al., 2021) Research into physical layer protection, that uses information-theoretic approaches to safeguard data secrecy, has lately gained a lot of interest. Physical layer security relies on the inherent randomness of transmission channel in order to safeguard physical layer. Physical layer security has become a new issue in 5G wireless communication. An overview of current 5G technologies, such as millimetre wave, multi-input multiple-output (MIMO), microcells with beamforming and full-duplex technology, is presented in this document. Technology like attenuation, millimeter-wave penetration and antenna array design have all been employed to overcome this problem. Aside from that, the author

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included explanations of the methods/algorithms employed, as well as aims, issues, and findings that mattered.

(Storck & Duarte-Figueiredo, 2020) Designed to boost the speed and responsiveness of wireless networks, the "Fifth-Generation Network" (5G) is capable of transmitting a large amount of data. End-user and corporate services are supported through wireless broadband connections. Designed primarily for use in the Internet of Vehicles, it ensures lightning-fast connectivity while still providing a high level of security. " Vehicle-to-everything" (V2X) communications as well as applications may be supported by the 5G network technology. People, cars, and infrastructure may communicate data with this technology. An improved and safer environment, as well as precise traffic information, may be provided. Pollution as well as accident rates may be reduced by improving traffic flow. It is possible to use the cellular network as a communication basis for V2X in order to improve road safety and self-driving car technology and to provide IoV connections. An in-depth look at IoV's V2X ecosystem's 5G growth, standards, as well as infrastructure is presented in this study. For example, it shows how 5G V2X communications may be used to support the Internet of Things (IoT) by examining its architecture, applications, as well as V2X capabilities and protocols. This research makes a significant contribution by conducting a systematic investigation of the interactions between IoV, 5G, & V2X. Eighty-four pieces were chosen to illustrate ideas, norms, and strategies for overcoming obstacles. New 5G-V2X services as well as technology specialised to the vehicle communications are expected to be developed as a result of this study, which is also expected to provide a roadmap for future developments.

(Salazar-Cabrera et al., 2020) "The "transit vehicle service" in the intermediate cities of Latin American is afflicted by a significant number of passengers being involved in the traffic accidents; the congestion caused by transit vehicles; as well as the pollution generated by these automobiles, which increases in high congestion circumstances. Studying "transit vehicle tracking service," which is critical to the implementation of transportation options to address these issues, as well as the key aspects of this service for the Latin American intermediate cities, were the focus of this research effort. As a direct consequence of this study, a solution for implementation was suggested. The following are the four stages of the study, as described in this document: (a) examination of services or systems linked to vehicle monitoring, including the "wireless communications technologies" and sustainability techniques, the use of specific algorithms for the efficiency improvement, as well as "intelligent transportation system" (ITS) architecture utilised as a foundation; b) procedure for determining which aspects of the service are appropriate in a particular situation; (c) a proposal for this service in an intermediary city, together with its specifications and potential technology solutions will be made; (d) the creation of trials to test the use of the essential technologies. With regard to recommended "wireless communication technology" (long range, LoRa), vehicle positioning technologies, energy consumption considerations as well as the use of artificial intelligence (AI) to determine user waiting times at bus stops, the review was able to identify the most important service characteristics. It is also suggested that the above features be taken into consideration while designing an ITS architecture for the Popayán (a Colombian city), and specific experiments involving the usage of such technologies are detailed.

Tilak Mukherjee

(Abdulkarem et al., 2020) Due to rising urban concerns about security and safety, the wireless sensor networks are becoming more important for the "structural health monitoring". Since the fast emergence of wireless technology and the widespread usage of wireless sensor networks, structural monitoring systems have made great strides in their effectiveness. An innovative wireless sensor network-based "structure health monitoring" system offers significant benefits over traditional cable systems, such as lower installation and maintenance costs. It is a revolutionary new technology. In addition, the "wireless sensor networks" are facing new design issues due to the need to monitor structure health. For the purpose of monitoring structural health, researchers have been using "wireless sensor networks" for some time now, and this article summarises their findings. The design, functioning, connectivity, and popular operating systems of wireless sensor nodes, as well as their wired as well as "wireless sensor system" technologies, are all being studied. After that, a comprehensive review of the wireless platform technologies that were used in laboratory testbeds as well as field test deployments for the "structure health monitoring" applications will be provided and summarised in the following sections: A classification taxonomy of the key challenges associated with wireless sensor networks for "structural health monitoring" is thoroughly discussed, along with research efforts that are currently available to overcome these challenges, in order to assist researchers understand better the hurdles as well as the suitability of "wireless sensor networks" for the applications of "structural health monitoring."

(Olayode et al., 2020) In recent years, there has been an increase in the amount of rural as well as urban road traffic flow, which has led to an increase in the incidence of traffic congestion, accidents, as well as pollution. If there are worries about the flow of traffic in the here and now, it is vital to make use of alternative methods of traffic management at road junctions when traditional methods of traffic control fail. This study investigates the stability and efficacy of AI techniques, such as artificial neural networks (ANNs), for reducing the amount of non-autonomous vehicle traffic in a mixed-flow traffic environment in South Africa. The goal of the study is to ultimately eliminate traffic completely. The "Mikros Traffic Monitoring" (MTM) organisation, which is a member of the Syntell Group of Companies in South Africa, gathered electronic data on the traffic patterns of 126 vehicles. The MTM traffic technology, which comprises of sensors implanted in road surfaces to monitor and regulate vehicles that regularly pass the traffic counter, was used to gather data on the flow of traffic. We used the vehicle class descriptions and accompanying speeds as input variables to train and evaluate the artificial neural network model on the MTM dataset under signalised road intersections under diverse conditions. In the end, it seems that the ANN model outperformed all other approaches in terms of predicting the likelihood of traffic congestion in a variety of traffic situations.

(Boukerche et al., 2020) In recent years, there has been a rise in the volume of rural as well as urban road traffic, which has led to an increase in the number of transportation disasters. These disasters include congestion, accidents, and a high rate of pollution in the transportation sector. When conventional methods of traffic control are ineffective or when there are issues with the flow of traffic in real time at a road intersection, alternative traffic management techniques must be used. An "artificial neural network" (ANN) is being tested in a mixed-flow South African traffic environment to determine whether

it can reduce or eliminate traffic volume caused by non-autonomous cars while still maintaining its stability and efficiency. Electronic traffic data from "Mikros Traffic Monitoring" (MTM) business, a part of the Syntell Group of South Africa, was monitored. A sensor implanted in the road surface monitors and controls the cars that pass the traffic counter every day, and the traffic data was gathered using this method. To train, test, and verify the artificial neural network model, we used the vehicle class descriptions and related speeds as input variables to the dataset collected from MTM. According to the findings after many iterations of training, using an ANN model yielded best results for the traffic congestion in a diversely congested environment.

(Lian et al., 2020) A new era has dawned: the age of Big Data. Big Data has recently been used in the transportation sector, particularly traffic safety, within the context of ITS and CAV (connected/automated vehicles). Using Big Data to investigate traffic safety in the context of ITS and CAV has been examined in this work. Predicting crashes, identifying contributing variables to accidents and identifying potential crash hotspots are some of the specific subjects covered in this course. Using sophisticated analytics for Big Data offers a lot of promise for improving road safety, according to the research analysed. Integrating and processing enormous amounts of multi-source information, Big Data in traffic safety breaks through the restrictions imposed by conventional statistical analysis. It then finds solutions to issues that cannot be addressed by conventional statistical methods. Finally, recommendations are made for future Big Data safety analytics in an ITS and CAV context.

3 EMERGING TRENDS IN TELECOMMUNICATION

a. 5G network – The network of Today and Tomorrow

There are now over 3 billion internet users in the world. Smartphones are the major means of internet access for many of these people. Because smartphones can increasingly assist customers in the management of crucial aspects of their life, customers are searching for high-capacity networks that provide quicker access to apps and richer services. With 5G and wireless broadband, data transmission speeds of up to 100 times faster than 4G, as well as high speed and low latency, may be made possible.

According to a survey by CCS Insight, the number of people connected to 5G networks globally is expected to reach 1.34 billion by 2022. Telecoms are already targeting certain industries with 5G apps and IoT devices. Telemedicine is being used by the healthcare industry as a method that is both cost-effective and timely for the delivery of diagnosis and treatments to both the medical personnel and the patients. The treatment of both the means of transportation and the traffic infrastructure is being improved thanks to connected automobiles. As the globe adjusts to the new normal in light of the Covid-19 scenario, the education industry is turning to electronic learning. By automating online clients, telecoms are spreading into a wide range of industries. It may be used in a variety of sectors, including transportation, agriculture, medical, and public services. Every technology that will be included in the next 5G network will work together to enhance current communications.

Tilak Mukherjee

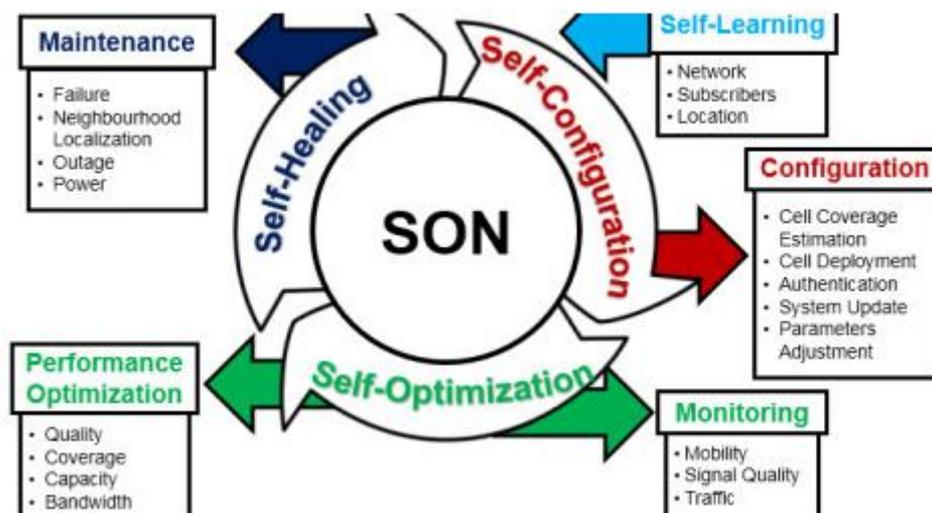
b. WiFi 6

WiFi 6 may be characterised as a wireless local area network (WLAN) that has an increased range, offers improved network performance, connects more devices, and speeds up communications. It's possible to expand network capacity, decrease latency, and provide many options to save money and earn more money with the inclusion of new technologies. WiFi 6 may be used by telecom operators to create new methods of optimising traffic across access networks. The industries of entertainment, telemedicine, education, and remote jobs will all benefit from this technology, and it will also be helpful in areas where the cost of reaching fibre is too exorbitant. In addition, the Internet of Things will be able to be deployed and always-on devices will be supported if WiFi 6 is combined with 5G technology, which will give greater signal strength. It reduces resource congestion in high-capacity networks so that data may be sent between IoT devices without interruptions.

c. Artificial Intelligence

Artificial intelligence has the potential to transform the telecommunications industry. They already employ AI tools like virtual assistants, chatbots, and other AI technologies to cater to the needs of their customers and enhance their level of happiness. It can handle and analyse massive amounts of data without compromising its security in any way. It is anticipated that by the year 2025, 70 percent of operators would have invested in AI systems as part of their efforts to upgrade their infrastructure. The use of artificial intelligence enables the development of novel approaches that reduce the costs of network maintenance, predictive maintenance, and customer support. It enables operators to tailor their B2C and B2B client offerings to their specific needs.

In addition to this, AI is able to identify issues within the network, facilitates the process of self-healing, and guards networks against any fraudulent activity. A key benefit of this technology is that it allows operators to keep tabs on the start of their equipment and predict when it will fail. In a nutshell, AI will allow for more efficient root cause investigation of new hardware faults.



d. Internet of Things

Telecom service providers' responsibilities in allowing communication between people and things have been revolutionised as a result of the Internet of Things. It is easier for telecom companies to monitor base stations and data centres thanks to the Internet of Things (IoT). As a result, the network is more stable, business processes are improved, and more income is generated. IoT solutions are being monetized in new ways by the telecom industry, which is creating new techniques and applications. To become IoT leaders and provide services that go beyond network connection, they may take use of these new technologies. Additionally, CSPs have the ability to explore new prospects and provide a wide range of services for a wide variety of sectors, from manufacturing to healthcare.

According to Berg Insight, an IoT analytics firm, there will be 4.15 billion IoT devices linked to cellular networks worldwide by 2024, presenting enormous prospects for telecommunications service providers throughout the globe. Smart home mobile applications and real-time monitoring systems benefit from superior mobile and network services provided by IoT in Home automation.

e. Big Data

With the aid of IoT sensors included in mobile devices and applications, telecommunications firms are able to collect vast amounts of data thanks to the Internet of Things (IoT). This helps these organisations create information pools. Hence, it is essential that their network be capable of moving large volumes of data and supporting new technologies indefinitely. Customers' use habits and business insights may be gleaned from the acquired data in the telecom industry. The data may be used to enhance customer service, assess new goods, and monitor and optimise the network in the long run. The utilisation of big data enables firms to establish better enterprises and gives them an edge over their competitors.

f. RPA

One of the industries that has one of the greatest acceptance rates for RPA technology is the telecommunications sector. It is able to take over jobs or processes that are repetitive and rule-based, such as replying to client inquiries, report production, pricing monitoring, and so on, and then finish them extremely precisely, which enables it to give great levels of scalability and agility. It offers the organisation with the appropriate power and capabilities to effortlessly handle back-office operations such as preserving data integrity and security, staff wages, marketing and advertising expenditures, and hardware and software costs. As a result, personnel have more time to focus on high-priority activities, build stronger connections with customers, improve operational efficiency, and fix delays in providing service to customers.

g. Cloud Computing

According to the Mordor Intelligence analysis, the telecom cloud market was valued at \$25.33 billion in 2020 and is expected to reach \$74.36 billion by 2026. There will be a huge change in communication service providers (CSPs) to cloud computing in the next several years. To offer a wide range of services, handle data, and charge customers, most telecommunications companies depend on a massive

Tilak Mukherjee

computational infrastructure. Internal computer resource requirements and costs are reduced, while income sources are increased, by moving to the cloud.

It is easier for telecommunications to launch new services, lower costs, and operate more efficiently as the market requires thanks to the pay-per-use model. Telecom companies may reap the benefits of cloud technology by moving essential business processes to the cloud and reaping the benefits of its efficiency. A single-product telecom like Lebara, which began expanding internationally in 2014, may also use the cloud to extend its service offerings and reach new markets more quickly.

h. Cyber Security

When it comes to cybersecurity, the telecommunications industry is one of the most susceptible. As a result of the vast number of customers that telecom firms serve, there is a plethora of opportunity for hostile attacks to get unauthorised access to the data that these organisations store. When a major telecom service provider's infrastructure is attacked, the repercussions have the ability to damage a whole nation, as well as companies, customers, and government agencies. It also has a significant impact on the brand's reputation and credibility in the communications industry. The telecom providers may better identify attacks, take preventive steps, and enhance resilience when attacked by using a comprehensive strategy such as cyber security mesh. Instead of guarding a single IT perimeter, the mesh adopts a more modular approach. This is necessary since networks do not have physical boundaries.

Zero-trust networks, such as the cybersecurity mesh, are on their way to becoming commonplace. In other words, unless the security protocol checks every connection used to extract data, it will be regarded untrustworthy. In addition, the mesh promises to handle all data systems and equipment equally and securely, regardless of whether they are located inside or outside of the mesh network.

4 CONCLUSION

What we observed throughout our investigation is merely scratched the surface by the innovative areas that are discussed in our study on the top 10 trends in the telecom industry. There are a number of areas that are certain to have a large influence on telecom firms, including the development and deployment of 5G networks and technologies, flexible networks that can accommodate high- and low-latency needs, and speedier means of communication. Competitive advantage and leadership in the market may be gained by early identification of new prospects and developing technology that can be included into a company's operations.

During our extensive investigation, we discovered a slew of trends in the telecommunications industry that we've included in this report. In addition to AI, 5G, and connectivity advancements, the industry as we know it now will be transformed. A significant step in gaining a competitive edge is making an early discovery of new business prospects and developing technological trends that may be incorporated into existing operations.

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A Comprehensive Review on The Emerging Technologies in The Field of Robotics and Automation

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Abstract

Robotic automation is a continuously evolving field. Industrial robots have become prevalent in production settings throughout the globe in only a few decades, and their productivity as well as profitability continue to grow. Looking into the future is often difficult, but one thing is certain: robots will be a vital part of the future, accessing sections of the economy that people could only conceive a few years ago. Learning robots are becoming more common as artificial intelligence for the robotics matures. Here are six developing trends in the field of industrial robots which will most likely have a significant impact on a broad range of industrial industries and deliver advantages much beyond what was previously thought conceivable.

Keywords: Robotic Automation, Artificial Intelligence, Emerging Trends.

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1 Introduction

There is a tremendous advancement in robotics technology. In the field of robotics, the design, manufacture, operation, and usage of robots is the primary focus. Robots will play a vital role in the future of each and every industry. In the industrial sector, robots are becoming more and more popular, as some experts believe this trend may continue for some time. Robots are used by businesses, companies, and even families to do activities that people are unable to perform.

Developing intelligent robots that can assist people and businesses in doing their work more efficiently is the ultimate objective of robotics. The epidemic has led to a wide range of changes in both our personal and professional lives. Some industries have been negatively affected by the pandemic, while others have benefited greatly. While the robotics industry has been hampered by a shortage of both supply and demand, it has also seen significant technical improvement.

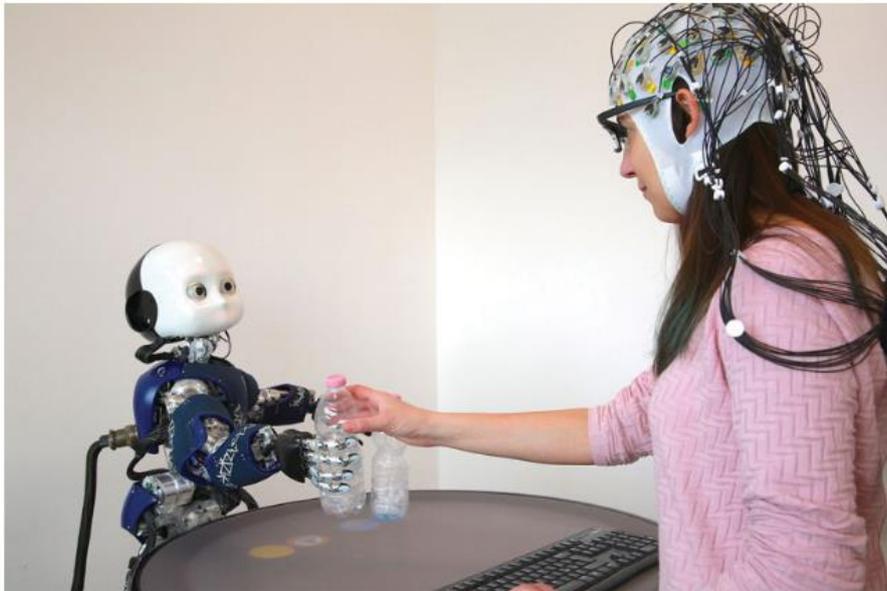


Figure 3 “An example experimental setup where a participant is involved in an interaction with the humanoid robot iCub, while neuro-cognitive mechanisms are measured through performance data, as well as eye tracking and EEG”.

The field of automation is growing at a fast rate. The employment of industrial robots has been widespread for a few years now in many sectors all around the globe. Because of their expanded production, profitability and appropriateness, their popularity is steadily increasing. Self-healing robots are a new kind of robotics that you may be curious about. Robotics has brought in a paradigm shift in the industrial sector. The next step for the robots will be to adapt their job. It's important to keep an eye on what's coming since the robotics industry is vast and the future application of robots is unclear. Engineers throughout the world benefit from the use of robots every day.

Dr.Nitin K Kamble

2 LITERATURE REVIEW

(Krishnakumari et al., 2022) Construction is a labor-intensive business that employs a large proportion of the global workforce. However, the business has had to adjust to a lack of workers because of a labour shortage (and now, social alienation). Although the construction business has long relied on its ability to quickly adapt, a new option has emerged in the form of construction robots. Innovative new technologies have a long history of boosting construction productivity, quality, as well as safety. The goal of this article is to describe the latest findings in the field of robotics, a brand-new emergent technology. Using robots in the upstream sectors, such as component manufacturing or building processes that may be completed in a typical industrial environment, is the primary focus of this article. There are several aspects of this article that focus on the construction industry's fundamental operations and r&d, as well as the economic viability of construction robots including their productivity, which are examined in this paper.

(Macrorie et al., 2021) Cities throughout the world are becoming testing grounds for new types of robotic & automation technology in a broad range of industries and sectors. As these technologies move out of the lab & factory, this paper examines how robotics & automation systems are being layered onto existing urban digital networks, expanding the capabilities as well as capacities of the human agency as well as infrastructure networks, as well as reshaping the city and citizens' everyday experiences. Until now, the majority of research in this area has been theoretical and isolated. To better understand how robotics and automation are interconnected across urban domains and the implications they have for different urban geographies, as well as the selective enhancement of the individuals as well as the collective management of the infrastructures, they have outlined a research agenda that goes beyond the analysis of the discrete applications and effects.

(Bader & Rahimifard, 2020) Consumer desire for more diverse food items is driving food businesses to experiment with new approaches to innovation and adaptability as a result of the ever-increasing global population. More severe regulations and restrictions on low-cost labour are also prompting the food sector to change its manufacturing methods. The food production business stands to gain a lot from the use of Industry 4.0's industrial robots, which will help it meet these new difficulties. In compared to other industrial sectors, the integration of these automation into food processing has been gradual and mostly restricted to packing and palletising. It is the goal of this study to identify a flexible automation solution for a particular food manufacturing need via the development of a methodological framework. Using the "Food Industrial Robot Methodology" (FIRM), customers may categorise, describe, and identify their food as well as automation solution in four simple stages. An industrial case study is used to demonstrate how FIRM may be used to help food producers evaluate the potential advantages of using industrial robots in their manufacturing processes.

(Melenbrink et al., 2020) Construction projects in the real world normally involve three categories of work: site preparation (earthmoving, levelling), substructure (anchoring, foundations), as well as superstructure (the actual building itself) (load-bearing elements, plumbing, facade, wiring, etc.). Construction automation advancements have revealed a gulf between the industry and academic

Handbook of Trends in Engineering Technology and Research

research, where the industry efforts have been focused on automating the conventional earthmoving equipment as well as embracing pre-fabrication to minimise the amount of work required on site, whereas academic efforts have largely focused on the proposals for on-site "additive manufacturing or discrete assembly", which may be of limited applicability to the industry. Research in the construction automation has progressed significantly in recent years, and this review focuses on the need of coordinating a wide variety of construction jobs amongst diverse task-specific robots to achieve completely autonomous building in unstructured settings. We take into account both well-established technology (such the standard industrial equipment we all use) and developing ones (novel machines designed for autonomy). From the survey, it is clear that site preparation & substructure jobs, material-robot systems (co-created robots as well as building materials), embedded sensors, auxiliary construction chores, and co-ordination operations amongst robot systems will be necessary to achieve completely autonomous construction. According to the research, incremental upgrades to existing technology could be beneficial to the business in the near term, but adding autonomy to the equipment meant for human operators has significant restrictions. To the contrary, we believe there is a need for new hardware to be designed for particular activities based on basic principles as well as the proper size, as well as an increase in cross-disciplinary research. With the apparent lack of competent workers in the business, experts believe that an increased focus on training for the use of automation advancements will help alleviate the problem.

(Javaid et al., 2020) Manufacturers and service providers throughout the world are feeling the effects of the COVID-19 epidemic. Since there are no vaccinations or medical treatments that have been proved effective, preventing the spread of this virus is a top priority. Lockdowns have been imposed in several nations as the virus spreads via human-to-human contact, and the public is urged to maintain strict social distance. Robots are capable of doing human-like tasks and may be profitably designed to take the place of humans in certain situations. This research identifies and proposes the use of robots in the battle against the COVID-19 pandemic. We conducted a thorough literature analysis to determine the potential uses of robots in epidemic as well as pandemic management. SCOPUS, PubMed, Google Scholar as well as Research Gate were used to search for relevant articles. Various kinds of medical robots were found by a detailed analysis of the literature. Robots might be used in a number of ways to help control the COVID-19 epidemic. There is no question that technology has a price. During the course of this research, we discovered how several kinds of robots may be utilised to transport medication, food, and other necessities to COVID-19 quarantined patients. When it comes to customising robots to do dangerous and monotonous tasks, there is a wide range of possibilities.

(Dotoli et al., 2019) In this work, researchers offer an overview of current theoretical approaches and technological developments that are responses to the basic issues that are presented by contemporary industrial automation. We divide these significant approaches and technologies into a few distinct categories, and then we report on seven of those categories, namely: vertical integration of the factory automation systems; distributed as well as decentralised control; advanced sensing for the factory automation; semantic models of factories; networked control systems as well as wireless sensors &

Dr.Nitin K Kamble

actuators; autonomy and self-organization of factories; advanced sensing for the factory automation; semantic models of the factories; engineering methods of the factory automation systems.

(Bailey et al., 2019) AI, robotics, data analytic, digital platforms as well as social media, but also digital tracks, blockchain as well as 3D printing, are reshaping human behaviour and interaction in a wide range of fields, from consumer credit risk assessment to the product design as well as platform work in health care diagnosis to hiring to predictive policing to custom manufacturing as well as automated fraud detection. These technologies are increasingly being used in almost every process, form, as well as condition of organisation, calling into question the fundamental theories as well as ideas about organisations and organisation. From organisational boundaries to the employment relationships to individual identification with organisations, these technologies are increasingly deployed. Scholars will be able to learn more from this Special Issue on how these theories and concepts will have to change in light of these new technological developments.

(Devarajan, 2018) In the past, most organisations in a wide range of industries used a variety of IT tools and procedures (workflows) that included both automated and human phases. This is changing. These labor-intensive, time-consuming, and error-prone manual processes are used in a wide variety of sectors, which results in decreased productivity, higher operating costs, and a host of other drawbacks. An IT automation solution's deployment has its own drawbacks, including higher licensing/development/maintenance costs, longer integration times, constant code patching to suit underlying business logic changes, and longer integration times. For years, businesses have been searching for IT solutions which may improve customer happiness, boost productivity and cut expenses while simultaneously enhancing the overall performance of their employees. Recently, RPA has emerged as a game-changing technology, surpassing other solutions developed by the "Business Process Management" (BPM) sector over the years. Since its beginnings, "Robotic Process Automation" (RPA) has made its way across numerous industrial sectors, expanding its use cases and evolving with business needs thanks to its capacity to automate basic rules-based operations which are repetitive & manual. It examines RPA's use in numerous industries, the advantages of RPA, and the future of RPA in this article, as well.

(Moffitt et al., 2018) With the introduction of "Robotic Process Automation" (RPA), the conventional audit approach may be disrupted in several ways. RPA's capacity to automate rules-based processes which are repetitive as well as manual is predicted to repurpose the auditor's position by replacing tedious duties and focusing on higher-order thinking abilities, which will ultimately lead to an increase in audit quality. In this editorial, the idea of RPA is introduced and its use in auditing is described. A variety of research questions and issues for RPA-based audits are also offered in the hope of creating a discourse in this evolving field.

(Horton et al., 2018) Designers should expect to see a rise in the use of digital technologies in the workplace as their capabilities and costs continue to improve. Artificial intelligence (AI), cyber-physical systems, augmented reality and virtual reality (AR/VR), as well as other cutting-edge technologies will soon be available. A "gig economy" based on task-based freelancing may be on the horizon because to

the rapid expansion of peer-to-peer (P2P) platforms like Airtasker, Uber, and Gobi, which have been made possible by recent technical advancements. It's taking place in the backdrop of a rapidly changing Australian workforce, which includes the end of the mining boom, a move to professional service-based employment, as well as an ageing population.

3 EMERGING TRENDS IN ROBOTICS

a. Collaborative Robots

A kind of collaborative robot called a cobot is meant to operate in tandem with humans without the requirement for safety obstacles, such as guard rails. End-of-arm tools, sensors, as well as software enable them to identify changes in their working environment swiftly and safely. Cobots are predicted to be the fastest-growing section of the robotics industry by 2025, in part because of the ease with which programmable software may be used.

b. Commercial Drones

Among the most recent developments in commercial drone technology are autonomous systems that can fly over the horizon and better sensors, batteries, lightweight construction materials, and payloads that can carry heavier payloads. A self-monitoring smart drone created by 3D Robotics is a promising option for the transportation, logistics, as well as military applications because of its superior sensor and automation technology.



(a)



(b)

Figure 4 (a) Collaborative Robots, (b) Commercial Drones

c. AI-Enabled Robots

Robots equipped with artificial intelligence (AI) are able to learn on the job. Automated systems gather and analyse real-time data from their surroundings, using actuators, vision systems, sensors, and complex software. They then reply in real-time with enhancements. As the robot performs its duties and accumulates data, the AI/machine learning algorithms become more efficient. Robots with artificial intelligence (AI) are already being utilised in industries to move goods, clean equipment, and keep track of inventories.

Dr.Nitin K Kamble

d. Self-Healing Robots

Robots may now do basic repairs on themselves because to advancements in self-healing technology. A team of researchers in Europe has built flexible plastic robots with integrated sensors that can detect structural damage and prompt them to repair themselves without the need for a human. It may take anything from a few minutes to a week for the robots to repair themselves depending on the location as well as depth of the damage, according to RoboticsTomorrow.com.

e. Customized Robots

Industrial robots are increasingly being customised by manufacturers to fulfil the precise requirements of their operations. It is preferable to employ six-axis robots since they have a bigger workspace and may be configured to suit a variety of production applications. Robot-mounted or fixed camera systems coupled with robot controls may increase their capabilities even further, resulting in more precise and efficient movements for specified jobs.

f. Cloud Robots

Cloud computing and cloud storage provide a single platform that provides services for robotics. When connected to Using cloud computing as well as cloud storage, robotics services may be provided. Connected to the cloud, robots may take use of the data analytics, storage, as well as software as a service offered by a data centre.

"Expect more cloud software that enables robots to operate together," stated Tom Brett in Innovation and Tech Today. A single platform for all of your robots' needs will enable them to perform more effectively and complete more tasks.

g. Smart Factories

As robots grow more sophisticated, manufacturing and distribution firms, for instance, will become more intelligent. Assembly lines will benefit from industrial robots as well as automated solutions, and smart factories will become the norm. As a consequence, designers should anticipate operations to be faster, more efficient, as well as more precise, with fewer errors. "Robots and autonomous mobile robots" (AMRs) will work together in the future, reducing the need for human involvement and maintenance.

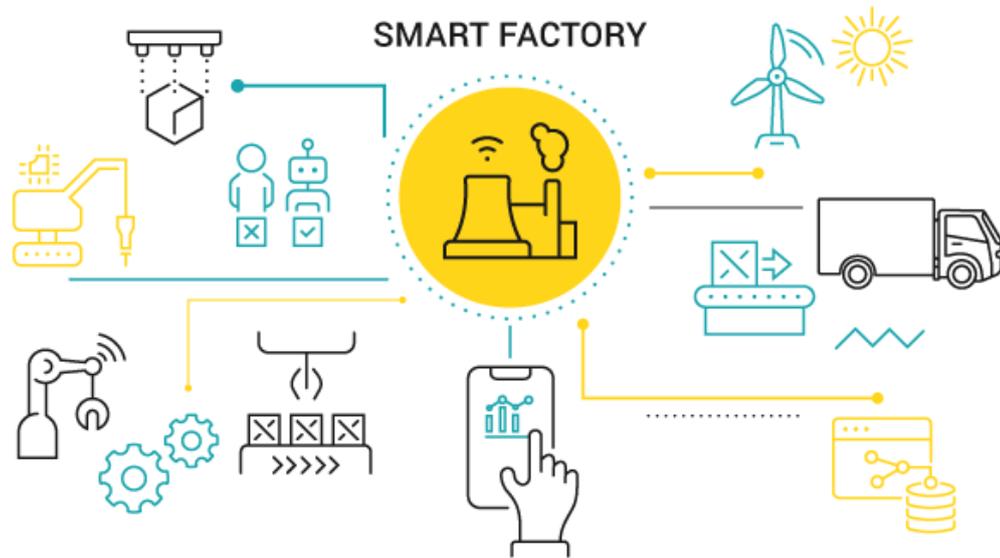


Figure 5 Smart Factory

The phrase "smart factory" refers to a manufacturing system that is highly adaptable and self-correcting by combining a variety of current technological options. To achieve new levels of efficiency and flexibility, smart factories may be able to simplify and integrate a wide range of processes, information sources, and stakeholders (such as frontline workers and planners). The term "intelligent factory" or "digital factory" is occasionally used to describe smart manufacturing efforts.

h. The Rise of “Cobots”

Collaborative robots, or "cobots," are one of the most popular advancements in robotics as well as electrical engineering. Robots like this are made to operate alongside humans in an environment free of health and safety concerns. These robots can instantly detect changes in their working environment and react as necessary while keeping humans safe thanks to powerful sensors and algorithms (including things like end-of-arm-tooling). As a consequence of recent advancements in programmable software, this industry is expected to increase greatly by 2025.

Users will be able to design and construct their own Cobots in the near future. Cobots may be used to do tedious, repetitive, and unappealing tasks, allowing humans to concentrate on work that best leverages their talents and abilities. It is the flexibility and dynamic nature of industrial cobots which sets them apart from other types of robots.

i. Maintenance Robots on the Rise

Because it allows for prediction as well as prevention of failures rather than just responding to them, maintenance is one of the most important roles of every industrial site. Research from the "National

Dr.Nitin K Kamble

Institute of Standards and Technology" shows that maintenance costs may vary from 15% to 70% of the total production costs, with a good return on investment for predictive maintenance solutions.

Maintenance occupations are good candidates for automation since they are so recursive. To further aid in the shift from a human-centric to a highly autonomous activity, these advanced gadgets contain AI features. As AI and robots advance, they may be able to change maintenance away from a "best practises" preventive check-list to more proactive predictive measures—a paradigm more comparable to repair before the issue arises"—that are based on regular data analysis.

j. Robot Employees

The COVID-19 epidemic has sparked a new trend in the use of robots in the workplace, just as cobots. Businesses were required to limit human contact between employees and customers because of the COVID-19 virus. During the second part of the pandemic and beyond, many companies found themselves dealing with workforce shortages.

Because of this, robots are taking over tasks that were previously considered to be impossible to automate. Food delivery robots and other minor internet orders are excellent examples of this. A growing number of jurisdictions have passed legislation defining the areas in which robots may and may not operate. Delivery robots meet the equally high need for delivery drivers as same-day orders for anything from food to gadgets reach historic levels of demand.

4 CONCLUSION

Over the previous ten years, the demand for robots has rapidly increased. Since COVID-19, there has been an increase in labour shortages, as well as a drive to reduce carbon emissions. These factors have pushed the requirement for the automated robotic systems as well as equipment outside of the conventional industrial and warehousing industries. In the next decade, it is only going to increase at an exponential pace. Robotics training as well as education will become more crucial as the usage of robots increases across the global economy. First, companies and consumers rushed to adopt the robotic technologies, which have since accelerated the expansion of robots. Most parts of daily life are being transformed by robots thanks to advances in AI, the Internet of Things (IoT), machine learning, and big data. The robotic revolution will continue to accelerate in the years to come, thanks to a combination of public confidence in technology, low cost, and a growing body of data.

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A Comprehensive Literature Survey on Research and Innovation in Robotics and Automation

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Abstract

Every year, new developments in the robotics industry revolutionise the sector. Robotics' future will be shaped by these tendencies as Industry 4.0 takes hold in various sectors. In the early stages of the epidemic, companies and consumers alike began adopting robotic technology in a big way, and this trend continues to this day. Many parts of daily life may soon be controlled by robots thanks to recent developments in machine learning, AI, the Internet of Things (IoT), as well as the big data analysis techniques. Robotics and automation will have a major impact on the future, and so this study conducts a thorough literature analysis to examine the most recent developments as well as current research and developments.

Keywords: Robotics, Artificial Intelligence (AI), Machine Learning (ML), The Internet Of Things (Iot), Big Data.

1 Introduction

A variety of industries, including healthcare, logistics, manufacturing, the hotel industry, and the auto industry all continue to get investment dollars to support new robotics technologies. Venture capital (VC), strategic investors and private equity (PE) are looking to take advantage of and influence the

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development of the disruptive robotics technology. In the same way, labour shortages and supply chain disruptions are driving up demand right now. In 2028, the Fortune Business Insights estimates that the worldwide market for industrial robots would grow from \$14.61 billion in 2020 to \$31.13 billion in 2028.

Full automation is something many businesses aspire to, but in practise, it may be prohibitively costly and robots cannot currently execute all activities as effectively as people can. Because of this, firms are looking for ways to combine the best of human and machine intelligences. Warehouse employees are being outfitted with the robotic exosuits in order to increase their mobility. Assistive devices like this support joints and reduce the stress of lifting and carrying, so reducing the risk of injury and increasing worker productivity. Exoskeleton wearable robots are predicted to reach \$5.2 billion in 2025, up from \$130 million in 2018, according to the Wintergreen Research.

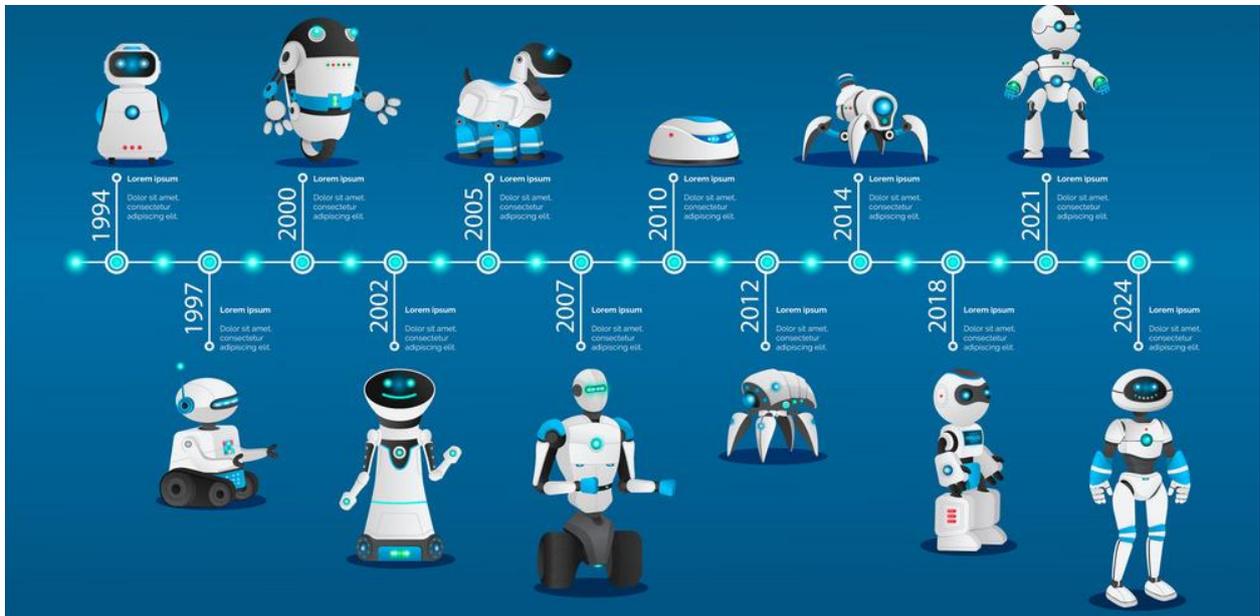


Figure 6 The Evolution of Robots

There is a growing need for cobots (robots which work alongside human beings), which may be used to do tasks that are tedious or risky. Sorting and packing items is a commonplace duty that pick & place cobots can easily do and can be easily integrated into current processes. Additionally, improved camera and sensor systems are being used by cobots to undertake thorough quality control checks in production environments. There has been a dramatic increase in industrial robots in production settings over the last five years worldwide, and cobots are predicted to account for 34 percent of all robot sales in North America by 2025, from 3 percent now.

2 LITERATURE REVIEW

(Nadikattu, 2021) Robotics is heavily influenced by automation, despite the fact that just a few industries have used AI. There is no sign of a halt in the current trend. Robotics and artificial intelligence

Dr. Sandeep S Sarnobat

(AI) are now being combined in novel ways to provide new technological possibilities. Self-driving motors as well as intelligent electronic agents which work for humans have been created economically as a result of robotic and AI breakthroughs, and this has led to an increase in the number of robots. Artificial Intelligence (AI) is anticipated to have a wide range of applications, like machine learning, which automates the building of analytical approaches using algorithms. Robots can help with humanitarian efforts thanks to algorithms. Artificial intelligence, on the other hand, has both benefits and drawbacks. Because of the advances in Artificial Intelligence Robotics, which carry out dangerous actions that people cannot, the advantages are able to overcome various human risk hindrances. Guidelines for AI in robotics include mobility, sensing and feedback, customer service alongside the open-source robotics, as well as the process optimization. These are all aspects of the industry. Manufacturers should be on the lookout for new trends in AI and robotics. Over time, manufacturing has come to be seen as having the highest technological level of any industry. Automation in industrial facilities is still a long way off, but AI robots are well-positioned to change that. The economic impact of AI on the global economy will be discovered as AI progresses. Discussing the economic effect of AI on the robotics industry, the study considers adjustments, advantages and downsides and financial outcomes, as well as the current rising trends in the field.

(Leno et al., 2021) Organizations may automate repetitive clerical duties with RPA, a new technology that uses scripts to encapsulate the sequences of the fine-grained interactions with the Web as well as desktop apps. Closing files, choosing fields in web forms and cells in spread sheets as well as copying and pasting data are instances of clerical chores. Considering that RPA may be used to automate a broad variety of tasks and processes, this brings up the issue of which tasks should be automated in the beginning. In order to address this need, this study proposes a family of approaches known as robotic process mining (RPM). Repetitive tasks that may be automated can be found in logs of interactions between employees and Web and desktop applications, known as user interactions (UI) logs, as the heart of RPM. What follows is an outline of how to use RPM to produce scripts for RPA from logs of UI actions. It also highlights research hurdles that must be overcome to build the pipeline that has been envisioned.

(Macrorie et al., 2021) In many parts of the world, cities are serving as testing grounds for new types of robotic or automation technology that are being used in a broad range of industries and contexts. An examination of how robotics as well as automation systems are being layered onto existing the urban digital networks, extending human agency as well as infrastructure networks, and reshaping everyday experiences for city residents and citizens is presented in this paper as these innovations leave the laboratory as well as factory. Until now, the majority of research in this area has been theoretical and solitary. Robotics and automation interact across urban domains, resulting in a variety of socio-spatial sorting of cities, the selected enhancement of people as well as collective management of infrastructure, the socio-spatial sorting of cities, and the opportunity for responsible urban innovation.

(Sherwani et al., 2020) New robotic & automation technologies are being tested in cities throughout the world in a broad range of economic and social contexts. After leaving the lab and the factory, this

Handbook of Trends in Engineering Technology and Research

paper examines how robotics as well as automation systems are being built on top of existing urban digital network infrastructures, thereby expanding human agency's capabilities and infrastructure networks' capacities while also reshaping everyday city life and citizen experiences. The majority of research done so far has been theoretical and isolated. Our research agenda goes beyond the analysis of the discrete applications as well as effects, to investigate how robotics as well as automation connect across the urban domains as well as the implications for the differential urban geographies, the selective enhancement of the individuals & collective infrastructure management, the socio-spatial sorting of cities, as well as the potential for the responsible urban innovation.

(Okpala et al., 2020) Safety in construction is still seen as bad, particularly when compared to other US sectors, in spite of the application of conventional and creative ways to enhance safety management. Work quality as well as productivity have decreased, and project costs as well as completion times have risen, as a result of poor safety performance. Innovative safety methods with high overall capacity across the project life cycle must be adopted and implemented by the architectural, construction, as well as engineering (ACE) sector to increase safety. There are now technologies that, when utilised correctly, may significantly improve safety. However, in terms of safety management, these technologies aren't widely used. According to researchers and experts, a possible contributor to construction's poor safety record is that these technologies have not been widely used throughout the project lifecycle. This article highlights the practical uses of several kinds of technologies for the safety risk reduction as well as management in the construction to bridge the practise gap and stimulate the adoption of new technologies. Information on the facilitators and hurdles to technological adoption, as well as information on the efficacy and perceived as well as real costs, are all presented. In order to help construction managers make educated judgments about which technologies to embrace and apply, the explanation of their practical consequences will help.

(Javaid et al., 2020) The worldwide industrial and service industries have been severely affected by the emergence of COVID-19. Considering that there are no vaccinations or established medical treatments for this virus, there is an urgent need to take preventative measures. Lockdown has been proclaimed in several nations due to the virus's ability to spread via human-to-human contact, and the general populace has been warned to keep a safe distance from one another. The ability to design robots to do human-like tasks means that they might eventually take the place of humans in a variety of situations. Identifying and proposing the use of robots to take on the COVID-19 pandemic problem is the focus of this research. We conducted a thorough literature analysis to determine the potential uses of robots in epidemic and pandemic management. Through SCOPUS, PubMed, Google Scholar as well as Research Gate's search engines, researchers have searched for relevant material. Various kinds of medical robots were found by a detailed analysis of the literature. In the fight against the COVID-19 pandemic, robots might play an important role. There is no question that technology has a price. Our research in this study focuses on the many sorts of robots that may be used to provide medication, food, and other necessities to quarantined COVID-19 patients. Consequently, a wide range of options exist for customising robots to do dangerous or repetitive tasks with high levels of accuracy and dependability.

Dr. Sandeep S Sarnobat

(Dotoli et al., 2019) An overview of current theoretical methods and technology that address the basic issues of contemporary industrial automation is presented in this study. For seven of these seven major methods and technologies, we report on the following: vertical integration; distributed and decentralised control; smart sensors and actuators; networked control systems; autonomy and self-organization; advanced sensing for the factory automation; engineering methods for factory automation systems; semantic models of the factories.

(Yang et al., 2019) Innovative building technologies have the potential to accelerate the construction industry's transformation towards a more sustainable and environmentally-friendly business. Co-evolution and transitional settings should be used to conceptualise the relationships between these technologies. This study proposes a novel theory to explain how new building technologies "co-evolve via contact." A conceptual model was created, based on socio-technical transitions as well as technology interaction theories, which defined three modalities of interaction. Two modern building technologies in Hong Kong were used to validate and contextualise the model: modular integrated construction as well as robotics. According to these findings, there has been a close relationship between the three emerging technologies in terms of mutually reinforcing mutual dependence, adaptive neutralism, and constrained competition. As a result of these results, we now have a theoretical basis for analysing the complexity of interaction and developing policy and management methods to help future building technologies evolve in a symbiotic relationship.

(Huang & Vasarhelyi, 2019) Despite the widespread adoption of RPA in many sectors, including the accounting industry, RPA's application to the auditing has lagged behind because of the industry's particular character. RPA is used in the auditing field in this research. An RPA framework is presented that allows auditors to concentrate on jobs that demand professional judgement rather than repetitive as well as low-judgment audit duties. Additionally, a pilot experiment demonstrating the viability of RPA in the confirmation process is presented in this article.

(Moffitt et al., 2018) Automated audits might be disrupted by the rise of the "Robotic Process Automation" (RPA). RPA is projected to repurpose the auditor position by replacing routine duties and stressing higher order thinking abilities that would ultimately lead to improved audit quality. RPA is capable of automating rules-based processes which are repetitive and manual. This article introduces the idea of RPA and explains how it may be used in auditing. A variety of research questions and issues for RPA-based audits are also offered in the hope of creating a discourse in this evolving field.

3 AREAS OF RESEARCH IN ROBOTICS AND AUTOMATION

a. Robotic Process Automation (RPA):

Automated repetitive tasks are a frequent use of the technology known as "robotic process automation" (RPA). Medical facilities which deal with human billing, appointment scheduling, as well as inventory management are excellent examples of businesses that might benefit from robotic process automation (RPA).

b. Robotics as a Service (RaaS)

Because of the rising trend of everything-as-service models, small businesses are now able and empowered to implement robo and RPA in subscription-based "Robotics-As-a-Service (RaaS)" as well as SaaS models — like Meili FMS — in the form of Meili FMS subscriptions.

c. Autonomous Mobile Robots (AMRs) as data acquisition platforms

The demand for AMRs has grown from €0.88B in 2017 to an expected €6.17B in 2022, driven by e-commerce development, labour shortages, rising automation, and mass personalization of items. AMRs are predicted to begin behaving more such as IoT hubs in the near future, resulting in an additional €2.64 billion in AMR market value due to mobile robot software.

d. Cobots and Assistive Robots Take Center Stage in the Workplace

Full automation is something many businesses aspire to, but in practise, it may be prohibitively costly and robots cannot currently execute all activities as effectively as people can. Because of this, firms are looking for ways to combine the best of human and machine intelligences.

Warehouse employees are being outfitted with robotic exosuits in order to increase their mobility. Assistive devices like this support joints and reduce the stress of lifting and carrying, so reducing the risk of injury and increasing worker productivity. From \$130 million in 2018 to \$5.2 billion by 2025, Wintergreen Research estimates that the exoskeleton wearable robotics industry will grow.

There is a growing need for cobots (robots which work alongside human beings), which may be used to do tasks that are tedious or risky. Sorting and packing items is a commonplace duty that pick as well as place cobots can easily do and can be easily integrated into current processes. Additionally, improved camera and sensor systems are being used by cobots to undertake thorough quality control checks in production environments. There has been a dramatic increase in industrial robots in production settings over the last five years worldwide, and cobots are predicted to account for 34 percent of all the robot sales in North America by 2025, from 3 percent now.

e. Progress in Robot Interoperability

As the use of robots grows more ubiquitous, so will the importance of interoperability between robots and humans. Because few firms obtain all of their robotic platforms from a single developer, it may be difficult to make these many platforms to interact and function together seamlessly. Because of this, the potential increases in efficiency are generally limited. The robotics sector, such as the computer and telecommunications industries, will be driven by customer demand to establish standards and use open designs to promote interoperability among robotic systems.

f. Increased Efforts to Prevent Hacking and Mitigate Liability

As a consequence of the dangers posed by hackers gaining control of robots, cyber security will remain a major worry for the robotics sector. In 2010, the Stuxnet computer worm was used to overspin Iran's

Dr. Sandeep S Sarnobat

nuclear centrifuges, causing them to split apart, and firms are increasingly more apprehensive of state-sanctioned cyber security risks as geopolitical tensions dominate current events. Such hazards have been proved. Terrorists, people, and even companies are all capable of launching similar assaults on their rivals. In this context, questions of culpability are also relevant, which is why the private sector and the government are working so hard to prevent new hazards from emerging.

g. Improved robot “senses”

Enhanced sensing & advanced grasping are two critical components of the technological challenge puzzle which enable robots to interact with their surroundings. Human-like skills in object detection, identification, and manipulation will be necessary for robots in order to do all of the tasks for which they are well-suited.

Force control and excellent 2-D & 3-D vision, when paired with robust computing capabilities, will enable the robot to make "decisions" about what to do when it faces the inevitable snags that emerge in ordinary operation. A new generation of the integrated force control as well as integrated vision is now offered to more & more end users.

As far as I know, robots are capable of doing very accurate and repetitive actions. For small-parts assembly, accuracy is pointless if you can't manipulate tiny items with delicacy and finesse. In this sense, they need end-of-arm tooling which as closely as possible resembles the human hand in terms of its feel, flexibility, attention to detail, and speed.

h. Improved ROI

Astounding capabilities and a speedy return on investment characterise today's industrial robots. Reducing workplace injuries, increasing company competitiveness in a global market, raising the quality and affordability of inexpensive goods and increasing profitability for innumerable firms have all been benefits of robots.

According to an overwhelming amount of facts, experience, and plain sense, organisations that use robots reap enormous financial rewards. Robotics integration may improve productivity, decrease overhead, give flexibility, minimise waste, and raise quality—in some instances by orders of magnitude—more than any other action enterprises can take.

i. Training robot employees of the future

There is a new ecosystem of high-paying and gratifying occupations thanks to industrial robots. Creating robots and all the occupations that go along with them produces new employment that didn't exist prior to the invention of robots. Robot ecosystem employment are often high-paying and fulfilling, and they typically come with generous benefits packages.

It is possible to stay cost-competitive in a high-cost nation by using robots rather than relocating manufacturing to a lower-cost country. So jobs that would have otherwise been moved to low-cost

nations are kept in high-cost ones. The notion of reshoring in the sector, known as relocating jobs back to the United States, serves to maintain employment balance throughout the globe.

4 NEED FOR RESEARCH IN ROBOTICS AND AUTOMATION

a. Easier to use, deploy, and maintain

Although the automobile sector has been utilising robots for a long time, programming robots may be a barrier for businesses that are new to automation. The deployment, operation, and maintenance of robotic systems should not need the utilisation of a highly qualified staff. In reality, this is one of the most pressing technological issues that the business is now dealing with.

b. Putting the environment first

There has been an increase in the importance placed on the environmental impact of everyday operations by organisations at all levels. This is mirrored in technology they utilise. Businesses want to reduce their carbon footprint whilst also improving operations and producing income, which is why robots in 2021 will be built with environmental considerations in mind.

Because of their increased accuracy and precision, modern robots may reduce the amount of resources they need by generating work which is more accurate and precise. Renewable energy equipment production may also benefit from robotics, helping other firms to cut their energy use.

c. Robots reduce carbon footprint

Robotics investments will rise as a result of the desire to reduce one's carbon impact. Modern robots utilise less energy than their predecessors, resulting in direct savings for industry. Because of their greater precision, they produce fewer rejections and substandard products, which has a positive impact on the ratio of the resource input to output. Renewable energy equipment, such as photovoltaics as well as hydrogen fuel cells, may also benefit from the use of robots in the manufacturing process.

d. Robotics, Industry 4.0, and the 2020s

The unmistakable rise of Industry 4.0 is shown by the most cutting-edge robotics trends for 2022. Automation has grown at a rate and in more sectors than anybody could have imagined in the last several years. Growth in robotics is at the core of this development. Increased use is driving down costs and igniting new waves of innovation. Many of such trends might become industry norms by the end of 2022.

5 CONCLUSION

In order to prepare the next generation for a world of robots and automation, a growing number of governments, industry organisations, and businesses are putting increased emphasis on early robotics education. There will be a heavy emphasis on education & training on the path to data-driven manufacturing. Robots are quickly being adopted by sectors that have just recently begun to automate. As a result of changing consumer preferences, businesses are scrambling to meet the growing demand for customised goods and services. Incorporating robots might be a challenge, although newer models

Dr. Sandeep S Sarnobat

are simpler to operate. Icon-driven programming and physical control of robots are becoming more common in user interfaces. As a way to streamline deployment, robot manufacturers and 3rd party providers are combining hardware and software. It may seem obvious, but solutions that concentrate on whole ecosystems provide enormous value by lowering the amount of time and effort required to operate.

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A Review on the Machinability Characteristic of Stainless steel in various machining operations

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Abstract

Austenitic stainless steels are one the most adaptable grade in stainless steel and are widely employed in a variety of sectors. It possesses a high level of durability, ductility, toughness at cryogenic temperatures, and corrosion resistance. Despite the fact that austenitic stainless steels are the most widely utilized of the five stainless steel families and have excellent ductility, endurance, and resistance to corrosion, they do have some drawbacks that operate as stumbling blocks in some applications. Because of the diverse nature of stainless steels, it is tough to put their machinability in concrete terms. One of the most broadly adopted materials is austenitic stainless steel., accounting for 10% of global manufacturing of steel, with austenitic steels accounting for 70% of total stainless steels. According to data from the ISSF, global stainless steel output has been steadily increasing, and consumption is predicted to continue to rise each year. The current study briefly introduces some key ideas in austenitic stainless steel metallurgy, as well as some of the issues surrounding austenitic stainless steel machining. A review of the numerous works of researchers in this field is also included. Finally, a discussion of prospective research fields concludes this work.

Keywords: Turning, Milling, Grinding, Drilling, Steel, Lubrication.

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1 Introduction

Today's manufacturing business relies heavily on machining. It is the most adaptable manufacturing small technique because it allows for the elimination of surplus, chips are materials that come in a variety of shapes and sizes to get the desired shape, size, and surface polish.

Machining is critical in the manufacturing industry for producing the desired form and component dimensions with adequate surface roughness. It is accomplished by removing superfluous substance in the form of a surface of chipping. Plastic deformation is the primary mechanism for chip removal. A considerable portion nourished with energy by the machine tool is turned into heat due to increased plastic deformation. When machining low-strength materials, the produced heat in the cutting zone isn't a concern, but when machining ferrous and also other high-strength materials, it is. Stainless steel is commonly utilized in the electronics and automotive industries to make unique inserts. Austenitic stainless steels are the most adaptable grade in stainless steel and are widely employed in a variety of sectors. It possesses a high level of durability, ductility, toughness at cryogenic temperatures, and corrosion resistance.

Stainless steel's early applications included cutlery, rifle barrels, and nitric acid tanks, among others. Stainless steels are now increasingly well-known and ingrained in everyone's lives, and they're used in a wider range of industries. Building exteriors and roofs, vehicle components, chemical processing facilities, pulp and paper manufacturing business, petroleum refineries, water supply pipes, consumer goods, shipyards and naval industry, pollution prevention apparatus, trading up, and telecommunications equipment are just a few examples.

One of the most commonly utilized materials is stainless steel., accounting for 10% of global steel manufacturing, with austenitic steels accounting for 70% of total stainless steels. According to data from ISSF, global stainless steel output has been steadily increasing, and consumption is predicted to continue to rise each year. The current study briefly introduces some key ideas in austenitic stainless steel metallurgy, as well as some of the issues surrounding austenitic stainless steel machining.

Some of the basic elements are hematite, chromium, silica, nickel, carbon, nitrogen, and manganese, present in the earth's crust. Based on their metallurgical structure, these steels are divided into five basic categories. They are martensitic stainless steel, precipitation hardening stainless steel, duplex stainless steel, austenitic stainless steel, and ferritic stainless steel.

Market shares of stainless steel categories around the world:- 2% martensitic, 1% stiffening of precipitation, 0.6% duplex, 72% austenitic, 24% ferritic , ASDA is the source of this information (2006).

Machineability is generally difficult with austenitic (300 series) steels. Chatter can be a concern, requiring high-strength machine tools. Machineability is good for ferritic stainless steels (including 300 series). Martensitic steels are abrasive and prone to forming a BUE, necessitating the use of tool alloys with greater hardness and crater-wear resistance.

2 Austenitic stainless steel metallurgy

Stainless steels are ferric alloys containing at least 10.5% chromium and no more than 1.2% carbon. Nickel, molybdenum, nitrogen, or titanium are examples of other alloy elements can be added to these steels to improve corrosion resistance. Gamma type of iron is employed in the most common stainless steels. When alpha iron (ferrite) is heated through 912°C to 1,394°C, it experiences a shift from body-centered cubic to face-centered cubic, resulting in gamma iron, commonly known as austenite. Because of the high chromium and nickel content, It is also the least corrosive of all the classes.

Austenitic grades are further divided into the 200 and 300 series.

a. Austenitic grade steels in the 300 series

It is the most widely used grade on the planet. The standard 18% chromium and 8% nickel stainless steel is used in the 300 series. The austenite structure is created with nickel, which is responsible for its exceptional toughness (impact strength) and strength at both high and low temperatures. Grade 304 and 306 are popular alloys of 300 series.

b. Austenitic stainless steels in the 200 series

This series contains significantly less nickel compared to the 300 series. The 200 series stainless steel is created when Mn and nitrogen are added in greater concentrations as a means of replacing some of the nickel. The most lasting of these types are 201 and 202, which comprise 3.5 to 6.0% nickel contrasted to 8.0 to 10.5% nickel in type 304, the most widely used 300 series grade. Nickel content in other 200-series grades, like type 205, ranges from 1% to 1.75%.

Connecting rods, crankshafts, and other car parts are made here, and so on, machining procedures are highly prevalent. Cutting oil is essential in machining, however it increases machining costs and causes environmental issues. Cutting fluid accounts for around 17% of the any product's price, while cutting oils are responsible for about 80% of skin disorders caused by mist and fumes.

The superior thermo-physical and mechanical characteristics features of nanoparticles are owing to the fact that choosing a coolant for a machining operation is mostly based on its lubricating capabilities, which nanoparticle-enriched cutting fluids provide in abundance. With the application of nanofluids, the performance of MQL utilising standard cutting fluids can be increased even more. Nanofluids are base oils with suspended solid nanometer-sized particles that improve heat conductivity and lubrication.

3 Literature Review

The most versatile stainless steel is austenitic stainless steel and are widely employed in a variety of sectors. It possesses a high level of durability, ductility, toughness at cryogenic temperatures, and corrosion resistance. Numerous investigations have been conducted on the machining qualities of stainless steels. Kumar et al.[1] summarizes the findings of numerous studies on the machining performance of AISI-304 stainless steel, as well as the factors that influence the performance of AISI-

Vineet Dubey and C.K. Dixit

304 stainless steel. such that future researchers can use this research to determine the ideal machining performance parameters, coolant fluid type, and for improving total machined surface integrity. Dyl,2021[2]the impact of various parameters on tool life span and wear was explored. Maximum tool wear was studied in relation to technological characteristics such as depth of cut, cutting rate, and feed. Carbide inserts were used to treat the top layer of the surface. As selection criteria, the roughness with the most wear and the least roughness was picked. Abbas et al.[3]carried out an experimental examination during final end milling operations into the machinability of AISI 316 metal under various cooling circumstances and process parameters. The cutting speed and feed rate were two variables in the operation., and three environmentally friendly cooling techniques were used: dry, MQL, and MQL with nanoparticles Al_2O_3 . Energy consumption and surface integrity were employed as machining responses to characterize the process parameters. The final surface roughness and surface integrity of the machined surface were evaluated to determine surface integrity. In comparison to dry conditions, the improvement in surface quality gained while utilising MQL and MQL + Al_2O_3 improved at greater cutting speed and feed rate, indicating that the increase in productivity without lowering the final surface quality.. Gowthaman et al. [4] examined duplex stainless steel's machining properties and tool wear mechanism and the harder insert grade is recommended for machining Duplex stainless steel. Ondin et al.[5] The goal of their study was to see how adding (MWCNTs) to a vegetable-based cutting fluid and PH 13-8 Mo stainless steel's machinability was impaired, which has good mechanical qualities. Taguchi's $L_{27}(3^3)$ orthogonal array includes three components and have three different levels, such as 120, 180, and 240 m/min cutting speeds, 0.1, 0.15, and 0.2 mm/rev feed rates, and different C/L environments. i.e. dry, pure-MQL and MWCNTs MQL, was used. As a conclusion, surface roughness was decreased by around 5% with pure MQL and 12% with NMQL. Under cutting conditions, such as pure-MQL and NMQL, flank wear was reduced by 40.2% and 69%, respectively.

He et al.[6]introduces a latest technique to using different PVD and CVD (coating + substrate) systems that work together for austenitic stainless steel machining. CVD TiCN + Al_2O_3 and PVD AlTiN coatings on cemented carbide slabs work best for austenitic stainless steel machining. Two distinct techniques were used to apply the coatings: PVD AlTiN was deposited in two different thicknesses (2.5m and 5 m) on the same substrate material; CVD TiCN + Al_2O_3 was deposited in two distinct substrates with the same thickness (5 m). The relationship between these material systems' coating and substrate properties and tool performance was investigated. The findings demonstrate that using a layer/carbide alloy that has been manufactured on the surface with the best possible coating/substrate combination increases tool wear efficiency and tool life. Koyee et al.[7]breaks down the research into criteria such necessary cutting forces, consumed cutting power, chip control complexity, and tool wear rate. Various MADM algorithms are used to translate attributes such as chip volume ratios, specific cutting pressures, cutting powers, and cutting forces as a result into single indices. The output of MADA methods is then transformed into a single answer termed Universal Characteristics Index using a Fuzzy Logic Unit (FLU) (UCI).

Sharma et al.[8] examined the effects of machining performance on tool wear and surface quality on dry turning of SS 304 with uncoated and multilayered coated carbide tools. As a result, utilising coated tools resulted in a 25% reduction in tool wear and a 15% drop in Ra when compared to using uncoated tools. Furthermore, when coated tools are used, tool life is increased by almost 200%. Endrino et al.[9] investigated the influence of AlCrN, AlCrNbN, fg-AlTiN, and nc-AlTiN PVD films on wear rate and durability of carbide end mills for finishing when cutting AISI 316L. In the end, the nc-AlTiN coated tool outperformed all others in the post-running wear stage. Majak et al.[10] studied, the feasibility of several natural vegetable oils as long-term machining lubricants utilising a Colechester Master 3250 lathe turning AISI 304 stainless steel. Coconut oil, palm oil, and sunflower oil were among the three natural vegetable oils used. The oils were used as virgin oil and lubrication was done with the smallest amount possible (MQL). The study employed the taguchi method of experiment design. To assess the applicability of these oils in machining AISI 304 stainless steel, cutting speed, feed rate, and depth of cut were utilised as input parameters, while chip w/c ratio and surface quality were employed as responses.. Sunflower oil outperforms other cutting fluids, according to the findings. Singh et al.[11] investigated using PVD-coated carbide cutting inserts and NMQL conditions, the impact of turning parameters like cutting speed, feed rate, and cutting depth on tool geometry and machined surface finish of AISI 304 stainless steel throughout NMQL circumstances on tool flank wear and machined surface quality. The following are the optimum input parameters: Cutting speed is 168.06 m/min, feed rate is 0.06 mm/rev, and cut depth is 0.25 mm, with the following estimated best output response factors: At the 0.753 desirability level, VB = 106.864 m and Ra = 0.571 m. The ANOVA test demonstrates that the depth of cut and the relationship between cutting speed and feed rate are variables with statistical significance impacting tool flank wear, while cutting speed is the most important factor determining surface roughness. Confirmation results demonstrate that both theoretically and experimentally tested values of VB and Ra are 5.70 and 3.71% off, respectively. Kulkarni et al.[12] demonstrated the consequences of AISI 304 austenitic stainless steels being turned dry at high speeds with a nanocrystalline cemented carbide insert with AlTiCrN coating. Nanocrystalline The AlTiCrN coating was applied to the fine-grained K grade cemented carbide inserts using HPPMS and CAE processes. As a consequence, the HPPMS-deposited AlTiCrN coating outperformed the CAE-deposited coating in terms of mechanical and tribological parameters. Due to exceptional adhesion and the creation of a (Al,Cr)₂O₃ mixed oxide coating that is stable, the HPPMS coating outperformed the CAE coating in the phase of post-stable wear. The tool with the HPPMS coating had a tool life 40% longer than before. the tool with the CAE coating. Fernandez-Abia et al.[13] evaluated PVD advanced tools for their ability to convert difficult-to-machine materials. AlTiSiN, AlCrSiN, AlTiN, and TiAlCrN were the four coatings evaluated. Wear tests were conducted, and numerous signals like cutting forces and insert EDX analysis, component roughness, and insert picture evaluation were analysed. According to the findings, nACo® and AlTiN coatings are the best for turning tough materials like austenitic stainless steels, because they provide the best performance. Seid Ahmad et al.[14] investigated that during the machining of austenitic stainless steel AISI 304, how three small jets of pressurised coolant pumped into the tool-to-chip contact affect chip shape and compared the tool's performance under dry and standard circumstances of cooling.

Vineet Dubey and C.K. Dixit

Also investigated the effect of tool wear on the chip generation mechanism during the turning process. As a result, HPC conditions assist in chip breaking apart, resulting in shorter segmented chips, which enhances process efficiency. Additionally, the chip undersurface is smooth, and tribological performance is increased. Nagy et al.[15] used two different PVD coated cutting inserts, dry turning experiments were done on casting of G X2CrNiMoCuN 26-6-3-3 super duplex steel. During the dry cutting of duplex stainless steel, One was TiAlN-coated, while the other was TiAlSiN-coated, and both of them underwent various sorts of wear. During our machining experiments, we saw a lot of burr and built-up edge creation, which harmed the tool edges. The effects of the coatings were not significantly different in the shorter testing. Mahdavejad et al.[16] investigated the turning parameters on AISI 304 stainless steel. Turning experiments were run with and without cutting fluid at three various feed rates (0.2, 0.3, and 0.4 mm/rev) at cutting speeds of 100, 125, 150, 175, and 200 m/min. To demonstrate the effects of each parameter on tool wear and surface integrity, a DOE and (ANOVA) were used. The findings show that the cutting speed and feed rate process parameters have a substantial impact on the AISI 304 stainless steel turning quality. The ideal condition of 175 m/min cutting speed and 0.2 mm/rev feed rate demonstrates excellent turning qualities when cutting fluid is employed, and when compared to dry cutting, the use of cutting fluid extends the tool life. Fernandez-Abia et al.[17] investigated the performance of austenitic stainless steel at extraordinarily high cutting speeds. The austenitic stainless steel AISI 303 was used for the turning tests. Cutting speed has been studied in relation to tool wear, surface smoothness, cutting pressures, and chip geometry. According to the findings, there is an untapped spectrum of cutting speeds that could be suitable for high-precision machining. Stainless steels have a very desirable behaviour, albeit tool wear is severe. Hamdan et al.[18] proposes a method for optimising machining settings for machining high-speed stainless steel with a coated carbide tool to reduce cutting forces and enhance surface roughness. In this study, the commonplace L_9 (3^4) orthogonal array was used. (S/N) ratio descriptive analysis and ANOVA were used to select the most relevant parameters impacting cutting forces and surface roughness for the optimization process..The cutting forces were lowered by 25.5%, and the surface roughness performance was improved by 41.3%. Kaladhar et al.[19] determined the impacts of process factors on surface finish and MRR in order to find the best setting for these factors. In addition, ANOVA is performed to investigate the impact of cutting factors on machining. PVD coated cement inserts (TiCN- TiN) nose radii of 0.4 and 0.8 mm are used to turn AISI 304 austenitic stainless steel work pieces on a CNC lathe. The most critical process parameters affecting work piece surface roughness are feed and nose radius, whereas the cutting depth and feed are important determinants on MRR, according to the findings. Responses are also projected to have an ideal range and level of parameters. Fernandez-Abia et al.[17] investigated the impact of cutting speed on tool wear, surface integrity, cutting pressures, and chip geometry using AISI 303 austenitic stainless steel in turning tests. When machining at standard cutting speeds versus high cutting speeds, these parameters were compared. The results reveal that when cutting at high speeds exceeding 450 m/min, the material suffers a considerable shift in behaviour, which favours the machining process. Korkut et al.[20] performed the impact of tool wear on cutting speed and surface roughness in AISI 304 austenitic stainless steel employing the cutting tools made of cemented carbide was explored, and the optimum cutting speed was

determined. The tool wear was minimised when the cutting speed rises to 180 m/min. Surface roughness (Ra) was similarly reduced as cutting speed was increased. A link was discovered between tool wear/surface roughness and the chips produced at the various cutting speeds of 120, 150, and 180 m/min. Kaladhar et al.[19] demonstrated the machining settings for employing CVD coated cemented carbide tools to convert AISI 202 austenitic stainless steel. According to the study, the feed is the most important factor in determining surface roughness, next by nose radius.

4 Turning of Stainless steel

Turning is a common machining technique for obtaining the desired form and size of materials. Various materials have been turned by a number of researchers.

Table 1. In the turning process, a summary of machining parameters and responses was as follows.

| Authors | Material | Cutting Tool | Response Parameters | Mode of Lubrication | Findings |
|---------------------------|----------------------------|--|--|---------------------|---|
| Ondin et al.[5] | PH 13-8 Mo stainless steel | PVD cutting insert | Surface roughness, and maximum temperature in cutting zone | Dry, NMQL | <ul style="list-style-type: none"> ●With pure-MQL and NMQL, surface roughness was reduced by around 5% and 12%, respectively. ●Flank wear was reduced by 40.2% and 69%, respectively. |
| Fernandez-Abia et al.[17] | AISI 303 | multilayer-coated, and cemented carbide cutting tool | Surface roughness, MRR, Cutting forces, Tool wear | Dry | <ul style="list-style-type: none"> ● As the cutting speed rises, the cutting forces fall, the depth of the deformed area increases as cutting speed increases, and increased cutting speed implies a higher tool wear rate. |
| Mahdavinejad et al.[16] | AISI 304 | Tungsten carbide tool | Tool wear, surface roughness | Dry and wet | <ul style="list-style-type: none"> ●Cutting speed is thought to have a greater impact on flank wear, feed rate has a greater impact on surface roughness. The use of cutting fluid extends the tool's life span and improves the surface polish. |
| Korkut et al.[20] | AISI 304 | Multilayer coated cemented carbide tools | Tool wear, surface roughness | Dry | <ul style="list-style-type: none"> ●As the cutting speed was increased to 180 m/min, tool wear was reduced. Surface roughness (Ra) was similarly reduced as |

| | | | | | |
|-----------------------|------------------|--|--|-----------------|--|
| | | | | | cutting speed was increased.. |
| Seid Ahmad et al.[14] | AISI 304 | Uncoated cemented carbide tools | Surface morphology Tool wear | | <ul style="list-style-type: none"> ●HPC helped to improve tribological performance. Under HPC circumstances, the underside of the chip is smooth and free of flaws., |
| Dyl [2] | DSS AISI 2507 | Carbide inserts. | Tool life and tool wear | Dry | <ul style="list-style-type: none"> ●The CC3 cutting insert type was found to have the least wear and roughness.. |
| Kulkarni et al.[12] | AISI 304 | nanocrystalline AlTiCrN coated cemented carbide insert | Tool wear Surface morphology | - | <ul style="list-style-type: none"> ●For the identical conditions, the HPPMS coated tool had a life span of 24 minutes, while the tool coated with CAE had a life span of 15 minutes. ●The surface of HPPMS films was more consistent and smooth, whereas the CAE coating was permeable and coarse. |
| Hamdan et al.[18] | AISI 304 | Carbide insert coated with titanium aluminum nitride | Surface roughness Resultant cutting force | Dry, Flood, MQL | <ul style="list-style-type: none"> ● The cutting forces were lowered by 25.5% and the surface roughness performance was improved by 41.3%. |
| Majak et al.[10] | AISI 304 | (high cut Inc TNGM160408 E-HC8009) | Chip compression ratio, surface finish | MQL | <ul style="list-style-type: none"> ● Sunflower oil performed better as a cutting fluid, according to the findings. |

5 Drilling

Drilling is a promising technique in a variety of strategic and societal applications, such as oil, gas, geothermal, and mineral reserves exploration and extraction, environmental control and restoration, underground extraction and infrastructure building, scientific analysis of the Earth's subsurface, and production. Various materials have been drilled by a number of researchers.

Handbook of Trends in Engineering Technology and Research

| References | W/P Material | Response Parameters | Cutting Tool | Cutting Fluid | Findings |
|-----------------------|-----------------------|---|--|------------------------------|--|
| Vignesh et al.[21] | SS410 stainless steel | Ovality surface finish MRR | HSS drill bit | Blasocut 4000 strong coolant | <ul style="list-style-type: none"> ● Surface roughness was most influenced by feed, then there's the point angle, and then there's the speed.. ●MRR was most affected by speed, followed by feed and point angle. ●Feed had the most impact on ovality, while point angle had the least impact. |
| Ku et al.[22] | SUS 304 | surface roughness(Ra), bushing length (BL) | tungsten carbide | Dry | <ul style="list-style-type: none"> ● The results revealed that FA and SS were the most important machining parameters for SR, while FCAR was relevant parameter for BL. |
| El-Bahloul et al.[23] | AISI 304 | axial force and bushing length. | tungsten carbide | - | <ul style="list-style-type: none"> ● The research aids in reducing the axial force as a result of the power absorbed in machining is reduced, and the machining cost is reduced.. |
| Pal et al.[24] | AISI 321 | Tool wear | HSS Drill tools | MQL | <ul style="list-style-type: none"> ●Thrust force, torque, surface roughness, and drill tip temperature all decreased by about 44%, 67%, 56%, and 26%, respectively. ● When machining under NFMQL settings, tool wear was greatly decreased. |
| Pradeep et al.[25] | AISI 304 | surface roughness, cutting temperature, and thrust force | Indexable carbide insert tool with TiCN coating. | Flood | <ul style="list-style-type: none"> ●When cryogenic LN2cooling is used, the cutting temperature is reduced, the thrust force is increased, and the surface roughness is reduced.. |
| Gunay et al.[26] | AISI 430 | lowering burr height, thrust force and surface roughness. | uncoated carbide drill | Dry | <ul style="list-style-type: none"> ● According to the findings, When drilling ferritic stainless steel, the cutting speed is just as essential as feed rate. |
| Jayaganth et al.[27] | 410 Stainless Steel | Surface roughness and machining time. | HSS twist drill of | NMQL | <ul style="list-style-type: none"> ●Surface roughness (Ra) values reduced as 'Vc' and 'f' were increased, whereas machining time increased as 'Vc' and 'f' were raised.. |

6 Milling

In the manufacturing industry, the milling process is the most often utilised metal cutting technique. Numerous studies have been conducted on milling process optimization issues.

| References | Material | Response Parameter | Cutting Tool | Lubrication | Findings |
|-------------------------|----------------------------|---|--|--------------------|---|
| Shao et al.[28] | 3%Co–12%Cr stainless steel | surface finish, tool wear | carbide tool of TiCN/TiN | | <ul style="list-style-type: none"> • A three-stage wear structure was identified in the research, with abrasion, attrition, adhesion, and diffusive wear all occurring at different phases. |
| Tansukatanon et al.[29] | AISI 304 | Surface roughness , channel width and burr height and material removal rate | TiAlN-coated tungsten carbide | | <ul style="list-style-type: none"> •The channel width was widened by a feed rate increase of more than 30 mm/min. The use of a 2-meter cut depth can doubled the MRR of a 1-meter depth. •Height of burr and average surface roughness both increased dramatically, resulting in deterioration in cut channel quality. |
| Airao et al.[30] | Super 2507 DSS | surface roughness | coated carbide insert | Dry, wet | <ul style="list-style-type: none"> •The feed rate, followed by cutting speed, is the most crucial component that determines surface roughness, according to the regression equation. Wet machining produces a far superior surface polish than dry machining, according to the findings. |
| Wika et al.[31] | AISI 304L | Tool wear, surface roughness and microhardness | multilayer coated tungsten carbide inserts | MQL, flood coolant | <ul style="list-style-type: none"> •After machining, the Ra value increased marginally for both cooling systems as the cutting speed increased. |
| Yuan et al.[32] | 316L stainless steel | Cutting force Surface roughness flank wear of cutting tool | End mill made of solid carbide with a PVD AlTiN coating. | MQL | <ul style="list-style-type: none"> •The use of scCO₂-OoW as a cooling lubricant for milling was found to be an effective strategy for reducing cutting forces and maintaining a more fluid cutting process than alternative circumstances of cooling. •When the scCO₂-OoW system was employed, the cutting tool operated satisfactorily in all cutting g parameter combinations. The surface finish underneath the scCO₂-OoW situation was substantially superior as compared to scCO₂-MQL, just sc CO₂, and only OoW machining. |

2.4 Grinding: Grinding is a common action in practically all manufacturing processes. It accounts for roughly 20-25 percent of the money spent on machining operations in industries. Grinding is one of the most critical methods for achieving high-quality surface finishes and tight tolerances on components. Numerous studies have been conducted on grinding process optimization issues.

| Authors | Material | Response Parameters | Cutting Tool | Lubrication | Findings |
|--------------------------------|-------------------------|--|--|--------------------|--|
| Mizobuchi and Tashima[33] | Sus304 | Surface Roughness | polyvinyl alcohol (PVA) grinding wheel | Wet (water) | <ul style="list-style-type: none"> When a polyvinyl alcohol (PVA) water from the tap and a grinding wheel were employed at an attachment pressure as the grinding fluid, the sheet's roughness could be reduced. |
| Rodriguez et al.[34] | AISI 4340 steel | surface roughness and surface micro-hardness surface integrity grinding efficiency | Conventional white Al ₂ O ₃ grinding wheel | MQL | <ul style="list-style-type: none"> The HMQL+WCJ fared better than the PMQL+WCJ in terms of surface roughness, resulting in a lower surface roughness. Due to its increased cooling capacity, on GWAS, HMQL+WCJ approaches caused reduced congestion. HMQL+WCJ procedures grind workpieces with a 28.2% higher performance than PMQL+WCJ. |
| Zhou Pong, and Petttersson[35] | 304L | normal grinding force, grinding surface temperature, MRR | conventional aluminum oxide grinding wheel | 3% of Mobilcut 321 | <ul style="list-style-type: none"> The rate of metal removal was greatly improved by grinding and lubrication. Using smaller abrasive grits improves surface finish and deformation while improving machine power, increasing surface deformation and minimising surface flaws. |
| Nie et al.[36] | 2Cr12Ni4 Mo3VNb N steel | Grinding force | Single grit grinding process | Dry | <ul style="list-style-type: none"> Cutting speed and cutting depth have a linear connection for both the normal and tangential forces. |

| | | | | | |
|--------------------------------|-----------------------------|---|----------------------------------|-----|--|
| Tamil vanan et al.[37] | AISI 304 stainless steel | Surface morphology | Silicon carbide | Dry | <ul style="list-style-type: none"> • The findings demonstrated that a shallower cut created a higher-quality surface than a deeper cut. |
| Zhou Peng Schonning et al.[38] | 2304 Duplex Stainless Steel | Surface Topography and Surface Roughness, residual stress | conventional aluminum oxide grit | Dry | <ul style="list-style-type: none"> • Both parallel and transverse grinding greatly increased surface roughness. |

7 Conclusions And Future Scope

The applications, machining, and the future study of metallurgy of austenitic stainless steels have all been canvassed in this work. The following are some of the inferences that can be drawn, based on an examination of the literature on austenitic stainless steel machining. Despite the fact that austenitic stainless steels are utilized more frequently compared to other grades, It's difficult to manufacture them.

The majority of the study is done on austenitic stainless steels in the 300 family, according to the literature review. As a consequence of rising price of nickel, the main elements of 300 grades and the stainless steels in the 200 series that are austenitic are becoming more feasible proxy to 300 series. Duplex stainless steel is currently undergoing rapid development, with a great potential for success in a variety of new markets.

- Duplex stainless steel is tough to machine. For each corrosion resistance level, the Duplex is an alternative to challenging the austenitic grade. SAF2202 is a 304 substitute, SAF 2305 is a 316L substitute, SAF2205 and super duplex, on the other hand, are both 316LMN replacements.
- Duplex stainless steels are extremely low alloying grades in comparison to the other duplex grades, and they are difficult to work with when it is hot. Duplex steel production accounts for 85% of overall output.
- Higher cutting speed (V_c), smaller depth of cut(d), lower feed rate(f) and higher nose radius are favoured for achieving AISI 202 steel with an excellent surface polish.
- More attention must be devoted in drilling, the effect of MQL with nanofluid in the field of machining operations.
- Surface roughness and burr height are two significant quality parameters in drilling operations that are given top priority in most research studies. Surface roughness (R_a) is significant in terms of quality control and production process planning. In various cases, such as sections sensitive to surface roughness, fatigue stresses, precision fittings, fastener holes, and aesthetic criteria has been a significant design characteristic and quality metric.
- A continuous MQL supply system outperformed an interrupted MQL supply system in terms of the tool's lifespan.

- When compared to traditional flood cooling grinding, using an optimally designed MQL lowered tangential as well as conventional grinding force and surface roughness(Ra). End milling at high speeds, MQL milling demonstrated outstanding cutting performance. Under all three cooling situations, MQL, flood, and dry, it had the least amount of flank wear.
- The impact of coatings on tool on the work piece can also investigated, as multilayer tools with a coating greatly enhance machinability of certain steels. It's also worth noting that there isn't much discussion on the high-speed machining behaviour of austenitic stainless steels

The effects of various cutting fluids were also looked into. However, only a few researchers have employed multi-coated tools and optimization techniques to machine austenitic stainless steel. Finally, it is indicated that research on machining of 200 series grade has enough potential. Future research can look into the durability of nanofluids, the efficiency of hybrid nano-cutting fluids, the impact of MWCNTs and various nanomaterials on various cutting tool substances, and the time span required to keep flowing the nanofluids integrity.

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Vineet Dubey and C.K. Dixit

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Vineet Dubey and C.K. Dixit

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Potential Model for Binding Energy of First and Second Row Diatomic Molecules

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Abstract

A model-potential method is employed to calculate binding, elastic scattering, and annihilation of positrons for a number of atoms and small nonpolar molecules. The model potential contains one free parameter for each type of atom within the target. Its values are chosen to reproduce existing ab initio positron-atom binding energies or scattering phase shifts.

Keywords: Mesons, Binding Energy, Spin and IsoSpin Interactions.

1 Introduction

The binding energy of diatomic molecules may be defined as the energy change in the process of transformation of the gaseous molecules to the separate ions. The nature of binding in the diatomic molecules has been a subject of considerable discussion during last decades, because the nature of binding energy in diatomic molecules plays an important role in spectroscopic studies of the molecules. Various spectroscopic properties of molecules can be predicted with the knowledge of exact nature of binding energy between the atoms of the molecules. It is a common practice to calculate the binding energies by considering the potential functions. The accuracy of the result depends upon the Nature of interaction potential and the accuracy of the molecular constants used in the calculation.

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Spectroscopic data for most of the diatomic hydrides and halides, available in the literature[1], have been used for the estimation of binding energy for these compounds. Various attempts have been made to compute the properties of a number of diatomic ionic molecules in the gaseous state on the basis of different interaction potentials. Some workers [2-8] have also attempted to correlate the experimentally observed values of binding energy with satisfactory models. On the basis of ionic models proposed by Rittner[11] , Brewer Mastick [9] and Klemper - Margrave[10], gaseous alkali metal halides and hydrides have been treated successfully.

The binding energy in the molecules arises from purely electrostatic interaction between ions which include charge – charge interaction, charge - dipole interaction, dipole- dipole interaction and quasi-elastic energy stored in the induced dipoles.

It also arises, in the light of Born- Mayer lattice theory from repulsive term of the empirical form, a van der waals interaction term and kinetic energy terms representing the difference in translational, rotational and vibrational energies between molecules and free ions of which it is composed. According to Margrave[3], binding in alkali halides may be fairly well described using only e^2/r term for the ionic binding energy. But according to shankar et al[12], e^2/r for all the hydrides under present study is less than the magnitude of the total experimental potential energy, which indicates that the charges on the ions in diatomic hydrides under study can not be taken simply as +e and –e . They have taken the ionic charges as +Ze and -Ze . Such a model can be supported from the consideration based on the nature of the chemical bond [13].

The evaluation of binding energy of diatomic molecules using appropriate form of interaction potential energy functions has been a subject of extensive studies for the last several decades. In the present section, expressions for the binding energy of diatomic molecules have been derived considering the different potential functions including the proposed new potential function. The potential functions have been assumed to be consist of the following terms :

- (i) Electrostatic , e^2/r and
- (ii) Repulsion of the form –
 - a. Exponential
 - b. Gaussian and
 - c. Logarithmic

In the present work the binding energy of spectroscopically popular fourteen diatomic molecules viz. LiH, BeH, BH, CH, NH, OH, HF, NaH, MgH, AlH, SiH, PH,SH and HCl have been computed by using different forms of potential energy functions including the newly proposed potential function. A comparative study of the result suggests that the new potential model gives the best results for the binding energies of all the fourteen diatomic molecules.

2 Theoretical

a. Previous Potential Model

The binding energy, D_i can be obtained by applying the following condition in the model.

$$D_i = -U(r_e) \quad (1)$$

The following interaction potentials have been considered :

b. Born – Mayer[14]

$$U(r) = -e^2/r + A \exp(-r/\rho) \quad (2)$$

c. Gaussian[15]

$$U(r) = -e^2/r + p \exp(-kr^2) \quad (3)$$

d. Logarithmic[16-18]

$$U(r) = -e^2/r + p \log(1 + p/r^4) \quad (4)$$

$$U(r) = -e^2/r + Q \log(2 + q/r^2) \quad (5)$$

$$U(r) = -e^2/r + D \log(4 + d/r^4) \quad (6)$$

$$U(r) = -e^2/r + M \log(3/2 + m/r^{3/2}) \quad (7)$$

All these three potential energy functions (4-6) can be labelled as Pot (1), Pot (2) and Pot(3) or L_1 , L_2 and L_3 respectively, amalgamated to a general form :

$$U(r) = -e^2/r + P_n \log(4/n + P_n/r^n) \quad (8)$$

$$n = 1, 2, 4$$

The potential energy function labelled in eq. (7) will be referred to Pot (4) or L_4 .

In Eqs. (2)- (7), A, P, p, Q, q, D, d, M and m are the potential parameters. These parameters can be determined by using the following molecule stability and force constant conditions :

$$U'(r) = 0 \quad (9)$$

$$U''(r) = k_e \quad (10)$$

A. K. Pandey and C.K. Dixit

Where $U'(r)$ and $U''(r)$ refer to the first and second derivatives of $U(r)$ and r_e is the internuclear distance.

On imposing the conditions (9) and (10) to potentials (2) to (7), we get the following expressions, respectively, for the binding energy, D_i

$$D_i = e^2/r_e [1 - (k_e r_e^3 / e^2 + 2)^{-1}] \quad (11)$$

$$D_i = \frac{e^2}{r_e} \left[1 - \left(\frac{k_e r_e}{e^2} + 3 \right)^{-1} \right] \quad (12)$$

$$D_i = \frac{e^2}{r_e} \left[1 - \left(\frac{r_e^4 - r_e^4 (k_e r_e^3 - 3e^2) / (k_e r_e^3 + e^2)}{-4r_e^4 (k_e r_e^3 - 3e^2) / (k_e r_e^3 + e^2)} \right) \times \right. \\ \left. \log \left(1 - \frac{r_e^4 (k_e r_e^3 - 3e^2) / (k_e r_e^3 + e^2)}{r_e^4} \right) \right] \quad (13)$$

$$D_i = \frac{e^2}{r_e} \left[1 - \left(\frac{r_e^4 - 2r_e^2 (k_e r_e^3 - e^2) / (k_e r_e^3 + e^2)}{-2(2r_e^2 (k_e r_e^3 - e^2) / (k_e r_e^3 + e^2))} \right) \times \right. \\ \left. \log \left(2 - \frac{2r_e^2 (k_e r_e^3 - e^2) / (k_e r_e^3 + e^2)}{r_e^3} \right) \right] \quad (14)$$

$$D_i = \frac{e^2}{r_e} \left[1 - \left(\frac{4r_e - (4k_e r_e^4) / (k_e r_e^3 + e^2)}{-(4k_e r_e^4) / (k_e r_e^3 + e^2)} \right) \times \right. \\ \left. \log \left(4 - \frac{(4k_e r_e^4) / (k_e r_e^3 + e^2)}{r_e} \right) \right] \quad (15)$$

$$D_i = \frac{e^2}{r_e} \left[1 - \frac{2}{3} \left(\frac{2(k_e r_e^3 + e^2)}{(e^2 - 2k_e r_e^3)} + 1 \right) \times \right. \\ \left. \log \left(\frac{3}{2} + \frac{3}{4} \left(\frac{e^2 - 4k_e r_e^3}{(e^2 + k_e r_e^3)} \right) \right) \right] \quad (16)$$

3 New form of Logarithmic potential Function :

In the present study, we have proposed a new logarithmic potential model of the form,

$$U(r) = m \left[\frac{-e^2}{r} + G \log \left(1 + \frac{g}{r^n} \right) \right] \quad (17)$$

Where G and g are potential parameters which are characteristics of the molecules. This new potential function will be labelled as Pot (5) or L₅. The value of force F(r) is given by ,

$$F(r) = -dU/dr \quad (18)$$

$$F(r) = m [-e^2/r^2 + nGg / r(r^n + g)] \quad (19)$$

The application of molecular stability and force constant conditions (9) and (10) to the potential function (17) yields the following expression :

$$g = r_e^n (n-1 - A/m) / (1 + A/m) \quad (20)$$

and

$$G = \frac{e^2}{r(n-1 - A/m)} \quad (21)$$

where ,

$$A = k_e r_e^3 / e^2 \quad (22)$$

From the above expression (20) we apply the condition $n < (1 + A/m)$, so that g should have negative values. For this we consider n and m as the function of constant r_e and k_e as,

A. K. Pandey and C.K. Dixit

$$n = f_1 (r_e, k_e) \quad (23)$$

$$m = f_2 (r_e, k_e) \quad (24)$$

Empirically we consider n as ,

$$n = 0.6 + k_e r_e^3 / m e^2 \quad (25)$$

or

$$n = 0.6 + A/m \quad (26)$$

and

$$m = 1 + 1.6/ A \quad (27)$$

It is obvious from Eq. (26), that the value of n is not fixed for the diatomic molecules as in the case of the models, L₁, L₂, L₃ and L₅. But the value of n changes from molecules to molecules, so that the potential energy curve should tend to infinity in positive side at a particular value of U(r) as shown in figure –(1).

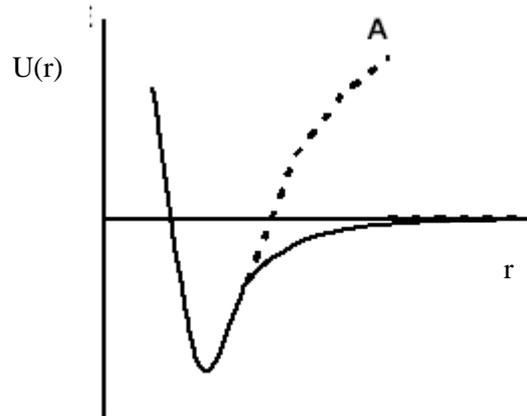


Figure-1

For the binding energy, D_i , according to new model L₅ using.

$$D_i = - U (r_e)$$

We obtained the following expression for the binding energy.

$$D_i = m e^2/r_e \left[1 - \frac{1}{\left(n - 1 - \frac{k_e r_e^3}{m e^2}\right)} \log \left(\frac{n}{1 + \frac{k_e r_e^3}{m e^2}} \right) \right] \quad (28)$$

4 Result and Discussion:

The binding energy of fourteen diatomic molecules (12 different hydride molecules and two hydrogen halide molecules) have been computed using seven forms of potential energy functions including the new potential function. A comparative graphical study has been made and it is found that the new potential model yields the best results for the binding energies of all the fourteen diatomic molecules. These molecules include LiH, BeH, CH, NH, HF, NaH, MgH, AlH, SiH, PH,SH and HCl. These spectroscopically popular molecules have been chosen for three fold reasons -

- (i) These molecules (except , LiH, NaH and BeH) have been investigated rarely by potential model.
- (ii) These molecules are co- valent than they are ionic so that the present investigation will indicate whether an ionic model can be applied to these molecules.
- (iii) To test the relative merits of the various popular potential models for these molecules.

It is crystal clear from figure (2) that Born – Mayer[14] and Gaussian[15] potential models have been found to be highly successful in reproducing the various properties of most commonly investigated alkali halides molecules. However, these models have not been found to be successful when applied to these hydrides under the present study. Therefore, we have selected the logarithmic potential which yields better results for these molecules. The computed values of binding energy, according to the eqs (11) to (16) and (28) are listed in Table (1)

It is evident from Table (1) and figure (2) that the Born - Mayer[14] potential which has been most widely used for various molecules yields the poor results for the binding energy of these hydride molecules, giving an average percentage deviation (APD) of 24.3 with the experimental values. The best agreement with experimental values is obtained from the new logarithmic potentials. The logarithmic potentials suggested by Thakur, eqs (5) and (6), appear to be successful in predicting the binding energy of the diatomic molecules. Various potential models used for the present study can be arranged in the order of superiority for these hydrides as :

$$L_5 > L_2 > L_3 > GP > BM > L_4 > L_1.$$

These hydrides are more covalent than they are ionic However, the present study indicates that the ionic model could be used to get reasonable results for the covalent molecules as well. It is well known that on the basis of the magnitude of the contribution of the ionic structures to the normal state[20] of

A. K. Pandey and C.K. Dixit

the molecules in the hydrogen fluoride is 45 percent, that is hydrogen chloride[20] 17 percent. The new L_5 model gives APD 3.0 for hydrogen fluoride and 31.3 APD for hydrogen chloride which is the highest in all the seven models for these diatomic molecules. Quite a few quantum mechanical treatments are also available for such molecules which are rather cumbersome and perhaps formidable in certain cases. But the ionic model could be used safely to obtain a quick estimate of the properties of such molecules.

The new potential model L_5 has been proved good for the various molecules under the present study. These can be arranged in order of applicability to model L_5 as BH, HF, LiH, AlH, BeH, NaH, MgH, CH, SiH, SH, NH, PH and HCl.

For PH and HCl the error is largest according to all the models. It is very interesting to note that the Born Mayer and Gaussian potentials gives very good results for LiH and NaH, the ionic molecules and yields bad results for the covalent molecules and reverse in for the logarithmic potentials.

Table – 1

The computed values of binding energy, D_i , from different potential models for first and second row diatomic molecules (in kJ mole^{-1})

| Sl.No. | Molecule | D_i (Exptl.) | Born Mayer (BM) | Gaussian (GP) | Logarithmic potential functions (kJ mole^{-1}) | | | | |
|------------------------------|----------|-------------------|-----------------------|------------------|---|---------|---------|---------|---------|
| | | | | | L_1 | L_2 | L_3 | L_4 | L_5 |
| 1. | LiH | 677.2 | 641.8 | 688.60 | 611.40 | 1280.49 | 1039.75 | 722.27 | 689.11 |
| 2. | BeH | 1015.0 | 797.52 | 841.37 | 752.73 | 1169.35 | 1106.40 | 809.71 | 852.92 |
| 3. | BH | 1085.2 | 674.21 | 920.18 | 824.08 | 1283.48 | 1189.97 | 878.09 | 934.48 |
| 4. | CH | 1341.7 | 976.82 | 1022.59 | 918.11 | 1289.72 | 1279.11 | 958.18 | 1046.16 |
| 5. | NH | 1683.6 | 1064.60 | 1111.28 | 999.12 | 1360.78 | 1352.22 | 1032.45 | 1166.45 |
| 6. | OH | 1680.8 | 1149.89 | 1195.83 | 1077.00 | 1416.52 | 1421.21 | 1100.84 | 1148.76 |
| 7. | HF | 1544.0 | 1223.90 | 1270.85 | 1146.92 | 1476.82 | 1437.46 | 1108.46 | 1309.89 |
| 8. | NaH | 816.3 | 663.33 | 895.88 | 532.48 | 849.35 | 799.23 | 679.58 | 602.83 |
| 9. | MgH | 853.3 | 637.08 | 655.25 | 898.00 | 817.60 | 812.20 | 618.70 | 688.19 |
| 10. | AlH | 779.9 | 678.35 | 704.99 | 653.23 | 828.08 | 832.52 | 647.52 | 723.85 |
| 11. | SiH | 1044.3 | 750.92 | 775.29 | 701.08 | 861.45 | 875.54 | 702.36 | 801.27 |
| 12. | PH | 1274.0 | 813.33 | 836.45 | 758.17 | 902.37 | 920.59 | 753.08 | 868.24 |
| 13. | SH | 1262.6 | 873.72 | 895.40 | 813.49 | 942.65 | 963.46 | 802.74 | 933.45 |
| 14. | HCl | 1631.0 | 924.59 | 946.07 | 864.48 | 986.00 | 1008.14 | 846.95 | 988.28 |
| Average percentage deviation | | | 24.8 | 24.2 | 27.6 | 17.8 | 18.8 | 26.7 | 11.9 |

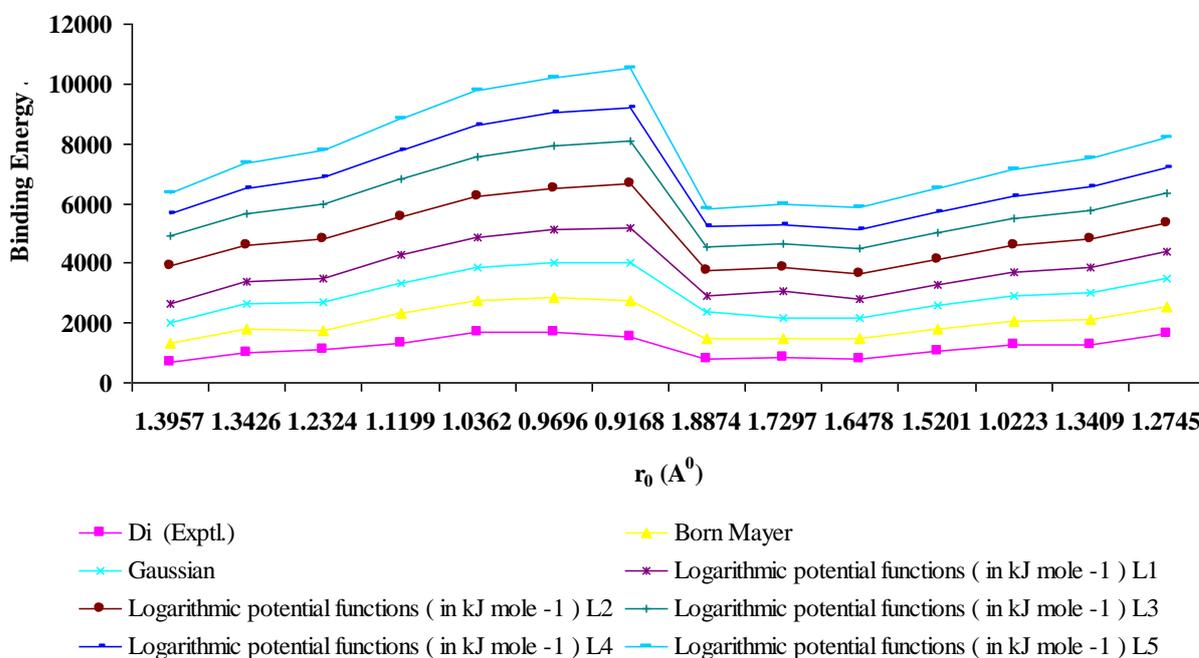


Figure 2 The variation of computed values of binding energy, D_i , from different potential models for first and second row diatomic molecules with interatomic distance

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Micropolar Fluid Model for Blood Flow through a Small Tapered Tube

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Abstract

The steady flow of blood through a small rigid circular tube with small tapering angles of 1° and 2° is analysed by a micro-continuum approach using the boundary conditions proposed by Ariman et al. [J Appl. Mech. (March 1974),1]. Analytical expression for flow velocity, micro-rotational velocity, volume flow rate and shear stress at blood vessel wall are obtained. The influence of hematocrit, Reynolds number and tapered angles on the flow characteristics are discussed. As the tapered angle increases the wall shearing stress increases resulting in a decrease in the velocity.

Keywords: Reynold's Number, Rotational Viscosity, Rotational Gradient Coefficient, Micro rotational Velocity.

1 Introduction

The theory of flow of blood in a small blood vessel dates back to the classic work of Poiseuille. The behavior of blood flow is principally due to the particles of suspensions of cells in an aqueous solution of plasma. Because of the presence of the suspended particles in plasma, there have been many attempts to explain the anomalous behavior of blood by proposing different theoretical models such as micropolar, Casson's fluid, etc. The use of micropolar fluid theories for blood have been suggested in various forms by several authors [1-3]. In each case it has been shown that the mean velocity profile for the polar fluid flow in a tube is flatter than the parabolic profile for the Newtonian fluid. The rotational viscosity (μ_R)

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Dr. Rajendra Kumar Tripathi

and rotational gradient coefficient (\odot) are determined as a function of hematocrit from the experimental in vitro blood flow data [4].

Models of the circulation generally comprise a collection of segments each of which is a uniform cylindrical tube [5-6]. Since the vessels bifurcate at frequent intervals, and although the individual segments may be approximately uniform between branch points, the diameter varies quite rapidly with respect to distance because of reduction in the vessel diameter at each bifurcation. Thus it is believed that even for the small angles of taper that have been reported i.e. up to 2° , the effect of taper cannot be neglected. The tapered tube model for blood vessels was suggested by Womersley[9] and has been discussed by Streeter et al[10]. It is also evident from the sketches found elsewhere[11] that blood vessels are tapered and branched in the flow directions. Therefore, for the understanding of the complex rheological problems of blood one would not only take into account the blood model but the geometrical shape of the vessels also.

In this chapter we approximate the nature of blood to be a micropolar fluid flowing in a rigid tube of small tapering. Also according to the experimental observation[11-12], the pressure gradient remains constant until the stenosis reached 80% Therefore, we have considered the constant pressure gradient throughout the analysis. Using these assumptions, we have obtained analytical expressions for flow velocity, micro-rotational velocity, shear stress at the wall and flow rate. We have also included the expressions for velocity profiles when the axial pressure gradient is a function of axial coordinate.

2 Formulation of the Problem

Application of Eringen's[13] micropolar continuum theory to a general blood flow has already been discussed by Ariman et al[14]. The continuity equation and the equations of motion for the micropolar fluid in vectoral form can be expressed as

$$\frac{\partial}{\partial t} + \nabla \cdot (\rho V) = 0 \quad (1)$$

$$\begin{aligned} (\lambda_s + 2\mu)\nabla(\nabla V) - (\mu + K)\nabla \times \nabla \times V + 2K\nabla \times v - \nabla\pi_t + \rho f \\ = \left[\frac{\partial V}{\partial t} - V \times (\nabla \times V) + \frac{1}{2}\nabla(V^2) \right] \end{aligned} \quad (2)$$

$$(\alpha_s + \beta + \gamma)\nabla\nabla \cdot v - \gamma\nabla \times \nabla \times v + 2K\nabla \times V = 4Kv - \rho I + \rho j \frac{\partial v}{\partial t} \quad (3)$$

where π_t = thermodynamic pressure, f = body force per unit mass, I = body couple per unit mass, and j = micro-inertia coefficient and $\lambda_s, \mu, K, \alpha_s, \beta, \gamma$ are the material and viscosity coefficients.

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In this model blood vessels are represented by circular tubes. Hence, cylindrical polar coordinate system (r, θ, z_1) representing the radial, azimuthal and axial coordinate has been considered.

The assumptions made in formulating the problem are as follows :

1. The fluid simulating blood is steady and incompressible.
2. The flow is axisymmetric such that

$$\frac{\partial}{\partial \theta} = 0, v_{\theta} = 0 \text{ and } v_r = v_z = 0 \quad (4)$$

3. The red blood cells are neutrally buoyant; under flow condition the setting tendency of erythrocytes negligible.
4. No body forces and no body complexes are present.
5. The tube simulating the arterial wall is thin walled. tapered, homogeneous and isotropic.

Under these assumptions and also the assumptions made by Tanner[15], the above field equations approximate to

$$\frac{1}{\eta} \frac{\partial}{\partial \eta} \left(\eta \frac{\partial u}{\partial \eta} \right) + \frac{2Re}{(Re + Rm)} \frac{1}{\eta} \frac{\partial}{\partial \eta} (\eta w) = \frac{\partial P}{\partial z} \quad (5a)$$

$$\frac{\partial p}{\partial \eta} = 0 \quad (5b)$$

$$\frac{\lambda}{2} \frac{\partial}{\partial \eta} \left[\frac{1}{\eta} \frac{\partial}{\partial \eta} (\partial w) \right] - 2\sigma \left(\frac{\partial u}{\partial \eta} + 2w \right) = 0 \quad (6)$$

$$\frac{\partial u}{\partial z} + \frac{1}{n} \frac{\partial}{\partial \eta} (\eta v) = 0 \quad (7)$$

Where,

$$u = \frac{U_{z1}}{U_o}, v = \frac{v_r}{U_o}, v_{\theta} = \frac{U_o \omega}{R_o}, Z = \frac{Z_1}{R_o}$$

Dr. Rajendra Kumar Tripathi

$$\eta = \frac{r}{R_o}, Re = \frac{\rho U_o R_o}{\mu}, Rm = \frac{\rho U_o R_o}{K}$$

$$P_{z1} = \frac{U_o(\mu + K)P}{R_o}, \lambda = \frac{\gamma}{\rho U_o R_o j}, \sigma = \frac{R_o K}{\rho U_o j} \quad (8)$$

Here. U_{z1} and v_r are velocity components in the axial (z_1) and radial (r) directions, v_ω is the component of particle spin R_o and U_o , represent characteristic radius and fluid velocity, ρ is mass density, j is micro-inertia moment, P_{z1} , is fluid pressure, Re and Rm represent Reynolds number and micropolar Reynolds number respectively.

The taper of the tube is given by Skalak et al [16].

$$R'_1 = R_o (1 - \alpha_1 z_1)$$

where

$$\alpha_1 = \frac{L - \beta}{L_1}$$

using non-dimensional parameter

$$\alpha = \alpha_1 \cdot R_o, R_1 = R'_1 = \frac{R'_1}{R_o} \quad (9)$$

we get $R_1 = 1 - \alpha z$

Here, the constant β is the ratio of two successive radii or lengths: L_1 , is the length of the first segment and α is the tapered angle

The appropriate boundary conditions are given by

$$u(R_1) = v(R_1) = 0$$

$$\frac{1}{\eta} \frac{\partial(\eta\omega)}{\partial\eta} = 0 \text{ at } \eta = R_1 \quad (10)$$

$$\omega = 0 \text{ at } r=0$$

The Solutions

$$\frac{\partial P}{\partial z} = \text{constant}$$

On solving Eqs (5)-(7) using the boundary conditions (10), we obtain

$$u(l, z) = \frac{1}{4} \frac{Re + Rm}{Rm} \left(-\frac{\partial p}{\partial z} \right) \left[R_1^2 - n^2 + \frac{4Re}{\lambda^2(Re + Rm)} \left\{ \frac{I_0(\lambda n)}{I_0(\lambda R_1)} - 1 \right\} \right] \quad (11)$$

$$v(z) = \frac{\alpha}{4} \frac{Re + Rm}{Rm} \left(\frac{\partial p}{\partial z} \right) \left[-\frac{R_1}{n} (R_1^2 - n^2) + \frac{4Re I_1(\lambda R_1)}{\lambda^2(Re + Rm)n} \left\{ \frac{R_1 I_1(\lambda R_1) - n I_1(\lambda n)}{I^2(\lambda R_1)} \right\} \right] \quad (12)$$

$$u(l, z) = \frac{1}{4} \frac{Re + Rm}{Rm} \left(-\frac{\partial p}{\partial z} \right) \left[n - \frac{2I_1(\lambda \eta)}{I_0(\lambda R_1)} \right] \quad (13)$$

where

$$\lambda^2 = \frac{4\sigma Rm}{\lambda(Re + Rm)} \quad (14)$$

and I_0 and I_1 , are the modified Bessel's functions of zeroth and first order respectively.

The volumetric flow rate is given by

$$Q(z) = \frac{\pi}{2} \frac{Re + Rm}{Rm} \left(-\frac{\partial p}{\partial z} \right)$$

Dr. Rajendra Kumar Tripathi

$$\left[\frac{R_1^4}{4} + \frac{2R_e R_1}{\lambda^3 (Re + Rm)} \left\{ \frac{2I_1(\lambda R_1) - R_1 \lambda I_0(\lambda R_1)}{I_0(\lambda R_1)} \right\} \right] \quad (15)$$

Using the following formula for the shear stress on the wall [17]

$$Tw = \frac{1}{Re} \left(1 + \frac{Re}{Rm} \right) \frac{\partial u}{\partial \eta} \Big|_{\eta = R_1} + \frac{w}{Rm} \Big|_{\eta = R_1} \quad (16)$$

and on substituting the value of u and w from Eqs (11) and (13) in Eq. (16), we get the shear stress on the wall as

$$Tw = \frac{1}{Re} \frac{Re + Rm}{Rm} \left(-\frac{\partial u}{\partial n} \right) \left[-R_1 \left(\frac{2}{Re} + \frac{1}{Rm} \right) + \frac{2I_2(\lambda R_1)}{\lambda Rm l_0(\lambda R_1)} \right] \quad (17)$$

Non-constant axial pressure gradient also constitutes possible cases under the problem which can be solved. Therefore, in this section we have taken the axial pressure gradient as a function of z . Then the solutions of Eqs (5)-(7) with the help of Eqs (10) are given as follows:

$$u(\eta, z) = \frac{1}{4} \frac{Re + Rm}{Rm} \left\{ -\frac{\partial p}{\partial z}(z) \right\} [R_1^2 - n^2 + \frac{4Re}{\lambda^2 (Re + Rm)} \left\{ \frac{I_0(\lambda \eta)}{I_0(\lambda R_1)} - 1 \right\}] \quad (18)$$

$$v(\eta, z) = \frac{\alpha}{4} \frac{Re + Rm}{Rm} \left\{ -\frac{\partial p}{\partial z}(z) \right\} \left[+ \frac{R_1}{n} (R_1^2 - n^2) - \frac{4R_e l_1(\lambda R_1)}{\eta \lambda^2 (Re + Rm)} \left\{ \frac{R_1 l_1(\lambda R_1) - n I_1(\lambda \eta)}{I_0^2(\lambda R_1)} \right\} \right] - \frac{1}{4} \frac{Re + Rm}{Rm} \left(-\frac{\partial^2 p}{\partial z^2} \right) \left[\frac{(-2\eta^2 R_1^2 + \eta^4 + R_1^4)}{4\eta} - Re \left[\frac{\{2\eta I_1(\lambda \eta) - 2R_1 l_1(\lambda R_1)\} - \lambda l_0(\lambda R_1)(\eta^2 - R_1^2)}{\lambda^3 (Re + Rm) \eta l_0(R_1)} \right] \right] \quad (19)$$

$$w(\eta, z) = \frac{1}{4} \frac{Re + Rm}{Rm} \left\{ -\frac{\partial p}{\partial z}(z) \right\} \left[\eta - \frac{2I_1(\lambda \eta)}{\lambda l_0(\lambda R_1)} \right] \quad (20)$$

3 Results and Discussion

We have carried out the analysis for a narrow vessel considering the geometrical shape of the vessels for velocity profile, micro rotations, volumetric flow rates and wall shearing stresses. We have observed the effects of hematocrit and taper nature of the blood vessels on flow characteristics. We have also calculated the radial velocity from the equation of continuity. But it is obvious that it will be very small because it is a product of the tapered angle (α), which is very small. Therefore, this quantity is not important in comparison to others (ie, axial velocity, micro rotational velocity flow rate and wall shear stress). Hence no discussion has been given explicitly. The numerical values of the various parameters have been taken from Chaturani and Upadhyay [18]. We have taken the constant pressure gradient throughout the numerical analysis, because constant pressure gradient is one of the possible cases (as regards the conservation of mass, momentum and energy) under which the problem can be solved, and can be verified by experimental observations [11,12].

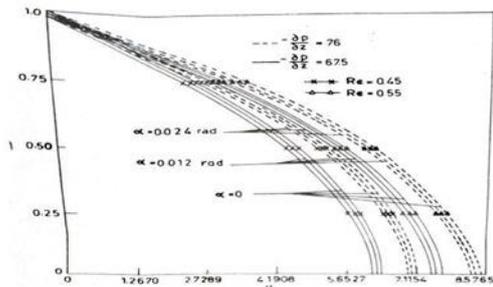


Fig. 1—Variation of axial velocity with the radius of the tube for different values of tapered angle, pressure gradient and Reynolds number [Diameter = $40 \mu_m$, $\alpha = 40^\circ$, R.B.C. = $z = 0.50$]

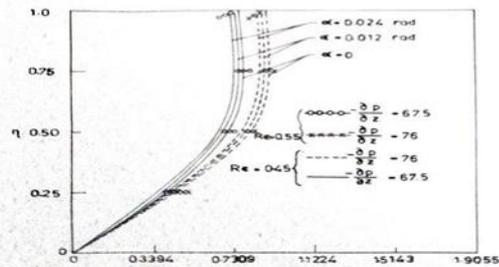


Fig. 2—Variation of rotational velocity with the radius of the tube for different values of tapered angle, pressure gradient and Reynolds number [Diameter = $40 \mu_m$, $\alpha = 40^\circ$, R.B.C. = $z = 0.50$]

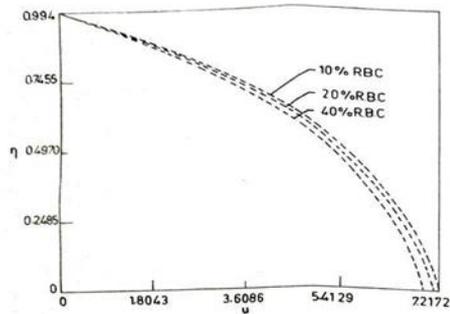


Fig. 3—Plot of axial velocity vs radial coordinate for different values of hematocrit [Diameter = $40 \mu_m$, $\alpha = 0.012$, $Re = 0.45$, $-\frac{\partial P}{\partial z} = 76$, $z = 0.50$]

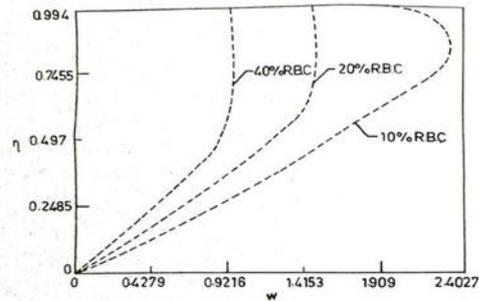


Fig. 4—Plot of rotational velocity vs radial coordinate for different values of hematocrit [Diameter = $40 \mu_m$, $\alpha = 0.012$, $-\frac{\partial P}{\partial z} = 76$, $Re = 0.45$, $z = 0.50$]

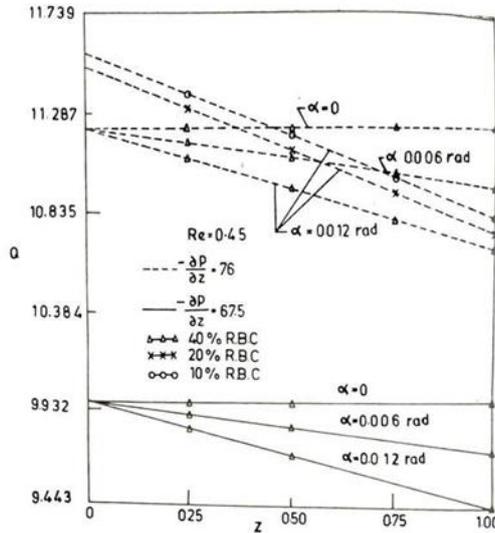


Fig. 5—Plot of volume flow rate vs axial coordinate for different values of tapered angle, pressure gradient and hematocrit [Diameter = 40 μ_m]

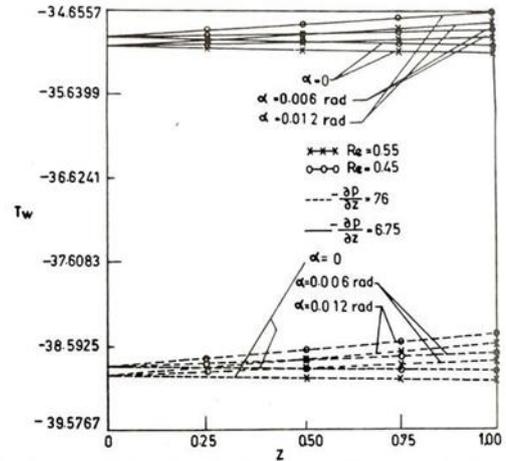


Fig. 6—Variation of wall shear stress with respect to axial coordinate for different values of pressure gradient tapered angle and Reynolds number [Diameter = 40 μ_m , 40% R.B.C.]

Figs 1 and 2 show the variation of axial velocity and micro rotational velocity with radial coordinate for different values of taper, pressure gradient and Reynolds number. The axial velocity and micro rotational velocity increase with increasing Reynolds number and pressure gradients but decrease with increasing taper. Further, the axial velocity and micro rotational velocity in a tapered tube are smaller than those in a straight tube.

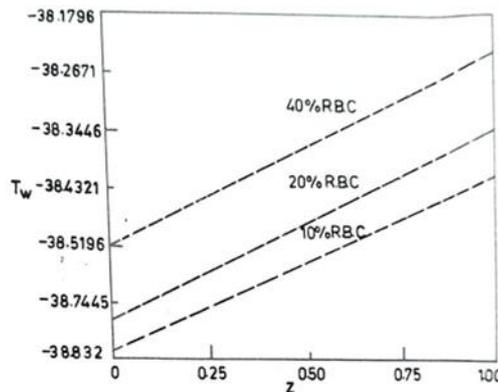


Fig. 7—Variation of wall shear stress with the axial coordinate for different values of hematocrit [Diameter = 40 μ_m , $\alpha = 0.012$, $Re = 0.45$, $-\frac{\partial P}{\partial z} = 76$]

Figs 3 and 4 show the variation of axial velocity and micro-rotational velocity with radial

Handbook of Trends in Engineering Technology and Research

coordinate for various values of hematocrit. As the hematocrit decreases there is an increase in the axial velocity and micro rotational velocity. It is in good agreement with the results obtained by Ariman et al[14].

Fig. 5 shows the variations of volumetric flow rate with to axial coordinate for different values of taper, pressure gradients and hematocrit. The volume flow rate decreases with increasing taper and hematocrit, but increases with increasing pressure gradients.

Fig. 6 shows the variation of wall shear stress with the axial coordinate for various values of pressure gradient, tapered angle and Reynolds number. The wall shear stress decreases with increasing pressure gradients, and decreasing Reynolds number and tapered angle. The wall shear stress is high at high hematocrit (Fig. 7).

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A State of Art Review on The New Innovations and Research in Education

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Abstract

In a knowledge-based society, the technology functions as a tool for enlightenment and continually investigating the possibilities for innovation to redesign the way education has historically been distributed. Today the whole education system is developing more around the digital world and so the time has come to grasp the necessity to apply efficient solutions to make this system more optimal. Technology has swiftly revolutionized every part of the society, such as the education business. Today pupils grow up with the “internet-connected technologies” at home as well as in the school, which affects the way they study. Future education technique will alter learning by offering instructors and students a range of new tools to engage with such as digital platforms, virtual reality, e-learning, immersive learning etc. This paper presents a comprehensive survey on the ongoing innovations and research in the field of education that will shape its future.

Keywords: Internet-Connected Devices, Digital Platforms, Virtual Reality, E-Learning, Immersive Learning.

1 Introduction

Increasingly, classroom innovation is more than simply a phrase. As a form of education, it is fast becoming popular among both students as well as instructors. Students and instructors are encouraged to do investigate, study and utilise all available resources to discover something new as a result of

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innovation in education. A new approach to tackling issues is at the heart of the innovation. A greater level of thinking is required to address complicated situations, which enhances education. Although technology and new innovations may play a role in fostering creativity, they are not the only factors. Students' creativity as well as problem-solving abilities benefit from innovative teaching methods.

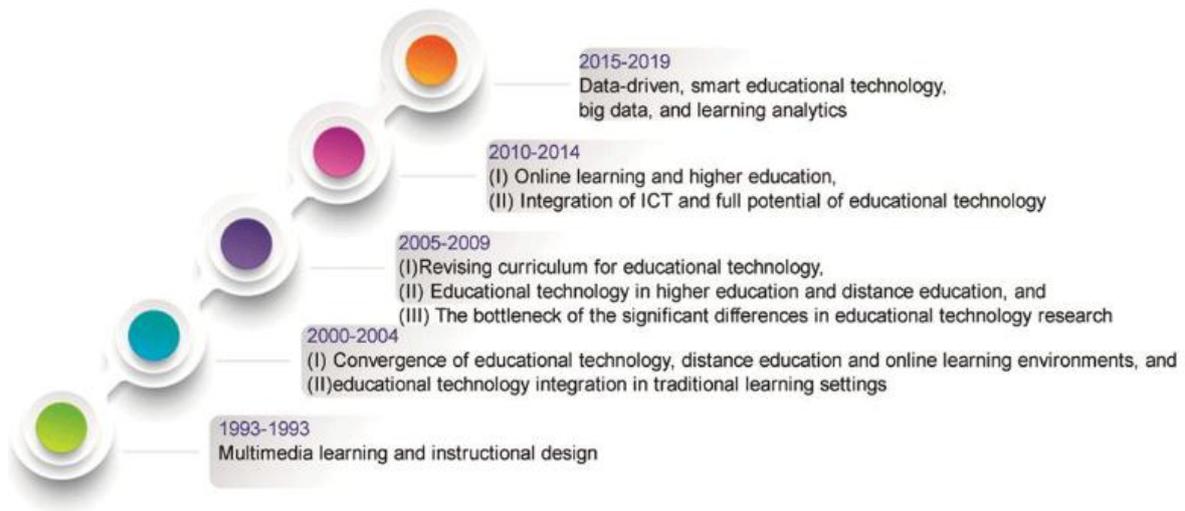


Figure 7 Innovation and Research in the Education field

The significance of Education innovation may be a fairly enigmatic notion that means a number of things to different individuals. Nonetheless, there are very real as well as concrete advantages to the educational innovation. Innovation cannot be assessed or evaluated, but it may be taught and nurtured in children. In this high-stakes testing environment, it may be difficult to incorporate creativity and uniqueness into the classroom. It's about time the education sector caught up with the rest of the world in terms of technological advancements. New educational technology advancements are a positive development. Since the spread of the virus, people have seen a variety of different educational methods.

Educational technology innovations provide opportunities to fulfil growing educational needs. Solutions such as online courses help to keep classes running, and trends like augmented reality as well as immersive learning are essential for leveraging growth and elevating the learning experience.

2 LITERATURE REVIEW

(Alam & Asimiran, 2021) Even while the epidemic rages on over the world, closing down the higher education has never been an alternative; rather than, finding methods to avoid it has led to a growing dependence on online technologies for course and programme delivery. Though it is not intended to be a comprehensive replacement, opponents believe that the online education has exacerbated the “diploma sickness dilemma”. They said that this would cause major long-term difficulties that might be irreversible. This comparison research used a “empirical survey” with 120 students from every group (before and throughout COVID-19, for a total of 240 samples/students) to undertake an in-depth

Dr. Ramakant Sharma and Dr. Mayank Sharma

examination of graduates' academic as well as job-ready performance. The findings demonstrate that pre-pandemic kids performed badly academically when compared to their post-pandemic classmates. However, “pre-pandemic graduates” had better work ready scores that included both ability and practical experience. The academic achievements of both groups also surpassed their work readiness evaluations. This raises the issue of whether it is the responsibility of higher education to value the notion of sustainable production or to provide certificates/qualifications. “The HE system seems to have exploited COVID-19 as an excuse to prolong the "diploma disease crisis," a problem which must be addressed by developing a suitable policy framework”.

(Almusawi et al., 2021) The goal of this paper is to investigate physical education instructors' perceptions on their preparedness to utilise and incorporate the wearable technology as a physical education innovation. “According to an analytic induction logic as well as a constructivist epistemology, the article comprises semi-structured interviews with 38 public school physical education teachers”. The research finds eight topics based on the thematic analysis of the interview data: attitude adjustments, appropriate capabilities, easy usage, effective workouts, injury prevention, non-sedentary behaviour, and system access. These topics highlight the technical and organisational factors that allow physical education instructors to be ready to employ and incorporate wearable technology in their classrooms. The essay finishes with assessments of the research's theoretical as well as practical implications, limits, and future prospects.

(Krupcała et al., 2020) The essay emphasises the need of incorporating practical e-business learning into management school in Poland in order to meet the labour market demand for the new professions like digital managers, e-commerce managers, and e-commerce front-end developers. It also shows the findings of a study on business curriculum as well as the findings of a survey done among students of the "Faculty of Management, UTP University of Science and Technology in Bydgoszcz, Poland", who took e-business/e-commerce programmes. As a result, actual application of this topic is not common in the major economics as well as management courses, with only UTP conducting lessons using the WordPress among the public institutions studied. According to the responders, this field of knowledge is vital, as well as the course itself is appealing and will be beneficial in the future. As a consequence, the study findings reveal that the given teaching method is novel.

(Lund & Karlsen, 2020) This article investigates the function of the “vocational education institutions” in the regional innovation systems, as well as the role of trained people in the implementation of new technologies in the manufacturing sectors. The case study is based on a wide understanding of RISs, emphasising the significance of all essential components of the industrial as well as institutional system. In two Norwegian industrial locations, they investigate cooperation between industry players and “vocational education institutions”. The findings show how important “vocational education institutions” are to manufacturers' competitiveness in developing innovative educational programmes tailored to current as well as future manufacturing. The research provides empirical weight to the hitherto largely theoretical idea of wide RISs, emphasising the critical role of trained employees and engineering technologists in the implementation of new industrial technologies. Furthermore, they demonstrate how

Handbook of Trends in Engineering Technology and Research

vocational education institutions as well as industry knowledge requirements change, RISs are developing along with it, resulting in new educational programmes at the vocational training facilities.

(Burbules et al., 2020) "Quality education" is one of the pillars of the "United Nations 2030 Agenda for Sustainable Development", that aspires to guarantee inclusive as well as "equitable quality education" and to encourage opportunities for lifelong learning for everyone. Several major concerns affecting education in the information age are connected to this overall goal. We contend that education is critical to future quality of the human existence and the global sustainability. In general, emerging "digital technologies" are transforming the education in both the formal as well as informal learning situations. Overall, some of these key developments and their impact on education may be described as follows: "1) our educational goals and objectives; 2) educational ecologies and learning environments; 3) learning processes; 4) teaching processes; and 5) educational governance and policy". Meanwhile, we highlight some of the possible hazards and drawbacks of these technological advancements. The study indicates a significant potential for the educational reform from a long-term viewpoint, but it can only be realised if we are ready to reconsider, and even forsake, some of the established methods of doing things in the education.

(Crompton et al., 2020) As research into the use of educational technology grows, more emphasis is being focused on the "psychological processes" that underpin teaching and learning using these tools. We investigate six modern technologies highlighted in the "Horizon Report 2020" edition through the perspective of the "educational psychology theory" in this study review. Researchers specifically highlight the educational, cognitive, as well as "social psychological processes" that occur during teaching as well as learning with every technology and demonstrate how taking these processes into account can inform the study and use of the "educational technologies", as well as "subsequent learning outcomes".

(Oliveira et al., 2019) This research examines the literature on emerging technologies in scientific teaching. We analyse articles published in key scientific education forums in recent years in an attempt to summarise the present state of research as well as identify particular kinds of technology that have lately "appeared" in K-12 science classrooms virtual labs. As a discipline, scientific education is increasingly distinguished by "hermeneutic and alterity" connections in which the physical world is perceived indirectly via the technology representations or has become secondary to students' experiences, as noted trends as it is "pushed aside" by emerging technological artefacts including virtual labs, computer simulations, robots, games, mobile devices, as well as digital photography as well as drawing. Scientists must help students see technical tools as strong epistemic resources that help shape the world they are studying, rather than as transparent or neutral gadgets that only "depict reality" or disclose what is really there. This is a difficult task for scientific educators (naïve realism). It is believed that emerging technologies do not originate in a social vacuum, suggesting that sociocultural components of technological innovation should be given greater emphasis in scientific classes.

(Dziuban et al., 2018) Blended learning (BL) in higher education has several benefits and implications in today's world of interconnected "information and communication technologies" (ICTs). When it

Dr. Ramakant Sharma and Dr. Mayank Sharma

comes to efficacy, the authors argue that BL is centred on access, achievement, and students' perceptions of their learning settings. Students' success or withdrawal rates are compared to those of BL in terms of their minority status in both “face-to-face as well as online courses”. It was discovered that there were significant if-then rules governing how students evaluate their “educational experiences” in an inquiry of their opinions of course quality. Regardless of the course format, the perceived relevance of the material, or the desired grade, these conditions apply. Even though current instructional technology predates blended learning, its advancement is inextricably related to the development of modern information communication technologies that mimic certain aspects of the human brain functions, say the authors.

3 INNOVATIONS IN EDUCATION

a. Digital Content

The introduction of the digital material has been the most noticeable change to the educational system. Digital learning has taken the educational system by storm. Learning using videos, photographs, texts, graphics, tales, short movies, prose, infographics, as well as even games improves conceptual knowledge above conventional whiteboard methods. Tutors in a few nations have begun to use mobile/web apps to give knowledge to pupils, which is really beneficial.

b. Campus Automation

This is one of the world's most popular automation systems. The automation of the whole school/college. All procedures are automated. And here o perations mean everything from the application form submission to the campus placement selection. There are several stages in between, such as assignment submission, admission, notes, research paper submission, home learning, attendance management, examination, assessment, result publishing, notification, meetings, cultural events, and campus placement. Consider obtaining all of them on your smartphone through a mobile app. One message may eliminate all of the difficulty.

c. Mobile Learning

Classroom instruction is gradually being replaced by digital development. Mobile learning is incredibly popular, and its reach is also quite broad. Users are free to walk around while learning through their mobile devices. Students may access learning modules including notes at any time and from any location. Video learning as well as other specialised tools for this purpose are also becoming more popular. The limitation of distance between the education provider and student has undoubtedly been decreased by mobility. Distances may be overcome and education delivered to the student's doorstep thanks to technology.

d. Quality Content

Access to high-quality information is much simpler than it used to be. Online information is now massive and individualised. After using books, artificial intelligence & machine learning, business

journals, case studies, research papers, newsletters, statistics, and so on are utilised to extract necessary and tailored material. The information is better organised and engaging for mobile devices. Education providers are adjusting and enabling students to access material to improve their expertise.

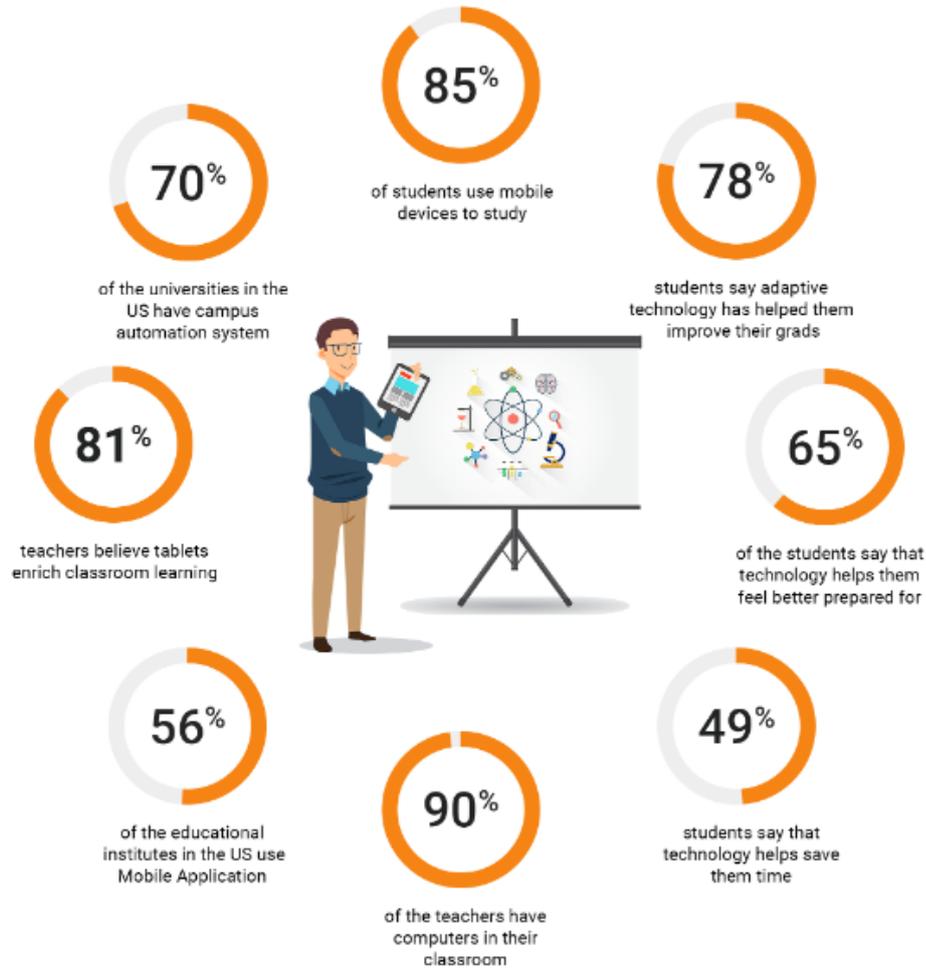


Figure 8 The growth of the innovative education technologies

e. Its more Practical Training than Soft Skill Training

Universities are emphasising practical instruction for their pupils. They use technology to provide their pupils with online case studies to complete, puzzles, study tools, and information. Rather of focusing on soft skills, they are aiming to develop their managerial abilities and IQ level, that will allow them to establish their own portfolio and advance their professional careers.

Dr. Ramakant Sharma and Dr. Mayank Sharma

f. Cost Effective Education

Many governments assume that using technology in any industry is expensive. However, this is a misconception. There will be no setup fees. You will not be charged for any eBook, application, or video lesson. Even the related expense is little in comparison to the quality it will bring to the system. There is no need to increase investment in physical infrastructure. Invest significantly less in improving IT infrastructure. It is a one-time expenditure, but it gives you complete control at the tip of your finger. There will be no physical barriers to information exchange.

g. Improved Efficiency

Educational establishments must manage all of its day-to-day activities, including but not limited to the students, teaching personnel and resources, laboratories, and exams, while keeping related costs in check.

Projectors and IT lab equipment must be maintained and updated. Real-time visibility will maintain track of all assets and inform when necessary. So that teachers may devote more of their valuable time to more productive activities.

h. Smart & Safe Campus

Have you ever considered the safety of your campus's properties, and more importantly, the safety of your students? This is where IoT (Internet of Things) comes into play. The capacity of IoT to monitor things, students, workers, assets, and link devices throughout campus raises the bar for safety.

A GPS-enabled transportation system allows routes to be traced and optimised, enabling parents to track where their children are, as well as get notifications about where the bus is and how long it will take to arrive at your pick-up location. Finally, it makes the system smarter, safer, and more time efficient. Smart ID cards may be used to find a student and provide cashless access to the cafeteria, library, lab, and other facilities, reducing money waste.

4 IMPORTANCE OF INNOVATION AND RESEARCH IN EDUCATION

a. Challenge students by giving them a problem that is both authentic and interesting:

“There is no one project that is appropriate for each kid. This implies that a project should be adaptable enough to allow students to incorporate it into their own interests. It also implies that instructors must be aware of their pupils' interests”. Authenticity entails utilising genuine instruments to solve issues that do not have solutions written in the back of a book. Ideal issues include establishing certain broad characteristics and tools while leaving the exact problem formulation to the learner. "Design a musical instrument which one can play without using their mouth or hands," for instance, may be an example of such a project.

b. Give students the basics but keep it short:

Instructors will need to provide students with some fundamental knowledge and information in order for them to begin working on their projects. However, the quantity of information required for the class will be less than you may imagine. They may arrange this knowledge into 5 to 10 minute chunks and offer them in a “mini-lesson at the start of class”.

c. Encourage students to research independently:

“If the project design is clear and consistent, students will be able to get the bulk of the information they want on their own”. This study may use Wikipedia, online message forums, sample code, computer language documentation, and other resources

d. Build complex skills in students:

Students might be encouraged to employ advanced tools to accomplish their tasks. Tickle, Scratch, Tynker, Makey Makey, and other similar gadgets are among them. To utilise these technologies on a daily basis, both instructors and students must get acquainted with them.

e. Check that students have understood the concepts:

Teachers need to keep an eye on what their students are doing in a classroom where assignments are tailored to each student's needs. Pupils learn most effectively when they struggle with a problem and come up with a solution. If they are upset or confused, they are more likely to quit up. “Teachers must keep meticulous track of what students know plus what they need to learn in order to finish their assignments effectively”.

f. Ensure that students find innovative uses of everyday objects:

Most individuals only perceive one use for an item. This is known as “Functional Fixedness”. Students may learn how to construct “electric switches” out of clothespins or a robot body out of a Coke bottle by teaching them to look beyond this. This will inspire students to use their imaginations and think beyond the box when it comes to everyday items.



Figure 9 Importance of innovation and research in education

g. Confirm that students know what they still need to learn:

“In order to properly develop and solve problems, students should understand both what they already know and what they still need to learn. Teachers should design their projects so that the students may express what they understand about their assignment as well as what they need to learn more about”.

h. Do not grade students on innovation and creativity:

When there is just one proper solution to a problem, grades function very effectively. There is no one solution for initiatives that promote innovation and creativity. One cannot inspire pupils with a grade if you want them to own an issue and discover a really innovative solution to it.

5 CONCLUSION

A fresh way of addressing and resolving problems lies at the heart of innovation. Students are compelled to think more abstractly in order to deal with more difficult problems, which benefits education as a whole. Technology and new inventions are important, but they are just a small part of what we mean by innovation. Innovation entails a new way of thinking, which aids pupils in developing their creativity as well as problem-solving abilities. If unrestricted access to material that can be converted into knowledge is utilised responsibly and with supervision, it may become a tool for the development of the higher order thinking abilities. Knowledge sharing has grown more collaborative, engaging, and transparent as a result of the growth of real-world education, learning analytics, online courses, open source textbooks, gamification, and social network integration.

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A Comprehensive Literature Survey on The New Emerging Technologies in Education

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Abstract

The education industry has been way overdue to accept digital developments. The newest educational technology developments offer a pleasant shift. Since the epidemic transferred learning from the classroom to homes, people have observed new modes of schooling. Innovative advancements in educational technology give opportunity to address expanding education demands. Solutions including online courses give a mechanism to keep lessons running, and trends such as augmented reality as well as immersive learning are crucial to harness growth and upgrade the learning experience. Since the pandemic rendered distant learning compulsory, it gave a unique chance to embrace digital trends which can adapt as well as transfer over to in-person training. The developing trends in the educational technology emphasize on connection, adaptability and student-centered learning.

Keywords: Innovation, learning experience, digital learning, augmented reality, immersive learning.

1 Introduction

Throughout today's classrooms, computers plus the internet have become just as commonplace as textbooks as well as pencils. It is possible for technology to aid instructors in identifying the unique needs of each student and developing tailored solutions. Auto-grading, for example, may reduce the stress on teachers and offer a more engaging educational environment. The use of technology to better

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one's education is something that many students are currently doing on a regular basis. Modern students prefer hands-on learning versus passively listening to an instructor talk. A major problem for educational information providers is how to make the most of the learning that takes place in the classroom as well as at home. Adaptability and application of concepts are critical to technological advancements. Observation, comprehension, and learning abilities are all evolving together with the generation as a whole. It's getting more and more graphic and computerised." This means that educational institutions must adapt their methods of distributing information in this regard.

Is technology capable of reshaping the educational system? In what ways will ICT have an impact? It's difficult to gauge the efficacy of a strategy, but the results will show up eventually. Certain aspects of the educational delivery system may be enhanced by technology, including;

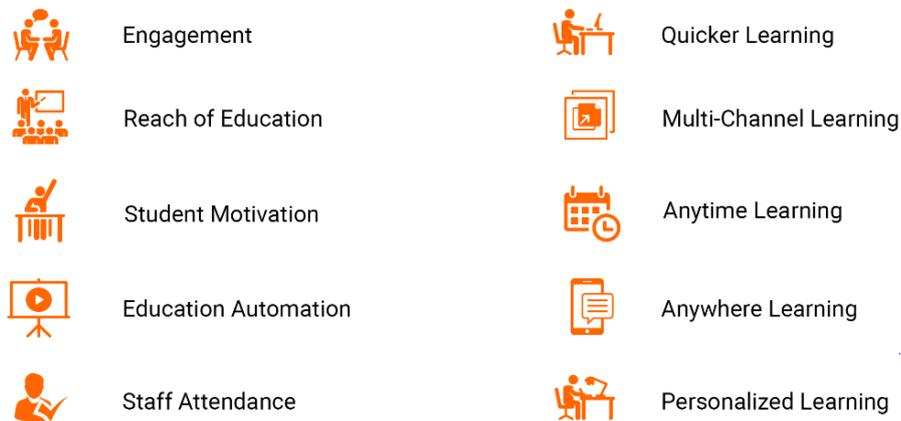


Figure 10 Effects of technology in Education

In education, there are two sides, I. Students and II. Facilitators

To get the greatest outcomes, it is critical that they work together as a team. Even while traditional classroom instruction is still the most common method of delivering a quality education, this is changing. In all, just 6% of students throughout the world are using a mobile computer device that their school has supplied for them. By 2017, the percentage is predicted to reach 11%. The significance of individualised instruction has grown. Notebooks, laptops, and tablets are gradually replacing whiteboards.

2 LITERATURE REVIEW

(Haleem et al., 2022) In the United Nations' 2030 Sustainable Development Goals, excellent education is a key component. It aspires to guarantee that all students have access to high-quality education. In order to attain this aim, digital technology have emerged as a crucial instrument. These technologies make it easy to identify the sources of emissions, avoid more harm via increased energy efficiency and the adoption of low-carbon alternatives to the fossil fuels, and even remove excess greenhouse gases from atmosphere. While boosting output and efficiency, the digital technologies aim to reduce or eliminate pollution. Such technologies have had a significant influence on the educational process. More

Dr. Mayank Sharma and Dr. Ramakant Sharma

recently, the COVID-19 Pandemic has solidified educational use of digital technology. The whole educational system has undergone a paradigm change as a result of these digital technologies. It's not only a repository of information; it's also a source of guidance, a critic, and an encourager. Students' lives have been made simpler by technological advancements in schooling. Students now choose to utilise a variety of software and tools to develop presentations and projects rather than pen and paper. A stack of notebooks is much heavier than an iPad. Surfing an E-book is more convenient than reading a heavy book. These strategies help to pique the attention of students in science. As a quick introduction to the importance of digital technology in education, this article focuses on a number of key applications and issues.

(The & Academy, 2021) Technology has altered the educational system in the twenty-first century. Students and educators benefit from a variety of instructional approaches and settings. There are also educational makerspaces among them. As a result of this new movement, the educational system is now more student-focused than teacher-focused. It's becoming more common for educational makerspaces to use Pervasive Learning (P-Learning) settings because of the low cost of mobile devices, the ability to share technical resources, as well as the smartness of the smartphone technology. Teachers and students may construct a virtual environment, complete with the newest ICT technologies, where they can exchange ideas, conduct experiments, and cooperate with one another whenever & wherever they choose in an educational Makerspace. Learning materials may be shared and accessed outside of a typical classroom using P-learning in the educational maker spaces. Paper proposes the concept of a P-learning environment for the educational makerspaces that can be accessed, shared, and used from anywhere and at any time with any portable device, 24*7*12; this implies it can be used from anywhere in the world and at any time of day or night. Students who live in distant places or who cannot pay laboratory costs will be able to access virtual laboratories, exchange their ideas, communicate with each other, and conduct experiments in a fully equipped makerspace classroom proposed herein.

(Burbules et al., 2020) The 2030 Agenda for the Sustainable Development of the United Nations emphasises the need of high-quality education for all people, regardless of their socioeconomic status, and encourages them to continue learning throughout their lives. Education developments in information age may be linked to this overarching purpose. With regard to human well-being and environmental sustainability, we think that education is essential. Generally, novel digital technologies are transforming education in both official and informal learning situations. Some of the most significant educational advancements and the ways in which they are altering education might be summed up as follows: There are five aspects of educational policy and governance to consider: our educational goals and objectives, the educational ecologies and settings, learning processes, as well as teaching procedures. The hazards and drawbacks of these emerging technological advances are also something to keep in mind. From a long-term perspective, our research shows that educational change is possible, but only if we are ready to reassess and even forsake some of our established educational practises.

(Hidrogo et al., 2020) Evolving technologies (ET), which include cutting-edge digital gadgets and applications, accelerate change and enhance several educational processes. This study compares and

Handbook of Trends in Engineering Technology and Research

contrasts the services provided by centres that promote the use of ET in their communities. The study includes Mostla, an area dedicated to investigating and engaging with the ETs which have the most potential to improve educational experiences. Eight developing technologies that Mostla believes will have a substantial influence on education are also examined, as well as some instances of their practical applications are provided. We've learned through our study, experience, and analysis that it's vital to create memorable learning opportunities using ETs if we want to help students develop skills like research, creativity, critical thinking, and innovation. The future professionals will be able to handle the difficulties of Industry 4.0 as well as society's most pressing issues with ease if they learn these skills. The creation of teaching tactics aided by ET is essential in order to pique students' interest. Curiosity aids learning and memory retention for pupils. Innovations in social and educational policy should be created in concert with, and supported by, universities. Students' skills are developed and strengthened when they are challenged to address real-world challenges. Finally, universities must open their doors to the general public and give their educational technology (ET) services to the other public or private institutions, so that national education may be enhanced.

(Guan et al., 2020) More than 400 educational research articles on the use of AI and DL approaches in teaching and learning were gathered from the last 20 years of the educational research. A "computerised content analysis" was performed to assess the evolution of AI and DL research topics in the most popular educational publications throughout time. Due to the ever-changing nature of the field, we're hoping to find the most common terms linked with "AI-enabled pedagogical adaptation research" in every decade. With the use of data from 2000 to 2019, one can see that, as educational technology has progressed over the years, certain study subjects have remained constant, while others have seen a surge in popularity. As a result of our investigation, we have discovered paradigm changes and emerging trends in educational research. Examples of this trend include the demise of traditional technology-enabled instructional design research and a rise in student profiling models and data analytics. As a result of this article, a conversation on the advantages and disadvantages of using AI and DL in the classroom has begun.

(Oliveira et al., 2019) From the perspective of scientific education, this research examines the literature on emerging technologies. The purpose of this study is to outline the present status of scientific education research and highlight specific kinds of technology that have lately "appeared" in K-12 science classrooms. According to the reported trends, science education has become increasingly characterised by hermeneutic as well as alterity relations in which the physical world is experienced indirectly through the technological representations or has become "pushed aside" by emerging technological artefacts such as computer simulations and virtual labs; mobile devices, robots, games and digital photography; as well as digital photography and drawing. So science educators are faced with challenge of helping students see technological instruments not simply "depict reality" (nave instrumentalism) as well as reveal what is truly "there," but as powerful epistemic tools which help co-construct the reality being explored, often (re)shaping what counts as "real" in revolutionary ways. It is stated that novel technologies do not arise

Dr. Mayank Sharma and Dr. Ramakant Sharma

in a sociocultural vacuum and that social and cultural dimensions of technological innovation need to be given greater emphasis in science classes than they now get.

(Huda et al., 2018) Data from business resources, like message, conversation, as well as transaction, including unstructured data sources like audio & video are used to build a network of structured data that can be used to extract value from the information space. In order to reach the organization's aim, it's possible to pattern data sources and broaden the value extraction process from social networks. Data complexity, including variety as well as velocity, as well as volume, is the focus of this study, which tries to show how the big data strategy may be used to extract value from such data. Analysis of the contents was used to design prototypes utilising data analytics connected with the subject of the study as well as users and time. This research was done in peer-reviewed journals and in books and conferences that have been peer-reviewed. Researchers' results show that big data analytics, a new emerging technology, offers specific benefits for transforming the pattern of information to be used in the creative environment of the online learning resources (OLR). Learning environments may be made easier and more convenient by improving the prototype as well as the model of data extraction value. It is hoped that the findings of this research will help to enhance the learning environment as well as results for students at Ijet.

(Zhao et al., 2018) Emerging engineers' ability to innovate and start their own businesses has significant ramifications in the real world and opens up a wide range of career options. This study proposes the creation of a novel cognitive system of innovation with entrepreneurship practise with new features based on the existing state and challenges of college students' innovation and entrepreneurship and the growth of the rising engineering education sector. Engineering education innovation as well as entrepreneurship practise cognitive system is based on students and society's demands. Information interchange, professional crossover, service economy, assessment system, and improvement are some of the features of this system. Innovation and entrepreneurship are discussed from a multi-party and cross-linking perspective. It has greatly enhanced the potential of new engineering schools to foster creativity and entrepreneurship, and it has produced high-tech workers who can contribute to the advancement of society.

3 ADVANTAGES OF EDUCATION TECHNOLOGY

a. Incorporation of Different Learning Styles

Student demands are vary, and adapting the learning plan properly might be tough. Technology may assist instructors change their teachings. Incorporating technology may help kids to study using a medium which interests them. For instance, youngsters who enjoy to sketch may develop infographics and show their grasp of the topic. Edtech can help instructors discover and analyze all students' capacities with a personalised experience.

b. Improved Collaboration

Technology also fosters teamwork among the students by motivating them to study together even outside the school. When professors give a group assignment, kids are more inclined to collaborate when they have the access to electronics. Small exercises become considerably more interesting when the students work together. Technology also lets instructors monitor who is providing what and assess the group's overall work.

c. Improved Student-Teacher Connection

Around 57 percent of professors feel the internet severely undermines students' capacity to communicate ideas with their teachers. From coursework to online chats, technology has made the student-teacher relationships more efficient.

d. Preparation for the Future

Many sectors include the newest technologies in their workflow, so being acquainted with technology may make it simple for students to settle in. If kids are acclimated to dealing with computers in school, they may apply that familiarity to the work-oriented tools like PowerPoint. In this approach, utilizing technology in classroom may prepare kids for future employment success.

e. An Engaging Environment

Technology may boost student involvement in the classroom. The usage of computers, tablets as well as other sorts of technology may make courses more engaging. Students may experience the lectures using technology, and that can help them recall the knowledge better. For instance, interactive movies may raise students' attention and increase their involvement in the classroom.

4 DISRUPTIVE TECHNOLOGIES IN THE FIELD OF EDUCATION

Modern instructors must keep up with the latest educational technology advances. Cutting-edge technology gives instructors the ability to enhance students' experiences and alleviate the stress of repeated activities. It's time to look forward to the next educational technology trends

a. E-Learning

When schools all across the globe closed to stop the spread of COVID-19, online learning rapidly became the standard method of instruction for many students. As a consequence, the demand for the e-learning platforms increased, and this technology quickly rose to the top of the list of the most popular educational fads. With the help of e-learning systems, you may provide instructional materials to students on their smartphones, laptops, and desktops.

With the advent of online education, instructors no longer have to confine their instruction to the four walls of a traditional classroom. In addition to text, audio, and video, educators often use animations, podcasts, and films to enhance the e-learning experience. We expect e-learning to continue to expand in

Dr. Mayank Sharma and Dr. Ramakant Sharma

popularity in the future because of the numerous benefits it offers, including the ability to create personalised learning experiences and lower overall costs.

b. Video-Assisted Learning

In addition to the pandemic shutdowns, video-assisted learning has proven useful. The inclusion of films and other visual aids makes this technology akin to e-learning. As a result, students may view these lectures at their own convenience.

Despite the fact that this medium predates the widespread use of e-learning, the epidemic compelled creators to make changes to meet current demands. It is not the same as "movie day," when instructors show instructional films to kids in order to help them learn about a subject. A more nuanced media has been crucial in the development of distant education. Scientific & Academic Publishing has produced an article stating that students benefit much from video presentations. Student performance is directly influenced by video-aided learning.

c. Blockchain Technology

Structured data is a feature of the blockchain. Information is stored in blocks on a blockchain. The data string termed as the blockchain is formed when these blocks link to one other. Data storage is one area where blockchain technology may have a huge impact in the education industry.

Credentials as well as certificates for students are no longer required to be verified because of this new trend in record-keeping. As a result, workplace fraud is reduced thanks to the use of blockchain technology. Transparency as well as honesty in academic credentials are ensured by blockchain. After data is entered into an institution's computer systems, it is difficult to alter; you must get the consent of other network users before doing so. Fraud may be thwarted with this technology, and data is kept safe. By keeping all data on a blockchain platform and making it very hard to edit without admin access, blockchain technology may help solve concerns such as plagiarism. Accordingly, blockchain is helping usher in an open and honest future.

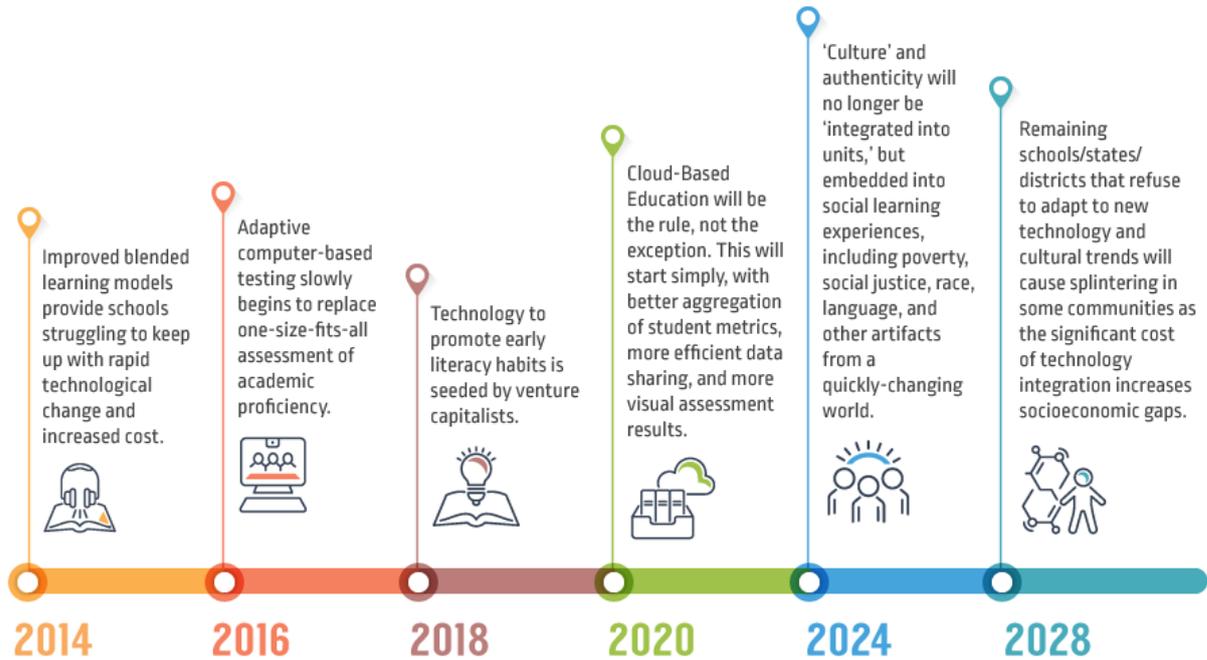


Figure 11 Evolution of Education technology

d. Growing Big Data

Distance learning has grown in popularity since the pandemic shutdowns caused a number of educational institutions to follow suit. A new opportunity presented itself for educational institutions to acquire student data, such as their reactions and levels of involvement. However, it is natural to lose crucial information in the midst of this deluge of information. Big data really shines in this area.

It is necessary to use particular approaches in order to find useful information hidden within the acquired data. As a consequence of this data, instructors may adjust their curriculum and track students' progress in order to better serve their pupils. With the ability to compare teaching methods and strategies to students' results, teachers may determine which methods are most successful.

e. Artificial Intelligence

In 2023, the worldwide AI in education market is predicted to reach \$3.68 billion. Artificial intelligence (AI) in educational technology holds great promise for automating mundane tasks such as grading. Educators don't need to be present to grade multiple-choice questions to fill in the spaces. Teachers benefit from the extra time since it allows them to work on other projects.

In a classroom with too many students, AI may alleviate the problem of providing personalised attention. Personalized instruction may be provided by AI to pupils in need. For students who like to study at their own speed, AI algorithms may create customised learning paths. By allowing students to

Dr. Mayank Sharma and Dr. Ramakant Sharma

go at their own pace, teachers can alleviate some of the stress that comes with more conventional methods of instruction.



Figure 12 Technologies shaping the face of Education

f. Learning Analytics

All of these things have helped the learning process, including research, measuring progress, as well as data analysis. Learning analytics depends on those pillars, but it also provides new ways to apply the information acquired. When it comes to improving the quality of education, learning analytics employs computational analytical tools from the data science as well as AI. Teachers may use learning analytics applications to track students' progress and anticipate their performance in school. Students at danger of failing or dropping out are also identified. Learning analytics systems examine the entire competence abilities and provide instructors with information that enable them to concentrate on other areas outside from academics, such as coordination, critical thinking, communication, and many others.

When teachers are given this information, they may figure out what their kids like the most. It gives them a chance to get students more involved in the classroom as well as find out if there are any roadblocks they are facing. Using this data, teachers may create a teaching strategy that benefits their students but also helps them achieve their maximum potential in the classroom.

g. Gamification

Gamification may be the solution for educators searching for new methods to engage students while still imparting important information. In order to boost student involvement, gamification incorporates game principles into routine tasks. This new fad is gaining traction in elementary schools. It's possible for students to learn a lot while having a good time. Incorporating elements of gaming into the classroom increases student motivation and reduces the likelihood of students becoming disinterested in their

studies. There are several advantages to using gamification, including helping children's cognitive development. In the classroom, gamification may foster a sense of community and teamwork among pupils.

h. Immersive Learning With VR and AR

It is possible to make the classroom more engaging and immersive by using augmented reality with virtual reality. Immersive learning is the ideal option for today's students who want new experiences. Immersive learning is a method of teaching that takes use of the senses of the pupils. In contrast to virtual reality, augmented reality offers a more detailed picture of an image.

When pupils are immersed in a situation, they learn more effectively. With the use of this technology, kids are better able to understand complex ideas. Student performance may be directly influenced by students participating in experiments while seeing genuine historical locations.

i. STEAM

STEM has been superseded by STEAM, which is a step forward. STEM (science, engineering, technology, math, and art) is the new acronym. As early as the early 21st century, STEM was a set of talents that educators urged young people to cultivate. The addition of art to this equation is a fresh factor that encourages creativity.

People with STEM degrees tend to earn more money because of the increasing demand for STEM jobs. The stability of the economy relied heavily on the contributions of STEM employees, but it is no longer adequate to give a well-rounded education. Personal expression, empathy, and a sense of purpose are all taught in arts and humanities programmes. Students' willingness to try novel things has skyrocketed as a result of arts education. A growing trend in STEM education is to include the arts, which advocates hope will persuade more students to choose careers in the field.

j. Cloud Technology

Students may work remotely and collaboratively on assignments using cloud-based tools. During school shutdowns, this technology's popularity grew, and it continued to grow even when students returned to in-person instruction. Because of the cloud, students may use their laptops, tablets, desktops, and smartphones to get to their programmes and data. Students now have more access to STEAM applications thanks to cloud computing, while instructors save time by not having to update computers on a daily basis.

k. Asynchronous Learning

With asynchronous online learning, students have greater control over their schedules and may work at their own pace. For students, it gives them the opportunity to design their own study schedules within a certain time range. In order to access educational materials & information, students must complete their assigned activities and assignments. Self-sufficiency as well as time management skills may be practised

Dr. Mayank Sharma and Dr. Ramakant Sharma

by students who use asynchronous learning. This is made feasible by online learning since it enables students to access information from anywhere.

5 CONCLUSION

A variety of our daily routines are being impacted by technological advancements. This is not an exception in education. You may get the following advantages by using new disruptive technologies in education:

- Personalized learning
- More profound progress evaluation
- Automated student data management
- Efficient recording and sharing of educational materials
- Efficient analytics and reporting

Disruptive technologies allow those who are unable to attend conventional educational institutions owing to schedule conflicts to get a contemporary education. It is possible to apply for educational services and study from the comfort of your own home using web-based applications. Student cooperation is facilitated through chat-based systems. Using competency-based education, educators may design educational programmes that are tailored to each student's unique abilities. Only recently has Artificial Intelligence begun to be used in education, however there is a great deal of optimism for the future because of this technology's capability.

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A Comprehensive Review on The General Concepts and Applications of Artificial Intelligence

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Abstract

An artificial intelligence (AI) is a computer programme that mimics human behaviour or thinking and may be taught to tackle certain issues. Deep Learning as well as Machine Learning are used to create artificial intelligence (AI). To be able to make intelligent judgments, AI models must be educated utilising a lot of data. Artificial Intelligence (AI) is becoming more and more popular as a tool and as a concept. Computer programmes with artificial intelligence (AI) may reason and adapt based on their interactions with the world around them. The use of artificial intelligence (AI) in business has grown dramatically in recent years which has found its way into practically every industry. This paper presents some of the fundamental concepts in AI and also reviews the most popular real-world AI applications.

Keywords: Artificial Intelligence (AI), Machine Learning techniques, Deep Learning.

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1 Introduction

Companies incorporating AI at a large scale now have a technical advantage since AI is being employed in almost every industry. In retail, McKinsey estimates that AI has the potential to produce 600 billion dollars worth of value and offer 50% more additional value to banking as compared to traditional analytical methodologies. The potential income increase in transportation as well as logistics is 89% higher.

In concrete terms, an organization's marketing staff may employ AI to automate dull and repetitive processes, enabling sales representatives to concentrate on relationship development, lead nurturing, etc. Gong, a business that specialises in dialogue analysis, offers its clients this service. The gadget records, translates, and analyses every phone call made by a Sales Representative. A successful plan may be devised by the VP with the use of AI analytics and recommendations. For complicated data that a person cannot process, AI gives cutting-edge technology. Allowing a worker to concentrate on high-level, value-added activities, AI automates low-level, repetitive duties. Cost savings and revenue growth may be achieved when AI is used in large-scale implementations.

Artificial intelligence may be classified into three broad categories: rule-based, decision tree, and neural networks.

- Narrow AI artificial intelligence lets you focus on a single job and accomplish it well.
- General AI is a sort of AI intelligence which can execute any intellectual work as effectively as a person.
- Rule-based AI which is based on rules rather than machine learning. There follows an appropriate output as well.
- Decision tree AI is similar to rule-based AI in that it uses sets of pre-determined rules to make decisions. Nevertheless, the decision tree also allows for the branching as well as looping to explore alternative possibilities.
- Super AI is a sort of AI that enables computers to grasp human language and reply in a natural fashion.
- Robot intelligence where robots may have thinking, planning, as well as learning capabilities.

2 LITERATURE REVIEW

(Floridi, 2021) Many stories have been written recently about AI and what it can do and what it can't do, as well as about the achievements and mistakes that have come from using it. What is the most likely scenario for its future? Of course, the most accurate prophecies are made with hindsight. But if such cheating is not permitted, then prudent individuals wager on the uncontroversial or untestable. On the uncontroversial side, one may add the increasing pressure that will come from law-makers to guarantee that the AI applications adhere with socially accepted standards. In the EU's case, for instance, everyone anticipates some kind of regulatory action at some point in the future. On the untestable side, some individuals will keep hawking catastrophic prophecies, with dismal scenarios taking place in some future

Dr Ishwarya M.V, Jayashree Ananth and Dr M.Suresh Anand

which is sufficiently far to assure that the Jeremiahs will not be there to be proved incorrect. Horror films, such as those about vampires or zombies, are always popular. More should be expected. What is difficult, and may be extremely humiliating later on, is to attempt to Blook into seeds of time, and declare which grain will develop and which will not^ It's a way of seeing if we can predict where artificial intelligence (AI) will go and, therefore, where it won't go. Identifying the pathways of least resistance while being open to the possibility of being proved incorrect is what I want to achieve here in the following pages.

(Suo et al., 2021) Mobile vision relies on images to play a pivotal role in seeing and understanding the surroundings. Recent exponential advancements in “Artificial Intelligence” (AI) have demonstrated enormous promise to construct powerful mobile platforms with new imaging equipment. It's impossible for “traditional imaging systems” based on the "taking photos first and processing later" method to keep up with the demand. Differently, "Computational Imaging" (CI) systems are meant to collect high-dimensional data in an encoded fashion to give additional information for the “mobile vision systems”. Thanks to AI, CI can now be employed in actual systems by integrating "deep learning algorithms" into the “mobile vision platform” to accomplish the complete loop of the intelligent acquisition, processing as well as decision making, thereby leading to the next “revolution of mobile vision”. Starting with the history of the mobile vision utilising digital cameras, this work first describes the developments of CI in varied applications as well as then performs a detailed analysis of the current research themes integrating CI & AI.

(Meshram et al., 2021) Food is seen as a fundamental necessity of human being that may be addressed via farming. Beyond meeting fundamental human requirements, agriculture is often regarded as a source of employment across the globe. In developing nations like India, the agriculture is seen as a vital pillar of the economy and a major employer. Agriculture provides 15.4 percent in the GDP of India. Agriculture operations are typically grouped into three key areas: pre-harvesting, harvesting as well as post harvesting. Advancement in domain of “machine learning” has assisted boosting gains in the agriculture. Using machine learning, farmers may reduce their agricultural losses by receiving detailed advice and insights about their crops. This study gives an exhaustive assessment of contemporary “machine learning application” in the agriculture to relieve the challenges in the three domains of pre-harvesting, harvesting as well as post-harvesting. Application of the machine learning in the agriculture offers more efficient and accurate farming with fewer human workforce with the high quality produce.

(Lalmuanawma et al., 2020) During the current worldwide urgency, scientists, physicians, and healthcare specialists across the globe keep on seeking for a novel technology to help in addressing the Covid-19 epidemic. Researchers are encouraged by the evidence of ML/AI application in the prior pandemic, which gives them a fresh approach to combat the novel Coronavirus outbreak. AI and machine learning (ML) will be extensively discussed in this article as a tool that may be used for SARS-CoV-2 and the pandemic it is associated with in terms of screening, prediction, forecasting, contact tracing, and therapeutic development. A selected evaluation of information on the study paper was done on the databases relevant to the use of ML and AI technologies on Covid-19. The model's potential for

Handbook of Trends in Engineering Technology and Research

combating the SARS-CoV-2 outbreak was evaluated by performing a quick and critical study of the three key parameters, namely the abstract, methodology, as well as conclusion. This study speaks on current studies that utilise ML & AI technology towards complementing the researchers from numerous viewpoints. It also covers a few faults and obstacles when applying these algorithms in the real-world scenarios. The report also includes advice addressing researchers on model creation, medical specialists, and politicians in the present circumstances while confronting the Covid-19 epidemic and ahead. The continuous research in AI and ML has considerably enhanced treatment, screening, prediction, medication, contact tracing, forecasting, as well as drug/vaccine development process for Covid-19 pandemic as well as minimise the human interference in medical practise. Nevertheless, most of the models are not installed sufficiently to illustrate their real-world operation, but they are still up to the standard to handle the SARS-CoV-2 outbreak.

(Lopez-Jimenez et al., 2020)“Artificial intelligence” (AI) is a nontechnical, common phrase which refers to machine learning including “deep neural networks”. Cardiology is at forefront of application of AI in the medicine. For this study, researchers searched PubMed as well as MEDLINE databases with no date constraint using search phrases relevant to AI as well as cardiology. Articles were chosen for inclusion on the basis of relevancy. Designers outline the tremendous breakthroughs in recent years in practically all fields of cardiology and stress the accumulating evidence showing how AI will take center stage in the profession. Artificial intelligence demands a strong cooperation among the clinical investigators, computer scientists, doctors, as well as other users in order to discover the most important issues to be addressed. Best practices in the creation as well as implementation of the AI include selection of suitable data sources, taking into consideration typical obstacles during the validation, interpretation, as well as generalizability of results, and resolving safety as well as ethical issues before the final implementation. The future of AI in cardiology as well as in the medicine in general is as bright as the cooperation between scientists and physicians continues to flourish.

(Brouwer et al., 2020)ML-based applications in radiation oncology are becoming more common, but there are no clear criteria on how to choose and commission them. In order to facilitate the summary of ML-based applications in ordinary clinical practise, this research sought to determine the existing utilisation and the support requirements. What you need and how to do it: “Clinical applications (1), model training and acceptance as well as commissioning (2), quality assurance (QA) in the clinical practise and the General Data Protection Regulation (GDPR) (3) as well as the need for education and guidelines were all part of a survey conducted among medical physicists working in radiation oncology (4)”. Physicists at the same radiation oncology centre were considered as a single unique respondent when reporting on various AI applications. It was determined that 213 radiation oncologists were involved in the study. About 37% of respondents were already utilising ML in their clinics, while another 32% were either planned to use it or already had it on hand. To ensure the ML algorithm's output was of high quality, human observers were still engaged in daily clinical usage in 86 percent of the cases. Respondents' knowledge of ethics, regulation, as well as data sharing was sporadic. Medical physicists' training and the development of huge databases with multicenter data were shown to be critical to the

Dr Ishwarya M.V, Jayashree Ananth and Dr M.Suresh Anand

successful use of ML in the clinical practise. This survey's findings suggest that ML-based apps' clinical launch might benefit from training and guidance on their deployment and quality assurance.

(Mak & Pichika, 2019)As a means of solving both particular and complex issues, AI makes use of personified knowledge and the answers it generates. It is possible to revolutionise the drug development process thanks to remarkable advances in processing capacity and AI technologies. The pharmaceutical industry is having trouble keeping up with its medication development programmes due to increasing costs associated with research & development (R&D) as well as declining efficiency. A look at the primary factors that contribute to the high attrition rates in new medication approvals, as well as prospective AI-driven strategies to enhance the drug development process, is the focus of this analysis.

(Wen-Xiang et al., 2019)Using "natural language processing" (NLP), it was possible to extract and show the fundamental information of a certain symptom element (SESD). Based on the major chapters of SESD, a corpus of text was created using the Python language as well as the text mining as well as analysis environment that was designed. The digitalization of the corpus was the next stage. Part of the process includes separating words, cleaning and combining data, creating an entry matrix, creating a dictionary, then converting the data. A word cloud, keyword extraction, and visualisation were used to mine and present the SESD corpus' internal information in the third stage. Using NLP, computers were able to recognise and understand SESD more effectively. The keywords and weights assigned to each chapter varied. Deficiency syndrome elements, like "Yang deficiency," "Qi deficiency," and "Yin deficiency," were critical components of SESD. "Qi stagnation," "Blood stasis," and other significant syndrome aspects were added. Symptoms of the core syndrome were tightly linked. SESD was founded on the principle of identifying and treating specific syndromes. As a result of using NLP to unearth syndromes distinction, artificial intelligence might learn how to differentiate between various syndromes.

(Noorbakhsh-Sabet et al., 2019)Scientists working with artificial intelligence (AI) in the life sciences face a new level of urgency. New insights & breakthroughs may be gained from large, multi-level, as well as integrated datasets. Fewer and fewer data are being filtered, integrated, comprehended and analysed even though more data are accessible than ever before. Artificial intelligence (AI) is concerned with the ways in which computers may learn from and imitate human mental processes. Health care's future will be transformed by AI's ability to boost learning capacity and deliver decision support systems at the scales required. This article gives a complete introduction to machine learning in health care by focusing on clinical, translational, and public health applications, as well as the crucial importance of privacy & data sharing in such applications.

(Fazal et al., 2018)Advances in imaging technology are driving the use of artificial intelligence (AI) in a wider range of medical applications. Artificial Intelligence (AI) has been touted as a solution to the problem of human mistakes in radiology reporting, which have a considerable frequency and influence on patient care. When artificial intelligence (AI) was initially proposed for use in imaging in the 1960s, the available technology made it difficult to implement. A major shift in radiological reporting began in the 1980s when artificial neural networks as well as AI-based computer-aided detection (CAD)

technologies were introduced. In mammography, CAD is already a standard procedure, and research consistently shows that it provides similar or better lesion identification, with only slight increases in recall rates. CAD still has significant false positive rates, however they have greatly improved over the previous decade. Clinicians may have difficulties understanding the thinking of an AI system, that might reduce their trust in its advice. Another issue is who should be held accountable in the event of a mistake made by CAD. Future integration of CAD and PACS will lead to the creation of more fully intelligent systems which can recognise numerous, hard diagnoses, as well as a shift toward more personalised patient outcome forecasts based on AI analysis of data.

3 BASIC CONCEPTS OF AI

For a complete understanding of AI, one must first familiarise themselves with the following concepts:

a. Machine Learning

“Machine learning (ML) is a subset of Artificial Intelligence (AI)”. It is based on the premise that computers may learn on their own based on data gathered from prior tasks and previous experiences. To put it another way, users won't have to pre-program the AI device each time they need it to work on a project.

Medical Informatics (ML) consists of three subcategories—unsupervised, supervised, as well as reinforcement.

- “Supervised learning occurs when an AI system arrives at a predictable conclusion based on existing data.
- Unsupervised learning, meanwhile, takes place when the AI agent produces an unpredictable result, which it was not pre-trained to do.
- Reinforcement learning (also known as goal-oriented programming) deals with the training the AI algorithm to recognize the rewards as well as punishments so that it can come up with the best solution to a problem”.

b. Deep Learning

This is a big step forward for ML. A system's capacity to gather unstructured data from a variety of sources, evaluate it, and then apply it to new issues falls under the umbrella of this branch of AI. "Differential programming" is another term for deep learning.

c. Artificial neural network (ANN)

System or programme that simulates the human brain's neural circuits, for example, while making sense of objects and occurrences are known as artificial neural networks.

d. Categorization

In order to create a successful AI system, a categorization or standard must be established for a certain area. The computer makes use of these measures or criteria while trying to figure out what's wrong. Its diagnosis might finally lead to a suitable treatment after additional study.

e. Classification

These characteristics of an AI model indicate its capacity to "classify" problems it meets, as well as their causes and the most effective solutions. For instance, in the medical diagnostics, an AI-powered technology may identify a disease based on the unique characteristics it has.

f. Collaborative filtering

When an AI system can learn about a user's preferences and activities in the past and utilise that information to make judgments or make suggestions on its own, we're talking about self-learning AI. One advertisement or media platform suggestion is an instance of its outcomes.

g. Natural language processing (NLP)

Human-readable outputs are a feature of sophisticated neural networks, which are characterised by this trait. The word is also used to describe a branch of computer science which focuses on constructing computers which can read as well as listen to the natural language. NLP is used in conversational AI systems, like chatbots as well as messaging applications.

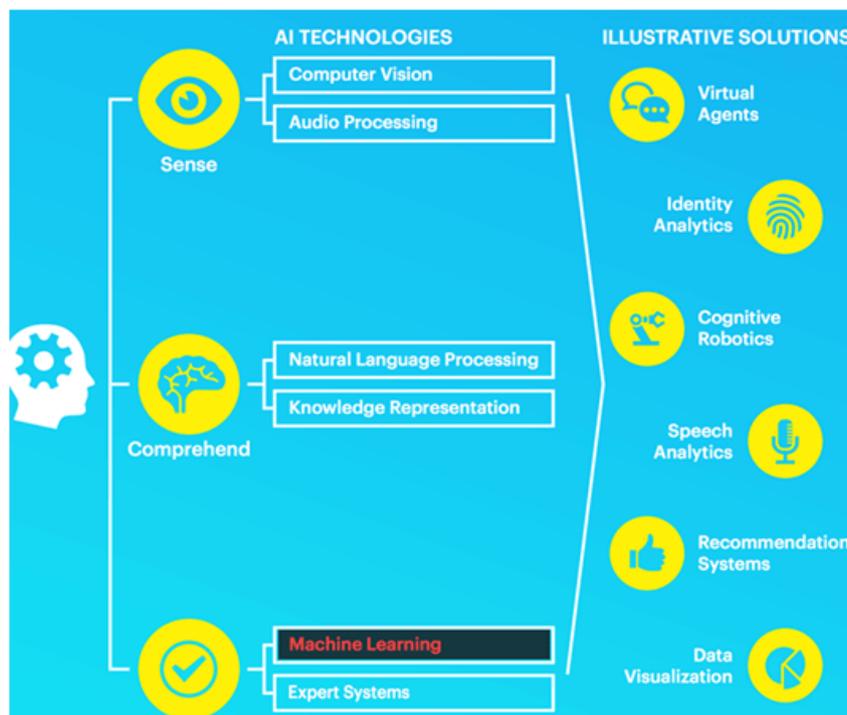


Figure 13 Components of AI

h. Data mining

Predictive AI systems may benefit from the unstructured data pulled from a variety of sources, including databases and webpages. In order to produce fresh data, AI systems employ statistical techniques to examine aggregated data for patterns and relationships.

4 APPLICATIONS OF AI

a. Healthcare

Artificial Intelligence (AI) has had a profound influence on the healthcare industry. Personal fitness trackers such as the Fitbit as well as the iWatch may aid in the early identification and customization of health issues. They can also help in the diagnosis of diseases. When driven by artificial intelligence, this gadget can quickly detect and alert users to aberrant tendencies. A doctor's appointment may even be scheduled automatically, which is a huge boon for physicians who can use AI to aid in decision-making and research. ICU transfers may be predicted, clinical procedures improved, or even hospital-acquired infections can be pinpointed with this technology.

b. Automobile

Artificial Intelligence (AI) is becoming more important as autos transition from a simple engine and chassis to a software-controlled intelligent machine. Self-driving vehicles are the ultimate aim, and Tesla's Autopilot has been the forerunner in this race, which collects data from every Tesla on the road and feeds it into “machine learning algorithms”. The system then compares the results from the two chips to see whether they are identical. Autonomous vehicles, which use machine learning as well as vision to safely navigate traffic, are common examples of AI in action. For example, robots commonly produce the basic nuts & bolts of a vehicle.

c. Banking and Finance

The banking as well as finance industry has been a pioneer in the use of artificial intelligence. Chatbots given by banks, like SIA by the Indian Depository Financial Institution, to the intelligent robo-traders like Aidya & Nomura Securities for the autonomous, high-frequency trading, there are several applications. Artificial Intelligence (AI) bots, digital payment advisors, as well as biometric fraud detection techniques improve service quality for a broader client base. Using artificial intelligence (AI) in banking is a continuing effort to reshape the business as a whole and improve customer service, minimise risk, and provide prospects for financial engines in today's digital economy.

d. Surveillance

It is now feasible to construct facial recognition tools that may be used for surveillance as well as security reasons thanks to advances in artificial intelligence. To put it another way, this allows the systems to monitor the film in real time, which might be a game changer in terms of public security. As a result of the continual human involvement required for CCTV camera monitoring, they are susceptible to mistakes and weariness. Using AI-based monitoring, you can get real-time information at any moment.

e. Social Media

Social media is more than simply a place to meet new people and share your thoughts. It influences our decisions, beliefs, and temperament on a subconscious level. Synthetic Intelligence programmes operate in the background to present us content and things that we "may" enjoy, depending on the search as well as browsing history, and they do so without our knowledge. The Explore Tab on Instagram, for example, was recently found to be a product of artificial intelligence. Due to its unique capacity to deliver sponsored advertisements to platform users based on very precise demographic and behavioural targeting, this helps with social media advertising.

f. Entertainment

Online streaming platforms such as Netflix or Amazon Prime have made it easier for show industry to acquire and exploit customer data. Recommendations may be made based on past viewing history. This is done not just to ensure that viewers get the most accurate recommendations, but also to ensure that the information is palatable to the majority. As more and more material is published every day, it becomes more challenging to categorise and make it simpler for users to find what they're looking for. A video's content is analysed frame-by-frame by AI technologies, which identify specific things to be tagged. Additionally, AI is assisting media firms in formulating long-term strategies.

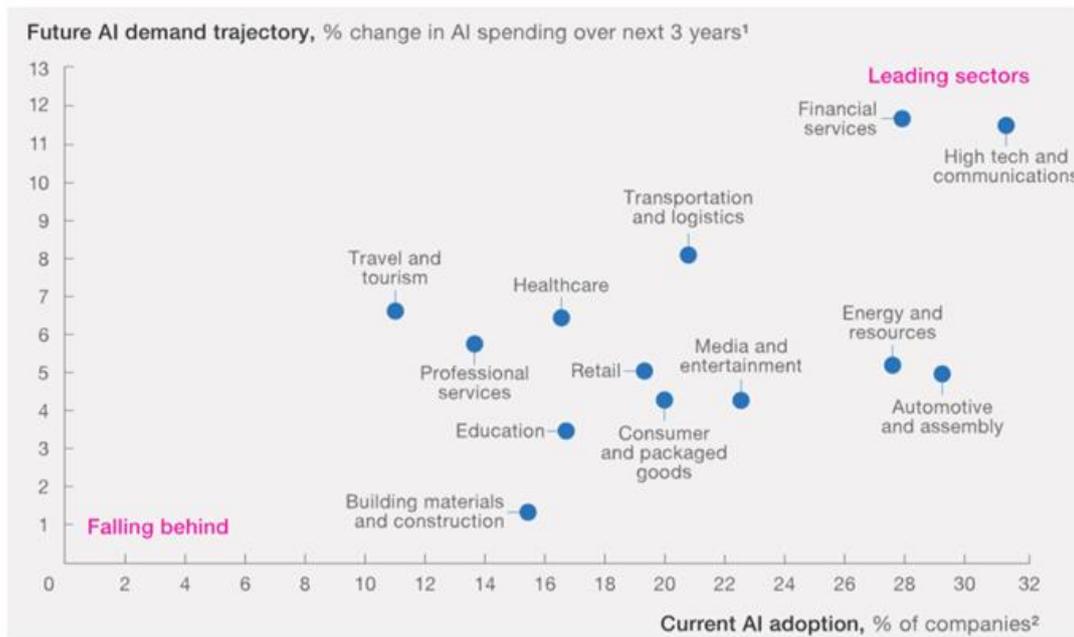


Figure 14 Adoption of AI technologies in different fields

g. Education

Artificial Intelligence (AI) may help address a variety of issues in the education industry as well. In addition to automatic tagging and content preservation approaches, there are other ways to recommend changes that need to be implemented. Teachers may use this to keep an eye on kids' mental, emotional, and physical health, as well as their overall growth. As a result, excellent education may be spread farther afield, even in places where instructors aren't physically present. Harvard Graduate School's case-based simulations are one example of this.

h. Space Exploration

Developing AI systems to reduce the risk of human life in the unexplored and unravelling cosmos is a highly perilous undertaking that the astronauts must undertake. Consequently, unmanned space missions such as the Mars Rover are now viable thanks to the use of AI. There are innumerable exoplanets, galaxies, stars, and even two new planets in our own system that have been discovered because to this technology. Additionally, NASA is experimenting with artificial intelligence (AI) applications for the space exploration in order to automate picture processing and produce autonomous spacecraft which can avoid space junk and improve communication networks without the need for human interaction.

i. Gaming

A new age of immersive gaming experiences is being brought in by computer game systems driven by artificial intelligence. Non-player characters (NPCs) in video games are generally influenced by artificial intelligence (AI) in order to achieve responsive, adaptable, or intelligent actions. Instead than relying on machine learning or making decisions, it enhances the player's experience. "Artificial intelligence" (AI) has also played a significant influence in the creation of video games and in customising them to the tastes of players.

j. Robotics

As AI advances, robots will be able to accomplish previously impossible jobs with greater efficiency. If you want a truly automated system that can not only do a job but also monitor, examine and enhance it without human interaction, you'll have to rely on artificial intelligence (AI). Using AI in robotics allows robots to become self-aware and carry out tasks without any human interference. Due to the fact that they're built to do the same thing over and over again, robots are ideal for these kinds of activities. Robotic applications that were before inflexible have become more adaptable and intelligent thanks to AI. These advantages are projected to boost the market's expansion.

k. Agriculture

The most rudimentary and basic occupation, farming, is being transformed by the use of AI. Agriculture robots, the predictive analysis, including crop & soil monitoring are typically cited as examples for the application of AI in farming. Furthermore, in big farms, drones are utilised for spraying

Dr Ishwarya M.V, Jayashree Ananth and Dr M.Suresh Anand

pesticides and monitoring the growth of weeds. Firms such as Blue River Technologies are benefiting from this. Improved crop production with real-time monitoring as well as harvesting, processing, as well as marketing are all made possible thanks to artificial intelligence (AI).

1. E-Commerce

Artificial Intelligence Applications such as this one are becoming more popular. “Artificial Intelligence” (AI) is disrupting several aspects of e-commerce, including logistics, demand prediction, smarter marketing, improved personalisation, as well as the usage of chatbots. E-commerce, with the Amazon as a major participant, is one of the first businesses to use AI. With time, it's possible that this will make effective use of AI.

Increasingly, online merchants are resorting to chatbots or digital assistants to provide their customers with round-the-clock customer service help. AI-powered chatbots are becoming more natural to use and providing a superior customer service experience.

5 CONCLUSION

Artificial Intelligence (AI) has had a significant impact on a wide range of businesses, from big data to self-driving cars. However, despite the fact that AI as well as machine learning (ML) play an increasingly important part in our daily lives, few people are aware of what they do. We hope this article will help you understand some of the fundamentals of AI in digestible terms and explain how AI may be used in many industries and sectors, including health care, education, business. and more. Across the globe, Artificial Intelligence (AI) is reshaping society, politics, and economy. Artificial intelligence is evident in a wide range of products, including Google help, SIRI, Alexa, and smart automobiles. From business to health care to the armed forces to schools, video games, and other forms of leisure. Revolutions in practically every industry have been made possible by artificial intelligence.

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Using Acridine Orange Dye/ PVA Composite Films for Flexible Laser Filters

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Abstract

Dye/polymer composite has risen as one of the most important segments of optoelectronics due to their excellent optical, mechanical and electrical properties. Dye loaded polymer materials have drawn tremendous attention in recent times due to its unique combination of electrical and optical properties and wide range of applications in different fields. In this work, the primary intension is to synthesize flexible, economic, non-toxic, highly durable and chemically stable dye loaded PVA self-standing films and to observe how it's structural, morphological, optical and electrical properties influence the laser filtering properties of the films. Here we study the structural, optical and electrical properties of the low-cost Acridine orange (AO)/poly (vinyl alcohol) (PVA) composites (AO concentration 0wt%, 1.0wt%, 2.0wt %) arranged by simplistic solution casting technique. A considerable change in the band gap is also observed for the 2.0% AO/PVA composite (~1.8eV) than that of the neat PVA (~4.7eV). A 2.0wt% AO/PVA film of width $350 \pm 25 \mu\text{m}$ can fully block electromagnetic irradiation in the 200-540nm wavelength region and can successfully block high power laser (1.5mW) of wavelength ~544 nm.

Keywords: Dye-Polymer Composite; Optical Properties; Band Gap; Laser Cut-Off Filter; Economic

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1 Introduction

Dye/polymer films have been in multiple applications throughout the last few decades. PVA, PMMA, PVDF and PVP are the mostly used hosts for incorporation of the dyes. Mainly available and inexpensive dyes which are used in the industries are the primary targets for the researchers all over the world. Dye and polymer systems are reported to have multiple applications including laser filter applications which are mostly common now days. Laser filters produced worldwide are expensive and recent researches have reported laser filters to be extremely cost-effective. Rose Bengal (RB), coumarine red, congo red (CR) and other dye incorporated polymer composites have been used as cut off filters and other optoelectronic devices [1-3]. PVA, a transparent polymer possesses the remarkable properties of an extraordinary host matrix and can host different optically and electrically active elements. Recently, band gap modified CR/ PVA composite films were used as optical filter in UV-Visible range [4].

In this work we suggest the use of Acridine Orange as a dopant in the PVA system for its excellent optical properties.

2 Experimental

a. Materials

Poly(vinyl alcohol) (PVA) and Acridine orange (AO) dye were purchased from Loba Chemie (India). All the substances were used without any additional refinement.

b. Preparation, Characterization and measurements:

PVA and AO/PVA composite films were prepared by modest solution casting procedure. X-Ray diffraction (Bruker D-8), scanning electron microscope (ZEISS Sigma 300), Jasco V-730 BIO Spectrophotometer (resolution 1nm) was used to study the crystallographic, surface morphological properties and UV-vis spectroscopic response respectively. The laser cut-off filtering property of the prepared films was investigated by HOLMARC. The synthesized films were ~250 μ m thick.

c. XRD and FESEM Analysis:

Fig. 1a describes the X-ray diffraction pattern of the films. Both the films show semi crystalline nature while the AO/PVA material is significantly less crystalline which is evident from its hump like structure and broadening of peaks. The peak positioned at $2\theta = 18.9^\circ$ and an amorphous hump positioned at $2\theta = 12.9^\circ$ are characteristic of the nature of PVA. H-bond formation is the main reason behind the complex formation and decrease of crystallinity [2-4]. The crystalline characteristic peak at $2\theta = 18.9^\circ$ is broadened with higher amount of AO in PVA. Fig. 1b portrays the FESEM image of 2.0wt% AO dye integrated PVA composite film respectively. Surface of the film reveals an even and flat surface essential for the proof of solubility between the dye and the polymer host. The AO/PVA films have immense reliability which is fundamental for laser filter purposes.

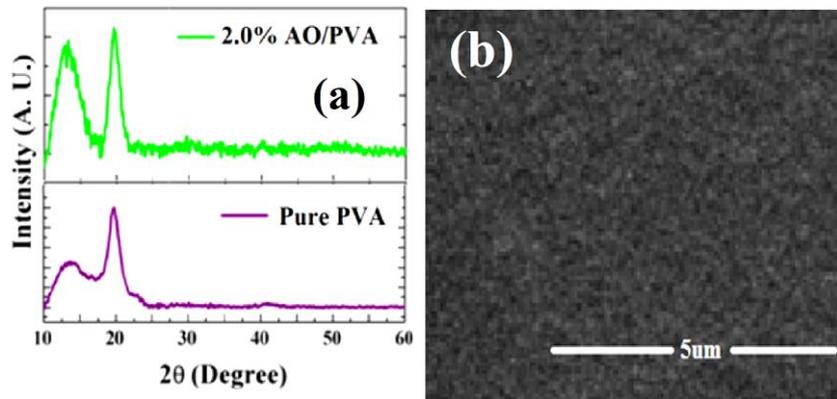


Fig. 1: (a) XRD diffractogram of pure and AO doped PVA films, (b) FESEM image of 2.0%AO/PVA films

d. Optical properties of AR/PVA thin films:

UV-Vis transmittances of AO/PVA composite films are shown in Fig. 2a. This figure depicts the excellent miscibility and complex formation in the films. The 2.0% AO/PVA film can completely block E.M waves in the 200-530nm wavelength range. The band gap is also found to decrease significantly which is projected by Tauc's formula ($\sim 1.78\text{eV}$ for 2.0% AO/PVA). The experimental data for the measurements of the optical filtering properties of the self-standing polymeric films is shown in Fig. 2b. An optical detection and measuring system was adjusted [1] to meet the necessities for observing the laser cut-off filter properties of the films bearing width $350 \pm 20 \mu\text{m}$. A laser light (wavelength $\sim 544 \text{ nm}$) having power 2.5 mW was used as source for the experiments.

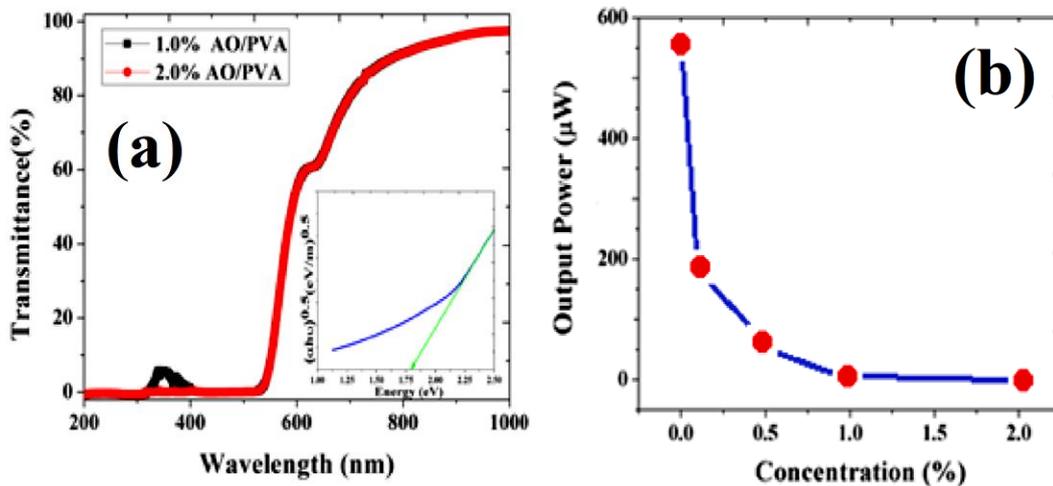


Fig 2: (a) Transmittance spectra of AO/PVA films and Tauc's plot of 2.0%AO/PVA (inset), (b) Laser filtering data for 2.0% AO/PVA

An optical setup was modified to study the laser cut-off behavior of neat PVA and dye/PVA composite films. The films were held perpendicular to the direction of propagation of the high power laser source (FWHM~1.24mm, spot size ($1/e^2$ of highest intensity of the Gaussian distribution) ~1.8mm, wavelength~544nm, power~100mW) at a fixed position and the output power was measured using optical multi-meter. Both red and green laser light was used as incident light in different occasions. The power of input irradiation was engineered by tailoring the actual power of the laser source (Power ~100mW) by using a normal filter and polymer filters indifferent occasions. The 3.0% MB/PVA has been used effectively to block 3.6mW laser light, whereas the 2.0%AR/PVA films can block laser light up to 10.7mW power for significant amount of time. At the same time the1.0%BTB/PVA can block laser light up to 5mW power for 36 minutes. The flexible laser filters also show excellent performance and stability for low power lasers. AO/PVA filters show promising behavior as laser filter. The maximum intensity blocked by the film of highest AO loading was 2.7mW, which is significantly high considering the thinner dimension.

3 Conclusion:

The present work explains the use of AO as an important part of de doped polymer films as laser filter. The change in band gap explains the material formation which is also supported by the XRD and FESEM images. The H-bond formation is an indication of complex formation and the materials proves to be extremely efficient in filtering a laser source of 1.5mW power being stable for a long period of time. The dye/PVA films have been successfully studied in this research work. In near future the work done in this research area has a scope for further extension. It can be extended in the domain of more thorough research on the dye/PVA films, detailed analysis on the bond structure and theoretical simulation on the application of the films to be used in devices Investigation on multilayer polymer film also plays a vital role to fine tune the filtering ability of the films. The challenge will still exist there to prepare thinner films for filtering the higher power laser irradiation.

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Debopriyo Ghoshal

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A Review to Understand the Advancements and Challenges in Wireless Technology

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Abstract

Wireless technology has developed greatly over the years. New and developing technologies like drones, robots, self-driven cars, and new medical gadgets are coming into existence is the necessity of the "Internet of Things" (IOT) will be the cornerstone for the development of such technologies. This paper review will look at several Wireless technology developments which found their position in the top 10 and revolutionized the way individuals and organizations interact in the future. These trends may come from enterprises' desire to be more adaptable to market and data security concerns, consumer needs, Internet of things, and so on.

Keywords: Wireless Technology, Internet Of Things, Data Security, Self-Driven Vehicles

1 Introduction

Wireless technology has slowly developed a stronger presence in many people's daily life. Whether it's at home, at work, at a stadium, or even in automobiles, people depend on wireless devices for information, entertainment to communicate, and far more. It's almost impossible to comprehend how so much got achieved prior to wireless technology being a vital component in so many various businesses and settings. Wireless is nearly a given in everything we do today, but that does not make it any less crucial than it was during its humble beginning. In fact, the wireless tech could be more crucial now than

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Nishtha Saroha

ever before. It accomplishes so much from delivering flexibility, speed, and network efficiency to conveying information and boosting productivity. As time goes on, dependence on wifi will only increase greater. Wireless technology is tech that enables individuals to communicate or data to be transmitted from one location to another without requiring cords or wires. A lot of communication is accomplished through radio frequency as well as infrared waves.

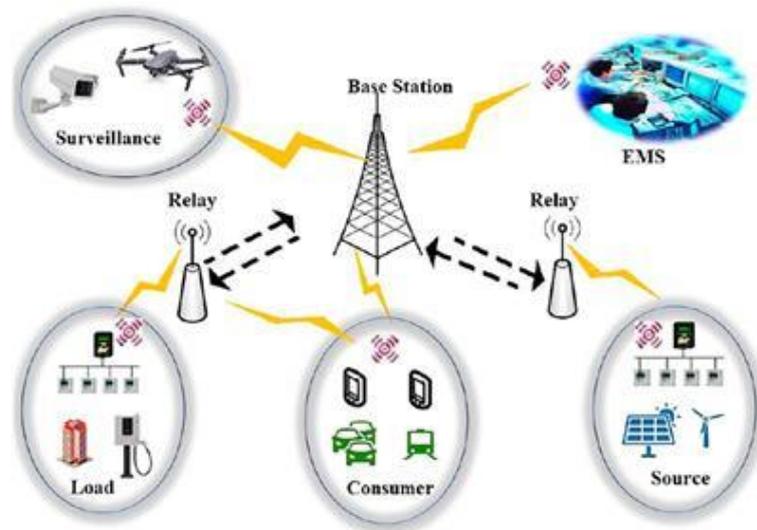


Figure 15 Wireless Technologies in trend

Wireless technology is becoming more important as more individuals choose a more flexible way of life, which may include working from home. It doesn't matter whether workers are in the same office or not when tech-savvy staff can exchange information instantaneously. Internet access is all they need. Nevertheless, improving workers' ability to work remotely is just one of the several advantages of wireless technology. According to AMS Technologies, the installation and maintenance costs of a wireless network are often lower than those of other types of networks. Wireless networks, that may be accessed at any time and from any place, transport data more quickly. Then there's the issue of security. Wireless communication between medical facilities in distant places is completely unaffected. Furthermore, wireless communication allows for quicker response in emergency circumstances.

2 LITERATURE REVIEW

(Khan et al., 2022) Bioelectronics, a field born by the marriage of electronics and biology, is poised to fill a need in the therapeutic treatments that has long been unfilled. Nanoelectronics as well as soft & biocompatible materials have showed potential therapeutic applications, such as physiological sensing, medication administration, cardiovascular monitoring, as well as brain stimulation, as a result of recent breakthroughs. Wired connections are required for electrical control on the majority of bioelectronic devices now in use. Bioelectronics that use wireless technology to provide biotelemetry, noninvasive control, and wireless power transmission are growing (WPT). In this review article, wireless

bioelectronics as well as their applications for the organ-specific therapies, such as diseases and dysfunctions, are discussed in detail. For the most part, the focus is on the important properties of antennas, such as materials, radiation characteristics, integration with the rest of the electronics, including experimentation setups. Wirelessly mediated bioelectronics, despite recent success, still faces significant problems that must be overcome for commercialization, and also for the ever-expanding and developing therapeutic targets of the future.

(Mazunga & Nechibvute, 2021) Industrial automation, agribusiness, smart cities, target tracking, environmental monitoring, structural health monitoring and so on are all benefiting from "wireless sensor network" (WSN) technologies. Due to energy limitations, WSNs using batteries have a short lifespan. An energy harvesting technology is one that uses renewable sources of energy to reduce the need for sensor node batteries. The WSN's total life span may be extended by using ultra-low power methods that result in considerable energy savings. The development of the Dynamic Power Management strategies may improve the performance and lifespan of "energy harvesting wireless sensor networks" (EHWSNs). As a result of the importance of energy management and conservation in EHWSNs, the development of energy harvesting-aware protocols as well as algorithms is necessary. As downsizing and ultra-low power technologies progress, the energy harvesting paradigm is expected to be widely used. Ultra-low-power approaches for EHWSNs are reviewed here in a thorough manner. We examine some of the current WSN power management approaches, as well as their drawbacks. The essential mathematical expressions as well as assumptions related with newly suggested applications of the ultra-low power methods in EHWSNs are examined, as are the operational principles and principles of operation of such applications. Additionally, an evaluation of contemporary ultra-low power techniques is given. The merits, limitations, and recommended remedies for each approach are laid forth. Open questions and prospective research paths are provided to the scientific community by us.

(Menaka et al., 2021) 72 percent of the Earth's atmosphere is covered by oceans. The oceans are still a mystery because of all the amazing things that go on under the surface of the water. Sea species tracking, water pollution, oil & gas production, natural hazard mitigation and maritime security are just some of the ways "underwater wireless communication" (UWC) is used. A new age known as the "Internet of Underwater Things" (IoUT) is established in order to accomplish these applications in a more effective manner. The "Internet of Underwater Things" (IoUT) is a scientific invention that has the potential to revolutionise research, commerce, and military uses under the water. Additionally, it serves as a crucial component of 5G & 6G networks. It is expected that the upcoming 5G and 6G connectivity networks will make a tremendous improvement over the current 4G systems in terms of 5G coverage performance, huge coverage, high-ability networking networks, low latency, low power usage, high protection, strong knowledge, as well as stable networking, among other things. In order to overcome the challenges of 5G networks, new technologies including optical (OWC) wireless communication are being used. Obstacles in 5G networks may be overcome with the help of new technologies like optical wireless communication (OWC). Other wireless technologies can't compete with OWC when it comes

Nishtha Saroha

to operating in 5G network standards. Using the OWC technique to develop 5G, 6G, & IoUT networks would be best as well as most effective option, according to this article.

(Salim & Lim, 2019) For real-time as well as continuous monitoring of the physiological state, flexible as well as wearable biosensors may interface with skin plus noninvasively harvest biofluids. Regardless of the sensing method or manufacturing technique, soft electronics is the primary element in these wearables. Wearable biosensors might benefit from wireless communication in distant and resource-constrained environments. Devices that conform to the wearer's skin are easy to use, battery-free (though not all), and noninvasive. They continually monitor the wearer's health and transmit data wirelessly. So they have the potential to enhance health outcomes by providing prompt diagnosis and treatment at the earliest possible point. To maintain skin compatibility, these devices are still in the early phases of development and have traditional sensing modalities, battery needs, soft electronics manufacturing limits, and feasible size restrictions. On this page, we categorise several types of wearable biosensors according to how they detect physiological parameters like skin temperature and pH as well as biomarkers like glucose as well as uric acid in sweat as well as electrolytes in sweat.

(Fan et al., 2019) Modern life has been transformed by the "Internet of Everything" (IoE), a technology that aspires to connect and exchange data with everything connected to the Internet. The growth of the Internet of Things (IoT) relies heavily on the development of the power supply systems. Power supply systems, on the other hand, present a number of obstacles, including distribution, connection, charging, and administration, owing to the multifunctionality, complexity, and widespread deployment of varied applications. There are certain obstacles and achievements in developing power supply systems as well as its units that are included in this overview. Wireless connectivity, efficient power management, including integrated energy harvesting as well as storage technologies are emphasised in the general area of system-level development. Power supply unit performance measures such as service life, energy density, and self-powering capability are also reviewed. The IoE's "high-performance power supply" systems will need to be able to withstand the demands of the IoE, hence some ideas for power quality evaluation at both the system as well as unit levels are offered in this paper.

(Jo & Shim, 2019) In spite of recent advancements in wireless communication technology, it remains a challenge to offer marine users with dependable data connections owing to the geographical peculiarities of the sea. We must build marine communications that enable high-speed data rates and increased communication coverage in light of the growing needs for maritime digital data services. Data needs for marine services and current maritime network technological features are discussed in this study as state-of-the-art work. Afterwards, we present a South Korean long-term evolution for marine (LTE-Maritime), which is now in the works. At a data rate of megabits per second, the goal of LTE-Maritime is to establish a "maritime communication infrastructure" capable of providing 100 km of communication coverage. Our testbed for LTE-Maritime included ships outfitted with LTE-Maritime routers, base stations (BSs) along the coast, as well as an operations centre to verify the technology's practicality. There is evidence that LTE-Maritime might be an effective method of transmitting data

between ships and land. The development of the LTE-Maritime networks is also the subject of discussion in this article.

(Sharma et al., 2018) Full duplex (FD) wireless technology can simultaneously transmit and receive data on the same frequency band, as well as it is considered a potential candidate for the fifth generation (5G) of the wireless communication systems and beyond, thanks to its benefits such as increased capacity and better utilisation of the spectrum. However, FD technology has a number of difficulties, chief among which is the need to combat significant Self-Interference (SI). Different wireless applications now have the option of adopting FD technology due to recent advancements in SI cancellation techniques including antenna cancellation, analogue cancellation, and digital cancellation methods. There are a number of potential applications for FD that include "Dynamic Spectrum Sharing" (DSS) in wireless systems such as 5G, where FD can provide numerous benefits and possibilities, including "Concurrent Transmission and Reception" (CTR), "Concurrent Sensing and Transmission" (CST), improved sensing efficiency as well as secondary throughput, as well as mitigation of the hidden terminal problem. Starting with a thorough examination of current advancements in the field of FD-enabled DSS, we present a full overview. Our next section discusses a number of approaches that might be used to make DSS wireless systems capable of supporting FD. Using a power control-based SI mitigation method, we next propose and analyse the throughput performance of a new communication framework for enabling CST in DSS systems. Lastly, we present several outstanding research questions and future initiatives in order to stimulate future research efforts in the growing FD-enabled DSS wireless systems.

(Ponnimbaduge Perera et al., 2018) The initial focus of wireless power transfer (WPT) has been on long-distance transmission and high-power applications. The reduced transmission efficiency and health risks associated with high-power applications, on the other hand, have prevented further development of these technologies. "Alternative wireless information and power transfer techniques" have been critical not only for theoretical research but also for operational cost savings and long-term expansion of wireless communications because of the enormous rise in energy consumption as a result of ever-increasing connected devices. With "radio frequency energy harvesting" (RF-EH) for a wireless communications system, nodes may recharge their batteries using RF signals instead of fixed power grids and conventional energy sources. Either ambient electromagnetic sources or sources that send RF energy in a specific direction for EH reasons may be used to gather RF energy in this method. In the recent decade, there have been notable research activity and significant achievements in this field. Accordingly, this study gives a thorough analysis of the current state of the art in wireless power and data transmission facilitated by "simultaneous wireless information transfer (SWIPT) and wireless power transfer (WPT)". With SWIPT/fifth-generation WPT's communications in mind, this article identifies and gives a thorough explanation of a number of new technologies. Our suggestions and challenges for future study in this burgeoning field are also included in this report.

(Aalsalem et al., 2018) Exploration, refining, extraction, transportation, and marketing of petroleum products are all part of the oil and gas industry's vital operations and apparatus. The processes as well as industrial assets of oil and gas firms must be efficiently controlled, monitored, maintained, and secured.

Nishtha Saroha

" Wireless Sensor Networks" (WSN) are a potential solution to the key difficulties of pipeline condition, gas leak detection, corrosion and integrity monitoring, and other issues. Remote monitoring of unusual occurrences like leaks, corrosion, or other damage has been made possible by the widespread usage of WSN in the oil and gas sector. Studies in the literature on WSN-based systems and techniques tend to focus only on pipeline monitoring systems. There are no contemporary WSN-based systems for monitoring and identifying pipeline as well as other oil and gas sector assets in these surveys. Here, we give a complete assessment as well as detailed comparison of the most current methods or methodologies created for monitoring different abnormal occurrences in the oil and gas industry's three segments (the up- and mid- and downstream). Also included in our discussion are details on the specific needs for WSNs in the oil & gas sector. Finally, we'll go through some of the most pressing issues facing the oil and gas business.

(Bhushan & Sahoo, 2018) Wireless sensor networks (WSNs) were made possible by advances in the wireless communications, hardware manufacturing technology, & micro electro-mechanical devices (MEMs). Small sensor nodes powered by energy-constrained batteries are used to create a large number of them. The vast variety of applications of WSNs, including as medical healthcare, battlefield awareness, military investigation, as well as home appliance control, have piqued the attention of both business and academics. As a result, sensor network data must be safeguarded from a variety of threats. WSN systems may be susceptible and unstable due to a variety of security risks used by attackers. To better understand the security risks and vulnerabilities provided by WSNs, this study investigates their unique open nature. WSNs have a variety of standards that must be met to ensure their long-term viability and security. In the next section, a complete review of wireless network routing & middleware difficulties is offered. Following this, the study examines the security concerns at various protocol levels. In this section, a variety of security threats and their remedies have been found by researchers during the last several years. There is a thorough examination of WSNS energy-efficient routing techniques as well. Final thoughts on the state of WSN security and possible future directions.

(Rawat & Reddy, 2016) There are numerous sophisticated applications where conventional networks are being replaced by "Software Defined Networking" (SDN), which is an emerging technology. In order to accommodate the ever-increasing volume of wireless traffic and change network settings on-the-fly, "Software Defined Wireless Networking" (SDWN) has been suggested as an SDN solution for wireless networks. Because of its manageability, flexibility, and control over the network, SDWN has been suggested in a variety of ways. A complete review of SDWN techniques and their advantages and disadvantages is presented in this research. The present status of the research & future plans are also discussed in this section. SDWN and current research trends may be better understood by those who read this work.

(Mi et al., 2016) Roadway-powered electric vehicles (RPEVs) as well as stationary charging electric vehicles (SCEVs), both based on the wireless power transfer system (WPTS), are being touted as the transportation mode of the future. There are no severe battery issues with RPEVs since they get their power from the road as they go, rather than from costly and cumbersome battery packs. Using

revolutionary semiconductor switches, better coil designs and enhanced highway building procedures, WPTSs have increased their efficiency, power transfer capacity, electromagnetic field, lateral tolerance, air gap, weight & cost. This review article summarises recent developments in WPTSs for RPEVs. For example, the interoperability between RPEVs & SCEVs is discussed in length in this work, which focuses on fifth-generation online electric cars. There are also summaries on the development of other RPEVs included. Technical topics such as coil structures, power supply systems and segmentation switching mechanisms for a lumped inductive power transfer system for RPEVs are discussed in the following sections.

3 EMERGING TRENDS IN WIRELESS TECHNOLOGY

a. Wi-Fi

WiFi will continue to be the most popular high-performance network technology for both households and businesses for a long time to come. Radar systems, two-factor authentication, and other new Wi-Fi domains will be supported.

b. 5G

When Wi-Fi was unable to keep up with the demands of huge facilities like airports & ports, 5G Cellular provided a more cost-effective as well as high-speed data networking solution. As a result, the entire implementation of 5G is expected to take between five and eight years. Currently, the majority of providers are marketing 5G as high-speed internet, but it will ultimately boost "Internet of Things" (IoT) and low latency applications in the future.

c. Vehicle-to-everything (V2X) wireless

Autonomous vehicles and traditional automobiles alike must exchange information, both with one another and with roadside infrastructure. V2X wireless systems will allow this integration. It is expected that V2X systems will be able to provide additional services such as safety, navigation support, and information and entertainment. Eventually, V2X wireless systems will be required by law for the vehicle industry, but 5G networks are required to get the most out of V2X systems.

d. Long range wireless power

While wireless communication for devices still has distance constraints, newer technologies may charge devices at ranges of up to one metre or across a desk or table. There will be no need for power connections in display monitors, laptops, kitchen appliances, household utility systems like vacuum cleaners, and so on in the future thanks to long range wifi.

e. Low power wide-area (LPWA) networks

A more power-efficient way of communication for IoT applications with low bandwidth is required in order to enable longer battery life. LoRa, LoRa+ and Sigfox are some of the low power wide area

Nishtha Saroha

networks that span enormous regions, such as major cities or even whole nations. Small, low-cost, battery-powered sensors and trackers may be enabled by IoT makers using very modest modules.

f. Wireless sensing

A wireless signal's absorption and reflection serve as the primary goals of a sensor system. Indoor radar systems for the robots & drones may make advantage of this sensor technology. When numerous individuals are gathered in one place and conversing, virtual assistants may benefit from a radar monitoring technology. Medical diagnostics, object identification, and smart home interactivity all employ sensor data as a source of IoT system fuel.

g. Enhanced wireless location tracking

The IEEE 802.11az standard, a 5G network capability, allows for very accurate device tracking in the wireless domain. In a variety of industries, including consumer marketing, supply chain management, and Internet of Things (IoT) applications, location is a critical data point.

h. Millimetre wave wireless

Frequencies vary from 30 to 300 gigahertz; wavelengths range from 1 to 10 millimetres. They operate at these frequencies and wavelengths. Wi-Fi, short-range 5G, as well as high-bandwidth communications like 4K & 8K video streaming will all benefit from this technology.

i. Backscatter networking

In Backscatter networking, data may be sent at a much reduced power usage. Especially for situations where wireless signals are already saturated and basic IoT devices, like sensors as well as trackers in small workplaces and smart homes, are required, this is excellent for tiny networking devices.

j. Software defined radio (SDR)

By using SDR technology, the majority of radio signal processing will move from chips to software. A greater variety of frequencies as well as protocols may now be supported by radios thanks to SDR technology. Because this technology has been around for a long time and is more costly than utilising chips, it hasn't taken off. Software updates will make it possible to include new protocols as well as support for older ones thanks to SDR.

4 CHALLENGES IN WIRELESS TECHNOLOGY

a. Attenuation or Signal Loss

The less power wireless signals have the farther they go. Attenuation is the term for this (or weakening signals). It's not as simple as it seems to bring outside wifi connections within. It is possible for signals from outside transmitters to be attenuated to the point that they are no longer usable.

Wireless signals may be disrupted by a wide range of obstacles, including:

- The building's structure (steel, glass, masonry & concrete)

Handbook of Trends in Engineering Technology and Research

- A lot of trees and a lot of vegetation
- Physical impediments such as hills, mountains, bluffs, and so on
- A large number of users

Unfortunately, using a neighbouring cell tower's signals requires more than a simple antenna on the building's outside. This results in overcrowding and capacity concerns, which have a negative impact on throughput. In order to properly transfer wireless signals inside, a set of processes and methods must be followed.

b. Movement/Time Variance

A wireless connection's greatest benefit is that it enables us to move about. It doesn't matter where you go; your device is always linked to the Internet. Wireless that requires you to stay in one place is of no use to anybody, so what's the point? Regardless of where the users are, how they move, or where they set their devices, a dependable wireless system must be able to maintain communication.

c. Reach

Increasing the frequency of wireless signals, such as those operating at 5 GHz & mm Wave, has been shown to improve data transfer and increase bandwidth for the applications such as streaming video. Look at higher-frequency spectrums as gadgets compete for bandwidth on the 2.4 GHz & 5 GHz channels (the lower frequencies are already in use). As a result, we've recently adopted a shared-spectrum strategy for the CBRS and the Wi-Fi 6E bands.

Higher frequencies often have a smaller operating range. The range of low-frequency transmissions is greater than that of high-frequency signals because the former may pass through walls and floors more easily. Wi-Fi 6E, for instance, is better suited for short-distance indoor connections between devices in the same room because of its greater available and unused bandwidth (arenas, think stadiums, campuses, etc.).

d. Network Densification

There are new people and gadgets joining wireless networks every day. Whatever the rate of growth, connection will always be demanded. There is an increase in the number of devices trying to send data at the same time, which results in network collisions (so nothing gets through). It is possible to redistribute data packets over a wired network when collisions are observed. preventing wireless collisions is the sole option for achieving optimum performance.

e. Multipath Fading/Interference

Signals don't always travel in a straight line while they are being broadcast. Signal degradation may occur if they bounce off surrounding indoor/outdoor objects and return at various times (delayed signals all carrying the same information). Those delayed signals must be eliminated by taking the proper actions.

Nishtha Saroha

5 The Best Way to Address Wireless Challenges

In light of the above, what steps may be taken to address these wireless issues? Improved technology may be implemented in a variety of ways, such as:

- “MIMO (multiple-input multiple-output), which supports the transfer of more data at the same time
- OFDMA (orthogonal frequency division multiple access), which divides wireless channels into smaller frequency allocations so multiple clients with varying bandwidth requirements can connect to a single wireless network at the same time”

The balance of the cable is also critical to achieving optimal wireless performance. The voltage and current on each conductor of the pair must be identical in magnitude and phase in order for the pair to be properly matched. The diameter, concentricity, and dielectric material of the two insulated conductors must be similar, and they must also be evenly twisted, which necessitates accurate design and manufacture on both sides.

One of the most important aspects of a wireless network is that data signals may reach endpoint devices without slowing down or experiencing any downtime due to external interference.

In order to avoid some of these difficulties, well-balanced cabling methods for wireless systems have been developed. A good example is the REVConnect® 10GXW System from Belden. It includes:

- Extensive Noise Immunity: 4 dB PSANEXT and 10 dB PSAACRF headroom to avoid poor network speeds as well as assure uptime for wireless access points
- It is important to have a small conduit diameter to accommodate as many wires as possible while also allowing for a rapid deployment.
- Excessive channel needs over 100 m may be met in some high-density, high-speed applications.

6 CONCLUSION

High spectral efficiency, massive device connectivity, very low latency, extremely high achievable data rates, excellent user fairness, ultra-high reliability, high throughput, energy efficiency, diverse quality-of-service, and dramatic cost reduction are just a few of the many technical challenges that must be addressed in order to meet the stringent as well as conflicting requirements of the future wireless systems. Wireless communications is poised for a flurry of innovative developments in the near future. Collaborations and cross-discipline conversations are essential for achieving these breakthroughs. An open platform for the idea generation, refinement as well as perfection will be provided by Frontier in Communications as well as Networking's "Wireless Communication" section in order to support multi-disciplinary activities and contribute to a universal as well as ubiquitous "cyber physical infrastructure" for the connected world.

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Nishtha Saroha

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A Comprehensive Review on The Activities Of 5th Generation Mobile Communication System

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Abstract

5G is the fifth generation of mobile networks. A new wireless standard has emerged in the wake of 1G, 2G, 3G, & 4G networks throughout the world. It is possible to create a new form of the network which is meant to link almost everyone & everything together, including objects, machines as well as devices. This next generation of wireless technology, dubbed "5G," is designed to provide consumers with faster download and upload speeds up to 10 Gbps (gigabits per second), ultra-low latency, enhanced dependability, vast network capacity, and a more consistent user experience. New user experiences, as well as new industries, are enabled by enhanced performance as well as efficiency. In addition, it is anticipated that the 5G IoT (Internet of Things) ecosystem would unleash a massive 5G IoT ecosystem in which the networks will be able to satisfy the communication needs of billions of connected devices with the appropriate trade-offs between the speed, latency, as well as cost.

Keywords: 5G, 5th generation mobile network, wireless technology, Internet of Things

1 Introduction

Researchers are just now beginning to understand and appreciate how much the internet as well as other technology have changed our lives. In the United States and throughout the globe, 5G is slowly but definitely becoming a household word alongside the contemporary smartphone as a representation of

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Vishakha Tomar

what is going place. Most people still have no idea what 5G is or how it will help consumers & businesses in the future.

The 5th generation of cellular networks (to which the term "5G" refers) first appeared in 2016 with the introduction of the 5G wireless technology. The 5G network has been slow to catch on, but it's expected to have more than 1.7 billion subscribers by 2025, as well as its use will be increasingly tied to an ever-evolving concept known as the "internet of things" (IOT), that includes devices, networks, as well as basically anything "smart" which uses the internet. People are increasingly owning several devices and spending more time online, which has resulted in a decrease in data transmission speeds. Faster than current 4G networks, the 5G network will bring a slew of advantages to consumers, businesses, and investors alike.



Figure 16 The 5G technology

Users may anticipate higher speeds for anything from sending images and files on their phones to watching movies at home as 5G becomes more widely accessible. Once 5G becomes the standard, consumers will enjoy cheaper tech expenditures and an improved work-from-home experience. 5G technology investors stand to gain from everything from semiconductor businesses to "real estate investment trusts" (REITs), which are projected to drive most of the investment in 5G infrastructure. Semiconductor companies as well as other tech-related areas. In light of this, let's take a closer look at what 5G is as well as how it will change customers' lives in the next few years.

2 LITERATURE REVIEW

(Jijo et al., 2021) There has lately been a lot of interest in physical layer protection, that uses information theory to safeguard data secrecy. Physical layer security relies on its inherent randomness of transmission route to provide protection. Physical layer security has become a new issue in 5G wireless communication. Several 5G technologies, such as millimetre wave, microcells, massive MIMO, beamforming, and full duplex, are discussed in this study. Attenuation, antenna array design, millimeter-wave penetration, security, coverage, and scalability, among other things, have all been employed to overcome this problem. Aside from that, the author included explanations of the methods/algorithms employed, as well as aims, issues, and findings that mattered.

(Dujuan, 2021) From 4G to 5G, the evolution of mobile communication technology. 5G has postponed the introduction of risky facilities, like autopilot, true AI in portable processes, and remote-controlled

Handbook of Trends in Engineering Technology and Research

capabilities, because of its close proximity to the previous generation. It's a vital 5G technology user support near delay important service to guarantee the aim of ultra-low latency is achieved by spreading computing resources to focus on the edge of the network. The multi-access edge computing design has flaws that might lead to traffic explosions due to "regional computing resource overloads." According to study undertaken by Ovum in Amdocs software and service firms, telecoms companies, and a renowned media research provider, 5G will transform stadium experiences for home fans. In addition, 88% of European operators expect 5G to provide a new "multi-screen pay-TV" service for home watching of sports events. It is expected that 5G would increase the quality of mobile TV as well as video, hence broadening the breadth of material accessible to the mobile audiences, beyond the spectrum of consumer electronics products and services. It is our objective to provide a so-called "mixed better communication architecture" that combines the advantages of "cloud computing access edge" with those of the cloud. A discrete event simulation model is used to evaluate the proposed network architecture's performance. Last but not least, numerous benefits and drawbacks associated with a particular network design are examined.

(Taboada & Shee, 2021) It is thought that the high bandwidth as well as low latency qualities of the 5G network would allow many devices to communicate in real time. Although 5G wireless technology has the potential to revolutionize supply chain management, there is a lack of research on the topic. As a result, a comprehensive analysis of the literature is conducted in this research to examine the role of 5G as well as its implications for "supply chain management". "Industry 4.0 & Supply Chain 4.0" technology, as well as components of the supply chain, are all explored in this report. According to bibliometrics, 5G-enabled "supply chain management" is a relatively new area of study with just a small number of papers published on it. Research on the influence of 5G on industry & supply chain 4.0 tends to concentrate on the technical aspects of 5G and its potential impact on these two industries. Research topics for 5G supply chain management will be addressed.

(Onishi et al., 2020) An evaluation of the incidence power density (PD) above 6 GHz when the wireless devices, like the "5th generation mobile communication system" (5G), are utilised in close proximity to head as well as body is described in this study, which discusses current activities. The "International Electrotechnical Committee" (IEC) and the "Institute of Electrical and Electronics Engineers" (IEEE) have collaborated on several projects (IEEE). Due to a lack of precise description, definitions of the PD are briefly discussed. Measurement and calculation methods are then integrated into the curriculum.

(Storck & Duarte-Figueiredo, 2020) Designed to boost the speed and responsiveness of wireless networks, the "Fifth-Generation Network" (5G) is capable of transmitting a large amount of data. End-user and corporate services are supported through wireless broadband connections. Designed primarily for use in the Internet of Vehicles, it ensures lightning-fast connectivity while still providing a high level of security. Vehicle-to-Everything (V2X) connectivity and apps on autonomous cars may be supported by the 5G network technology. People, cars, and infrastructure may communicate data with this technology. A more pleasant and secure environment, as well as precise traffic information, may be

Vishakha Tomar

provided by this technology. It is possible to reduce pollution & accident rates by improving traffic flow. For better road safety as well as autonomous driving, the cellular network may be used as a communication base for V2X, as well as for the Internet of Things. IoV has compiled a report on the growth of 5G technology, standards, as well as infrastructure for the V2X ecosystem. Also included are an overview of IoV features and protocols enabled by 5G V2X communication as well as an analysis of various modes, evaluations and technical support in this context. Systematized research on the interactions between IoV, 5G, & V2X is the paper's main contribution. Concepts, criteria, and methods for overcoming obstacles were presented in 84 works. New 5G-V2X services as well as technology specialised to vehicle communications are expected to be developed as a result of this study, which is also expected to provide a roadmap for future developments.

(Ahmad et al., 2020) Small-cell and Internet-of-Everything device adoption has skyrocketed, resulting in massively increased traffic. The present network has been transformed into 5G technology, that requires enhanced capacity, high data rate, & ultra-low latency. Spectrum exploration and maximising use of its bands will help address these needs. An efficient management strategy will be difficult to achieve because of the "scarcity of the spectrum resource". An in-depth analysis of contemporary "spectrum sharing" (SS) technologies including recent 5G-enabling technologies is the goal of this work. Studies on 5G network-relevant SS methodologies, including SS surveys and associated research, are evaluated and categorised. Network design, spectrum allocation behaviour, and spectrum access method are used to classify surveys and research into one of the primary SS approaches. An extensive study of "cognitive radio" (CR) technology in SS in relation to 5G deployment is also carried out, The present deployment of SS & CR and the measures to promote effective 5G progress are discussed in a comprehensive study.

(Fotouhi et al., 2019) "Unmanned aerial vehicles" (UAVs) are exploding in popularity among consumers, which is offering new commercial prospects for mobile phone providers. As new forms of user equipment, unmanned aerial vehicles (UAVs) may be linked to cellular networks and so generate large income for the operators who can ensure their rigorous service needs. An unprecedented opportunity is offered by UAVs to the "UAV-mounted flying base stations" (BSs) which can dynamically adjust themselves to improve coverage, spectrum efficiency, as well as user quality of experience are an entirely new possibility made possible by UAVs. Commercial UAVs may be served by cellular networks, as standards committees are now considering. Earlier prototypes of the flying BSs or the user equipment are being tested by industry, while academics are working hard to find mathematical and algorithmic answers to exciting new cellular network issues. All of the recent innovations that have made it easier for unmanned aerial vehicles (UAVs) to operate in cellular networks are discussed in detail in this article. To that end, we look at: "1) the types of consumer UAVs currently available off the shelf; 2) the interference issues and potential solutions addressed by standardisation bodies for serving aerial users with existing terrestrial networks; and (3) the challenges and opportunities for aiding cellular communications with flying relays and BSes. 4) the ongoing prototyping as well as test bed activities; 5) the new regulations being developed to manage commercial use of UAVs".

Handbook of Trends in Engineering Technology and Research

(Zong Chen, 2019) 5th generation technology is a new network platform that not only improves the mobile paradigm, but expands the network to support a wide variety of heterogeneous devices as well as services. This new technology will revolutionise the globe by delivering a seamless connection with expanded capacity, reduced latency, and better speeds. 5G technology and its improvements in linked life are examined in this study.

(Adriano et al., 2019) Using 5G technology in an educational setting is the topic of this article. AR and VR-based activities are examined (VR). In the next section, we'll outline the major aspects of 5G and provide an instance of its use in music instruction.

(Li, 2019) Despite significant efforts, meeting the healthcare needs of an ever-increasing elderly population remains a huge issue. There are growing worries about rising healthcare expenses, an imbalance of resources, ineffective management of the healthcare system and uncomfortable medical procedures. Nevertheless, cutting-edge technologies are being developed to address these challenges, such as, but not limited to, “big data, the Internet of Things (IoT), artificial intelligence, as well as 5G wireless transmission technology”, to improve patient experience as well as quality of the healthcare services while reducing the total cost of health care. This isn't a pipe dream; new technologies are already having a subtle influence on healthcare and reshaping it. Despite the fact that the aforementioned technologies have been merged, we will concentrate on the use of the “5G wireless transmission technology” in the healthcare in this assessment. There are also possible disadvantages to 5G technology's availability.

(Kumar & Gupta, 2018) In 2020, several nations will begin deploying 5G mobile communication, which aims to create a wireless world free of current communication system barriers, which is a major driving element for all researchers, academics, and engineers. To ensure the effective rollout of 5G, researchers from across the globe are hard at work developing a new technology. Technology that provides high speed and capacity, spectrum efficiency and energy efficiency, as well as pseudo outdoor communication is being researched to tackle the existing challenges in the mobile communication systems. Key technologies, difficulties, spectrum allocation, initiatives, and current scenarios for 5G are examined in this article. The current report provides an in-depth investigation of the problems and developments associated with the rollout of 5G.

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Vishakha Tomar

(Panwar et al., 2016) Designers need to reevaluate the present generation of mobile communication systems due to the proliferation of devices, increased volume of data, and increased speed of data transfer. Cellular networks of the fifth generation (5G) are intended to fulfil the most stringent specifications. There are three distinct characteristics of the 5G networks: pervasive connection, minimal latency, and fast data transmission speeds. New architectures and technologies would be provided by 5G networks, which would go beyond and beyond the capabilities of current architectures and technologies. To address the question, "What and how will 5G do?," we've written this study. We look at and explore some of the significant drawbacks of 4G cellular networks, as well as some of the exciting new capabilities of 5G networks. New technologies for the 5G networks are identified, and we give a comparative evaluation of the suggested designs based on network hierarchy, energy efficiency, and network kinds. 5G networks are impacted greatly by implementation challenges such as interference and QoS, handoff and security-privacy, as well as channel access as well as load balancing. A review of existing real-world trials and testbeds also serves to illustrate the viability of our models.

3 UNDERLYING TECHNOLOGIES THAT MAKE UP 5G

For the purpose of reducing interference, 5G uses "Orthogonal frequency-division multiplexing" (OFDM), a technique in which a digital transmission is modulated over many distinct channels. OFDM and 5G NR air interface are both used in 5G. Sub-6 GHz as well as mmWave technologies are also used in 5G. 5G OFDM follows the same concepts of mobile networking as 4G LTE. With 5G NR air interface, OFDM's scalability and adaptability may be greatly increased even more. This might expand the reach of 5G to a wider range of people and things, allowing for a wider range of possible applications. The utilisation of spectrum resources will be expanded in 5G from the sub-3 GHz, which is now utilised in 4G, to 100 GHz and even beyond. 5G's flexibility to operate in both lower as well as higher frequency bands will enable it to achieve multi-gigabit speed, extreme capacity, plus low latency (e.g., sub-6 GHz and mmWave).

Additionally, 5G is predicted to establish new service areas, such as mission-critical communications and connecting the massive Internet of Things (IoT), in comparison to 4G LTE (IoT). A self-contained TDD subframe architecture for the 5G NR air interface makes this achievable.

The previous generations of the mobile networks are 1G, 2G, 3G, & 4G.

- "First generation - 1G 1980s: 1G delivered analog voice.
- Second generation - 2G Early 1990s: 2G introduced digital voice (e.g. CDMA- Code Division Multiple Access).
- Third generation - 3G Early 2000s: 3G brought mobile data (e.g. CDMA2000).
- Fourth generation - 4G LTE 2010s: 4G LTE ushered in the era of mobile broadband".

With 5G, humans have arrived at the conclusion of the past 4 generations of the mobile networks. As a result, 5G is the name given to a single, stronger air interface. Because of this, it has been designed with a higher capacity to accommodate new user experiences, deployment patterns as well as new

services. Because of its high speeds, reliability, plus low latency, 5G will expose the mobile environment to the new possibilities. Everything from safer mobility to remote treatment to computerised logistics will be possible thanks to 5G.

4 5G TECHNOLOGY IS DRIVEN BY 8 SPECIFICATION REQUIREMENTS:

Consumers can store and transfer larger amounts of data more rapidly on the 5G networks because of the increased bandwidth. However, 5G & 4G do not just vary in terms of speed & bandwidth. The internet as we know it is set to be replaced by the full 5G network. It is possible that cable internet connections might be replaced by 5G in the future, unlike 4G, that is largely used for mobile devices. In the long run, costs connected with 5G adoption are expected to decrease, which is a significant change from its predecessor one which won't happen immediately (and will be pricey).

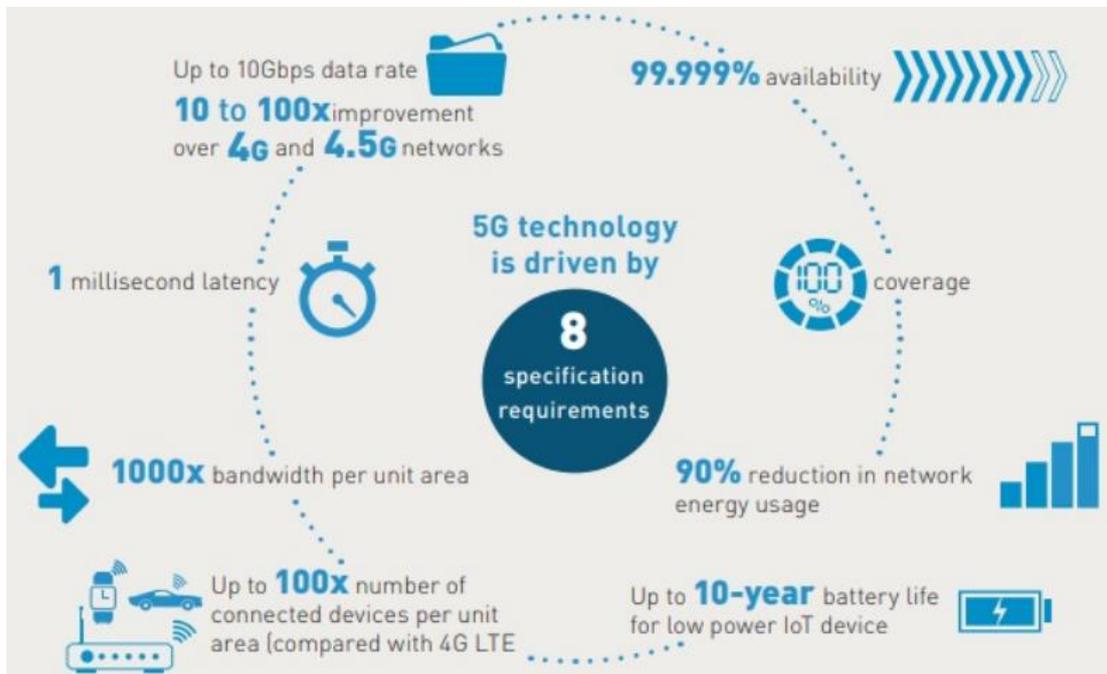


Figure 17 Specifications of the 5th generation mobile communication

Although 5G is expected to be more costly in the beginning, it is expected that the improvements would gradually lower the prices of the technology. According to Nokia, after 5G reaches full capacity, the cost per bit would drop by 70%, allowing carriers to reduce the cost of extra services. As more smartphone manufacturers add 5G capabilities to their models, the overall cost will come down. As many as 2.8 billion devices might be 5G-ready by 2025, allowing for more supply and hence lowering prices. As a result, 5G will undoubtedly change the way people interact with technology, but what particular advantages will it provide consumers & investors?

- “Up to 10Gbps data rate - > 10 to 100x speed improvement over 4G and 4.5G networks

Vishakha Tomar

- 1-millisecond latency
- 1000x bandwidth per unit area
- Up to 100x number of connected devices per unit area (compared with 4G LTE)
- 99.999% availability
- 100% coverage
- 90% reduction in network energy usage
- Up to 10-year battery life for low power IoT device”

5 HOW IS 5G BETTER THAN 4G?

There are a number of advantages that 5G will have over 4G:

- “5G has significantly lower latency than 4G
- 5G is significantly faster than 4G
- 5G is a unified platform that is more capable than 4G.
- 5G has more capacity than 4G
- 5G uses spectrum better than 4G
- 5G is a unified platform that is more capable than 4G”

Emerging services like as mission-critical phone calls and the “Internet of Things” (IoT) will also benefit from 5G's more unified, more powerful platform than 4G LTE, which focuses on offering significantly faster mobile internet. A broad variety of deployment models (from typical macro-cells to hotspots) and novel methods of the interconnecting (like device-to-device & multi-hop mesh) are also natively supported by 5G, which can also handle all spectrum types (licenced, shared as well as unlicensed).

6 5G uses spectrum better than 4G.

Five-generation (also known as 5G) networks are designed to make the most of all available spectrum in a variety of frequency ranges as well as regulatory frameworks, from the low bands below 1GHz up to the mid- as well as high millimetre wave bands (mmWave).

- “As a result, 5G is more faster than 4G.
- Up to 20 Gigabits per second (Gbps) peak and 100+ Megabits per second (Mbps) average data speeds can be delivered by 5G, making it far faster than 4G.
- The capacity of 5G is more than that of 4G.
- There will be a 100x improvement in traffic capacity as well as efficiency with 5G.
- 4G has a higher latency than 5G.

- There is a 10x reduction in end-to-end latency down to 1ms in 5G, allowing for faster, real-time access”.

7 WHAT ARE THE REAL 5G USE CASES?

As wireless networks advanced, so did the number of uses they could support.

- IoT as well as critical communications applications are the primary emphasis of the next generation of 5G networks.
- On a timeline, we may point to the following usage cases:
- The use of a wireless network that is permanently installed (from 2018-2019 onwards)
- Improved mobile broadband with the 4G fall-back capability (from 2019-2020-2021)
- Huge M2M / IoT (from 2021-2022)
- Critical IoT connections with ultra-low latency (from 2024-2025)
- Self-driving vehicles, for example, need highly aggressive latency (quick reaction time), but they do not necessitate high data rates.

Enterprise cloud services that analyse large amounts of data, on the other hand, will need greater improvements to latency than to speed.

8 CONCLUSION

Many people have a hard time adapting to new situations. However, whether people like it or not, the 5G network's eventual supremacy is also unavoidable. In the present world, there is little question that technology advancements will continue to play an important role. As an example, consider the generation of young adults who were raised exclusively on their mobile devices, such as smartphones, tablets, as well as laptops. Even if we don't like the high-tech society we live in, we can't stop it. To be successful in the future, you'll need to get familiar with current technology developments, such as 5G.

Consumers and investors who know more about the 5G network and its potential advantages will have an advantage while purchasing or investing in a company. There are several chances for both consumers and investors to take advantage of the rise of 5G. Streaming, downloading as well as uploading data will be more enjoyable for consumers, as will their time working at home as well as driving. As more individuals switch to 5G networks, the accompanying prices are projected to fall for all users in the long run. Being at the forefront of 5G will also help investors and businesses: Knowing when and how to take chances is all that is required.

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A State of Art Review on Advancements in Vehicular Embedded System Technologies

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Abstract

In the last two decades, the no. of the computer-based features incorporated in automobiles has increased significantly. Even though vehicle manufacturing is expected to rise modestly in the next years, the embedded electronics, and specifically embedded software, is rising. In addition, hardware components' quality and performance are improving whereas their price is declining. Many novel functionalities that would be prohibitively expensive or impossible to implement using the mechanical as well as hydraulic technology may now be implemented using the software technology, thus addressing the end user's needs in the terms of safety as well as comfort. Customers can now purchase a secure, effective, and customised vehicle owing to such technologies, whereas carmakers seem to be able to the master product differentiation as well as the innovation. Several studies have indeed been undertaken to improve embedded system design and the newest technologies to create smart automobiles, which are reviewed in this article. DSPs, ASICs, FPGAs, as well as other microprocessor-based embedded systems are only a few of the many options out now (field-programmable gate arrays). There has been a lot of recent discussion on the use of AI (artificial intelligence) as well as fuzzy logic controllers in automobiles.

Keywords: Vehicular Embedded System, DSPs, ASICs, FPGAs

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1 Introduction

Vehicles as well as automotive systems have gotten "smarter" as a result of the development of technology, notably in the areas of "Internet of Things (IoT) and Artificial Intelligence". Today's private and commercial automobiles are equipped with features like collision detectors, cruise control, navigation systems, and many others. These functions are designed to help the driver take greater control of the car, to boost security, or to utilise the data for analysis. Automotive embedded systems are the aggregate name for these devices, programmes, and procedures. For instance, the cruise control automatically and without the driver's input drives the vehicle at a predetermined speed. The speed of the car is adjusted in accordance with the speed restriction of the zone you are in by the traffic sign recognition function. Over 100 such gadgets are now employed in high-end automobiles employing "Electronic Control Units" (ECUs), which emit 3000-5000 communication signals.

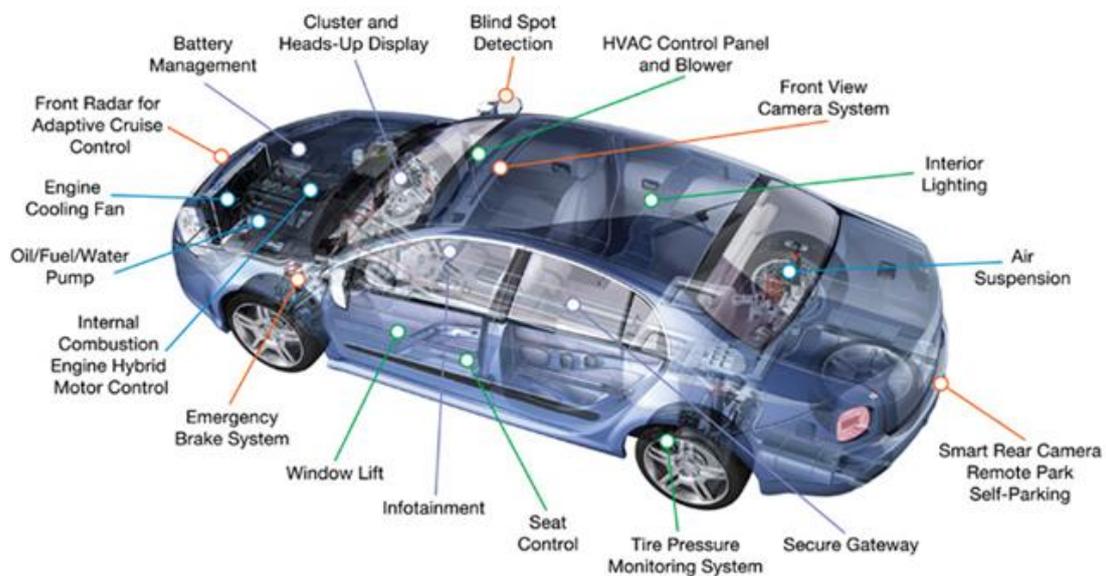


Figure 18 Embedded Systems in vehicles

It is common for embedded systems to have one or a few specific functions, sometimes with real-time calculation requirements, integrated in them. As a result, it is generally integrated into a larger device rather than a stand-alone computer. Embedded systems, such as smart phones, SoCs, and smart sensors, are becoming more commonplace. ASICs that is "Application-specific integrated circuits", and also DSPs "Digital signal processors", FPGAs that is Field-Programmable Gate arrays, as well as other microprocessor-based embedded systems are only a few of the many options out now (field-programmable gate arrays).

2 LITERATURE REVIEW

(Singh et al., 2019) A wide range of safety, entertainment, mobility, as well as environmental applications are made possible by vehicular communication. Because of its unique uses and qualities,

vehicular communication is a hot topic in university, industry, and government research labs throughout the globe. A complete review of vehicular communication is presented in this study, which includes current research and possible future directions. In a similar vein to previous tutorials and surveys on the vehicular communication, this page provides the most up-to-date information. Standardization, developing radio access technologies, as well as project activities are all included in this overview of current state of the art. ITS protocol stacks in the United States, Japan, and Europe are reviewed using the most recent specifications. For connected as well as autonomous cars, researchers discuss new radio access technologies, including a visible light communication, Cellular-V2X, mmWave, and 5G, as well as their accompanying problems in this study. There are new study directions in the growing areas of this domain that are also present. These include seamless connection, fog, the edge, software-defined as well as named data network, plus security. This effort will assist scholars, developers as well as government agencies learn about the most recent aspects of the domain, and designers are confident in its impact.

(Jabbarpour et al., 2019) A review of CVNs released from 2010 to 2016 is presented in this publication. It is also given in this paper that there is a taxonomy based on 3 basic CVN categories, notably VCC, VuC, & HC. Systems, applications, architectures, and services that are connected to one another are the emphasis of the taxonomy. It has been widely explored in literature, but a complete study of the other two groups has not been done to yet. As a result, our study is inspired by this. Cloud computing, VCC, VuC & HC, mobile cloud computing are all compared to each other in terms of similar qualities. Designers then provide a conceptual architecture for cloud computing. Ultimately, they discuss unresolved difficulties and challenges in the article.

(Rahim et al., 2018) Mobile social networks as well as vehicular ad-hoc networks (VANETs) are being combined to create a new sphere of communication known as a Vehicular Social Network (VSN). A new paradigm for content sharing, data distribution, as well as delivery services is evolving. Virtual social networks (VSNs) may take advantage of the interdependencies among network elements by using SNA applications and methodology. Passengers & drivers in a virtual community of cars, passengers, and vehicles all share a same goal or travel pattern. In this research, researchers examine the potential uses of VSNs as well as communication architecture in light of social networking in a mobile setting. In VSNs, nodes' social & mobility behaviours are used for recommendation systems as well as route planning. A literature overview of socially-aware uses of VSNs, data distribution, and mobility modelling is presented here. A look at the various recommendation systems and route planning protocols based on the crowd sourcing as well as cloud computing is also included.

(Zhou et al., 2018) A scalable and dependable mobile communication network is needed for autonomous cars and the vehicular cloud. However, despite their best efforts, LTE and "Dedicated Short Range Communication" (DSRC) are unable to fully fill this function owing to structural constraints. Thanks to a 5th generation mobile network as well as "Mobile Edge Cloud/Computing" (MEC), super low packet latency, great dependability, including Gigabit-level wireless bandwidth are on the horizon for 5G. Rather than merely offloading application service to edge servers on MEC, the vehicular

Mr. D. Karthik Prabhu

communication packets are routed across the MEC network in this unique vehicular MEC architecture. In this paper, the authors On this pag go over in depth how it supports communication between vehicles as well as communication between vehicles as well as infrastructure (V2I). The mobility management problem on edge cloud is also addressed in full in the MEC vehicle network architecture. DMM operations allow us to seamlessly and transparently switch between edge cloud IP addresses. NS3 is used to do proof-of-concept simulations.

(Huang et al., 2017) Fog computing in vehicles is an extension of the fog computing concept. This enables us to serve more cars, achieve higher communication efficiency, and solve limits in traditional vehicular networks in terms of latency, position awareness, and real-time reaction (typically required in driving safety applications, smart traffic control, entertainment services, as well as other applications). The importance of such standards increases in situations when there is conflict between two or more parties (e.g., urban warfare as well as battlefields in the "Internet of Battlefield Things" involving the military vehicles). The term "vehicle fog computing" and its application cases aren't well defined. This paper presents a typical use case for automotive fog computing while also formalising the architecture of vehicular fog computing. After that, we'll talk about some of the most pressing security as well as forensic issues and possible remedies.

(Boukerche & De Grande, 2018) Innovative traffic management services and applications, as well as access to information for other systems including users are provided by intelligent transportation systems. For the transportation systems, there is a pressing need to leverage underutilised onboard resources, as well as developments in Cloud computing resource management technologies. Vehicular Cloud applications, services, including traffic models which may be used in a more dynamic environment are all included in this study, which aggregates and discusses the most current methods and solutions. We looked at a wide range of options that would improve the transportation system as a whole, including its administration, drivers, passengers, as well as pedestrians. In spite of this, building a Vehicular Cloud on constantly changing physical resources is a huge problem. Constructing a new sort of Cloud is made more difficult by environmental changes that raise basic questions. Using current traffic models, researchers discovered that the "Vehicular Cloud computing" is technically viable in both static and dynamic environments, including a parking lot or garage where cars are immobile.

(Karagiannis et al., 2011) There is a lot of promise for vehicular networking to allow a wide range of traffic efficiency, traffic safety, and entertainment-related applications. It is our goal to give a fundamental understanding of vehicle networks by presenting an overview of the most common uses, their corresponding needs, as well as problems and potential solutions. Also included is a review of the current and previous main ITS initiatives and projects in the United States, Japan & Europe. Furthermore, the protocols as well as architectures used in such initiatives and projects in the United States, Japan, as well as Europe are examined.

(Ratnani et al., 2015) In recent years, "vehicular ad hoc network" (VANET) communication has been a hot research issue in both the wireless networking and automotive sectors. It is now feasible to create "Vehicular Sensor Networks" (VSN) where mobile cars are outfitted with sensors of various kinds that

can notice events, analyse data, as well as route messages to other vehicles. It is the purpose of VANET research to construct a vehicle-to-vehicle communication system that can quickly and cost-effectively distribute data for the benefit of passengers. Even though they may seem like a novelty, VANETs have a serious purpose: to prevent accidents by broadcasting vehicle status information like location and speed vectors and alerting the driver to potentially hazardous conditions in their immediate surroundings. Applications in the areas of safety, convenience, and entertainment have the potential to make driving and riding safer and more enjoyable for everyone involved. This work focuses on providing real-time data in VSN with minimal latency by making optimum use of the available bandwidth. One of the most pressing concerns in vehicular networks is the ability to send data quickly and scalable to all users in the same application. Autonomous cars may dynamically evaluate their transmission range and leverage this knowledge to efficiently distribute a broadcast message with the fewest number of hops as well as transmission.

(Qureshi et al., 2014) Since they have the potential to be used in new ways in the transportation industry, Ad hoc networks are becoming more popular. The technology has recently been confronted with a number of difficulties and is now dependent on a costly architecture. Reduced investment and improved intelligent application performance for driving safety as well as traffic efficiency are two benefits of integrating Wireless Sensor Networks (WSN) into vehicular network infrastructures. A wireless sensor-based hybrid architecture for vehicle navigation systems is presented in this study. Because of the difficulty of vehicular communication on mountain routes, this design is ideal. Roadside information and alarm messages are both made easier with the proposed architecture since it may be exchanged and seen by drivers.

(Jiau et al., 2015) A fundamental understanding of vehicular networks as well as cloud computing are presented in this article. In order to accommodate subscription service methods, an architecture for the multimedia cloud computing has been developed. Advanced and embedded technologies, such as various sensors, are becoming more common in automobiles, enhancing the cars' ability to provide computing and data collecting for multimedia content as part of the vehicular network.

(Whaiduzzaman et al., 2014) Due to its unique characteristics and uses, vehicular networking has become a prominent study subject. Expect to see additional communication systems, on-board computer facilities (including storage), and enhanced sensing capabilities in the future. To maintain as well as promote Intelligent Transportation Systems, a variety of new technologies have been implemented. (ITS). Solutions to the problems and concerns faced by vehicle networks have recently been offered. One approach is Vehicular Cloud Computing (VCC). By using on-board resources including computer, storage, and the internet, VCC has the potential to have a significant influence on traffic management as well as safety. This report provides an up-to-date analysis of cloud computing in vehicles. Furthermore, researchers provide a taxonomy for the vehicular cloud that emphasises the wide range of applications, key management, cloud formations, inter-cloud communication systems, including privacy and security concerns. We've done a lot of reading and research to come up with a VCC architecture and a list of all the attributes needed to make this model work. Using a standard Cloud Computing (CC)

Mr. D. Karthik Prabhu

model, we examine and contrast this new technique. In our research, we discovered that VCC is a technologically realistic and economically viable paradigm change for converging intelligent vehicular networks toward autonomous traffic, vehicle control, and sensing systems.

3 EMBEDDED SYSTEMS IN VEHICLES

In a wide range of the control applications, Fuzzy Logic has shown to be an effective tool. It is necessary to create a mathematical model of system in order to employ a (PID) proportional-plus-integral-plus-derivative control strategy. For the systems that seem to be difficult to describe, fuzzy logic controllers are indeed an alternative to the PID controllers. "If-then" rules may be used to represent control actions in the fuzzy logic controllers. The controller may be implemented in a variety of the ways in order to generate new products. Most often, the general-purpose microprocessor or even the microcontroller is used to construct a fuzzy controller. The controller is required to regulate vehicle's settings in order to maximise its entire performance. The Fuzzy Logic Controller has been used to regulate several parameters in an autonomous vehicle.

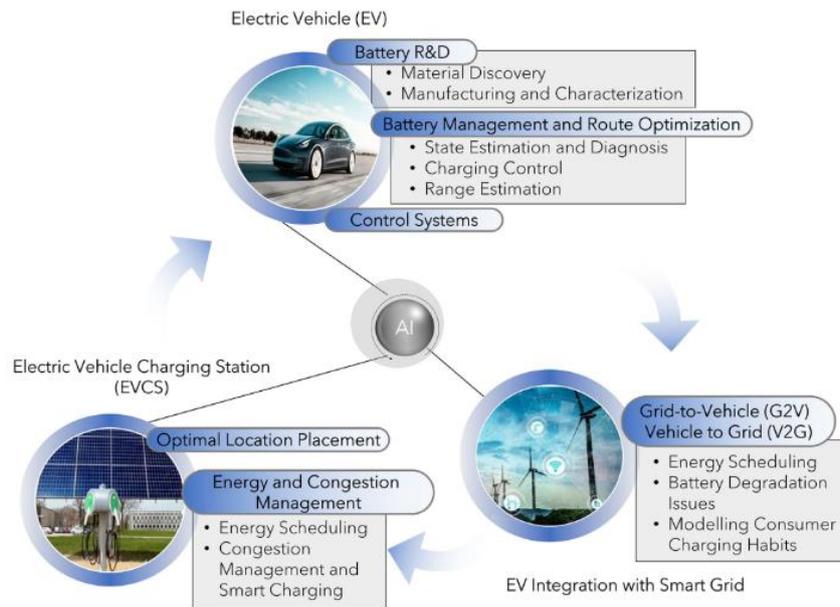


Figure 19 Overview of the use of AI in EV, EVCS, and EV integration with smart grid

EV battery design as well as the management, the charging stations, as well as smart grid have recently seen the industrial and academic uses of (AI) artificial intelligence, that is described as the algorithms supporting models aiming at replicating natural thinking, the perception, as well as the action. In the purpose of this study, machine learning as well as the computational intelligence-related AI techniques are taken into account. As a result of their capacity to detect odd patterns and their ease of implementation, such artificial intelligence algorithms may outperform traditional rule-based systems (also known as expert systems), that rely on human expertise to design rules for the systems.

The EV cost reduction via effective battery-material design as well as the manufacture are some of the appealing features of the AI application employing AI controls for such auxiliary systems of the EV to reduce energy consumption, and (4) precise range estimate to alleviate EV customer range anxiety for the potential for improved road safety as well as the traffic flow as a result of connected as well as the autonomous vehicle use; an efficient modelling strategy to locate EV charging stations (EVCSs) in the most appropriate locations and allocate resources, and to schedule EVs' interactions with the smart grid.

4 INTEGRATION OF AI AND ML IN VEHICLES

(ML) that is referred as the Machine learning and computational intelligence (CI) are indeed the two primary AI approaches employed in electric vehicles and associated infrastructures, as seen in Figure 4. It's important to note that ML models are excellent at identifying patterns in data that have been seen before, hence they need to be trained using data from a prior dataset. The supervised, the unsupervised, as well as reinforcement learning are the three broad categories into which machine learning in electric vehicles and associated infrastructures may be grouped (RL). Large datasets, like those used in estimating the battery condition and discovering novel materials for the EV batteries, make supervised as well as the unsupervised learning methods well-suited for EV but instead infrastructure applications. As shown in Figures 4A–4C, the DL model employs neural network designs with more than single hidden layer, while RL model attempts to learn optimum course of the action on its own via trial as well as error, and as a result, the agent gets rewarded in accordance including its actions.

There are many additional complicated issues that can be solved using CI techniques than those that can be solved with machine learning (ML). Control system optimization, appropriate EVCS location, as well as the integration of EV infrastructure including smart grid are all examples of complicated, dynamic optimization issues that may be solved using CI algorithms. A growing number of research papers, patent filings, and manufacturing scales have been devoted to artificial intelligence in the EV sector, notwithstanding this. Research and development and large industrial use and commercialization of AI in the EVs as well as their infrastructure requires a comprehensive look at its function in these systems.

Artificial Intelligence-based embedded controllers are getting more and more common, and research in this area has grown significantly. Many sensors as well as the devices have nonlinearities that need to be corrected, hence (Cotton & Wilamowski, 2011) provided a lightweight technique to apply the neuron-by-neuron procedure on the embedded systems.

It's a common one to use fuzzy logic to operate the AIC controller, and it's also known as the (FLC) Fuzzy logic controller. When numerical input signals are fuzzified and then defuzzified using rule-dependent inference (as seen in Figure 5D), the linguistic output is identified as well as transformed into the numerical output. When used in the HVAC systems, FLCs outperform traditional controllers since of their ability to improve comfort during using less power. Whenever SOC and vehicle speed are utilised as the FLC inputs, this decrease in the energy usage results in a greater EV driving range.

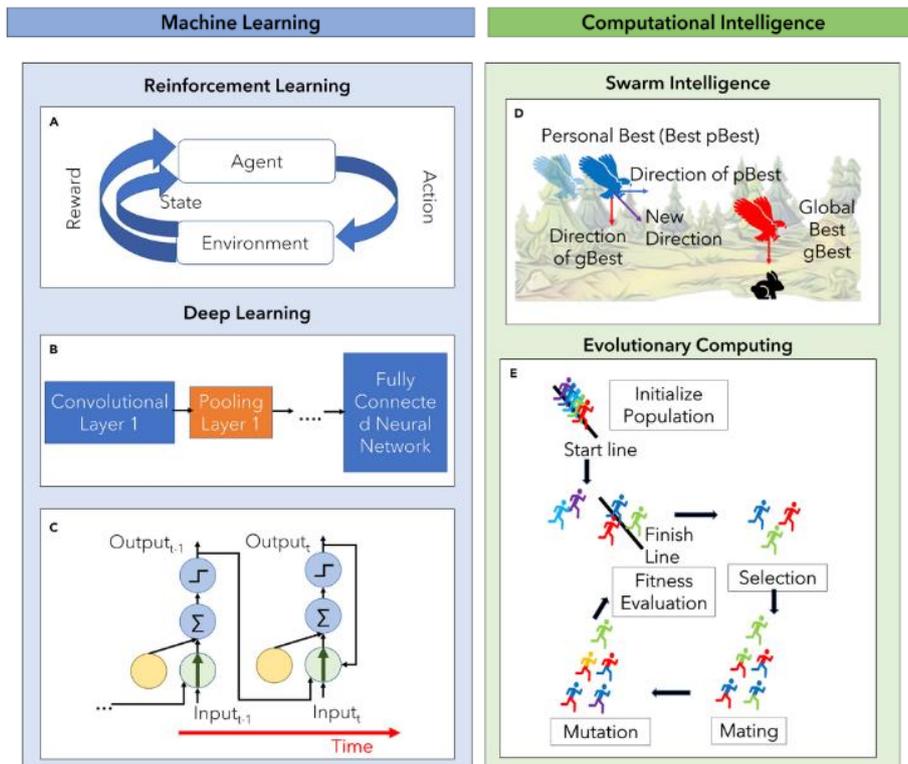


Figure 20 AI techniques (ML and CI) used in EV and mass adoption

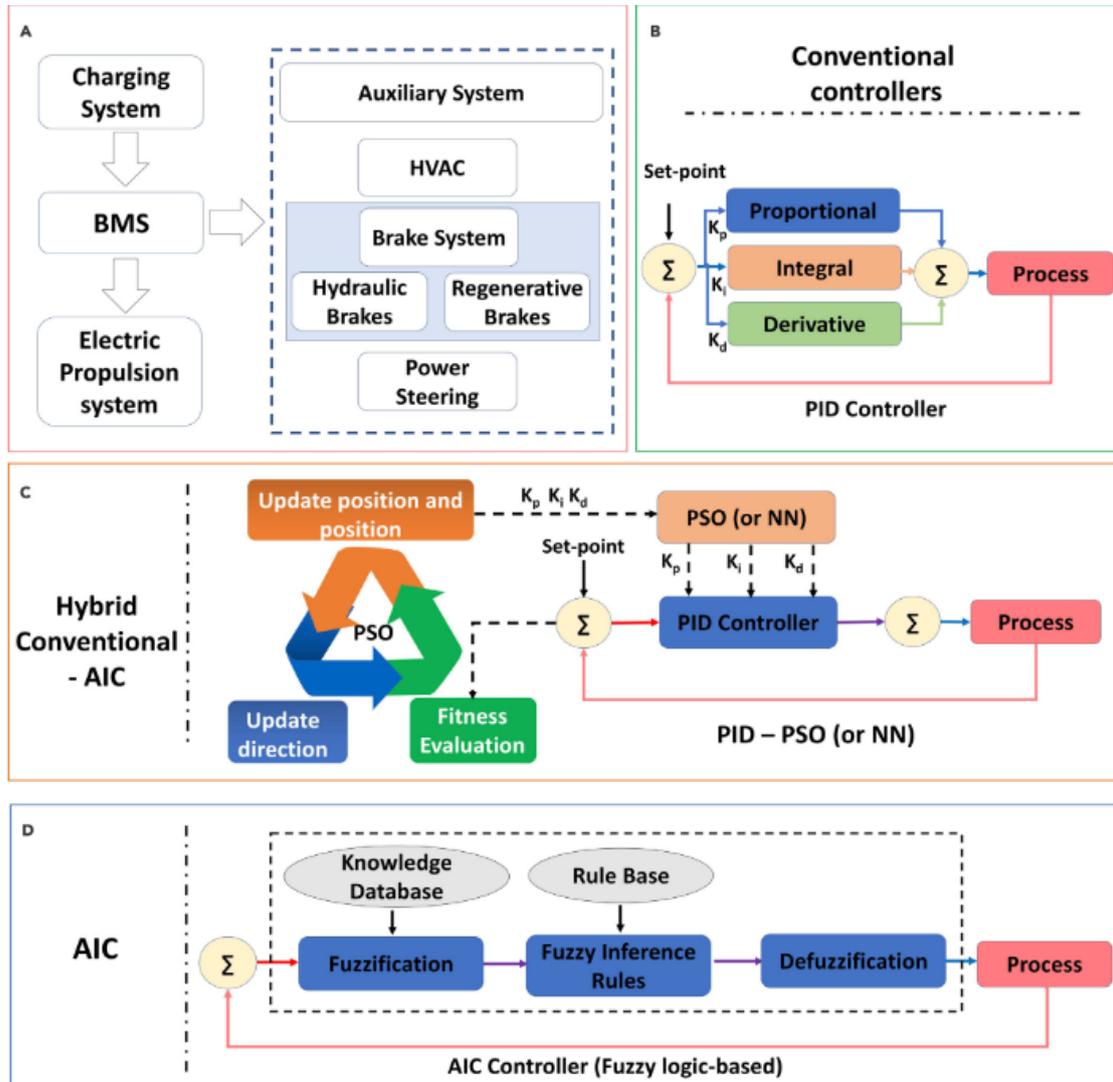


Figure 21 (A) EV control architecture. (B) Conventional (PID) controller. (C) PID-artificial intelligent controls (AIC) (particle swarm optimization [PSO] based) controller. (D) AIC (fuzzy-logic based) controller.

New technology, customer demand, social concerns, as well as the government laws all have an impact on the need for vehicle thermal management advances. For example, There have been a number of recent advancements in car thermal management technologies and modelling, with a particular emphasis on the interior, electronics, especially external components of the vehicles. The Thermal loads, the HVAC systems, including window glazing or even the tinting as well as the vehicle surface treatments are all included in this section. Active or even passive cooling technologies that use jet impingement, heat pipes, the heat sinks, the forced convection, as well as the phase-change materials are reviewed in this article.

5 CONCLUSION

Embedded systems, particularly those found in automobiles, are an integral part of our daily lives. Development of the embedded systems has a profound effect on people's daily lives as well as society as a whole. But even as the embedded systems technology continues to evolve, there are still significant problems in methodology, and these obstacles will only increase as the market demands ever-increasing speed and dependability. The performance of (FLC) fuzzy logic controller is heavily reliant on the rules it uses to make inferences. For the most part, adding additional rules to the FLC increases its precision. The more rules you have, the longer it takes to process them. In order to implement FLC, the high-performance CPU is needed.

It also looks at how AI has been used in adjacent fields including electric vehicles, electric vehicle control systems, and how electric vehicles engage with smart grid, all of thst have been emphasised and summarised for the sake of highlighting commercial appeal. Battery design as well as discovery, as well as battery management including accurate renewable energy (RE), are examples of AI algorithms being utilised in the EV battery design, as well as smart control of the EV hardware as well as auxiliary systems to preserve battery energy. With regard to EV user comfortability, AI is examined in the next section with regard to the appropriate position and energy consumption of EVCS.

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Concepts of Cloud Computing and Its Applications

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Abstract

In this chapter, the various applications, issues and services of cloud computing have discussed. The concept of Cloud Computing solves the various technical issues to the users for the solution of problems. Virtual abstraction, a technology used in cloud computing, facilitates the quick deployment of applications and data simultaneously reducing the price and complication of the runtime environment, which also enables operations quicker. The overall perception of Cloud Computing is explained here with various services and applications.

Keywords: Cloud Computing, Architecture of Cloud Computing, Cluster Computing, Grid Computing, Mobile Computing, Issues, Services and Applications of Cloud Computing

1 Introduction

Cloud computing plays an important role in the field of networking using internet; it provides a new innovative research area of information technology and study related to store the data over the network using internet of Things (IoT).

Internet of things provides a new way of communication using a number of connected devices using the internet to share or distribute the data .It also use the internet or global network to secure the data. With the help of cloud computing, the information and files can be used anywhere in the world. The

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cloud computing technology is useful for both businesses and IT industries to develop the various web applications and services or websites.

Employees working in different locations of the world can easily utilize the data over the internet or server of the specific organization using cloud computing services. Amazon, Microsoft, Google Cloud Platform and many more agencies are providing the cloud based information using internet services / networking and Cloud computing. Cloud computing provides a unique way to store and back up the data with high performance and speed.

The benefits of cloud computing and related internet services are discussed briefly in this section; it reviewed the Basic Concepts of Cloud Computing in Internet Services and other Applications. It also discussed the existing problems in the field and provided possible solutions and future directions.

2 Cloud Computing: An Overview

Cloud computing is previously known as Computing on the client/server side in which a number of users can access the data through a specific storage wherein the various applications / services and programs / records are stored at the server level.

If any client connected to a network wants to retrieve the information or execute the applications or programs for individual / business purpose can easily explore / use the required services without any interrupt among a number of nodes or mobiles with high performance and speed using cloud computing. Cloud computing provides a platform to share the data / records over a internet among a number of connected computing devices like: computer systems, mobiles and laptops etc.

Cloud computing standards were advised by an American computer scientist named John MacCharty. The concepts of cloud computing were moved toward in practical round 1961 at Massachusetts Institute of Technology (MIT), United States.

In 2002, Amazon began out Amazon Web Services, supplying offerings like storage, computation or even human intelligence. However, most effective beginning with the release of the Elastic Compute Cloud in 2006 a sincerely industrial carrier open to anybody existed.

In 2009, Google Apps additionally began out to offer cloud computing business enterprise applications.

Of course, all of the huge gamers are present within side the cloud computing evolution, a few have been earlier, and a few have been later. In 2009, Microsoft released Windows Azure, and corporations like Oracle and HP have all joined the game. This proves that today, cloud computing has come to be mainstream.

Cloud computing is defined as the storage and retrieval of data and computing services via the internet. It does not store any information on your personal laptop. It is the accessibility of laptop solutions such as servers, document storage, communication, data warehouses, and so on. The primary reason for cloud

Dr. Arvind Kumar Shukla, Dr. Rajdeep Singh and Dr. C K Dixit

applications is to provide many individuals with access to data storage facilities. Users can also access data from a remote server.

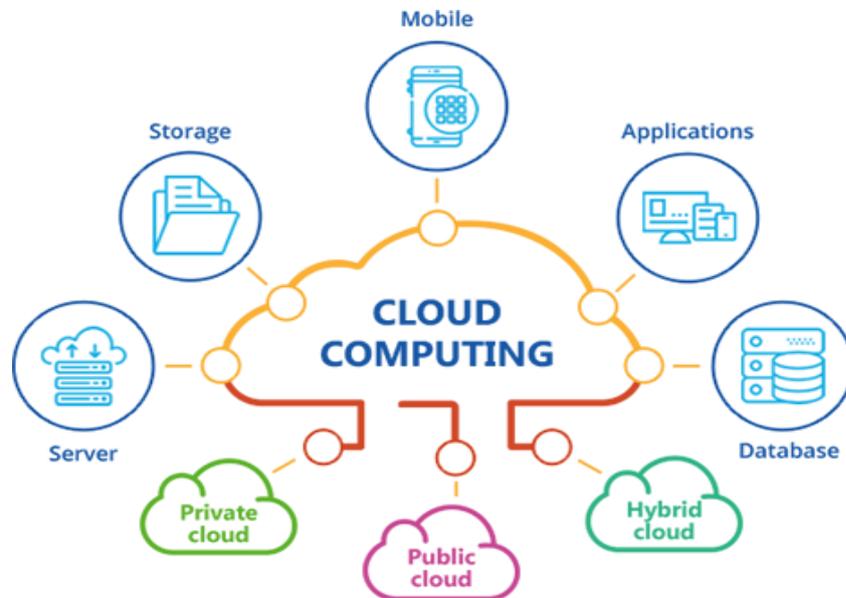


Figure1: Cloud Computing

a. Cloud Computing?

Data storage has become a challenge in all areas as a result of the rise in laptop and mobile users. These days, both large and small businesses rely on their facts, and they spend a lot of money to keep track of them. It necessitates a competent IT support team as well as a storage hub. Not many businesses can afford to invest in high-value in-house IT infrastructure and low-cost backup support services. Cloud Computing is a cost-effective alternative for them. Perhaps its ability to store facts, compute, and have a far lower preservation value has attracted even larger organizations.

Cloud computing reduces the amount of hardware and software that a user needs. The most important thing that individual should be able to do is run the cloud computing structures interface software, which can be as simple as a Web browser, and the Cloud community will take care of the rest. We've all used cloud computing at some point, and some of the most well-known cloud services we've used or are still using include mail services like gmail, hotmail, or yahoo, among others.

Our information is now saved on a cloud server rather than on our PC while we have access to an email provider. The cloud's generation and infrastructure are hidden from view. It doesn't matter if cloud services are largely based on HTTP, XML, Ruby, PHP, or another specific technology as long as they are user-friendly and functioning. An individual can connect to the cloud machine using his or her own devices, such as a desktop, laptop, or Smartphone.

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Cloud computing enables small businesses to operate efficiently with little resources by providing them with access to technology that was previously unavailable to them. Small businesses can use cloud computing to turn their protection costs into profit. Let's have a look at how.

In order for an in-house IT server to work successfully, you must pay several interests and ensure that the system is free of faults. And if there's a technological problem, you're completely accountable; it'll cost you a lot of interest, money, and time to fix it. In cloud computing, on the other hand, the carrier business assumes full responsibility for the problem and any technical issues.

b. Cloud Computing's Advantages

The chance to save money is the primary motivation for many businesses to use cloud services. Cloud computing gives you the freedom to customize your products based on your needs and only pay for what you use. Because of cloud computing, it is now possible to manage IT operations as an outsourced unit without a large number of in-house resources.

In this Cloud Computing theory, we'll look into the advantages of cloud computing. The following are some of the benefits of cloud computing:

- Lower IT infrastructure and computer costs for users
- Improved presentation
- Fewer upholding issues
- Instant software updates
- enhanced compatibility between Operating systems
- Endorsement and Recuperation
- Recital and Scalability
- Increased storage competence
- Increase data protection

c. Clouds of Various Types

There are four different cloud models to choose from, each tailored to the demands of a commercial enterprise. The following are the different kinds of clouds:



Figure 2: Clouds of Various Types

- **Private Cloud:** Computing resources are being utilized for a single organization in this case. One such method is also used for interpersonal and inter connections. Where the software applications are influenced, owned, and continued to operate by the same company.
- **Community Cloud:** Computing resources can be utilized to the public and associations here.
- **Public Cloud:** This cloud model uses the B2C business model type relationships for resource sharing. Here, the government and business agencies have the overall monitoring over the services for further processing.
- **Hybrid Cloud:** Both B2B (Business to Business) and B2C (Business to Consumer) models use the hybrid cloud model to communicate the information or records among the different organizations.

3 The Architecture of Cloud Computing

It is arrangement of different required cloud services with internet and other program delivery for business and personal use. This Architecture provide a platform for server, community based resource sharing methods using internet. It also offers the cloud Programming framework for the clients and server side nodes. The Design of cloud computing architecture is given below.

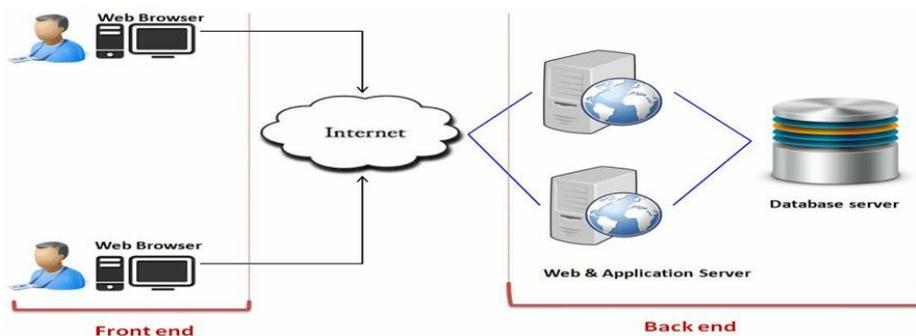


Figure 3: The Architecture of Cloud Computing

The spine stop refers to the cloud, but it also encompasses the resources necessary for cloud computing environment. It includes, among other things, digital computers, servers, data storage, and authentication methods. It is beyond the provider's control.

Cloud computing helps to distribute a document system across a few storage devices and machines. Information is not saved in a particular region, and if one unit keeps failing, the other requires over directly. The user disc area is allotted at the dispensed file device at the same time that every other key aspect is a system of regulations for useful resource allocation. Cloud computing is a reliable distributed environment that relies heavily on a series of principles.

a. Clouds Computing Roots

The various web applications, grid computing, cluster / distributed computing using the hardware (multi-core chips) and software have been proved a important part or root of the cloud computing for virtualization of services and resource sharing of information. The services related to internet technologies and system management has offered a number of web applications for the cloud based services.

From Mainframes to Clouds

- Providers of IT offerings gain higher operational costs; h/w and s/w program infrastructures are build to offer more than one answers and serve many users, for this reason growing performance and in the end main to quicker go back on venture in addition to reduce overall value of tenure .



Figure 4: Convergence of advent of cloud computing

- The workstation technology distorted with the arrival of rapid and cheaper microprocessors and IT data services moved to gathering of commodity servers. Apart from its sparkling

Dr. Arvind Kumar Shukla, Dr. Rajdeep Singh and Dr. C K Dixit

advantages, this new version unavoidably caused seclusion of workload into committed providers / servers especially because of diversities.

4 SOA (Service Oriented Architecture):

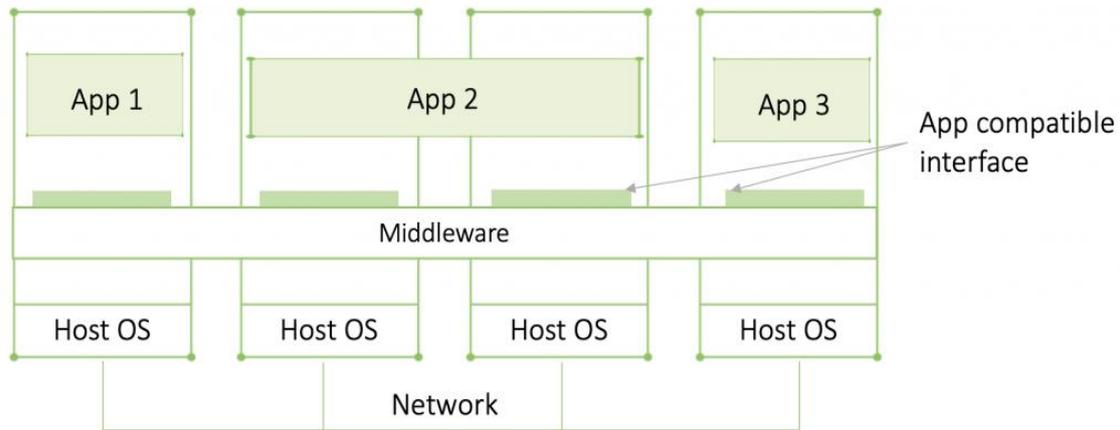
- The various internet services can fasten collectively programs strolling on extraordinary mailing result platforms, permitting records from one software to be made available to others, and permitting inner programs to be made to be had over the Internet.
- HTTP and other web applications have contributed the web based services using the SOA for providing and implementing the data or records.
- The collective internet / web services have solved the difficult and complex business logics using SOA standards.

a. Distributed Systems

A distributed system is a group of self-contained computing pieces that seem as a single machine to clients. These components, referred to as network, might be either hardware devices (such as a workstation or a Smartphone) or application programs. A notable example is the internet, which is the world's largest distributed system. Despite being made up of tens of thousands of servers, it seems to you to be a single machine. You have no idea where the data is kept, how many computers are implicated, or how the contents get to your site. The term for this concept is virtualization, and it arises frequently in IT.

In relatively brief, your web application segregates the internet's difficulties and challenges. The same is true for applications like Gmail, Sales Force, and any other software products you might use. Every single day, you interact with disbursed applications!

Connectivity is at the heart of parallel computing; if it fails, no cooperation is possible, and your browser will be blank. Web logic is a separate software application layer that is typically implemented as part of a distributed system's windows os. It facilitates integration that allows computers that aren't always well though communicate to operate. It also provides a variety of services to the programmers, such as security, encryption, and failure recovery.



(Figure 5: Major objectives of Distributed systems)

- **Resource sharing.** The database or records, networking and other service facilities are the key factors for resource sharing among the connected users in all around the world. It may be cheaper to have many applications for storage purpose individually.
- **Abstraction.**
- In cloud computing, the processing and resource sharing activities are not dependant to the devices and geographically isolated node oriented service consuming by the users. The client or any node does not know the actual or hidden logics to explore the use of various cloud services over the internet.
- **Openness.** The distributed systems must be available for users to use the applications related to many organizations using different components. It provides a liberty to access the system services for business or personal use.
- **Scalability** is also required when a large number of consumers require additional facilities. Netflix, for example, sees a spike in viewership every Friday evening. Scaling out entails action sequences resources (e.g., increasing network capacity to encourage greater video streaming) and then scaling back once usage has returned to normal.

b. Cluster Computing

Cluster computing is a grouping of associated equipment linked by an increased home network. Also every device has the same (H/W and OS). Cluster computing is frequently used for multithreaded, in which a single work properly application runs on various machines in parallel. Each cluster contains a collection of nodes in the cluster that are controlled and monitored by one maybe more grasp base stations. The comprehension is in charge of things like distributing employee nodes to specific systems and controlling request queues. It also provides users with a device interface. In short, the basic understanding manages the cluster while the users run the actual application.

Dr. Arvind Kumar Shukla, Dr. Rajdeep Singh and Dr. C K Dixit

Cluster computing cannot be in reality differentiated from cloud and grid computing. It is an extra preferred technique and refers to all of the approaches wherein individual computer systems and their computing power may be blended collectively in clusters. Examples of this consist of server clusters, clusters in huge information and in cloud environments, database clusters, and alertness clusters. Computer networks also are an increasing number of being utilized in high-overall performance computing that could resolve in particular traumatic computing problems.

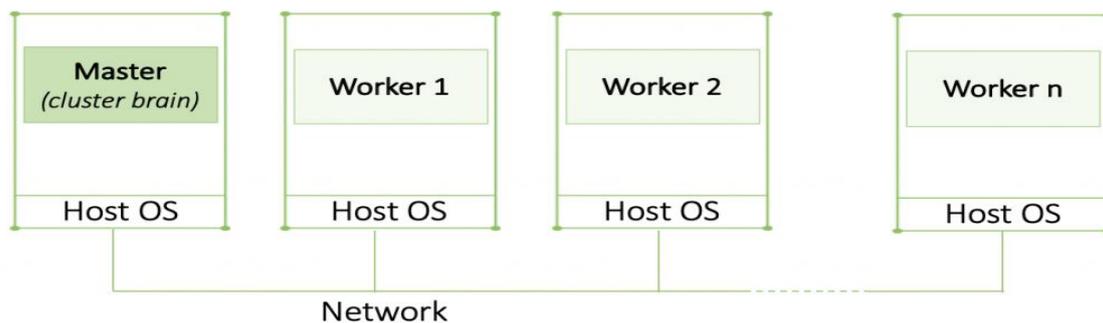


Figure 6: Cluster Computing

Cluster computing refers to a group of software applications that are interlinked over a network and perform as a single entity. A node is a laptop that is connected to the same network. Cluster computing provides solutions to tough problems by delivering faster calculation speeds and enhanced information integrity. As a result, the linked computer systems perform functions in unison, making it appear of a common platform (digital machine). Accessibility of the system is the term coined to this method. This connectivity generation's operations are based on the concept of allotted systems. LAN is the association unit in this situation. Because of the system's accessibility, this approach is presented. Cluster computing can perform the following activities:

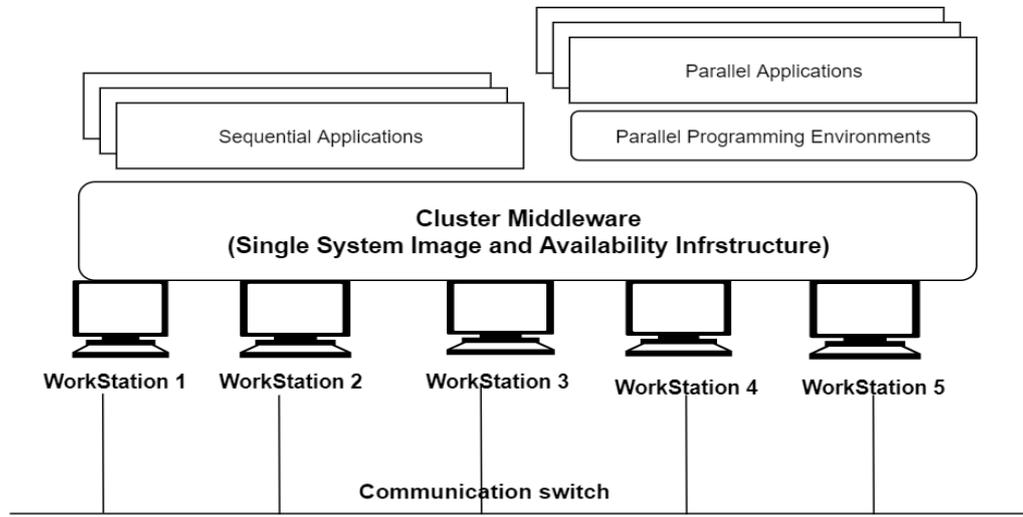
- Similar devices are always connected.
- These devices are strongly linked to the network technology.
- All computing devices or computers share the same and common home directory.

Clusters are divided into two types: open and closed. In open clusters, all nodes require IP addresses, and users are best reached via the internet or the web. Clustering like this raises serious concerns about safety. Closed Clustering, on the other hand, hides the nodes in the rear of the default gateway, enhancing overall security.

c. Cluster Computing: The Architecture

- A cluster is a set of interconnected distributed infrastructure that consists of a collection of networked autonomous computer systems that run as a single end - user premises.

- A node or workstation, PC is a client having the BIOS structure for networking purpose to share the data or records over the internet.



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Figure 7: The Architecture of Cluster Computing

d. Cluster Computing's Advantages:

The following are some of the benefits of cluster computing:

- **Cost efficacy** – Despite the fact that mainframe data centers appear to be quite robust, cluster computing is more widely used due to its economic and sustainability. Furthermore, their architectures outperform mainframe computer networks in terms of total performance.
- **Processing speed:** The performance or speed of every cluster is always remain same as similar to the mainframe / centralized computer.
- **Expandability:** Many more computers or workstations, nodes can be added easily to the system for cluster computing.
- **High availability of resources:** Due to non working of any node of the cluster, the processing never stop in cluster computing over the system processing but if mainframe system failed then no workstation will work.

e. Grid computing

Grid computing is made up of nodes with vastly different networking and security capabilities. The current trend of setting nodes specifically for positive roles has resulted in more range being employed in grid computing. In terms of hardware, operating system, community, or appropriate security, no

Dr. Arvind Kumar Shukla, Dr. Rajdeep Singh and Dr. C K Dixit

assumptions are made. It's important to remember that the term "cluster" is routinely used in everyday tech terminology to refer to both groups and distributed systems.

Grid computing is primarily based totally at the concept of a supercomputer with big computing power. However, computing responsibilities are achieved via way of means of many times as opposed to simply one. Servers and computer systems can hence carry out one-of-a-kind responsibilities independently of one another. Grid computing can access assets in a completely bendy way whilst acting responsibilities. Normally, individuals will allocate unique assets to a whole mission at night time whilst the technical infrastructure has a tendency to be much less closely used.

One benefit of that is that especially effective structures may be fast used and the computing strength may be scaled as needed. There is no need to update or improve a high-priced supercomputer with any other high-priced one to enhance performance.

Since grid computing can create a digital supercomputer from a cluster of loosely interconnected computers, it's far specialized in fixing issues which are mainly computationally intensive. This technique is frequently used for bold scientific initiatives and decrypting cryptographic codes.

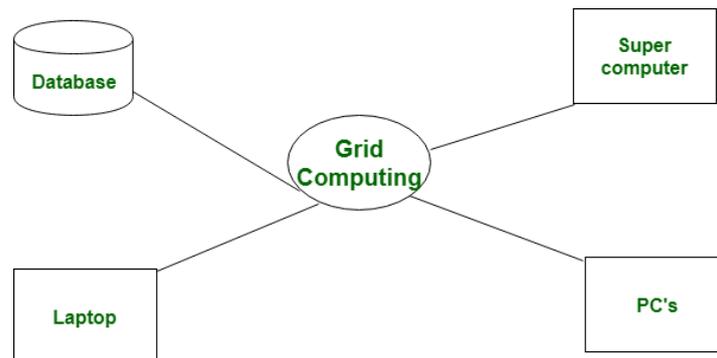


Figure 8: Grid computing

Grid computing is a combination of workstations and servers that operate together as a computerized mainframe to perform enormous tasks such as processing large amounts of data or weather forecasting. You may aggregate and use massive laptop grids for various time periods and purposes through the use of the cloud, paying because of what you use to save the other money and effort over purchasing and maintaining the important components individually. Also with the aid of using splitting responsibilities over more than one machine, processing time is drastically decreased to boom performance and decrease wasted assets.

Unlike with parallel computing, grid computing initiatives normally haven't any time dependency related to them. They use computer systems which might be a part of the grid simplest while idle and

operators can carry out obligations unrelated to the grid at any time. Security ought to be taken into consideration while the usage of laptop grids as controls on member nodes is typically very loose. Redundancy has to additionally be constructed in as many computer systems may also disconnect or fail at some point of processing.

How is Grid Computing Used?

Grid computing is specifically beneficial whilst exclusive problem count professionals want to collaborate on a assignment however do now no longer always have the approach to right away proportion facts and computing assets in a single site. By becoming a member of forces in spite of the geographical distance, the allotted groups are capable of leverage their personal assets that make contributions to a larger effort. This approach that every one computing assets do now no longer must paintings at the equal precise task, however can work on sub-responsibilities that together make up the cease goal. For example, a studies crew would possibly examine climate styles within side the North Atlantic region, whilst every other crew analyzes the south Atlantic region, and each outcome may be mixed to supply a entire photo of Atlantic climate styles.

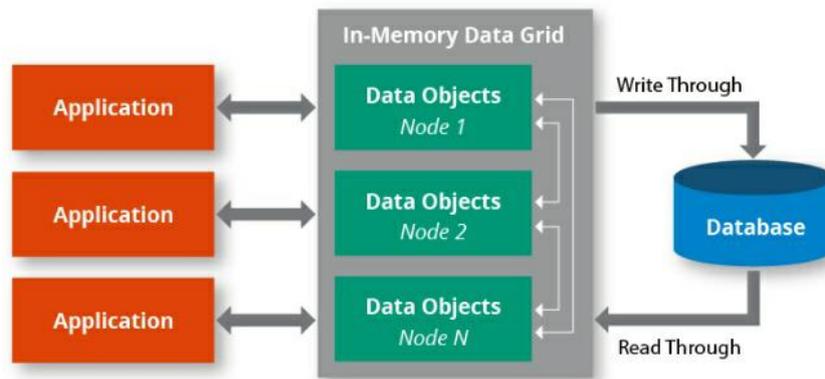


Figure 9: Functions of Grid Computing

Cloud Computing V/S Grid Computing

| S. NO | Cloud Computing | Grid Computing |
|--------------|--|---|
| 1. | It has a Client-server computing design. | Even as it has a scattered computing structural design. |
| 2. | It is a federal executive. | While it is a decentralized executive. |
| 3. | In cloud computing, resources are used in centralized pattern. | While in grid computing, resources are used in collaborative pattern. |
| 4. | It is more flexible than grid computing. | While it is less flexible than cloud computing. |
| 5. | Cloud computing is a high reachable service. | While grid computing is a low reachable service. |

5 Mobile Computing

Mobile Cloud Computing (MCC) is defined as a collection of cellular technology, cloud computing, and Wi-Fi connections that come together to give rich computer resources to mobile terminals, community operators, and cloud computing providers. Mobile Cloud Technology is prepared to make it possible for rich cellular applications to run on a wide range of mobile devices. Data collection and processing take place even outside cellular devices underneath this technology. Mobile Cloud Computing applications take advantage of this IT environment to provide the number of benefits:

- Comprehensive battery life.
- Enhanced capacity of processing and storage.
- Improved management of data.
- Better consistency and scalability.
- Simplicity of arrangement.

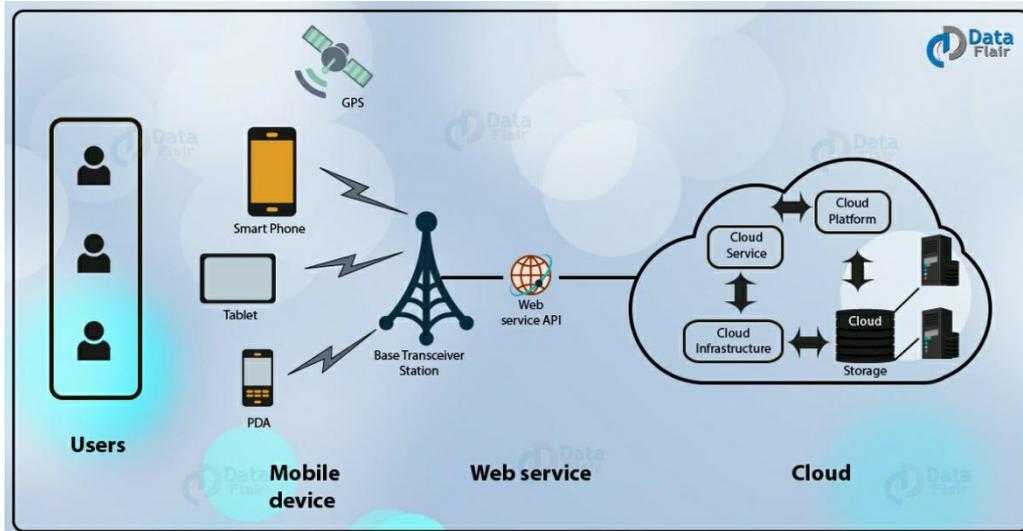


Figure 10: Mobile Cloud Computing

a. Key Factors for Adoption of Mobile Cloud Computing

- **Trends or demands:** With the help of mobile computing, using can access the online applications based services in anywhere in the world easily. Any customer may order or purchase the things and services online. Mobile Cloud Computing saves the time and money of the user. It provides an easy way to process the business at any time and place.
- **Enhanced & amplified internet exposure:** The Improved internet speed (3G, 4G and wifi) increases the performance of mobile cloud computing for better online services existence.
- **Enabling technologies:** The adoption of new technology helps to use the various online services smoothly using mobile cloud computing with latest version of web applications and websites to explore and store the information.

b. Mobile Cloud Computing Applications & Characteristics:

- **Architecture for the cloud:** It is a precise structure of data structural design that is used to store the records and information.
- **Information supply:** Data can be freely used anywhere by the user easily.
- **Client adjustment:** There is a wide scope of different user requirements using mobile cloud computing to develop the various applications in cloud computing also.
- **Simple admittance:** It is simple to use the mobile cloud computing by cell phones, desktop and other computing devices easily.
- **Cloud computing services** make it possible to have access to a whole new spectrum of functions.

Dr. Arvind Kumar Shukla, Dr. Rajdeep Singh and Dr. C K Dixit

c. The working of Mobile Cloud Computing

Mobile Software Solutions are frequently maintained on a remote server by a foreign entity. Statistics are kept, and compute cycles are accomplished. A backend manages the uptime, amalgamation, and precautions aspects, as well as providing guidance to a huge number of access methods.

These apps may do a lot of things online, but they need to be updated regularly basis. These don't have to be totally saved on the tool, but they don't typically take up any storage space on a workstation or mobile device.

Furthermore, it provides the same level of enjoyment as a computer application while also having the adaptability of an online environment.

d. The Uses of Cloud Computing on Mobile Devices

Mobile cloud computing (MCC) web applications are divided into two categories that are extremely similar. Some of them are as described in the following:

- The term "mobile cloud application" refers to a model in which activities are done in the cloud, storage is done in the cloud, and the exhibition platform is a smart phone. A strong web server, as well as a smart phone possible to run a browser, is mandatory. It provides a Smartphone to be used in the cloud environment and also has the basic specifications:
 - A Smartphone runs on an eminent OS.
 - It comes with enhanced calling features including teleconferencing and collaboration.
 - The cell phone must be capable of running the embeddable application.
 - There really are messaging features enabled.
 - A Smartphone requires a stable and reliable internet connection.
- **Web Services for Smart Phones / Mobiles:** In Mobile Web Services, cellular devices demand greater internet usage. It may also lead to a number of tough circumstances for internet services, such as inconsistencies in computing device decision and information. The tool needs to remember about that carrier and how it can be accessible to join any internet-carrier so that the cell tool can transmit unique information about the tool and the user's situation. The following steps are followed to enabling Mobile Web Services:
 - Web services are used to enable web-service systems.

- Allows in-built external services to be used.
- Allow the rest protocol to be used.
- XML-RPC protocols are enabled.
- Authenticates user roles and allows them to be changed.

The Benefits of Mobile Cloud Computing

- Due to the obvious adaptability, their work is simpler and more convenient, and Cloud Computing Technology saves money for corporations.
- Cloud users use their mobile phones to explore new features.
- Manufacturers can reach a larger number of people by using mobile cloud online services.
- In this category, more network providers can join.

e. Mobile Cloud Computing's Challenges:

- **Low bandwidth:** Limits the potential is one of the most serious difficulties in the virtualized environment. Mobile cloud exploits electromagnetic radiation, which are limited when comparison to data communication. Different wavelengths are available on different smart phones. As a consequence, in terms of access speed, it is four times quicker than a network infrastructure.
- **Protection and Solitude:** Because there are far more chances of communication being lost on a cellular connection, it is harder to recognize and minimize vulnerabilities on android platforms than it would be on desktop computers.
- **Service Accessibility:** Users routinely complain about service disruptions, overcrowding on mass transit, and a lack of coverage, among other things. Subscribers may get a low-frequency signal from time to time, which affects accessibility computation and high capabilities.

Dr. Arvind Kumar Shukla, Dr. Rajdeep Singh and Dr. C K Dixit

- **Alteration of Connections & Networks:** Mobile computing is used on devices that run a variety of operating systems, including Apple iOS, Android, and Windows Phone. As a result, it must work on multiple platforms. The IRNA technology (Intelligent Radio Network Access) is being used to track the contribution of various mobile operating system infrastructures.
- **Limited Energy source:** Smart phones have become less sophisticated or use more resources than desktops and laptops. Mobile cloud computing allows for an efficient use of mobile device chargers, which is a massive obstacle. A long-lasting battery is required to enter programming and accomplish other functions. When the size of the refining is small, offloading costs more energy than local processing.

f. Development of infrastructure and systems

Technology and computing platforms - Integrating platforms and frameworks with a variety of services, ranging from actual hardware architecture to custom systems that meet unique demands, is what cloud development environment entails.

Amazon cloud platform / services-

Amazon Web Services (AWS) is a data storage service that enables services including database storage, content delivery, and encrypted IT infrastructure for corporations. Elastic Compute Cloud (EC2) and Simple Storage Service are two of its on-demand offerings (S3). If you want to get through the AWS cloud, you'll now have to know about Amazon EC2 and Amazon S3. Amazon EC2 stands for Elastic Cloud Compute and is software for running cloud servers. In 2006, Amazon announced EC2, which allowed businesses to quickly and efficiently spin up servers in the cloud rather than going out and buying, set up, and handle their own workstations on-premises.

While bare-metal Amazon EC2 instances are possible, most Amazon EC2 server instances are virtualization technology managed on Amazon's platform. The cloud provider controls the server, so you don't have to set it up or maintain it.) A wide range of EC2 instances are available at various rates; in general, the more processing capabilities you required, the larger the EC2 instance you will require.

Material by itself, you can run a functioning load on a computer system instead of a virtual something with Cloud Instances. Different sorts of applications, such as parallel processing of big data with GPUs, are suitable for use in some Amazon EC2 examples. Auto-scaling, for example, is a feature of EC2 that automates the process of raising or lowering compute resources available for a given workload, not specifically to make server deployment quicker and easier.

Handbook of Trends in Engineering Technology and Research

Auto-scaling therefore aids in cost and efficiency optimization, particularly in working settings with considerable volume changes. Amazon S3 is a cloud storage service provided by Amazon Web Services (as its full name, Simple Storage Service). It allows customers to store and access almost any type of data in the cloud using a web interface, AWS Command Line Interface, or AWS API. For the purposes of using S3, you must create a 'bucket,' which is a specialized object that you use to store and retrieve data. You can create as many buckets as you want. Amazon S3 is an object storage system that excels at storing large, unequal, or highly dynamic data sets.

The Google App Engine (GAE)

It is a service provided by Google. The Google AppEngine (GAE) is a platform as a service (PaaS) cloud computing service for developing and hosting web-based applications within Google's data centres. GAE web applications are sandboxed and distributed among multiple redundancy servers, allowing resources to be scaled up in response to current traffic demands. To manage higher load, App Engine allocates additional resources across servers.

App Engine distributes additional resources to servers to handle enormous burden. Google App Engine is a Google framework that helps programmers and businesses to create and deliver services using Google's comprehensive programme. Apps should always be written in one of the few languages that are supported, namely Java, Python, PHP, and Go. This also involves the use of Google query language, with Google Big Table as the database of choice. The application must satisfy the condition, which means it must be designed in compliance with GAE or modified to suit them.

GAE is an infrastructure for manufacturing and distributing Mobile applications for digitally mobile devices. Without this all-in feature, developers should be accountable for developing their own workstations, database management system, and Methods that allow everyone else to work together properly. GAE eliminates developers of their commitments, placing an emphasis on the device's frontend and features, which enriches the user engagement.

Microsoft Azure-

Azure is a tune-up provided by Microsoft. Microsoft Azure is a platform as a service (PaaS) that allows businesses and administrators to create and supervise functions for use with Microsoft products and in computer servers. This is a compendium of cloud products that enable users to create enterprise-level apps without having to build their own communications. The Windows Azure, SQL Azure, and Azure App Fabric controllers are three cloud-centric analogous yields on the Azure Cloud platform.

This is the location where the software's backend is maintained. The Azure Software solution role is groupings of online media that work together again to requiring attention and many of them are automated, massive amount, and Web service.

Dr. Arvind Kumar Shukla, Dr. Rajdeep Singh and Dr. C K Dixit

The Azure fabric controller also governs Software Solution Roles, that will provide the create a unified of size, predictability, and personalization. The Online Activity is an Azure Cloud service capacity that is built and structured to handle websites and applications implemented in Web - based information Services (Http) technology programs and capabilities such as ASP.NET, PHP, WCF, and Fast CGI.

The Website Role is a modified and enhanced Azure Software solution role for launching internet computer applications in Web - based information Services (IIS) computer technologies and capabilities including as ASP.NET, PHP, Application Programming Platform, and High speed CGI. Any Azure role that works on applications and services that don't typically involve IIS is considered to as a worker role. In Worker Roles, IIS is not selected automatically.

They are primarily used to support digitally ongoing activities and to handle operations like immediately resizing uploaded pictures, running algorithms, retrieving incoming messages out of queuing and processed, and more once something modifies the databases. VM Role: The VM role is an Azure Platform role that enables automated management of Windows Azure service packages, fixes, updates, and apps that have been already launched.

The main difference is that an Online Involvement utilises IIS to deploy and host the application continuously. Employee work assignments are not dependant on IIS and to instead run the conducted with a sample. Both can be treated in the same manner and run within the same Azure instances when published and delivered via the Online Platform. In some circumstances, Web Activity and Professional Role technologies are equivalent and used by the similar business at the same moment. For example, a web role illustration can collect user programs and thereafter pass such on to a databases worker role description.

Apache Hadoop

It's a freeware framework for gathering and evaluating big data on heterogeneous computing platforms. Hadoop is indeed a highest Apache application that is generated and administered by an international community of programmers and clients. It's licensed under the Apache 2.0 license. Map and Reduce are the two steps of the MapReduce function. Reduce tasks shuffle and reduce data, whereas Map tasks deal with data splitting and mapping. Hadoop can execute MapReduce software written in Java, Ruby, Python, and C++, among other languages. The MapReduce software is parallel in nature, making it ideal for large-scale data analysis using numerous cluster processors. Each step receives key-value pairs as input. In addition, the programmer must define two functions: map and filter.

Force.com and Salesforce.com

To comprehend the differences between salesforce.com and force.com, you must first understand the fundamental concepts of cloud computing. Salesforce is a firm, and salesforce.com is a customer relationship management tool built on the software as a service (SaaS) model (CRM). Developers and business users can utilise the force.com platform to create successful commercial applications. Salesforce

Handbook of Trends in Engineering Technology and Research

is a SaaS platform that contains out-of-the-box (OOB) functionality for sales automation, marketing, and service automation, among other things. Dropbox, Google Apps, and GoToMeeting are some SaaS examples that allude to moving software from your workstation to the cloud.

Force.com is a PaaS (Platform-as-a-Service) platform that includes an app development environment. It features a programming environment. Force.com allows users to add the graphical interface, capabilities, and application logic. Simply told, Salesforce.com's iPhone program saves relationships, texts and emails, phone conversations, and other basic operations. Force.com can be used to quickly create the applications. The iPhone keypad is powered by the ios Operating system, and Salesforce.com is provided by force.com.

Aneka Manjra soft Pvt. Ltd.

It is a company that develops software that is compatible with dispersed networks across various servers and works on cloud computing technologies.

- Develop scalable and adaptable building pieces for cloud computing platforms.
- Create software for networked multi-core machines that accelerates applications.
- Provide quality of service (QoS) and service level agreement (SLA)-based solutions that enable the scheduling, dispatching, and pricing of applications and accounting services in business and/or public computing network environments, depending on the service level agreement (SLA).
- Application development by enabling the quick generation of legacy and new apps utilising cutting-edge parallel and distributed programming techniques.
- Organizations' ability to employ computing resources

Business applications that require a lot of "compute" or "data" execution will be sped up.

6 Summary

Inside this piece of work, we looked at the purpose of cloud computing, as well as the benefits and issues that come with it. Many of its supporting concepts and technologies, primarily parallel programming, cloud technology, services-oriented computing, and desktop virtualization, have already been fully integrated as a result of continuous development. We're looking at different theories, implications, and deployments of the theme.

Just the changeable availability of IT solutions (being simulated architecture, software applications, or web applications) and the use of a resource costing system to evaluate such facilities are shared by all cloud computing perspectives. This paradigm is used across the open source cloud computing stack and provides for the task scheduling of IT and equipped assets in the context of network platforms, allowing for the development of extensible software and services.

Dr. Arvind Kumar Shukla, Dr. Rajdeep Singh and Dr. C K Dixit

This paradigm illustrates the cloud services reference technique. Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS), and Software-as-a-Service (SaaS) are the three major components of the Cloud computing sector and the services they deliver (SaaS). These features precisely integrate the many types of cloud computing environment into broad categories.

7 Conclusion:

The issues and difficulties with cloud computing were covered in this chapter. The connections between cloud computing, service-oriented computing, and grid computing have been explained. We looked at a few obstacles in the path of embracing cloud computing. The accessibility problem was brought up, and the several solutions are then covered for various cloud service delivery approaches.

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Corrosion– Major Cause of Deterioration of Reinforced concrete

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Abstract

Corrosion of reinforced bars in reinforced concrete structures is the main cause of structural deterioration of bridge decks, tall buildings, tunnels and reinforced containers. In order to evaluate the service life of reinforced concrete structures, the mechanisms of corrosion of steel in concrete must be assessed and modelled. The present work deals with a literature review on corrosion mechanisms happening during the life of a reinforced concrete structure. Usually, the deterioration process begins with the “passive state” of the steel, when aggressive reagents - mainly chloride and carbon dioxide, responsible for a pH decrease onto the steel-concrete interface - are penetrating inside the porous concrete.

Keywords: Corrosion , Reinforced Concrete, Service Life Prediction, Structural Safety

1 Introduction

Corrosion of steel bars in reinforced concrete (RC) structures has been identified as one of the major cause of premature failure of concrete structures. Corrosion of steel in RC structures which initiates the cracking of the concrete cover may be a significant problem in construction industry.

Reinforced concrete is recognized as an important building material and has proven to perform well. However, although it deteriorates, corrosion occurs due to the influence of the environment, and the performance of concrete deteriorates. The degradation rate of concrete buildings relies on environmental conditions as well as proper maintenance. Corrosion as a consequence of chemical as well as

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Dr. Sanjeev Kumar Verma

electrochemical activities is the most frequent kind of RC deterioration and is connected with chloride invasion as well as carbonation of concrete.

When the concrete holes allow oxygen, moisture, as well as chloride ions to permeate the surface of the rebar simultaneously, corrosion occurs. In high humidity conditions, air pollutants can penetrate concrete pavements and cause steel corrosion. When corrosion begins, the by-products of the corrosion expand as well as occupy about 6-10 times the volume of steel bars. This creates tensile stress in the concrete, causing cracks and accelerating corrosion.

Iron is consumed in oxidation process this might lead to reduction in effective load bearing sectional area of the reinforcing iron bars and reduces significantly the load carrying capacity of RC structures. Reinforced members of a structure affected by ongoing reduction of cross-section area of steel rebar due to corrosion can gradually reduce its resisting capacity.

Together with cracking of cover corrosion leads to a series of structural problems like reduction of the cross section area of the reinforcement, due to the lack of bonding force between concrete and metal, the load bearing capacity of RC structures is reduced. [1].

Penetration of chloride ions from environment in concrete and reaction with atmospheric CO₂ is the main source of corrosion [2]. Here during this phenomenon of corrosion in detail along with the causes, effects, measurement and methods to guard steel from corrosion have been discussed.

2 Effects of reinforcement corrosion

Tensile strength of ordinary cement concrete is weak in tension, so, adding reinforcing steels can improve the strength and lastingness of concrete as steel is strong in tension, and this forms a stone like "material reinforced cement concrete". The hydration of cement in the concrete structures produces an extremely basic pore solution (alkaline in nature) because of high pH (12.5-13.5) and it forms a passive compound film on the steel to protect it from corrosion. This protecting film is destroyed once decent quantity of chloride ions penetrates into the concrete or once the pH of the pore solution drops below nine because of destructive distillation [3].

After the rupture of protective coating, corrosion begins by forming an electrochemical cell consisting of the anode and cathode regions of the steel, the movement of ions through the concrete cover and the movement of electrons along the rod, and thus the flow of corrosion current starts as shown in fig 1. Corrosion of embedded steel requires loss protective film with the presence of moisture and oxygen. Within the case of dry concretes which are protected from rain, even within the presence of sufficient carbonation corrosion of reinforcement is negligible.

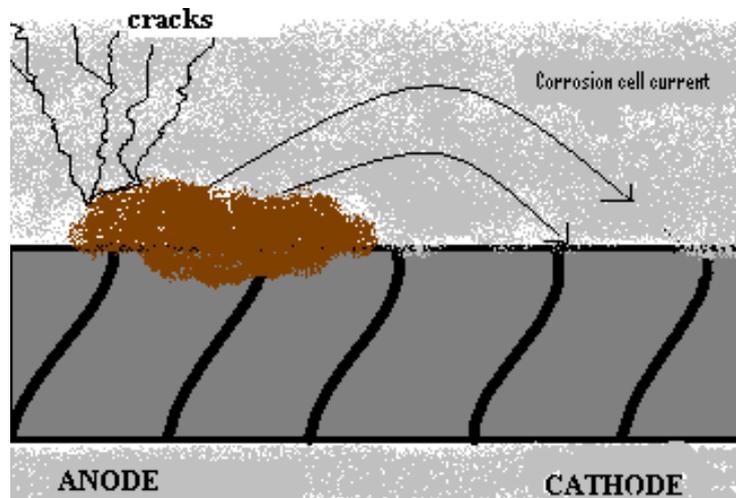


Figure 1 - Corrosion of steel bar.

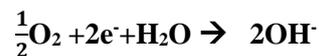
a. Principles of corrosion

Anode as well as cathode are present on the same steel bars in the electrochemical process of corrosion. Oxygen in the presence of water takes electrons from iron atoms to generate OH⁻ and at the anode iron atoms lose electrons to become Fe⁺⁺. This includes chemical reactions such as the acquisition and loss of electrons and currents (charge flow). Following reactions are involved in corrosion process

anodic



cathodic



A combination of anodic as well as cathodic reactions is essential for corrosion to occur and must take place at the same time.

3 Factors affecting the corrosion of reinforcement

The factors responsible for corrosion of concrete structures are presence of chloride/ or carbon, adequate concrete cover, porosity or permeability of concrete.

3.1 Chloride concentration- Using concrete's high alkaline content (pH > 12.5), steel implanted in the concrete is shielded against corrosion by a passive layer on the steel. Concrete contains a little amount of chloride, however significant chloride ion infiltration from deicers or saltwater may degrade the protective coating on concrete. Chloride ion diffusion through concrete has traditionally been regarded as the primary mode of transport [1].

Dr. Sanjeev Kumar Verma

3.2 Carbonation depth- Carbon dioxide from surrounding penetrates into the protecting cover through air and then reacts with the hydroxides to produce carbonates and reduces the alkalinity ($\text{pH} < 9$) of concrete as well as increases the risk of corrosion [4]. In excellent feature concrete the carbonation depth is usually found to be around very few millimeters, however, it may be deeper in concrete with low quality.

3.3 Concrete cover- Concrete surrounding reinforcement in RCC play role of protecting cover and protects embedded reinforcement from external harmful attacks transported through air or water, and insufficient cover of concrete to reinforcement will increase the hazard of penetration of dangerous agents, beginning the corrosion from surroundings. In different national and international codes of design the concrete protection thickness is defined, but only enough concrete cover to the steel bars does now no longer assure long lasting strengthened concrete. Permeability of the concrete cover additionally performs significant role in the performance of concrete.

3.4 Permeability- Permeability is the ease with which liquids, ions and gases can penetrate into the concrete. It is an important property for concrete structures, as it controls the penetration of harmful ions in the concrete. The water tightness of the liquid retention structures as well as chemical assault both depend on this feature.

4 Corrosion monitoring and detection

Usually, when cracking of concrete cover is visual by eye, it indicates some serious damage within the concrete and reinforcing steel bars. Presently various methods are available which may help to provide a pre-damage warning of steel corrosion like linear polarization, half cell potential, electrical resistivity etc. for monitoring and detecting the extent of corrosion. Now, the utilization of ultrasonic methods has been increasing for the detection of reinforcement corrosion. Several methods were described in Table 1.

Table 1- Methods for evaluating corrosion (Verma et al.[5])

| S. No. | Method | Defects | Working Principle |
|--------|--------------------------------------|---|--|
| 1 | Half cell potential. | Corrosion risk | Corrosion risk is determined by comparing the electric potential of the rebar with that of a half cell |
| 2 | Linear Polarization Resistance (LPR) | Corrosion rate | As the applied current divides the potential shift, polarisation resistance and corrosion rate go hand in hand |
| 3 | Concrete Resistivity | Resistivity against corrosion | Probes inserted in concrete monitors moisture movement associated with chloride ingress. |
| 4 | Galvanostatic pulse method | Half-cell potential as well as electrical resistance are both | the polarisation of rebar is achieved by passing modest continuous currents through it |

| | | | |
|---|-------------------------------------|---|--|
| | | measured at the same time. | |
| 5 | Time Domain Reflectometry (TDR) | locate corrosion and identify extent of damage | By putting a sensor wire beside the reinforcement, corrosion will alter the electromagnetic characteristics of the line, which is traditionally used to detect the electrical discontinuity in the transmission lines. |
| 6 | Ultra sonic guided waves | It is necessary to identify corrosion's location as well as extent. | Based on ultrasonic waves' propagation |
| 7 | X-Ray diffraction | Damage and corrosion extent | When an x-ray beam passes through a defective material, its intensity decreases |
| 8 | Embedded corrosion instrument (ECI) | Early warning to cracking, spalling, and other deterioration | Sensors are incorporated sensors in a pack and installed on the rebar. |
| 9 | Visual inspection | Visual defects, cover cracking and spalling | Inspected visually in a regular interval of time. |

These are the various techniques for detecting the corrosion in the reinforcement steel as shown in table 1. However, the half cell potential is that the most common technique for detecting the corrosion activities.

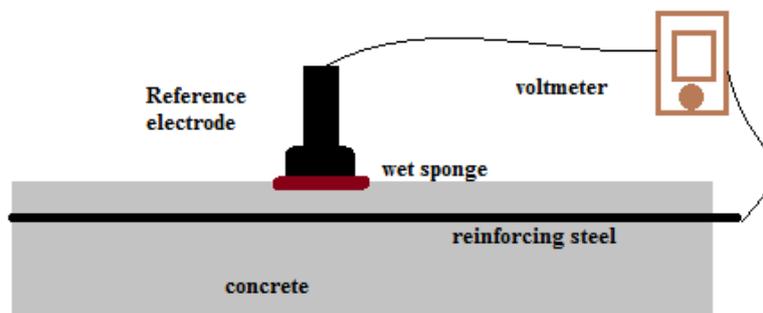


Fig. 2- Half cell potential measurement (Verma et al. [6])

Voltmeter measurement of the reinforcement bar/external electrode potential differential. A metal rod is submerged in a specific solution (Cu/CuSo₄ or Ag/AgCl) to form the half-cell. As seen in Figure 2, a voltmeter is used to connect the metal rod to the rebar. A better electrical connection requires certain surface treatment, such as wetting. Figure 2 Half-cell potential measurement (Verma et al. [6]) For the

Dr. Sanjeev Kumar Verma

half-cell potential measurement of the reinforced concrete structures, a high level of expertise as well as experience was necessary since only the corrosion probabilities were available. It is not about the rate of corrosion or the nature of corrosion. Half-cell potential tests are affected by variables such as cover thickness, oxygen availability, as well as concrete resistivity. A concrete structure's exposed surface may be evaluated using this approach. Potential is often assessed from every conceivable vantage point on the earth's surface. may also use the average of multiple measurements taken at various locations on the same surface to determine the likelihood of corrosion. Higher negative value of the measured half-cell potential specifies a high probability of corrosion, as reported in Table 2 according to ASTM C876 [7] for Cu / CuSo4 half-cells.

Table 2 – Criteria for Cu/CuSo₄Half Cell (ASTM C876)

| S. No. | Half cell potential (mV) | Probability of corrosion |
|--------|--------------------------|--------------------------|
| 1 | > -200 | 10% |
| 2 | -200 to -350 | 50% |
| 3 | < -350 | 90% |

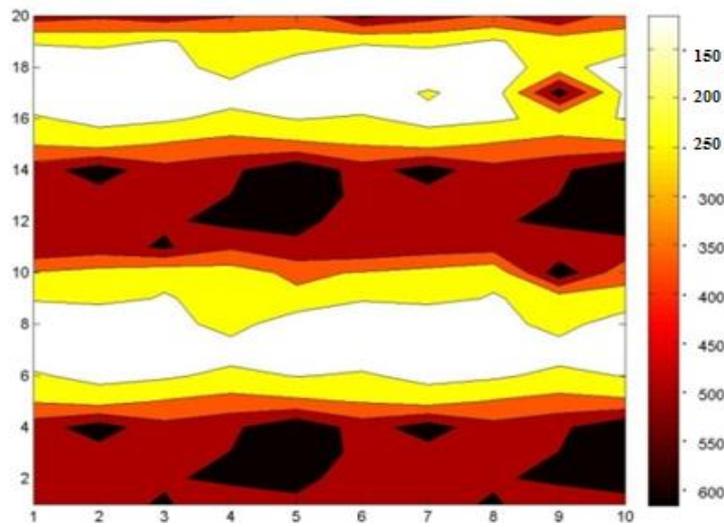


Fig. 3- Half cell potential contour

As shown in Figure 3, the measured half-cell potential values are often used to outline the potential on the surface of “reinforced concrete structures”. It is used to assess the potential for corrosion at various points on the surface of concrete structures. Parts of the structure that can exhibit high corrosive activity are often preserved and recognized by their high negative potential. Manually measuring potential values at various points in an oversized structure can be a daunting task. Therefore, an automatic evaluation procedure is required. Using half-cell potential measurements, structural engineers may determine the likelihood of corrosion in their structures. This system has some practical limitations, including: B. (1)

to establish a connection with the rebar, especially in the structures with large concrete covers, (2) proper wetting of the concrete protects the establishment of a proper connection between the reference electrode as well as the rebar. (3) Availability of the oxygen. Coverage thickness as well as resistivity of concrete can affect the results of half-cell potential tests [6].

5 Protection of rebar against corrosion

Early weakening of reinforcing steel due to corrosion is now the point of discussion among researchers and engineers worldwide. Corrosion reduces the load carrying capacity of steel bars, so it's necessary for an engineer to understand the causes and effects of corrosion.

There are numerous chemical as well as mechanical techniques available to stop new concrete structures from being corroded. Some protecting methods retard the corrosion rate by reducing corrosion reaction rates, some methods control corrosion by reducing the permeability of the concrete and further reducing the entry of damaging ions, oxygen as well as moisture, and a few protective systems have been used in form of coating.

Repair of existing corrosion affected concrete may be a difficult task, repair of concrete, without knowing the explanation for failure has been usually unsuccessful. If the concrete is repaired without maintaining the corroded steel, corrosion will continue and repair will fail.

Normally, reinforced concrete is a durable and almost maintenance free construction material. However, harsh environmental conditions like exposure to deicing salts or seawater can cause premature deterioration. Corrosion of reinforcing steel is recognized together of the major problems of civil infrastructures causing financial losses. As many structures experienced severe and unacceptable loss in serviceability when exposed to adverse environmental conditions, hence, it's been concluded that prevention or delaying of concrete corrosion is necessary to minimize the above loss. Amleh and Mirza [8] described various parameters influencing the deterioration caused by corrosion of steel bars, such as

- (a) **Type of concrete:** Concrete prepared by mixing Fly Ash as partial replacement of cement is more resistive against corrosion as compared to plain concrete.
- (b) **Cover thickness to bar diameter ratio:** Increase in cover thickness causes delay in rebar corrosion.
- (c) **Water Cement ratio (w/c) and corrosion cracking resistance factor:** Variation in w/c ratio causes variation in strength, and corrosion cracking resistance factors depends upon w/c ratio.
- (d) **Crack width:** Increased crack width decreases resistance against corrosion.

Protection of steel bars are often divided in two parts, first one is to stop new concrete from corrosion inducing agents, and second is to repair already affected existing structures. Researchers and engineers are working continuously to develop cost effective methods for shielding the reinforcing steel from corrosion. Several researchers proposed different means to extend the corrosion resistance of rebar. Few are presented in following table 3.

Table 3- Techniques proposed by researchers for protecting concrete

| S. No | Protective techniques |
|-------|---|
| 1 | Mineral additives such as High-performance water reducing agents and pozzolanic materials can increase the porosity and the corrosion resistance of concrete and reduces the penetration of harmful ions. |
| 2 | By using low-nickel stainless steel as reinforcement bars |
| 3 | Utilization of amino alcohol corrosion inhibitor |
| 4 | Calcium nitrite based corrosion inhibitor |
| 5 | “Calcium nitrite based inhibitor” increases the “chloride threshold value”. |
| 6 | “Benzotriazole” as corrosion inhibitor |
| 7 | Polyvinylpyrrolidone |
| 8 | Alkylaminoalcohol |
| 9 | “Fusion Bonded Epoxy Coated” (FBEC) steel bars |
| 10 | Alkano lamine based corrosion inhibitor with inorganic coating. |
| 11 | Steel bars coated with DINITROL AV |
| 12 | Amino alcohol based mixed (organic/ inorganic) inhibitors |
| 13 | ZnO for reducing the “concrete porosity and chloride content” |
| 14 | By providing high chromium steel, |
| 15 | Lamination of CFRP reduces the expansion caused by corrosion |

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A Schematic Review on non-Conventional Manufacturing Process

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Abstract

Non-Conventional Machining Approach is an advanced method used to solve the issues of Traditional Machining procedures. The Non-Traditional Machining techniques include Laser Beam Machining, Ultrasonic Machining, Water Jet Machining, Electron Beam Machining, Abrasive Water Jet Machining, etc. that have been discussed in this paper in a thorough fashion. The non-Traditional Machining technique is an advanced approach used to address the issues of Conventional Machining methods.

Keywords: Non-Conventional Machining , Laser Beam Machining, Ultrasonic Machining, Water Jet Machining, Electron Beam Machining, Abrasive Water Jet Machining

1 Introduction

Cutting-edge tools are used in conventional techniques of machining such as drilling and boring as well as milling and other processes. These traditional ways of machining have become obsolete as technology and time have advanced, despite the fact that these methods form the foundation of the machining process. The term "non-traditional machining" refers to a manufacturing process in which contemporary technology is used instead of traditional processes. Aside from non-traditional machining, the terms non-conventional machining and contemporary machining are also used to describe this kind of work. Although non-conventional machining facilities have a higher initial investment, they have a lower maintenance cost than traditional ones.

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Conventional machining methods are being phased out in favour of non-traditional ones. Because they are more accurate and provide better outcomes. There is a huge difference in efficiency between the classic machining methods and the non-traditional procedures. As a result, contemporary manufacturing calls for non-traditional machining methods. When working with hard materials like tungsten and uranium, typical machining procedures are ineffective. Modern machining methods may readily accomplish this task.

Carbide, Hastelloy, wasp alloy, nitralloy, stainless steel, and any other hard as well as brittle material which can be machined by a traditional method employing conventional machinery like lathe, shaper, milling, and planer are used in the unconventional machining. The nuclear business, space research, missile technology, and other fields that need for high strength-to-weight ratios, heat resistance, hardness, and toughness rely on these materials heavily.

Traditional machining methods take longer to complete the machining process, provide fewer surface finishes, and have zero precision. Thus, unusual machining reduces the amount of time it takes and improves the quality of the surface finish as well as accuracy. Unconventional machining removes metal by applying energy to the tool rather than the workpiece. Additionally, this method is costly, time-consuming, and perhaps difficult to use when trying to create intricate designs.

2 LITERATURE REVIEW

(Asmael et al., 2021) "Carbon fiber-reinforced polymer" (CFRP) composites are widely used in manufacturing because of their exceptional properties. CFRP composites, on the other hand, often need additional machining procedures in order to increase their dimensional accuracy as well as component integrity. "Since CFRP composites are difficult to cut, brittle and rigid, the "ultrasonic machining" (USM) technique has become more popular as a means of machining these materials. As a promising technique, USM offers superior surface quality, reduced cutting force, little or no fibre breakage, laminate delamination as well as lower tool wear rate. Many researchers have recently looked at USM for the machining of CFRP composites. Two viewpoints are used to categorise the findings included in this study, which aims to provide a complete overview of recent developments in the USM of CFRP composites. For starters, the study analyses most research published between 2011 and 2020 that employed the USM method, equipment/system/platform used to conduct experiments, evaluated process parameters as well as output variables, and explored or addressed problems. For each kind of USM process, CFRP composites, chosen process parameters, and their corresponding outcomes and conclusions are given in this section. USM research on CFRP composites will be presented in order to create a platform for future study.

(Sivaprakasam et al., 2020) Small parts and components may be machined using the "Micro Electric Discharge Machining" (Micro-EDM) technique, a well-established manufacturing method. Using "Response Surface Methodology" (RSM), this study analyses inconel alloy Micro-EDM using a magnetic field as an aid. Using RSM design, the tests were carried out using Micro-EDM procedures with as well as without magnetic field aid in the middle of the cube. The experimental design parameters

Birajashis Pattnaik

are the voltage, capacitance, as well as feed rate, each of which may be varied at three different levels. The response parameter is the "material removal rate" (MRR). It was determined that RSM approaches could be used to forecast MRR. Checking the significance of the models of MRR for both the machining processes was done using analysis of variance (ANOVA). MRR is influenced by voltage, capacitance and their interactions, according to experimental evidence. Magnetic field aided Micro-EDM has a higher MRR than non-magnetic field assisted Micro-EDM, by a factor of 22 percent greater than the former.

(Yang et al., 2020) Conventional machining (CM) has shown poor cutting performance for advanced materials compared to the ultrasonic vibration-assisted machining (UVAM). Ultrasonic transducers, ultrasonic generator, as well as horn structural advancements in recent years have accelerated UVAM development. Numerous novel design needs and theoretical ideas have been put up and investigated in the wake of this trend, but few extensive studies have been done. This paper provides a critical review of UVAM, including various vibration-assisted machining techniques, device topologies, and theoretical analysis, in order to solve this gap in literature as well as better comprehend the evolution of UVAM. With the periodic separation between tools as well as workpiece, this review discusses cutting characteristics and analyses processing qualities as well as the development of conventional hardware systems used to create vibratory movements, from 1D UVAM to 3-dimensional UVAM. With the advent of high-powered, large-amplitude, high-efficiency ultrasonic vibration systems as well as theoretical study into UVAM dynamics as well as cutting properties, UVAM has new and difficult obstacles to overcome. As a result, given the existing setbacks and difficulties, UVAM research will need to focus on device advancements and theoretical breakthroughs.

(Natarajan et al., 2020) It is now common practise to apply cutting-edge manufacturing processes to address difficulties such as high-strength material processing, the manufacture of complicated curved profiles with improved surface characteristics, the reduction of waste as well as secondary operations as well as the decrease in production time. AWJ machining, one of many newer advanced machining methods, has attracted the attention of both academics and practitioners in the manufacturing industry due to the wide range of operations it can perform and the exceptional quality of the cutting edge it produces, which is far superior to that of any other method. "Abrasive water injection jet" as well as abrasive slurry jet are the two types of AWJ processes based on how abrasive and water are mixed. There have been many studies on the "Injection type AWJ machining" method that have been generally acknowledged by academics and industries to solve different problems. From 1960 to 2019, AWJ review articles have been gathered. There are numerous studies on various aspects of metals and their compounds, including performance as well as surface characteristics, hybrid methods and versatile operations, micro machining as well as medical applications, that have been presented in this study to provide a comprehensive report on the AWJ process. Research on current trends as well as AWJ process applications has been recorded in the literature as well. The AWJ machining method has been the subject of several optimization research. Here, this has been mentioned. AWJ's future prospects, including the need for requirements in several disciplines, were also considered. Finding future specialised

applications for manufacturing processes will be made easier thanks to the whole set of findings. Furthermore, this paper's findings will help researchers in the present and future to identify the most important process factors as well as work materials including advanced methods to improve the AWJ machining process.

(Chien et al., 2020) An established technique, EBM has been used in several sectors. To generate an electron beam, most EBM systems need a high voltage. By transforming the kinetic energy of the electrons into thermal energy of the substrate, the EBM may be utilised for a variety of processing operations, including drilling, welding, as well as surface modification. Electron beam generation is at the heart of EBM. Magnetic lens devices and magnetic coils have long been employed to concentrate and deflect the electron beam, respectively. However, the vast majority of EBM systems on the market are built for macro-sized work-piece milling. High-power supplies are standard for these machines, which feature spacious chambers. Because of this, micro-machining on tiny workpieces becomes challenging. Therefore, a desk-top EBM system with a vacuum chamber smaller than 5 L was designed specifically for micro-machining procedures in order to execute machining on tiny work pieces. The power source is a microwave oven transformer. Argon ambient electron beam source with concave cathode for focus. To prevent contamination during the machining process, Argon ambient may also be used. The desk-top EBM's electron beam behaviour was examined in this research in order to get good micro machining outcomes on smaller workpieces. The results of the experiments reveal that this desk-top EBM is capable of welding, tiny hole drilling, as well as surface modification of different materials. Desk-top EBMs are likely to be commercially viable in the near future, particularly for micromachining.

(Sabyrov et al., 2019) Ultrasonic vibrations are used in many industrial processes, such as material removal operations for surface form development. The use of ultrasonic vibration to enhance the performance of a process is becoming more common. The use of ultrasonic vibration (UV) in industrial processes like electro-discharge machining (EDM) is one of the most important uses of this technology. Typically, ultrasonic vibration is used in conjunction with the EDM process in order to remove junk from the sparking gap and boost the procedure's efficiency. Ultrasonic aided technology has seen major advancements in recent years. A number of EDM processes, including wire cut, micro, and die sinking EDM, now use ultrasonic aid because of the benefits it provides. Ultrasonic vibration in the electric discharge machining is discussed in this article. There is a lot of information in this article on the various UV application methods and how they affect various performance factors. Current problems and prospective research directions to increase process capabilities are outlined based on existing ultrasonic vibration aided EDM research studies. Researchers found that using ultrasonic vibration-assisted EDM resulted in better material removal rate (MRR), higher surface roughness (SR), and a lower tool wear ratio (TWR). Carbon nanofibers and ultrasonic vibrations, on the other hand, may reduce tool wear as well as surface roughness. In addition, when ultrasonic vibration is used on both the tool and the workpiece, the MRR is larger than when it is used on a single electrode.

(Bilal et al., 2019) High cutting pressures and substantial tool wear are common in traditional ceramic machining processes like milling, drilling, as well as turning. There are still possibilities for machining

Birajashis Pattnaik

ceramics, which are believed to be highly hard and brittle, including laser machining as well as electro-discharge machining (EDM). It is important to note that the EDM process, the varieties of ceramics materials with their many applications, and the machining processes involved, are all discussed in this study. In addition, a comprehensive overview of previous experimental and theoretical work on ceramic EDM is included in this report. Ultimately, towards the conclusion of the study, there is a section summarising the significant difficulties, potential solutions, and recommendations for future research.

(El-Hofy & El-Hofy, 2019) In the aerospace, automotive, and marine sectors, carbon fiber-reinforced polymer (CFRP) composites have been widely accepted because of their superior qualities. Many weight-critical components, such as the new A350 and B787 aircrafts, use composites instead of metals, with composite content in excess of 50%. CFRP constructions can't be made perfectly flat because of the need for procedures like edge-trim drilling sawing milling and grinding. It is common for traditional machining of these materials to result in fibre delamination, surface imperfections, and tool wear since they are anisotropic and very abrasive. It's possible to use atypical techniques like electrodischarge machining (EDM), ultrasonic machining (USM), as well as abrasive water jet machining (AWJM). "Laser beam machining" (LBM) is an emerging technique giving an ideal option for cutting CFRP composites. This report summarises the findings of recent studies on LBM-CFRP composite materials. kerf width, kerf depth, and edge quality accuracy investigations, as well as heat-affected zone (HAZ) thermal properties are all included in this paper (HAZ). The key challenges in CFRP industrial applications are reducing the kerf taper, increasing the kerf depth, and removing the HAZ from the polymer matrix. Reduce machining time while simultaneously boosting material removal rate (MRR), kerf depth, and other productivity-enhancing techniques are examined. There has been a thorough examination of a number of mathematical and statistical modelling and optimization strategies. The notion of specific energy as well as its influence on HAZ and kerf width is presented. The association between laser type as well as HAZ is examined. The present study also shows the prospective tendencies for future research.

3 TYPES OF NON CONVENTIONAL MACHINING PROCESS:

a. Electro-discharge machining (EDM):

Electro discharge machining (EDM) is one of the most often utilised non-traditional ways of machining. Spark erosion as well as spark machining are two more names for this process. Hard materials are often machined with this technique. Proper energy fluctuation and spark duration govern material discharge. A DC supply ranging from 50V to 450V is required for an EDM system. A dielectric medium is used to keep both the tool as well as the workpiece safe. This means that the workpiece is linked to the positive terminal, whereas the tool is attached to the negative terminal which functions as the cathode for the electrochemical process. Because copper, graphite, as well as brass are excellent conductors of electricity, they are often employed as tools.

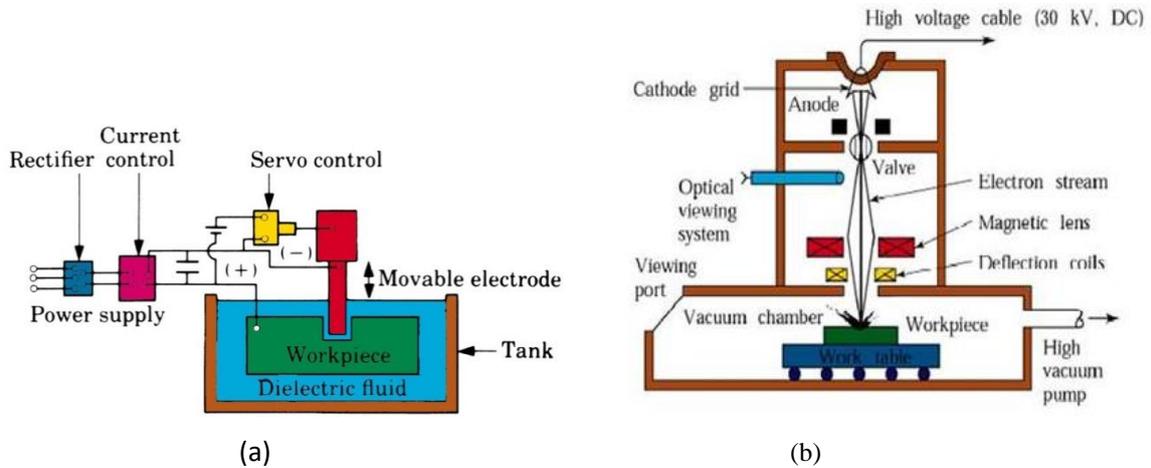


Figure 22 (a) Electro-discharge machining (b) Electron Beam Machining

b. Electron Beam Machining (EBM):

Using an electron beam to remove metal from the workpiece is known as electron beam machining. A vacuum chamber is used to hold the workpiece. An electron cannon is used to concentrate an electron beam on the workpiece. The temperature of the contact point rises when the electron hits the workpiece. As a consequence, some metal vapours are released into the air.

A tungsten filament acts as a cathode in a vacuum chamber where the electron cannon is located. The anode & cathode are coupled to a DC power source. Diaphragms reduce the path of electrons generated by the electron cannon. Deflector coils and lenses are utilised to converge the beam onto the workpiece. At the conclusion of the day, the item is left on the worktable.

c. Plasma Arc Machining (PAM):

Using plasma to cut the workpiece is a low-cost machining method known as plasma arc machining (PAM). Partially ionised gases are those whose temperatures above 5500oC. There are positive and negative ions in this partly ionised gas combination, and this mixture is termed plasma. Plasma arc cutting is the name given to the process of using this plasma for cutting.

The nozzle (anode) is powered by a DC power source, and the torch's electrode is powered by the negative terminal of the power supply. In usually, the electrode is constructed of tungsten and has insulation on top of it. In certain circumstances, a water-cooling system is used to dissipate the heat generated at the nozzle's end.

d. Laser beam machining (LBM):

Laser beam machining is a well-known example of non-traditional machining. The term "laser" refers to a method of enhancing light via the stimulation of radiation emission. An rise in temperature may be

Birajashis Pattnaik

seen at the site of contact if a laser beam is appropriately focused. The metal evaporates at the surface because the temperature is higher than the melting point.

The xenon flash bulb is the most important component of an LBM system, and it is housed in a highly reflective shell. The laser rod is made up of two mirrors, one of which is completely reflective and the other of which is somewhat reflective. A ruby laser is a popular kind of laser. A timer-controlled power source that emits flashes of light. The divergent light beams are focused using a convex lens.

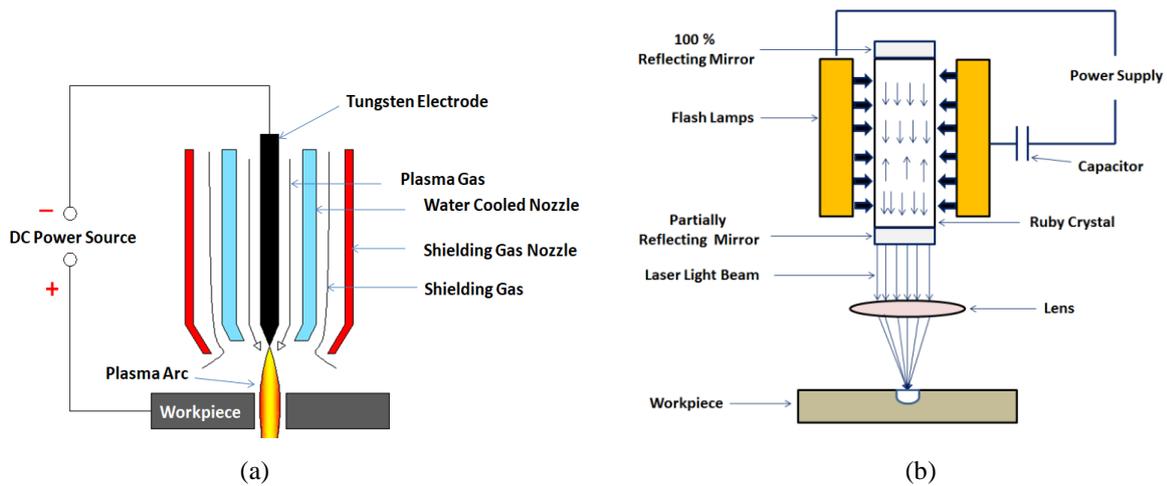


Figure 23 (a) Plasma Arc Machining (b) Laser beam machining

e. Ultrasonic machining (USM):

Using ultrasonic machining means using vibration frequencies greater than 20kHz, that is much beyond the hearing range of human ears. The machining process makes advantage of these vibrations. An ultrasonic oscillator serves as the power source for a USM system. Using an ultrasonic transducer, the oscillator generates mechanical vibrations from electrical impulses. The tool holder has a transducer linked to it, and the tool itself is hooked to it. The workpiece is sprayed with an abrasive slurry, which breaks down the material into chips.

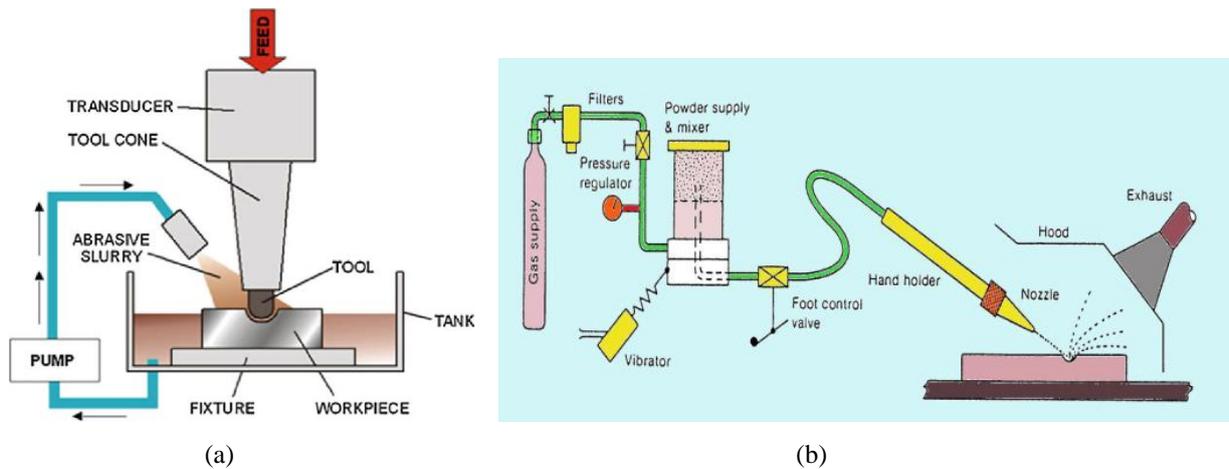


Figure 24 (a) Ultrasonic machining (b) Abrasive jet machining

f. Abrasive jet machining (AJM):

Air or another gas is used to cut metal using an abrasive jet with particles as small as 10-40 microns to create the abrasive jet. A stream of the mixture is applied to the workpiece. The tiny particle combination moves at speeds ranging from 200 to 400 metres per second. Erosive action removes the metal from the workpiece. When the combination is slammed onto the workpiece, the force of impact causes it to crack.

A hopper is used to deliver fine-grained abrasive particles into a mixing chamber for use in the abrasive jet machining. The hopper has a vibration control regulator located underneath it. A gas supply line, a filter, and a pressure gauge are located in the chamber for the delivery of gas. A pressure gauge is used to monitor the gas's pressure, while a filter is used to remove contaminants. Another pressure gauge and a control valve make up the exit system. The fine mixture is directed over the workpiece by a nozzle located at the end of the outflow pipe.

4 Advantages of Non-traditional methods of Machining:

- **High accuracy:** Accuracy has become a major problem for businesses of all sizes, huge or little, in the modern day. In comparison to non-traditional machining processes, conventional machining methods yield less precise results. As a result of its great precision, unconventional machining has found a place in contemporary manufacturing as a viable alternative to more traditional methods.
- **Less noise:** Machines that use non-conventional techniques to reduce noise pollution play an important role, since they are more effective than traditional methods at doing so. It's possible to locate certain non-traditional machining factories in residential neighbourhoods due to the fact that the operation is so quiet.

Birajashis Pattnaik

- **High production:** Compared to the traditional machining procedures, modern or the unconventional methods of machining have a far higher output rate. It's because non-traditional approaches have a speedier and more precise working procedure.
- **Less waste product:** When using typical machinery, it becomes very difficult to handle waste products. Additionally, it's necessary to quickly dispose of the created chips. A little amount of trash is generated when using non-traditional machining processes, but this waste is simple to manage and dispose of.
- **No wear of the tool:** In non-traditional machining procedures, there is no physical touch between the tool as well as the workpiece. In this way, there is no chance of tool failure and the tool does not wear and strain.

5 Disadvantages of Non-traditional methods of Machining:

- **High initial cost:** Non-traditional machining plants have a greater initial setup cost than standard machining plants because they use more electrical components in addition to mechanical ones. As a result, it's unsuited for home-based or small-scale businesses.
- **High power requirement:** Traditional machine shops demand less power than non-traditional machine shops, while non-conventional machine shops require more power than traditional machine shops. It takes more energy to machine the tool surface when there is no contact between the tool as well as the workpiece.
- **Complex mechanism:** It is more difficult to use non-conventional machining techniques than typical machining techniques. Non-traditional machining procedures need a trained operator to manage the processes involved. An expert in the field is required to repair the plant if it malfunctions for any cause.
- **Lower metal removal rate:** Non-traditional machining technologies often remove metal at a lower pace than conventional procedures. As a result, non-traditional production techniques aren't appropriate for large-scale items.
- **Not suitable for soft materials:** Localized heat buildup is often responsible for the cutting action of non-traditional manufacturing methods. This means that cutting soft materials like rubber or plastic is out of the question since the workpiece would be burned.

6 CONCLUSION

There must always be direct contact between a machine tool and its workpiece in traditional machining methods. To cut an aluminium bar, for example, you'll need an iron cutter with a high rate of rotation. To use this procedure, the cutting tool as well as the substance being cut must come into direct touch. Non-conventional machining, on the other hand, uses the most up-to-date and cutting-edge technology. The machine tools and the material do not come into touch with one other throughout this procedure. Because there is no direct contact between the tool as well as the material, the non-conventional approach resulted in a longer tool life. Conventional tools used to make conventional components are less exact and precise than those used in non-conventional procedures.

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A State of Art Review on The Design and Applications of Flexible Microstrip Antennas

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Abstract

The microstrip antenna is a practical, planar, and simple-to-fabricate antenna that has a number of appealing characteristics and features in addition to a number of glaring restrictions. The passive antenna is a vital aspect of any wireless communications network, for both transmit and receive sides. Using the same antenna for both purposes is possible, but it is also possible to use drastically different ones, depending on the application. It is common to find microstrip antennas in communication systems because of its unique characteristics, including their tiny size, light weight, low profile and flexibility, as well as their cheap production cost. Textile materials are often employed to increase the pliability of microstrip antennas, and they are also inexpensive, with the added benefit of having a low specific absorption rate (SAR). A wide range of applications for flexible microstrip antennas, such as GPS tracking, RFID identification and military usage are possible.

Keywords: Flexible microstrip antennas, wireless communications link, GPS, RFID

1 Introduction

Any wireless communication system is not complete without an antenna since it is one of the most important components. The Latin word "antenna" is where the English word "antenna" originates from. The antenna has been an essential component in the design of any wireless communication system ever since Heinrich Hertz gave the first public demonstration of wireless technology and Guglielmo Marconi

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made the first application of wireless technology in the form of a practical radio transmission. IEEE defines an antenna as “an element of a transmitting or receiving system that is intended to broadcast or receive electromagnetic waves.”

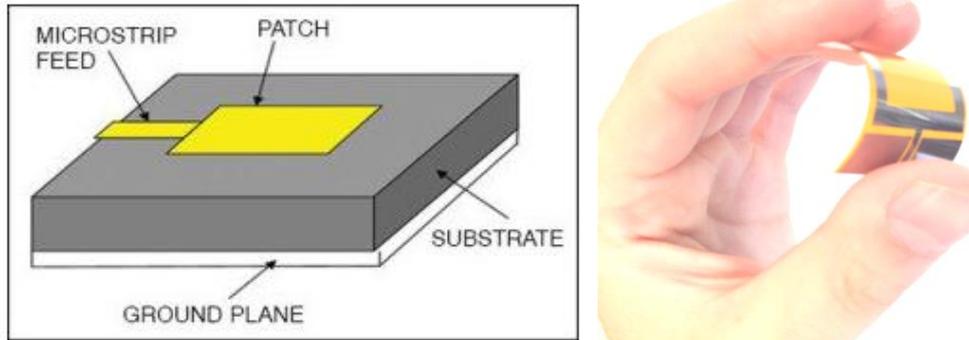


Figure 25 A Flexible Microstrip Antenna

The micro strip antenna is made out of a very thin metallic strip that is put on a ground plane and has a di-electric substance sandwiched in between. Radiating and feed lines are positioned on dielectric material via photo-etching. In most cases, a square, circular, or rectangular patch or micro-strip is used since it is more convenient for the analysis and manufacture of the patch. A micro-strip or patch antenna is shown in the accompanying picture. The length of the metal patch is a factor of two. A very little amount of energy is emitted from a metal patch's edges when the antenna is activated, due to reflections of the waves created inside the dielectric material.

When using a microstrip or patch antenna, you might expect a wide radiation pattern. Radiation power and frequency bandwidth are both modest in this device. An example of a microstrip or patch antenna's radiation pattern is illustrated above. It's less accurate in its targeting. It is possible to create an array with these patch antennas. It emits three kinds of electromagnetic radiation. The first component is emitted into the atmosphere, which is referred to as a 'beneficial' emission. The second component is called diffracted waves, and it is these waves that are responsible for the real power transfer. They are reflected back into space among the patch and the ground plane. Due to complete reflection at the air-dielectric separation surface, the final component of the wave is trapped in the dielectric substrate. It's not a good idea to have waves trapped in the substrate.

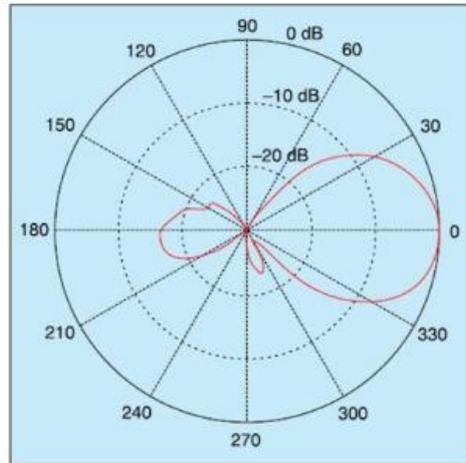


Figure 26 The Radiation pattern of a Microstrip Antenna

2 LITERATURE REVIEW

(Mitra et al., 2021) It is becoming more difficult and costly to manufacture radio frequency (RF) equipment because wireless technology requires ever more complicated structures and conformal geometries. As a result, the incorporation of innovative alternative production technology, such as additive manufacturing (AM), can prove to be not only a one-of-a-kind solution but also a highly cost-effective one for microwave circuits and flexible RF and devices. 3D-printed conformal microstrip antenna manufacturing processes are presented in this work, which uses the fused filament fabrication (FFF) method of AM technology. The conducting trace for the conformal microstrip antennas is produced from Electrifi, a commercially available conductive filament, while the substrate is NinjaFlex, a commercially available nonconductive fibre. Additional to this, the high-frequency characterisation of the prototyped antenna was illustrated here by comparing full-wave modelling and measurements in a properly calibrated anechoic chamber. The prototyped antenna has dimensions of $65.55 \times 55.55 \times 1.2$ mm³, and the data from the measurements indicate that the 3D-printed Electrifi-based patch antenna achieved extraordinarily good impedance matching at a resonance frequency of 2.4 GHz and a maximum antenna gain of -2.78 dBi. Finally, the suggested antenna's conformality performance was shown by mounting the antenna prototype on five various cylindrical curved surfaces. For the future use of smart communications, flexible electronics, and radar, this was done in preparation.

(Zhu et al., 2021) Stretchy antennas are an essential part of flexible and stretchable electronics since they are the primary element in the transmission of wireless data as well as the supply of power. However, mechanical deformations may result in frequency detuning, which restricts their use to wireless sensing rather than wireless transmission, which continues to be an unattainable capability. A microstrip antenna with mesh patterns organised in an arched form is seen in this image. This antenna exhibits a variable resonance frequency based on the deformations that are applied to it, as well as an enhanced overall stretchability. Resonance frequency shifts with deformations allow for on-body

wireless communication and RF energy harvesting, while wireless sensing is made feasible by the almost constant resonance frequency during deformations. The proposed stretchable microstrip antenna was proven to be capable of wirelessly connecting with a transmitter (input power of 3 dBm) and doing so successfully (i.e., receiving power higher than 100 dBm over a distance of 100 m) on human bodies. This was proved to be the case even after the antenna was stretched by a factor of 25%. A distance of 100 metres proved the antenna's efficacy in this regard. The flexibility of structural engineering and the corresponding mechanical–electromagnetic modelling makes it feasible to construct stretchy microstrip antennas and other potential wireless devices for stretchable electronic gadgets.

(Santhakumar et al., 2020) Wearable antennas are the most important component of Wireless Body Area networks because they allow for a wide range of fabric materials to be easily integrated into the network. Because of the robust nature of the wearable antennas, the health monitoring devices that include these antennas may be attached to any region of a person's body. This allows for more flexibility in terms of placement. These adaptable instruments for easy mining may be used to assess the health of underground miners on a regular basis. In this study, we present a flexible microstrip antenna with a dielectric constant of 1.67 and a thickness of 3 mm made of denim cotton substrate, which operates at 2.45 GHz in the ISM band. A human phantom and empty space are both used to test the proposed antenna's VSWR, reflection coefficient, gain, and radiation pattern performance.

(Zhang et al., 2020) In the case of current wireless communication equipment, textile structural antennas are essential components for wearable electronics and multifunctional constructions. Deformation of the fabric-based antenna is inevitable in real-world applications, and this may have an impact on its performance. In order to create a flexible antenna that can adapt to various conformal forms, a three-dimensional orthogonal woven microstrip antenna (3DOW-MA) was developed by weaving together conductive and dielectric threads in a compressed and homogeneous manner. According to predicted and experimental results, the 3DOW-MAs displayed high radiation performance even after being bent into various conical shapes. Due to the homogenous distortion throughout the bending process and the integrated textile structure, this was possible. These 3DOW-MAS optimised conical conformal 3DOW-MAS are ideal for realistic wireless applications with resonance frequencies of 2.47 and 4.23 dB (single and double components). One of the most important takeaways from our investigation is that 3DOW-MAs show significant potential for use in upcoming smart flexible systems and wireless body-area networks (BANs).

(Santhakumar et al., 2020) Wearable antennas are the most important component of Wireless Body Area networks because they allow for a wide range of fabric materials to be easily integrated into the network. Because of their adaptability, these wearable antennas for health monitoring devices may be attached to almost any area of the body. These adaptable instruments for easy mining may be used to assess the health of underground miners on a regular basis. In this study, we present a flexible microstrip antenna with a dielectric constant of 1.67 and a thickness of 3 mm made of denim cotton substrate, which operates at 2.45 GHz in the ISM band. In this study, the performance of the suggested antenna in terms

Dr. Jacob Abraham

of its VSWR, Reflection Coefficient, Gain, and Radiation Pattern is investigated both in free space and on a human phantom.

(Poornima et al., 2020) A straightforward and condensed variant of a rectangular microstrip patch antenna, often known as an RMPA, is presented along with improved cross-polarization (XP) purity. When it comes to modifying the resonance frequency of the antenna to achieve the highest possible level of performance, this sort of design offers a great degree of freedom, which is a significant advantage. An exhaustive design guide that is based on theoretical analysis has been published. The purpose of this guide is to identify the antenna resonance frequency and the corresponding resonant mode. A higher-order spurious mode that is orthogonal to the fields that are co-polarized has been identified as the source of X-ray and particle radiation. This was discovered via research. Extensive research and development work has gone into incorporating the physical understanding of XP suppression into the design of the best feasible product. In order to achieve an improved antenna design, the ground plane and the radiating patch have not been altered in any way. All aspects of the proposed antenna, including its dimensions, gain, and impedance matching, as well as its ability to suppress the XP value, have been taken into consideration. By making some simple modifications, this may be used to any RMPA that functions in the normal manner. It is feasible to accomplish a suppression of up to 16 dB of XP radiation in the H-plane without having an influence on the value of 5.27 dBi, which is the co-polarized peak gain. This may be done by using a combination of techniques. The proposed concept has been evaluated with the assistance of antenna prototypes. There is a high degree of concordance between the predictions made by the models and the actual measurements that were taken.

(Masihi et al., 2020) In this work, we exhibit the design of a tunable and tiny microstrip antenna that may be utilised for applications in the industrial, scientific, and medical (ISM) band. Additionally, we show how rapid prototyping can be done for this kind of antenna. Antennas may be built quickly and precisely using laser machining. The dielectric constant of 3.5 of the Kapton polyimide substrate was sandwiched between two flexible copper tapes, which acted as the radiating patch and ground plane, to create the antenna, which was 65 times 46 times 0.127 mm in size. 65x46x0.127 mm was the antenna's total length and width. By patterning the radiating patch in a meander configuration with three slots, it was shown that it was able to lower the resonance frequency of the microstrip antenna from 2.4 GHz to 900 MHz. This was accomplished by decreasing the frequency at which the antenna resonated. This was done with no change to the antenna's overall dimensions, resulting in an 87% reduction in size. Mechanical load on the antenna was studied using bend and stretch tests. The antenna's resonant frequency rose by as much as 3.1 percent and by as much as 1.3 percent, respectively, when it was compressed along the x- and y-axes and bends of 86 mm and 150 mm were used. Antennas were bent similarly, but with a smaller radius of curvature: 79 millimetres along the x-axis and 162 millimetres along the y-axis for a minimal radius of curvature. The resonant frequency was reduced by 4.2 percent and 0.3 percent, respectively, as a consequence. This resulted in a 0.9 percent overall decrease in the antenna's resonance frequency when the antenna was stretched along the y-axis by 0.09 percent.

Handbook of Trends in Engineering Technology and Research

(El Gharbi et al., 2020) Antenna sensors are the topic of this review study, which aims to offer an overview of the several methodologies that have been created in the research literature. The results of the poll will be used to identify the strengths and shortcomings of the technology. In addition, it offers a high-level overview of all the important parts that are involved in the process of producing flexible antenna sensors. This includes everything from the choice of materials to the building of the antenna, as well as a number of different application situations. An examination of textiles used to make antenna sensors is also provided. Flexible antenna sensors have been shown to be useful for detecting salt and sugar solutions in the body as well as blood and a wide range of other biological factors such as temperature, strain, and finger position throughout this article. There are a few innovative ideas for solving problems in exploration and research.

(Panda et al., 2019) Designing wearable antennas for health monitoring systems allows for worldwide monitoring and communication. It is important to pay attention to aspects such as affordability, adaptability, and data transmission rate while developing wearable antennas so that they can fulfil the necessary functions. The objective of this study is to illustrate the design and simulation of a U-shaped slot "rectangular microstrip patch antenna" (RMSA) using a high frequency structure simulator (HFSS), as well as an investigation of the performance of these antennas with a variety of flexible substrates. In order to regulate the 2.4–2.6 GHz working frequencies, the RMSA makes use of a variety of flexible substrate materials, including Epoxy, Teflon, Polyethylene Polyamide, RT Duroid, and PDMS. The height of all substrates must be the same while doing an antenna study, such as the reflection coefficient, bandwidth, radiation pattern, gain, and cost. 'Health and weight monitoring systems may benefit from a suggested antenna that uses PDMS as a substrate material.

(Rexiline Sheeba & Jayanthi, 2019) Two-dimensionally flexible SoftWear antennas combine Wearable and Textile antenna characteristics. The softwear antenna is a component of clothing, and as such, it should not have any effect on the user as a result of any radiation that is still present in it. It is designed to operate in close proximity to the human body's fabric antenna substrate. Softwear textile antenna development evidence is presented in this research. In today's wireless technology, it's difficult to create a gadget that's small, light, and low-profile, all while being easy to manufacture. A softwear microstrip patch antenna is the best option for this sort of antenna. The substrate for this antenna type is textile. In this study, a variety of cotton substrates and polyester substrates were evaluated and contrasted using two different feeding techniques, namely line feed and co-axial feed. The performance of the softwear antenna demonstrates that using a polyester substrate yields better results than using cotton as a substrate for any of the feeding approaches. Consideration has been given to a simple rectangular patch. This antenna's operating frequency is 2.45 GHz. When it comes to wireless body area networks, it's widely accepted (WBAN). It is also feasible to communicate with the body wirelessly using the ISM band (2.45 GHz), which is used for industrial, scientific and medical purposes. A network analyzer was used to determine the S11 and VSWR of this softwear antenna, which had been manufactured using a polyester substrate.

Dr. Jacob Abraham

3 APPLICATIONS OF FLEXIBLE MICROSTRIP ANTENNA

There are several applications for microstrip patch antennas;

a. Satellite Communication:

Microstrip antennas used for satellite communication must have circularly polarised radiation patterns, which may be achieved by utilising square-shaped microstrip antennas or circular-shaped microstrip patch antennas, respectively. Circular polarised microstrip antennas have become a popular feature of GPS systems. Because of their location, they are modest yet expensive.

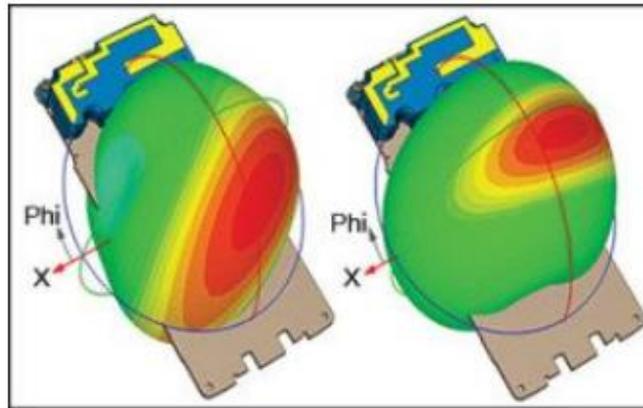


Figure 27 GSM antenna radiation pattern for a cellphone

b. RFID:

RFI utilises wavelengths between 30Hz and 5.8GHz as its primary means of identification. Microstrip antennas are often used to operate at these frequencies. Tag and reader are both part of an RFID system. It's found in everything from cell phones to medical equipment.

c. Telemedicine:

When it comes to applications involving telemedicine, generally flexible wearable antennas are suited for WBAN, which operate on the 2.45GHz ISM band. FBR (Frequency Bandwidth Rejection) of 11.7dB for the antenna utilised in Telemedicine applications.

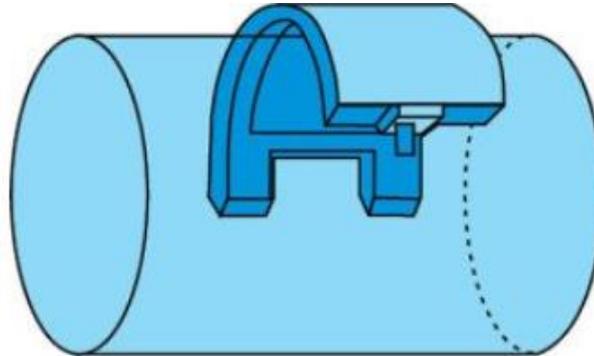


Figure 28 Flexible microstrip applicator for hyperthermia medicinal applications

d. WiMax:

IEEE 802.16 is the standard for worldwide interoperability in microwave access (WiMax). WiMax has a communication range of up to 48 kilometres (48 miles) and a data rate of 70 megabits per second. Microstrip antennas are utilised in WiMax-based communication equipment because they may be designed to operate at several frequencies.

e. Medical applications:

Treatments for some of the most dreadful tumours are carried out using microwave frequencies (energy). Microwave energy is one of the helpful means of inducing hyperthermia; thus, a microstrip patch radiator is used to create microwave frequency since it is tiny in size, inexpensive, and tough. Microwave energy is one of the beneficial ways of inducing hyperthermia. [4]

4 TEXTILE ANTENNAS FOR DIFFERENT APPLICATIONS

Flexible materials and a planar construction are required for textile antennas that may be worn on the body. The antenna's performance is affected by a variety of factors, including the material's flexibility. Microstrip antennas are characterised by a number of characteristics, including dielectric material thickness, which affects the antenna's bandwidth and efficiency. As a consequence of the low dielectric constant of most textile materials, surface wave losses diminish and boost the antenna's impedance bandwidth.

In some medical applications, the biometric data of a human body is continually monitored. In order to do this, the antenna, which is used to transmit the biometric data to the outside world, must be kept in close proximity to the human body at all times. Because they can't be kept linked to the body for an extended period of time, traditional antennas that are hard in nature aren't ideal alternatives for this kind of monitoring system. It is safe to wear a textile antenna, which is often made from ordinary garment material, for an extended period of time without harming the human body. There are a wide range of applications for wearable antennas, from healthcare monitoring to fire-fighting and entertainment.

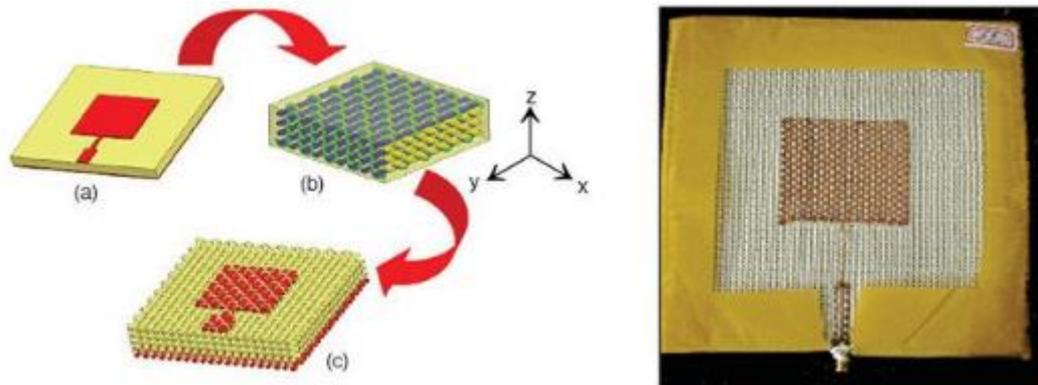


Figure 29 TEXTILE ANTENNAS

Fabric materials have recently been increasingly popular for the design and development of flexible wearable antennas for a variety of applications as a direct result of the extraordinary developments that have occurred in the development of wireless devices. We employ textile materials to create flexible wearable antennas because they can simply be incorporated into clothing. The textile antenna seen in Fig. 2 is constructed using exclusively textile materials, including those that are utilised for the radiating element (patch), ground plane, and even the dielectric material. Each of these textile components has a specified dielectric constant. It is termed a textile antenna because everything in the antenna is composed of textile material.

5 CONCLUSION

In light of the present circumstances, the majority of academics are shifting their attention increasingly toward the design and development of flexible microstrip wearable antennas for a variety of applications. At 2.4 GHz, the ISM band, a flexible wearable antenna shows good performance. Wearable antennas that are used in medical applications need to be flexible and lower in size by 15% to 20% compared to antenna lengths that are used in free-space applications. Additionally, these antennas need to be safer for medical treatment on the human body. It has been discovered that many of the antennas described in numerous academic studies are utilised in cellular technology. Several writers have discussed flexible Microstrip antennas for wearable telemedicine applications in their research papers and publications during the last several years. Research publications often include mention of wearable and body-mounted antennas that were created and developed for a variety of telemedicine applications operating on a variety of frequency bands throughout the course of the last decade. Several writers have discussed the use of wearable microstrip antennas in their research articles to cure a variety of diseases that affect humans.

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