INTELLIGENT TECHNOLOGIES FOR RESEARCH AND ENGINEERING

Editors:
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Advanced Technologies for Science and Engineering

(Volume 2)

Intelligent Technologies for Research and Engineering

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PREFACE

The book on **Intelligent Technologies for Research and Engineering** contains new research findings from academics. The book contains research conducted by active researchers who are involved in the cooperation between businesses and a variety of intelligent technologies, such as those that may be used in the production and distribution of industrial goods, factory automation, and other fields. The theory, design, development, testing, and evaluation of all intelligent technologies relevant to different areas of industry and its infrastructure are the main topics of this book. All computational intelligence techniques applicable to industry, intelligent data science techniques applicable to business and management, intelligent network systems applicable to industrial production, intelligent technologies applicable to smart agriculture, and intelligent information systems for agriculture are some of the topics covered. Significant advancements in intelligent systems have occurred as a result of the exponential growth of modern technologies. As a result, there is more potential for advancements and new uses.

A vital source of academic content on the creation, deployment, and integration of intelligent applications across several sectors is the journal*, Developments and Trends in Intelligent Technologies and Smart Systems*. This book is ideally suited for researchers, engineers, computer scientists, academics, students, and professionals interested in the most recent applications of intelligent technologies, highlighting a variety of cutting-edge topics like enterprise modelling, remote patient monitoring, and service-oriented architecture.

The latest advances in the field of solidification research and the problems posed by the community in the 21st century in terms of processing and analysis are presented in this book. On behalf of the editors, we would like to offer our appreciation to everyone who took part in the preparation of this project. First and foremost, the authors, whose excellent work is at the core of the book, and we gratefully congratulate all those who contributed to this book in any possible way and wish them great success. We would like to take this time to thank our family and friends for their support and encouragement while we worked on this book. Also, we offer all credit and respect to our almighty Lord for his bountiful grace, which enabled me to finish this book successfully. We would like to express our gratitude to the writers for their contributions to this edited book. We would also like to thank Bentham Science Publishers and its whole team for facilitating the work and providing us the opportunity to be a part of this work. The content of this book is summarized as follows:

1. **Chapter 1:***Data Analytics* is the present and the future of problem-solving in computing. With the increasing trends in data and processing power, Machine learning solutions are evolving to cater to the needs and challenges in both the scientific and business worlds. In this work, the current solutions have been discussed and the results of the practical experiments conducted are shown with a glimpse on the future direction. The problem of automatic identification of fake news has been addressed. Fake news datasets are obtained through crowdsourcing and web covering celebrities. Due to the inherent relationship among publishers, news and social engagements in the news dissemination process on social media, the SVM classifier model has been implemented. Multilayer Perceptron model for distributed environment is proposed and performance comparison of the two models is established.

2. **Chapter 2:** In this chapter, the synthesis and characterization of a metal matrix composite material encompassing MoS2, B4C, and graphite as reinforcement are presented. Hybrid composites are prepared by using stir-casting techniques with various weight percentages (1%, 2%, and 3%) of each reinforcement (Molybdenum Disulfide, Boron carbide, and

Graphite). After fabrication, the ingots were subjected to various tests to study their mechanical behaviour and microstructural study. A tensile test, hardness test, and impact test were conducted by ASTM standard to find the effect of reinforcement on aluminium metal matrix composite (Al 7075- MoS2, B4C, and graphite). The microstructural study (scanning electron microscope) was conducted to assess the distribution of reinforcement on the composite. The spread and interaction of constituent materials play a key role in their properties. The results show that with the addition of reinforcements up to 3% to matrix metal Al 7075, the hardness, tensile, and impact properties were increased compared to the base AL 7075 alloy.

3. **Chapter 3:** In the current scenario of automation and digitization, sensors are available in almost all fields of inventions. Sensors are everywhere for example in our phones, workplaces, automobiles, and in the environment. With the increasing evolution of sensors, sensor networks are a significant aspect of the Internet of Things (IoT) and the contemporary world. A sensor network comprises multiple sensor nodes. Each sensor node is small in size, lightweight, and portable, as are the detection stations that make up the network. Detecting and processing nodes that have been constructed are used for sensing and processing the surrounding environment, as well as relaying the detected data to the other nodes in a network. Almost every sensor node in a network is equipped with four primary components i.e., a transducer, a microcontroller, a transmitter, and a power supply. Sensor nodes in the sensory network must be able to operate on restricted and small sources of energy, which are often available in the form of operational battery power. These types of networks also incorporate a variety of antennas, which help to increase the network's capacity while also increasing the transmission range, improving spatial reuse, and reducing interference. The primary goal of this chapter is to provide an overview of the sensors and antennas used in wireless sensor network applications.

4. **Chapter 4:** We use a variety of electrical devices in our day-to-day operations. Home appliances, industrial applications, automobile applications, and other gadgets are among the devices available. So many electrical instruments rely on the electrical machine as their heart. If a fault arises in the machine, it will cause the instrument to malfunction. It can sometimes result in a dangerous situation. To avoid this, we must constantly monitor the electrical machine. If a problem arises, we must be informed as soon as possible. Only then will we be able to take corrective action and prevent fault occurrence. In this way, we can leverage Artificial Intelligence (AI) and the Internet of Things (IoT) for electrical machine condition monitoring. AI focuses on creating intelligent machines that think and work like humans. The IoT is a network of connected systems that can collect and transfer data wirelessly without human involvement. We can take condition monitoring, control, and information exchange to the next level by combining these two approaches (AI-IoT). This study employs an induction motor for analysis purposes because it is one of the most widely used electric motors worldwide in a broad range of applications. Throughout its various operating stages, the induction motor is continuously monitored, and the state of the motor is updated to the users accordingly. Additionally, utilizing IoT and modern communication technologies makes it possible to remotely monitor and control the induction motor. We can achieve numerous advantages over traditional methods by combining these two methodologies (AI-IoT).

5. **Chapter 5:** The semiconductor material InP plays a key role in optoelectronic devices, high-speed devices, and fiber optic communications systems. The major problems with these materials are the high lattice mismatch and variance in thermal expansion coefficient between InP and Si. This mismatch produces high dislocation density at the interface and the propagation of the threading dislocations away from the interface into the device layer is a major concern in optoelectronic applications. Image processing algorithms play a pivotal role

in the medical field, archaeology, and remote sensing. This work proposes an image processing method to analyze the SEM images of the InP heteroepitaxy layer to determine the etch pits to confirm whether the substrate is suitable for optoelectronic applications. In this work, a variant of anisotropic diffusion filters for noise reduction on SEM image and Fuzzy C means clustering method for image segmentation was employed for analysis.

6. **Chapter 6:** This research work proposes a "Solar PV Charged Pineapple Leaf Cutter" (SPVPLC) for rural community people. The cutting of pineapple leaves is crucial and time-consuming and also a very laborious task. A portable leaf cutter system comprising a DC motor with blade arrangement is utilized in this work and is powered by the PV panel. A mechanical trolley system is also designed, which supports the entire system and facilitates movement. The outcome of this research work paves the way for the beneficiary of farmers. A 50w solar panel charging battery was utilized in this work. The battery output drives the motor coupled with the blade arrangement through a simple electronic circuit comprising the voltage regulator and current limiting resistors. The simulation was carried out using Proteus software and the prototype model was also depicted in this work.

7. **Chapter 7:** Computer-aided algorithms play a vital role in industrial automation; image processing algorithms have a wide variety of applications in the detection of defects in real-time studies. This chapter proposes image processing algorithms for the detection of defects in solar panel electroluminescent images. This research work proposes a median filter for filtering images followed by a region of interest extraction by fast fuzzy c means clustering. The outcome of this work paves the way for researchers working in the processing of solar panel electroluminescent images for defect classification.

8. **Chapter 8:** A collaborative filtering recommender system is utilized as a significant method to suggest products to the users depending on their preferences. It is quite complicated when the user preference and rating data is sparse. Missing value occurs when there are no stored values for the specified dataset. Typical missing data are divided into three categories such as (i) Missing completely at random, (ii) Missing at random and (iii) Missing not at random. The missing values in the dataset affect the accuracy and prediction outcomes. In order to alleviate this issue, the data imputation method is exploited. Imputation is the process of reinstating the missing value with a substitute to preserve the data in the dataset. It involves multiple approaches to evaluate the missing value. In this paper, we reviewed the progression of various imputation techniques and their limitations. Further, we endeavored k-recursive reliability-based imputation (k-RRI) to resolve the boundaries faced in existing approaches. Experimental results show that the studied methodology appreciably improves the prediction accuracy of the recommendation system.

9. **Chapter 9:** Women in India are diagnosed with breast cancer at a far higher rate than men. Breast cancer is the most common kind of cancer in women, accounting for more than half of all cases. It is possible to minimize the mortality rate of breast cancer via early and precise detection. By utilizing mammography, early breast cancer detection and assessment is currently possible. There is still a lot of controversy about mammography mass classifications, yet they are crucial for helping radiologists make accurate diagnoses. Using convolutional neural networks (CNNs), it has become possible to classify and segment images in a meaningful way. Unlabeled picture data, on the other hand, presents challenges, and while manual labeling is inefficient, pre-trained CNNs also perform poorly on genuine medical images. In this research, we propose the use of Transformer-Based Networks (TBN) in computer vision. Transformer-based vision models have been found to outperform convolutional models in previous studies as well. A self-supervised learning (SSL) technique called the Decision Tree Algorithm (DTA) is proposed in this study for processing

mammography images for diagnostic purposes. The Decision Tree Algorithm works effectively with categorical and continuous dependent variables. In this study, the population was divided into two or more homogeneous groups based on the most important traits and independent factors. According to this article, a previously trained model can be enhanced by transitioning from making predictions on uniformly tiled regions to making predictions on the complete image. There were two studies that utilized the Kaggle archive breast cancer sample pool, the second of which used 286 samples. In the initial experiment, the decision tree was 100 percent accurate, but in the follow-up investigation, it was only 97.9 percent accurate.

10. **Chapter 10:** The groundwater cycle is one of the most vital elements of life. This is the sole most cardinal provenance of potable, agricultural, and industrial water. Underground water may be of good quality for cooking and drinking (potable) or it can be medium quality (domestic and industrial) or have another inappropriate quality for any use due to various contaminations. Heavy metals, minerals, and other factors can be present in the water. Septic systems can be contaminated by natural and artificial sources. There are many artificial polluting sources, such as chemicals, fertilizers, and mining activities, and there are also natural ones, such as seawater intrusion, geothermal brine seepage, and rock water leaching. Health hazards are associated with contaminated water. Groundwater contamination can lead to degrading surface water systems, loss of water supply, poor quality, or even no drinking water. It is well known that water is an essential part of life of all animals, including humans. We all need water in order to survive. Throughout this paper, we have examined the health effects, environmental impacts, and prevention of groundwater contamination.

11. **Chapter 11**: The improvement of agricultural practices for enhanced productivity has been the driving factor for the Green Revolution. Its introduction has led to modernization in farming with the use of high-yield variety seeds, chemical fertilizers, pesticides, *etc*. Excessive usage of these chemicals, due to urbanization, has led to the deterioration of soil quality, depletion of essential nutrients and microbes present naturally in the soil, and caused water pollution. The use of fertilizers has been found to be very effective in achieving food production goals, but the widespread use of inorganic fertilizers seems to have a significant impact on soil physicochemical parameters, as this approach causes the exhaustion of essential minerals in the soil, which depletes soil fertility. As a result, adopting an alternative method that will act as a replacement and treatment has become critical in order to overcome this difficulty. The introduction of biofertilizers could be a boon for the agriculture industry as they are cost-effective, improve soil health by replenishing the soil with nutrients, and enhance the growth of plant growth-promoting microorganisms. Plants are also protected from brininess and aridity by biofertilizers. Biofertilizers are also environment-friendly and do not cause any hazards. Biofertilizers, when used as a supplement, have been shown to protect plants by releasing antibiotics that can fight against various plant infections.

12. **Chapter 12:** India is an agricultural country. 75% of the population is directly dependent on agriculture for their living. Modern farming uses enormous amounts of pesticides and chemical fertilizers, which disrupt soil fertility and also cause water hardness and genetic variation in plants. In this paper, we are going to focus on organic farming and its benefits. Quality crops are produced through organic farming without influencing the health of the soil. Therefore, organic farming provides macronutrients and micronutrients to the plants and also improves the different characteristics of the soil. Organic agriculture helps the farmers get synced with climate change. The change in climate makes the growing conditions more and more difficult. To overcome such a situation, the earth holds and removes the required greenhouse gases in the soil. The eco-agriculture has a higher ability to reduce environmental change, largely because it is higher in lowering the emission of gases like CH_4, NO_2, and CO. The confirmation of cultivation practices as expected in natural horticulture gives a

straightforward assurance of natural standards and guidelines. This additionally permits the upheld reception of new and successful practices pointed toward working on the relief of environmental change. Besides, natural agribusiness is profoundly versatile to environmental change contrasted and regular farming. In any case, a more noteworthy acknowledgment of the capability of natural farming to alleviate environmental change is required. As of now, this acknowledgment relies upon the capacity of natural yields to outperform traditional yields, which has been displayed to happen in emerging nations. More examination is expected to work on natural yields in developed nations and to work on the capability of mediating environmental change through natural agribusiness. Future techniques for enhancing the adequacy of natural farming in relieving environmental change are introduced and talked about.

13. **Chapter 13:** Carbon dioxide is one of the unfavorable gases that will be released into the atmosphere in different ways such as through the burning of fossil fuels, factory emissions, vehicle smoke, *etc*. Carbon dioxide is a greenhouse gas which leads to global warming, climatic changes, and acid rain. Photosynthesis is the production of starch and oxygen with the help of carbon dioxide and water under sunlight in the chloroplast. It is a natural phenomenon carried out by the plants. Moreover, this is one of the significant activities conducted by plants, because they absorb harmful gases and release oxygen which is very helpful for the process of living for all the organisms. A team of Chinese scientists found a way to synthesize starch artificially in 2021, which is a great achievement in the field of science. Therefore, here they had collected carbon dioxide gas from the atmosphere in order to conduct these reactions. This is a very effective method where the useless, toxic, and harmful gases like carbon dioxide are converted finally into a useful product. Therefore, this can promote the formation of a sustainable bio-based society.

14. **Chapter 14:** Soil contamination, otherwise called soil pollution in simpler terms is caused due to the presence of anthropogenic substances mainly chemicals in the natural soil habitat. It is frequently caused by contaminants from industrial and agricultural activities or because of improper disposal of waste. Heavy metals like lead and arsenic; chemicals like pesticides, fungicides insecticides, and petroleum hydrocarbons are the most common chemicals involved in soil pollution. Soil pollution is now a global concern due to its impact on the environment and majorly human health. Industrialization, mining, and overuse of chemical fertilizers are the major causes of contamination of soil and also pose a significant threat to the environment. One way to restore soil to its original state is soil remediation. It is the process of cleaning and reviving the soil with external help. It is the process of removing toxicants from the environment to protect the health of both the population and the environment. There are three major soil remediation techniques that are generally used - soil washing, bioremediation, and thermal desorption. Bioremediation is a method of using living organisms to remediate the soil that removes contaminants, pollutants, and toxins from the soil. Bioremediation includes the remediation of the soil by bacteria, yeasts, or fungi called mycoremediation. Remediation can also be brought about by mycorrhiza which are associations of fungal species with roots of higher plants. Vermiremediation is the remediation of soil with the help of earthworms.

15. **Chapter 15:** Any substance which does not have any further function is called “waste”. Waste management is the proper control of the waste in order to protect it from environmental hazards. Industrial waste, commercial waste, domestic waste, agricultural waste, and electronic waste are a few types of waste that can be categorized. Environmental problems such as water pollution, air pollution, and soil pollution are a few different problems that can take place due to the improper management of waste. Landfill, incineration, waste compaction, composting, vermicomposting, recycling, plasma gasification, and conversion of

waste to energy are some innovative methods of waste management that are discussed in this work.

16. **Chapter 16:** Vehicle fuel theft is one of the key worries of many bike and automobile owners these days. We've all heard stories of fuel being taken from our motorcycles or automobiles, and some of us have even experienced it ourselves. The primary goal of this detector is to prevent such an occurrence. A simple, cost-effective method is suggested here for maintaining vehicle fuel security when the vehicle owner is located anywhere on the planet. This style detector digitally displays the quantity of gasoline in the fuel tank. When the gasoline is stolen, a buzzer sounds, alerting the bike's owner. The goal of this project is to utilize it to monitor fuel security. When this system detects an instruction, it sends an alert to the vehicle's owner. When the owner of a motorcycle, automobile, or truck enters the key into the ignition lock and turns it on, a signal is sent to the microcontroller. Because the microcontroller recognizes that the bike/car has started, it will not monitor the fuel level. With this project, we've included a bike ignition key. When the key is taken from the ignition lock, the level sensor is activated. As soon as the individual exits the vehicle, the key is removed, and the system is triggered.

17. **Chapter 17:** Biochar is a charcoal that is used as a soil amendment. It is made up of wood, bones, and other organic substances including dried manure which is produced by a process known as pyrolysis under a lower oxygen amount. Biochar can be used to improve the fertility of the soil which results in finally increasing the crop yield. It has a honeycomb-like structure which will help increase the water holding capacity, and nutrient retention as well as stop the soil particles from getting compacted with each other. Infertility in the soil occurs due to the addition of different types of pesticides, weedicides as well as a lot of chemical substances. Therefore, biochar can act as a promising solution for the infertility of the soil while indirectly increasing the crop yield.

18**. Chapter 18:** Toxic and hazardous contaminants generated and accumulated as a result of industrial activities, improper waste management and other anthropogenic factors, have become one of the major environmental threats. Heavy metal contamination, in particular, has long-lasting negative impacts on the different life forms. In plants, it can disrupt the water and nutrient uptake mechanisms, photosynthesis, and other metabolic pathways, adversely affect the vital soil microflora, and can also make its way into the food chain, thereby resulting in the deterioration of human health. Although several chemical and physical treatment options have been developed, these conventional methods are expensive, and may not be feasible for large-scale remediation. Bioremediation is therefore considered a better eco-friendly alternative for solving this issue and for potentially reducing toxic metal concentration in polluted resources. This review in brief discusses the scope of bioremediation for contaminated soil, the various metal-remediating microbes found, the different mechanisms of bioremediation used, and much more.

19. **Chapter 19:** Sustainable agriculture is foreseen as a practice that will preserve and protect the environment. It tends to be a solution for ecological degradation of soil and other natural resources. In spite of the utilization of chemical pesticides and fertilizers, there still exists poverty and people live without a full-day meal worldwide. This global issue needs to be addressed in order to save our environment and ecosystem. Also since soil is a non-renewable resource, it has to be carefully planned and used without any degradation. Sustainable agriculture reforms the entire chemical system of farming. It all started with the initiation of the green revolution in order to tackle a significant increase in the human population. The use of chemical fertilizers hastened the period of crop production and resulted in surplus production of food grains. At the same time, it forces poor laborers for monetary borrow to

invest in fertilizers and pesticides during the initial stages of cropping.

20. **Chapter 20:** The weight loss approach was used to investigate the corrosion characteristics of various metals found in varying concentrations of solutions containing acids. The degree of these metals' corrosion in 1–5 M HCL solutions was investigated for 24 hours. The order of metal corrosion is zinc > galvanized iron > copper >, whereas the order of aqueous media corrosion is HNO_3 > H_2SO_4 > HCl. It has been observed that increasing concentration increases the corrosion potential. Further investigation into the dynamics of corrosion has demonstrated that the rate of reactivity in terms of metals rises with increasing solution concentration when the half-life decreases.

21. **Chapter 21:** At present, with the increase in human population, the amount of plastic consumption has multiplied, and with it, pollution levels are getting alarming day by day. Plastic is a disaster and threatens the whole world. Since this is a big problem for our environment, there may be a call to find a change for traditional plastics. Therefore, bioplastics are the perfect option as they can be synthesized from various active biodegradable wastes. Bioplastics are formed from various renewable biomasses, including starch, biopolymers, cellulose, and aggregates from various compounds. These plastics can be easily synthesized and can be easily degraded compared to conventional plastics. So, the synthesis of it becomes a crucial challenge.

22. **Chapter 22:** This is an overview of the photocatalyst TiO_2 which gets activated under UV rays. Its use in wastewater management is discussed. TiO_2 is a semiconductor that uses the transient nature of electrons and holes to produce radicals such as OH• and HO2 • to degrade organic pollutants, inorganic pollutants, and pathogens, particularly into carbon dioxide, water, and oxides of organic compounds, respectively. The oxides are recycled back into the biogeochemical cycles. TiO_2 differs in its structure such as anatase, brookite, and rutile, and hence its properties. Besides this, there are several methods of preparation which can be through natural sources or synthetic preparation. To enhance the outcome of wastewater treatment, TiO_2 is doped or modified with certain elements. These include nonmetal Dopants such as porous minerals, carbon materials (fiber, graphene, activated carbon), polymer materials (PLC, PE), nitrogen, *etc*., and metals such as precious metals (Ag, Pt), ions (Fe^{3+}, Mo^{5+}). Composite modifications are also made. The formation of a heterojunction is one such method that enhances the activity of TiO_2 to increase the photo response to the visible and infrared regions. Co-doping is also done such as N and Co-doped TiO_2. Certain parameters which affect the efficiency of TiO_2 are discussed briefly along with the limitations it has. The degradation rates of some doped TiO_2 acting on Methylene blue and Rhoda mine B are recorded and a case study on degradation of Butachlor using Degussa-25 is discussed briefly. While degradation, a new byproduct i.e., carboxylic ions (such as acetate, and formate), was also found but later on after undergoing photo-Kolbe's reaction, CO_2 was formed along with regenerated TiO_2. Here, peroxide ions played a major role in degradation as due to the presence of common salt, there was a competition to occupy the active holes of TiO_2. Hence, OH• became non-selective.

23. **Chapter 23:** Plastics are primarily composed of polymers and contain additives that allow them to inherit properties like durability, thermal insulation, electrical insulation, and density. Studies have shown that approximately half of all the conventional synthetic polymers in the market are used as short-term products, during disposal, they end up in landfills and oceans where large amounts of plastic are washed ashore, sink or float, and fragments into micro plastics which can harm and kill various organisms before making its way through the food chain. The term bioplastic is an abbreviation for bio-based polymers. A bio-based polymer can be shaped by components that stem from an organic source or its derivatives. In this

paper, we'll discuss the types, production, advantages and disadvantages, and applications of bioplastics.

24. **Chapter 24:** Accurate nanotechnology is an advanced, emerging science that has mostly the fields of industries, environmental issues, biotechnology, health, and medicine. NanoRemediation is known as the usage of nanoparticles for bio remediation. It is mainly used to treat wastewater soil, contaminated environmental material, groundwater, and sediments. In this technology, nano titanium dioxide or non-toxic nanoparticles are used. Basically, chlorine-containing organic wastes are removed using nano remediation. Although this method is a good technology, it is still present in investigational stages and has been applied mostly in laboratories.

25. **Chapter 25:** Bioremediation is a type of biodegradation that involves the phenomenon of biological transformation of organic compounds by living organisms. Biodegradation mainly involves the conversion of complex organic compounds to simpler and non-toxic ones. Bioremediation is a natural and genetically engineered technology that involves cleaning up polluted air, water, and soil using various forms of life such as bacteria, fungi, fishes, algae, animals, and plants. Bioremediation includes biotransformation which is incomplete biodegradation of organic compounds and it is employed for the synthesis of commercially important products by microorganisms. The other names that can be used for bioremediation are bio-treatment, bio-reclamation, and bio-restoration. Bioremediation is mainly used for the degradation of xenobiotics. Xenobiotics are substances that are man-made or synthetic and take a very long time to degradate. They are also known as recalcitrants. Some examples of recalcitrants are pesticides, herbicides, refrigerants, solvents, and other organic substances. Accumulation of these substances in soil water, air, and water causes so many problems. Therefore, we can use bioremediation to remove these chemicals from the environment. So it will be a very good solution for the environmental problems caused by toxic chemicals.

26. **Chapter 26:** Today, the main driver of socioeconomic development is energy. However, the interest in renewable energy is important because of the increasing level of environmental concern. Due to the ongoing depletion of fossil fuels, this alternative energy source is steadily growing in popularity. It is energy that is derived from the sun, wind, rain, *etc*. Solar energy has one of the greatest potentialities for conversion into electric power among the unconventional, renewable energy sources. To improve efficiency, a solar system should produce as much electricity as possible. Keep the solar panels aligned with the sun to optimum power production. This chapter discusses the production of electricity from solar energy. By appropriately positioning the panel in line with the position of the sun, the suggested method assures the maximum efficiency of the conversion of solar energy into electricity.

27. **Chapter 27:** A particular region's rapid industrial development necessitates the construction of numerous facilities. These include, in particular, production, warehouse, and commercial buildings along with office and social structures and the necessary supporting infrastructure. New industrial facilities must be built in expansive areas that are suitable for this kind of development. It goes without saying that the majority of locations with favourable ground conditions and location have already been developed, necessitating the implementation of this type of investment in less desirable locations. Due to the specific implementation challenges caused by this, it is necessary to properly improve and prepare the subsoil in order to construct the buildings and other objects that make up the entire investment safely.

28. **Chapter 28:** In recent years, the IIoT has piqued the interest of academic and industrial researchers. When IT was combined with industrial automation and control systems, the term

IIoT was coined. It provides an integrated development environment for businesses to create intelligent interconnected systems that leverage a variety of IoT devices to connect the cyber and physical worlds with greater availability and scalability. IIoT includes networked smart electricity, industrial, medical, and transportation. In terms of technology, the consumer IoT and the Industrial IoT are not similar. In this chapter, the evolution of the industry, recent research, and the applications in IIoT are discussed. This chapter aims to assess the current state of IIoT in the current context and make some research recommendations for future researchers.

29. **Chapter 29:** PH plays an important role in determining product quality industries like in various chemical, petrochemical, petroleum refineries, fertilizer, pharmaceutical, food industries, effluent treatment and in many other organic and in organic plants. For instance, in any industrial wastewater treatment plant, the PH is monitored and controlled by manipulating the acid or base stream which is a strong acid or strong base. Modern treatment plant involves physical and chemical precipitation/flocculation along with biological treatment in aerators/trickle filters, membranes, *etc*., where the control of PH is the key factor for efficient treatment. In chemistry, PH is a measure of the acidity or basicity of an aqueous solution. Pure water is said to be neutral, with a pH close to 7.0 at 25 degrees Celsius. Solutions with a PH less than 7 are said to be acidic and solutions with a PH greater than 7 are basic or alkaline. PH measurements are important in medicine, biology, chemistry, agriculture, forestry, *etc*. By PH control, we mean to maintain the PH value during continuous operation at a specific desired value by manipulating the alkaline flow rate. Usually in most industrial applications, the desired value is chosen to be around 7. This is the safest value for portable water, utility water used in industry, or waste-disposed water.

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CHAPTER 1

Detection of Fake News in Distributed Environment

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Abstract: Data analytics is the present and the future of problem-solving in computing. With the increasing trends in Data and Processing power, Machine learning solutions are evolving to cater to the needs and challenges in both scientific and business worlds. In this work, the current solutions have been discussed, and the results of the practical experiments are shown with a glimpse into the future direction. The task of automatic identification of fake news is addressed. Fake news datasets are obtained through crowdsourcing and web covering celebrities. Due to the inherent relationship among publishers, news and social engagements during the news dissemination process on social media, the SVM classifier model has been implemented, the Multilayer Perceptron model for distributed environment is proposed and a performance comparison of two models is established.

Keywords: Apche spark, Feature extraction, Multilayer perceptron, Support vector machine, Tokenization.

INTRODUCTION

The use of social media for news consumption has two sides. On the one hand, consumers seek out and access news *via* social media because of its low cost, easy access, and rapid transmission of information. It allows "fake news," or low-quality news that contain purposefully incorrect material, to proliferate widely.

The boundless scattering of news can possibly have hugely unfavorable ramifications for the people and society. Thus, distinguishing misleading news *via* online media has as of late turned into a rising review point that is acquiring a great deal of interest. Counterfeit news ID *via* web-based media has extraordinary qualities and obstructions that render exemplary news media discovery calculations wasteful or unimportant. To start with, counterfeit news is deliberate-

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ly intended to misdirect perusers into accepting misleading data, making it troublesome and nontrivial to recognize in view of information content alone

GjorgjiMadzarov *et al*. [1] described the architecture of Support Vector Machine classifiers utilizing binary decision tree (SVM-BDT) for solving multiclass problems.

Veronica P Rosas *et al*. [2] explained the need for automatic fake detectors. They also explained the features that are needed to be extracted for implementing fake news detection.

Kai Shu, *et al*. [3] presented the detailed optimization process for the proposed framework TriFN, which is a model developed for fake news detection. It also explains the performance metrics for the given model.

Yunfei Long *et al*. [4] proposed a novel method to incorporate speaker profiles into an attention-based LSTM model for fake news detection.

Salman Salloum1*et al*. [5] presented what Apache Spark has for designing and implementing big data algorithms and pipelines for machine learning, graph analysis, and stream processing.

XiangruiMeng *et al*. [6] presented MLlib, Spark's distributed machine learning library. The library targets large-scale learning settings that benefit from data-parallelism or model-parallelism to store and operate on data or models.

G.M Nasira *et al*. [7] presented a BPSO-based feature selection with a multilayer perceptron classifier with a back propagation algorithm and presented the working and implementation of neural networks for data classification techniques.

METHODS

Problem Statement

The rise of false information in everyday access media venues like social media feeds, news blogs, and online newspapers has made it difficult to identify reliable news sources, necessitating the development of computer algorithms that can assess the authenticity of online content. The two-fold model is focused on the automatic detection of false information in Internet news. First, a dataset for the purpose of detecting fake news is presented, which covers various news domains. The procedure of gathering, annotating, and validating data is detailed, and many exploratory analyses of linguistic distinctions in false and authentic news articles are offered. Second, a series of learning experiments are carried out in order to develop accurate fake news detectors. The technology has been built to examine

the information and, if necessary, detect bogus news using natural language processing.

Support Vector Machine

Support-vector machines (SVMs, otherwise called help vector organizations) are directed learning models with related learning calculations for grouping and relapse examination in AI. Given a progression of preparing tests, every one of which is named as having a place with one of two classes. A non-probabilistic parallel straight classifier, an SVM preparing procedure makes a model that provides new occasions to one of two classes (despite the fact that strategies, for example, Platt scaling involves SVM in a probabilistic grouping setting). An SVM model is a portrayal of occasions so that the instances of the various classifications are isolated by a distance as wide as it could be expected. New occurrences are then planned in a similar space and allocated to one of the classifications based on which side of the hole they land on.

In both the typical inductive and transductive situations, SVMs can considerably minimise the demand for labeled training instances, making them useful in text and hypertext categorization. Support vector machines are used in several shallow semantic parsing approaches. SVMs can also be used to conduct picture classification. After only three to four rounds of relevant feedback, SVMs provide much higher search accuracy than standard query refinement systems, according to experimental results. This is also true for image segmentation systems that use a privileged approach, such as those that use a modified version of SVM.

SVM can be used to recognize handwritten characters. The SVM algorithm has been widely utilised in biological and other disciplines to identify proteins, with up to 90 percent of the molecules accurately identified. SVM weights-based permutation tests have been proposed as a mechanism for SVM model interpretation. In the past, support- vector machine weights were also utilised to analyse SVM models.

Multilayer Perceptron (MLP)

A single perceptron with numerous layers is not referred to as a “multilayer perceptron.” Rather, it is made up of a number of layers of perceptrons. “Multilayer perceptron network” is another option. Moreover, MLPs “perceptrons” aren't correct perceptrons in the strictest sense. Genuine perceptrons are a sort of fake neurons that utilize a limited actuation work like the Heaviside step capacity to enact. MLP perceptrons can use whatever activation function they want. A genuine perceptron conducts binary classification; however, depending

CHAPTER 2

Influence of MoS_2, B_4C and Graphite on Mechanical and Dry Sliding Wear Behaviour and Micro structural Characteristics of Aluminium 7075 Hybrid Matrix Composites

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Abstract: In the current study, the synthesis and characterization of a metal matrix composite material encompassing MoS_2, B_4C and graphite as reinforcement have been carried out. Hybrid composites are prepared by using stir-casting techniques with various weight percentages (1%, 2%, and 3%) of each reinforcement (Molybdenum Disulfide, Boron carbide and Graphite). After fabrication, the ingots were subjected to various tests to study their mechanical behaviour and microstructure. Tensile test, hardness test, and impact test were conducted by ASTM standard to find the effect of reinforcement on aluminium metal matrix composite (Al 7075- MoS_2, B_4C, and graphite). The microstructural study (scanning electron microscope) was conducted to assess the distribution of reinforcement on the composite. The spread and interaction of constituent materials play a key role in their properties. The results show that the addition of reinforcements up to 3% to matrix metal Al 7075, the hardness, tensile, and impact properties were increased compared to base AL 7075 alloy.

Keywords: Aluminium alloy 7075, Boron Carbide B_4C, Dry Sliding wear rate, Graphite, Hardness, Impact, Molybdenum Disulfide MoS_2, Stir casting, SEM, Tensile.

INTRODUCTION

Aluminium and its alloys show a major role in diverse industrial sectors such as automobile and aerospace sectors due to their superior mechanical properties and weight-to strength. Aluminum matrix composites are commonly fabricated by liquid method casting [1]. In the liquid casting method, the reinforcement particul-

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ates are mechanically scattered over the liquid metal before solidification and casting. These casting methods are classically less costly [2]. Aluminum-based MMCs give improved mechanical properties than monolithic aluminium alloys and broadly due to their higher strength -to-density ratio and amended mechanical strength, performance has been a motive for growing curiosity towards numerous applications in technological fields.

Al7075 is an alloy of aluminium, which contains zinc as a primary alloying element. Molybdenum disulfide consists of virtuous thermal stability and chemical stability. MoS_2 is an extremely effective dry lubricating film. The nano particles of molybdenum disulfide own a decent catalytic activity, exceptional physical properties, and a low friction coefficient form [3 - 8]. The nanoparticles of molybdenum disulfide seem in black colour solid form. The higher hardness of boron carbide stretches its outstanding wear and abrasion resistance. Graphite is generally utilized as an engineering material over numerous applications such as thrust vanes and bearings, and piston rings. The seals which are based on carbon are used in the shafts and fuel pumps of various aircraft jet engines.

An attempt was made to prepare Aluminum Metal Matrix Composites by adding B_4C, MoS_2 and Gr reinforcement particles into 7075 matrix alloy using a stir casting method [9 - 14]. The main objective of the current investigation is to find the mechanical properties of the AMMC by varying the reinforcement percentage of the aluminum alloy [15, 16].

MATERIALS AND METHODS

Materials

In the hybrid matrix composites of metals, the aluminium alloy (Al 7075) is utilized as a matrix material. Al 7075 alloy chemical compositions are shown in Table **1**. Molybdenum Disulfide powder (40µm), Boron carbide powder (50µm), and Graphite powder were used as a reinforcement for the matrix material as shown in Fig. (**1**).

Table 1. Al 7075- Chemical compositions.

Component	Al	Zn	Mg	Mn	Si	Ti	Fe	Cu	Cr
Wt. %	87.1 – 91.4	5.1 – 6.1	2.1 – 2.9	0.0 – 0.3	0.0 – 0.4	0.0 – 0.2	0.0 – 0.5	1.2 – 2	0.18 – 0.28

Reinforcement

Molybdenum Disulfide (MoS_2)

In general, molybdenum disulfide contains very good thermal stability and chemical stability. It will form the most effective dry lubricating film as shown in Table **2**.

Table 2. Molybdenum disulfide properties.

S.No.	Properties	Values
1.	Density	5.06 g/cm^3
2.	Melting point	1,185 °C
3.	Thermal Conductivity	3.5 W/mK

Boron Carbide (B4C)

Boron carbide is called a robust material that possesses extremely high cross section for neutron absorption, high hardness, stability to ionizing radiation, and most chemicals Table **3**.

Table 3. Boron Carbide (B4C) properties.

S.No.	Properties	Values
1.	Density	2.3 g/cm^3
2.	Melting point	2,350 °C
3.	Thermal Conductivity	120 W/(m·K)

Graphite

Graphite is known as a distinct material as it contains both nonmetal and metal properties. Although graphite is flexible, it is not elastic and has more thermal and electrical conductivity as shown in Table **4**.

Table 4. Graphite properties.

S.No.	Properties	Values
1.	Density	2.26 g/cm3
2.	Melting point	4750–4800 K
3.	Thermal Conductivity	25–470 W/(m·K)

CHAPTER 3

Sensors and Antennas for Smart Sensor Networks: A Review

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Abstract: In the current scenario of automation and digitization, sensors are available in almost all fields of invention. Sensors are in our phones, workplaces, automobiles, and the environment. With the increasing growth of sensors, sensor networks are a significant aspect of the Internet of things (IoT) and the contemporary world. In a sensor network comprising multiple sensor nodes, each sensor node is small in size, lightweight, and portable, as are the detection stations that make up the network. Detecting and processing nodes that have been constructed are used for sensing and processing the surrounding environment, as well as relaying the detected data to the other nodes in the network. Almost every sensor node in the network is equipped with four primary components, *i.e.,* a transducer, a microcontroller, a transmitter, and a power supply. Sensor nodes in the sensory network must be able to operate on restricted and tiny sources of energy, which are often available in the form of operational battery power. These types of networks also incorporate a variety of antennas, which help to increase the network's capacity while also increasing the transmission range, improving spatial reuse, and reducing interference. The primary goal of this chapter is to provide an overview of the sensors and antennas used in wireless sensor network applications.

Keywords: Antenna, Energy, Network application, Sensor, Smart network, Wireless sensor network.

INTRODUCTION

Any sensor network is made up of a collection of small, powered devices that are linked to a wireless or wired infrastructure *via* which data is collected and sent. They may be used to record conditions in a variety of settings, including industrial sites, farms, hospitals, and medical institutions. Sensor network communicates with the internet or computer networks to send data for analysis and use. With the

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introduction of low-cost sensors, there has been a significant surge in the usage of WSNs in a variety of applications including traffic monitoring, medical care, wildlife monitoring, military establishment applications, and others. Nodes in a sensor network work together to perceive and regulate their surroundings. Individuals or computers can communicate with one another as well as with their environment using these technologies. Sensor networks may be either wired or wireless in their operation. Sensors in wired sensor networks are connected *via* the use of Ethernet connections. Wireless sensor networks (WSNs) are networks of sensors that communicate with one another using wireless technologies such as Bluetooth, LTE, WiFi, or near-field communication (NFC).

Ethernet is the most widely used form of wired connection today. Phone-line and powerlines are two types of lines that are comparable. Ethernet is the best choice if you want high performance and reliability. It offers smooth data transmission experience, as well as network stability and reliability. It is recommended to use this kind of network for home networks when you just have a single computer and don't need to move it around too often. Ethernet speed varies from 10-100 Mbps depending on the manufacturer, but you can simply upgrade it to 1 Gbps with a simple software update. Wired networks are typically considered safer than wireless networks, and many come with firewalls preinstalled. Even though it seems to be a win-win situation on paper, there are some disadvantages to using wired connections. Suppose there are multiple PCs in a house or at a workplace that all need internet connectivity. All computers and devices have to be linked together *via* a cable. As a result, if all computers and devices need to inter-communicate with each other, and exchange data, the option is to set up a local area wired network, which may be accomplished by using a hub. If no additional cords and adapters are required, this option may be a good choice for connectivity. Fig. (**1**) illustrates the wired sensor network and the sensors connected to it. When compared to wired sensor networks, wireless sensor networks (WSNs) are less complicated to deploy and maintain, and they provide more device portability and flexibility. WSNs have emerged as a critical component of the Internet of Things, because of the rapid growth of sensors and wireless technologies. WSNs do not need the modification of the physical network architecture.

The chapter is divided into the following sections: Section II discusses various types of antennas used in sensor-based networks, Section III discusses different sensors, Section IV discusses the application areas of sensor networks, Section V presents issues and security threats related to sensor-based networks followed by section VI representing the conclusion of the chapter.

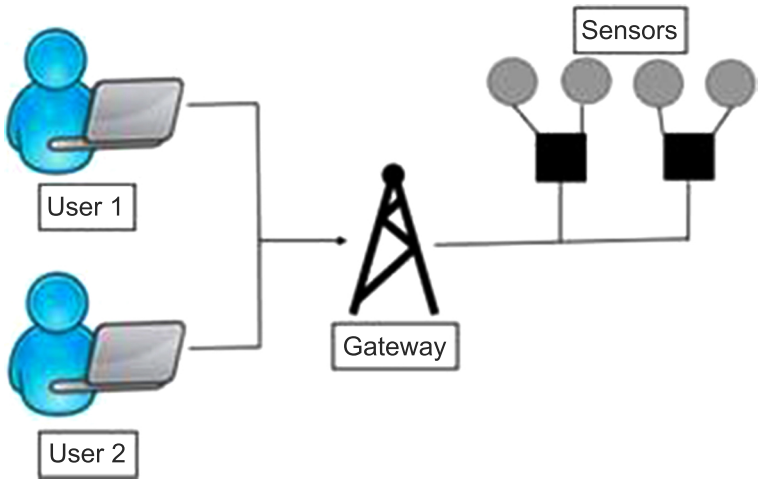

Fig. (1). Wired Sensor Network.

ANTENNAS

An antenna is a device that is used for the collection and transmission of electromagnetic energy from or into space. A wireless sensor network (WSN) comprises multiple types of sensor nodes, which are produced and utilized for detecting the surrounding environment and sending the perceived data to all other nodes present in the network. The kind of antenna that is used is regarded to be one of the most important aspects that influence the characteristics of how much power is used by a transceiver. For the extended communication range, a high-power source is required for the transmission of signals [1]. The construction of a low-power communication system using an effective antenna is one of the important study areas in wireless sensor networks (WSN).

The selection of antennas is by far the most often overlooked process when planning or deploying a system. They are just passive gadgets that provide no analytics and no useful software in any way. They just connect to advanced effective gadgets, while the radio performs all the functions. A fancy software on a fancy radio will not function properly unless it uses a proper antenna. Devices will not be able to communicate with one another and will not be able to offer consumers the service they need. The choice of an antenna does not have to be a difficult undertaking. The most common problem that we have seen throughout the years comes under the area of radiation pattern selection. Generally, two types of antennas are used in WSN as per the radiation pattern: Omni directional and directional antennas. The kind of antenna to be used is determined by the deployment circumstances, configuration, and distance coverage requirements. The section discusses each one of them with their types, pros and cons.

CHAPTER 4

Induction Motor Condition Monitoring Using Hybrid AI and IoT System

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Abstract: We use a variety of electrical devices in our day-to-day operations. Home appliances, industrial applications, automobile applications, and other gadgets are among the devices available. So many electrical instruments rely on the electrical machine as their heart. If a fault arises in the machine, it will cause the instrument to malfunction. It can sometimes result in a dangerous situation. To avoid this, we must constantly monitor the electrical machine. If a problem arises, we must be informed as soon as possible. Only then will we be able to take corrective action and prevent fault occurrence. This way, we can leverage Artificial Intelligence (AI) and the Internet of Things (IoT) for electrical machine condition monitoring. AI focuses on creating intelligent machines that think and work like humans. The IoT is a network of connected systems that can collect and transfer data wirelessly without human involvement. We can take condition monitoring, control, and information exchange to the next level by combining these two approaches (AI-IoT). This study employs an induction motor for analysis purposes because it is one of the most widely used electric motors worldwide in a broad range of applications. Throughout its various operating stages, the induction motor is continuously monitored, and the state of the motor is updated to the user accordingly. Additionally, utilizing IoT and modern communication technologies makes it possible to remotely monitor and control the induction motor.We can achieve numerous advantages over traditional methods by combining these two methodologies (AI-IoT).

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Keywords: AI-IoT, Artificial Intelligence (AI), Condition monitoring, Internet of Things (IoT), Induction otor.

INTRODUCTION

Most of the electrical instruments used in our residents and industries have the Induction Motor (IM). The fault in the IM lead to the malfunction of the electrical equipment. The faults may significantly impact the production units in industry and cause inconvenience to the residents. Continuous observing and monitoring the health of the IM is known as condition monitoring of the IM. The main aim behind the condition monitoring is improving efficiency, productivity, reduction in cost, and increasing the motor's availability. Fault diagnosis is an integral part of condition monitoring. The fault diagnosis and condition monitoring are carried out using many computational techniques.

Artificial Intelligence (AI) is a discipline of computer science that focuses on developing an intelligent system that thinks and functions like humans. The term AI can also refer to any system that demonstrates human-like characteristics like problem-solving and learning. Many of the researchers discussed the importance of AI in the process of fault diagnosis and condition monitoring. Another important aspect of condition monitoring is the identification of the fault at the beginning stage itself. The initial detection of the fault will definitely reduce the damage occurring on the machine. Moreover, earlier detection faults allow the consumer to make other alternatives. Through continuous monitoring, the health of the IM is also identified at a regular interval [1 - 5].

The information about the actual condition of the IM (fault or normal) must be conveyed to the user. For this purpose, the Internet of Things (IoT) is utilized. The Internet of things (IoT) is a network of physical items embedded with various hardware, software, transducers, sensors, and other modern technologies that communicate and share data with other devices and systems using the Internet. In simple terms, The IoT is a network of connected systems that can collect and transfer data wirelessly without human involvement. Primarily, the IM's fault and the health of the IM are continuously monitored by using AI, and the information obtained is transferred to the user by using the IoT methodology.

By combining the AI-IoT (Artificial Intelligence (AI) and Internet of Things (IoT)), we can get the advantages of both techniques. We will cover the condition monitoring of Electrical Machines, specifically the Induction Motor, using AI-IoT in the present manuscript [6 - 10].

In the present manuscript, the literature review is carried out in Section 2. Section 3 discusses induction motors and the various faults occurring in the IM. Different

AI-based computational techniques for identifying fault identification and classification are explained in Section 4. Section 5 discusses the importance of IoT and the use of IoT condition monitoring of IM. Section 6 discusses in detail the combination of AI-IoT in condition monitoring.

REVIEW OF LITERATURE

Induction motors (IM) are commonly used in various industries, such as railways, mines, woodworking machines, cars, chemicals, paper mills, *etc.* Due to their high performance and durability, single-phase IMs are commonly used in industrial machines, blowers, centrifugal pumps, fans, and mixers for domestic applications [11 - 15]. Due to their simplicity and efficiency of construction, IM, a vital part of modern industries, acts as an important prime mover in various applications . Different types of faults occur in the IM drive. The faults may be either electrical or mechanical faults. A study has been conducted to analyze various faults such as broken rotor faults, eccentricity faults, misalignment faults, and stator winding faults.

Condition monitoring (CM) of the IM needs to be carried out to increase the IM drive's performance. Monitoring motor's condition also plays an essential role in many industrial and residential applications. Induction motor Condition Monitoring (CM) is a monitoring method for observing the system's health. It aims to improve productionefficiency and cost savings and increase machines' availability [16 - 20]. The CM and fault detection are the primary steps to stop IM's unexpected breakdown and minimize the IM drive's unscheduled downtime. Several methodologies are used to identify the faults, such as Current signature analysis, vibration signature analysis, Acoustic Emission Monitoring, *etc.* These methodologies are used to monitor the system's condition. But these are complex and complicated and require more expensive sensors [21 - 25].

Artificial intelligence (AI) techniques play a vital role in condition monitoring. Through advancements in AI techniques, fault prediction and condition monitoring accuracy increased. AI techniques such as Fuzzy Logic (FL), Expert System, Genetic Algorithm (GA), and Artificial Neural Networks (ANN) are used for automatic fault diagnosis and condition monitoring of the IM [26 - 30].A practical CM approach should be capable of issuing alerts and forecasting faults at a preliminary phase. This approach captures all motor's primitive data using data analysis techniques or digital signal processing. The system's biggest weakness is that it requires human involvement. It's logical to automate condition monitoring and fault detection [31 - 35].

The drawback of data collection's human intervention can be avoided by using the Internet of Things (IoT). It refers to internet-connected objects, interrelated

CHAPTER 5

Automatic Conversion of Building Plan to Graph for Navigation of Robots – A Computer-Aided Approach Based on Extended Conditional Erosion Algorithm

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Abstract: This research work proposes a computer-aided algorithm for the conversion of building plans into a graph for the navigation of robots. Rescuing people from burning buildings manually is a tedious process. Robots play a pivotal role in industrial automation and the deployment of robots in rescue operations can save many people. Indoor navigation for robots is a challenging task since every building has a unique structure. A routing graph is inevitable to find the path in a building quickly for the navigation of robots to perform the rescue operation. The automatic extraction of the routing graph from the image of the floor plan is offered in this research work. The floor plan images are acquired and converted into a raster image. Then, by using the predefined kernels, the white pixels are eroded for obtaining the routing path of common walkways through corridors and rooms. The Extended Conditional Erosion Algorithm is used for the extraction of the routing graph from the floor plan images. The resultant graph as output aids the navigation of the robot.

Keywords: Direct Simulation MonteCarlo, Fractional brownian motion, Knudsen number, Lattice-Boltzmann, Nanoscale pores, Mesoscopic methods, Rarefied flow, Reconstruction, Porous media, Slipflow, Transition regime.

INTRODUCTION

The fire outbreak is one of the biggest risks worldwide. Over the period of 1993-2016, an estimated average of 3.7 million fire accidents were recorded and 43.2

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thousand were confirmed dead according to the Center for World Fire Statistics of CTIF 2018. Moreover rescuing people from the burning building manually is impossible. Finding people inside a burning building is unfeasible, hence robots are used for rescuing people from the building. But for the operation of robots, automatic navigation is inevitable. Normally the navigation is done using Global Positioning System (GPS) and satellite images [1]; these images are captured by very high spatial resolution (VHR) imagery sensors. But for indoor navigation, these data are not reliable and insufficient for routing. The navigation map was extracted from high-resolution Light Detection and Ranging (LIDAR) data directly from on-site and stored in the cloud [2]. The robot is navigated using text recognition from the image [3]. In this case, when the building is on fire, on-site data collection is impossible. The floor plan is easily available and can be used for navigation. The routing graph is extracted from the floor plan by using image processing techniques.

The floor plan of the building is initially segmented to separate the thick and thin lines which give the necessary information about the walls, doors, and other useful data. Further, for the analysis, edge tracing and boundary-based methods are used. Finally, extraction and labeling are performed [4]. The automatic navigation of the robots is done by a localization algorithm and obstacle avoidance algorithm [5]. In a study [6], the data is acquired from depth images in 3D and are converted into 2D planes using Fast Sampling Plane Filtering. The navigation map is extracted from the data collected by multiple robots and the free space provides the exploration strategy; also the walls are extracted, and the structure of the environment is mapped [7]. Non-uniform-sized regions are automatically decomposed from the game map by flooding and a path finder algorithm [8], it takes only a few seconds to decompose a map. The text is detected and the location of the text is used for extracting doors and walls using the flood fill algorithm [9] and Hough transform [10]. Acquiring the building plan can also be done by capturing pictures of evacuation plans [11]. Interiors of the buildings are captured by using a smartphone-based pedestrian navigation application. Inertial measurement units (IMUs) are used to find the position and orientation, and the Kalman filter is used to detect the stairs and open doors [12]. Externals of the buildings are captured by a Zero Velocity Update (ZUPT) based MEMS IMU navigation application.

To extract the navigation map automatically, the system was trained in such a way that the images are processed automatically. In a study [13], the center lines of the building images are trained in such a way as to get the closest distance of the centreline and are applied to the input images. A new terrain algorithm, Brood War Terrain Analysis 2 (BWTA2), is used [14] for Real-time strategy (RTS) games. The computation speed of BWTA2 is 10 times faster than the Brood War

Terrain Analysis (BWTA) algorithm. Generally, navigation is divided into position estimation and routing. The position is estimated from the infrastructure or the floor plan of the image. While using the infrastructure-based method, the cost estimation is very high, hence the image-based method is used. In the image-based method, the images are acquired from the building floor plan.

The floor plan of the building was captured using a smartphone and it was processed for navigation. This research work proposes an Extended Conditional Erosion Algorithm to extract a routing graph from the raster image. The extracted graph is used for the navigation of the robots. Section 2 comprises the algorithms used in this work and Section 3 describes the results and discussion with the conclusion drawn in Section 4.

MATERIALS AND METHODS

The flow diagram of the proposed methodology is depicted in Fig. (**1**). The preprocessing stage involves the RGB to grayscale conversion and thresholding operation. The thresholded image is subjected to the extended conditional erosion algorithm and finally, the edge point is traced and the distance between the edge points is determined.

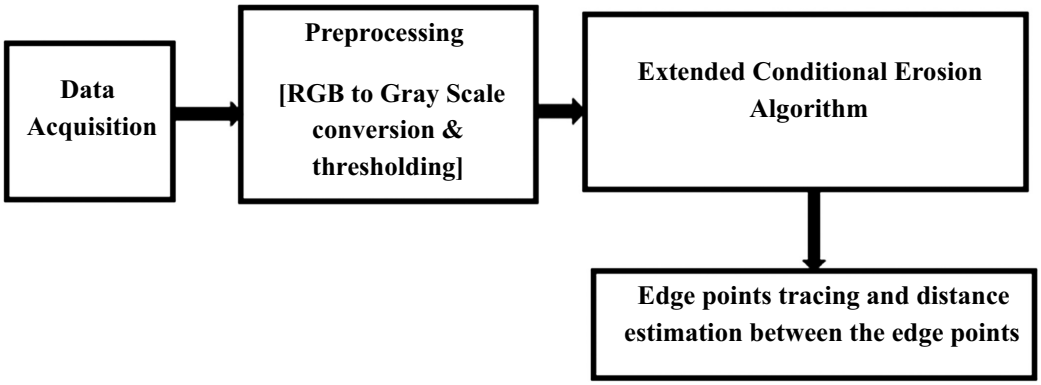

Fig. (1). Flow diagram for path detection in floor plan images.

DATA ACQUISITION

The floor plan of the building is captured using a smartphone and the building plan in .jpg or .png form is given as input. The details of the input floor plan images are depicted in Table **1**.

CHAPTER 6

Analysis of Defects in Microscopic Images of Hetero Epitaxial Growth Technique Using Fuzzy K Means Clustering Algorithm

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Abstract: The semiconductor material InP plays a key role in optoelectronic devices, high-speed devices, and fiber optic communications systems. The major problems with these materials are the high lattice mismatch and variance in thermal expansion coefficient between InP and Si. This mismatch produces high dislocation density at the interface and the propagation of the threading dislocations away from the interface into the device layer is a major concern in optoelectronic applications. Image processing algorithms play a pivotal role in the medical field, archaeology, and remote sensing. This work proposes an image processing method to analyze the SEM images of the InP heteroepitaxy layer to determine the etch pits to confirm whether the substrate is suitable for optoelectronic applications. In this work, a variant of an anisotropic diffusion filter for noise reduction on SEM images and Fuzzy C means clustering method for image segmentation was employed for analysis.

Keywords: FCM, Image processing, Optical communication, Semiconductor.

INTRODUCTION

Nanotechnology is a field of applied science, which aims at the production and use of materials and structures engineered close to the atomic or molecular scale. These structures are referred to as nanostructures, which possess one dimension at least less than 100 nanometers. To visualize and characterize this kind of nanostructure materials, high-resolution microscopy images are commonly used.

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The InP nanocrystals grown on a silicon wafer were found to be applicable for optoelectronic applications [1]. Image processing helps in improving the image features of interest by removing irrelevant details of the project and then enhancing the image with useful information. Recently, image analysis is being used in the field of nanotechnology [2].

For qualitative and quantitative information on physical properties, the images collected are thoroughly analyzed and processed. Although the images obtained by SEM and AFM are good enough to analyze the above-mentioned properties, they cannot be analyzed in the raw image format as the images are abstract. Hence, the raw image has to undergo several image preprocessing techniques to make it easy for the researcher and to obtain the correct information. The preprocessing steps aim at contrast enhancement, restoration, compression, and background subtraction. Once the image has been preprocessed, the next crucial step is image segmentation, which is a process of associating similar image features together based on intensity, color, and texture. Thresholding is a basic segmentation method that segments different intensities in the foreground and background regions of an image.

Many image thresholding algorithms have been developed in the past several years and still, much research continues due to the existence of needs. Although there are so many methods present, none of them perform well under all conditions. Every method is based on certain conditions and works only under some assumptions. These methods fail when they are applied to SEM or AFM images of nanostructures because the images are fuzzy and abstract. One example of such issues is that carbon nanotube images captured by AFM always produce a unimodal distribution, making it difficult to distinguish the foreground and background regions. This is one of the special cases of thresholding methods. Another example is that nanorod images captured by SEM have a poor vision in separating the top view from the stem region. This hinders the researchers from further processing of their nanostructure images, forcing them to do such processes as calculating the length, orientation, and density of the carbon nanotubes manually. Therefore, it is very clear that a good thresholding method is required.

The algorithms based on image processing were proposed [3] for the processing of TEM images of nanoparticles. The manual estimation of particle count was cumbersome and the precision was also low. The particle size was exported and was exported to an Excel file for analysis purposes [3]. The anisotropic diffusion filter was found to be proficient in the filtering of SEM and TEM images, the edge preservation was better when compared with the classical filtering algorithms [4]. The classical thresholding algorithm fails in the ROI extraction of

SEM and AFM images of nanostructures; the Expectation-Maximization (EM), K means and a combination of EM and K means to segment the image are considered [5]. The FCM algorithm was proficient in the ROI extraction of underwater images [6]. The Otsu thresholding along with the morphological operators and canny edge detector was employed to estimate the size of the nanoparticles in the TEM images [7]. The FCM algorithm was proficient in the extraction of ROI on medical images [8]. A thresholding algorithm based on Imperial Competitive Algorithm was used for the study of nanofiber images [9]. The deep learning model was found to be proficient in the segmentation of TEM images [10, 11]. The multistage segmentation model was found to be proficient in the extraction of nanoparticle size in TEM images [12].

In high-speed applications and even in fiber-optic communication networks, the III-V compound semiconductor InP with a direct bandgap of 1.3 eV gets affected even at room temperature [13]. Silicon (Si), on the other hand, is an indirect bandgap material and in the microelectronic industry it is a dominant material due to its high thermal conductivity, mechanical power, wide area, and less expensive, but the drawback is the poor light discharge. The heteroepitaxy of InP on Si substrates is of great importance to take advantage of the benefits, as it provides a great potential for monolithic integration of InP-based optoelectronic and high-speed devices with Si integrated circuits [14 - 16]. For the deposition of Epitaxial lateral overgrowth (ELOG) InP layer on Si substrate, HVPE is a very suitable and successful technique as it is a near-equilibrium method and highly SAG [17 - 19]. The dislocations spread along those paths during the growth of the ELOG. It is understood that the dislocations spread parallel to the {111} plane and in the direction of <101>, which is 45° from the normal surface to the substrate. Most of the defects and dislocations occurring in the InP seed layer may be choked during the ELOG [20, 21] if the openings are small enough. Section 2 highlights the algorithms deployed for the analysis of TEM images and Section 3 describes the results and discussion, lastly, the conclusion is in Section 4.

MATERIALS AND METHODS

Experimental Procedure of Pattern Preparation for Epitaxial Lateral Overgrowth (Elog)

Patterns have been made up with InPprecoated on Si (001) substrate seeds by MOVPE. Initially, the substrates have been cleaned by using organic solvents such as acetone, isopropyl alcohol, and distilled (DI) water in an ultrasonic bath for 5min every three times in a cycle. To avoid water contamination on the surface of the substrate, prebake has been carried out in the hot plate at 90° C for

CHAPTER 7

Solar PV Charged Pineapple Leaf Cutter: An Aid for Rural Community

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Abstract: This research work proposes a "Solar PV Charged Pineapple Leaf Cutter" (SPVPLC) for rural community people. The cutting of pineapple leaves is a crucial, time-consuming and laborious task. A portable leaf cutter system comprising a DC motor with blade arrangement is utilized in this work and is powered by the PV panel. A mechanical trolley system is also designed that supports the entire system, and it facilitates movement. The outcome of this research work paves the way for the beneficiary of farmers. A 50w solar panel charging battery was utilized in this work. The battery output drives the motor coupled with the blade arrangement through a simple electronic circuit comprising the voltage regulator and current limiting resistors. The simulation was carried out using Proteus software and the prototype model was also depicted in this work.

Keywords: Green energy, Solar energy, Pineapple leaf, PV panel.

INTRODUCTION

The results of a study generated over the past years exhibit that the rural area constitutes India's 70 percent of the population. Development of rural areas is required for economical progression [1]. Agriculture serves as a link between human demands and the environment's resource base [2]. The decentralized solar photovoltaic energy-based power system is a potential choice for rural electrification [3]. Pineapple leaf fiber (PALF) has excellent mechanical properties, making it feasible for composite fabrication [4, 5]. Biopolymers have recently been the subject of a lot of research, particularly in the packaging business. However, the low mechanical and water barrier qualities of biopolymers make them unsuitable for a variety of applications. Various approaches, including mixing, crosslinking, and nano reinforcement, can be used to address this problem. One of the greatest techniques for improving the properties of bio-

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polymers while preserving their biodegradability is to reinforce thermoplastic starch with naturally generated nanomaterials such as nano cellulose, Nano clay, and Nano chitin [6, 7]. There has been a growing recognition of "energy poverty" as a serious worldwide issue affecting basic human necessities.

Around 1.1 billion people in developing and developed countries don't have access to electricity or don't have it at all. This is harmful to one's health and happiness. Individuals or households who spend more than 10% of their income on energy bills, such as electricity, heating, and cooling, are said to be living in energy poverty. Solar PV systems are said to have a number of advantages, including the ability to offset energy costs, minimize the environmental effect and CO_2 emissions, and contribute to energy independence. Because of their improved performance, lower capital costs, and tighter government energy policies, solar panels in buildings are likely to rise in popularity. PVs with high visibility are also more likely to encourage individuals to commit to renewable energy and a greener future [8]. Pineapple cultivation is common among rubber planters during replanting, particularly in the districts of Kerala. Section 2 focuses on the proposed methodology and results and discussion are highlighted in Section 3, finally a conclusion is drawn in Section 4.

MATERIALS AND METHODS

An embedded system for chopping pineapple leaves is proposed in this research work. The proposed system's flow diagram is shown in Fig. (**1**). The prototype model is proposed in this research work. The charge control circuit of a solar battery charger ensures that a steady voltage is produced. Through diode D1, the solar panel's output is supplied to the LM317 voltage regulator. The voltage regulator's output is sent to the battery. A controlled switch is used to feed the battery's output to the motor. The cutter blades are powered by the mechanical energy of the engine.

Fig. (1). Block diagram of the proposed system.

Since the circuit requires an adjustable voltage regulator, the LM317 variable voltage regulator was used. The LM317 can generate a maximum voltage of 1.25 to 37 volts and a maximum current of 1.5 amps. The voltage drop of an adjustable voltage regulator is typically 2V-2.5V. As a result, the solar panel is chosen to have a higher voltage than the load. This research work uses an 18V/100W solar panel. The solar charger specifications are depicted in Fig. (**2**).

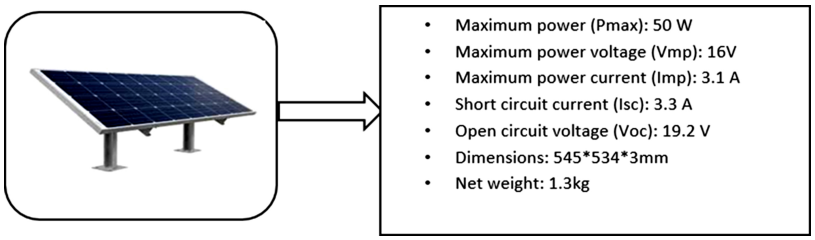

Fig. (2). Specifications of the solar panel.

The lead-acid battery utilized here has 12V/1.3Ah specification. Due to the thermal resistance of the LM317 voltage regulator and the heat sink, here is a limitation in this research work. The power must be limited to 10W to maintain the temperature below 125 degrees Celsius. Internally, the LM317 voltage regulator features a temperature-limiting circuit that shuts it down automatically if it becomes too hot. The heat sink warms up when the battery is charged. When charging at maximum voltage, the heat sink becomes very hot. This heat is caused by extra electricity that is not required during the charging of a battery is shown in Fig. (**4**). The 3D view of the proposed system is depicted in Fig. (**3**).

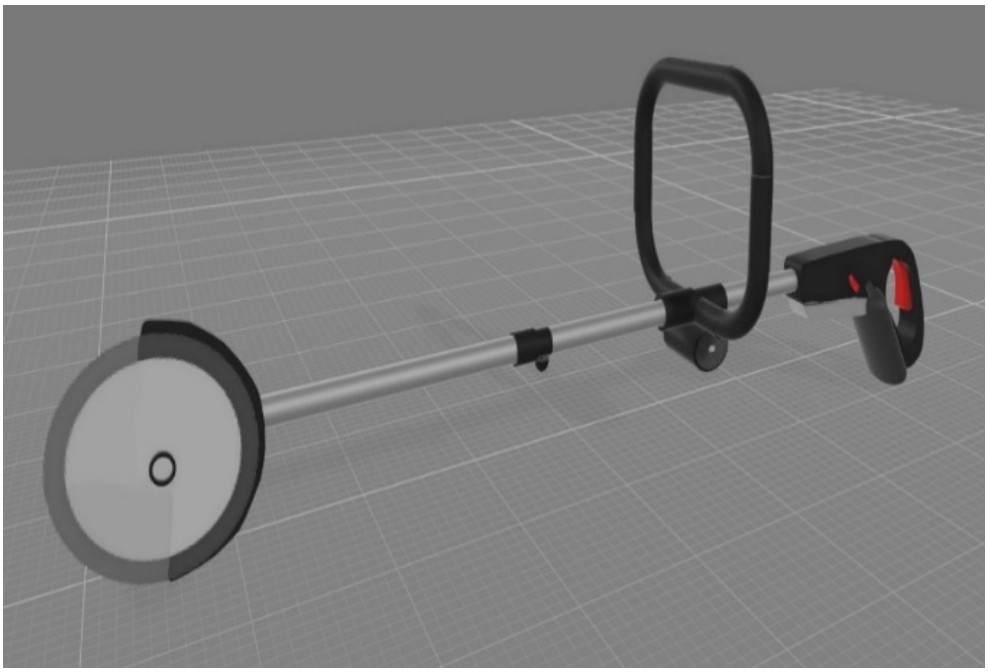

Fig. (3). 3D view of the proposed system generated by 3D paint software.

CHAPTER 8

Analysis of Defects in Electroluminescent Images of Solar Panel using Image Processing Algorithms

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Abstract: Computer-aided algorithms play a vital role in industrial automation; image processing algorithms have a wide variety of applications in the detection of defects in real-time studies. This chapter proposes image processing algorithms for the detection of defects in solar panel electroluminescent images. This research work proposes a median filter for the filtering of images followed by a region of interest extraction by fast fuzzy c-means clustering. The outcome of this work paves the way for researchers working in the processing of solar panel electroluminescent images for defects classification.

Keywords: Direct simulation monte carlo, Fractional brownian motion, Knudsen number, Lattice-boltzmann, Mesoscopic methods, Nanoscale pores, Porous media, Rarefied flow, Reconstruction, Slipflow, Transition regime.

INTRODUCTION

The energy demand is increasing day by day and renewable energy resources are the best choice. Solar energy is utilized by many countries with some challenges such as degradation in cell efficiency and defects in solar panels (Mekhilef, Saidur& Safari, 2011). The International Energy Agency (IEA) survey states that in 2050, the solar panel will be providing 45% of the energy demand in the world. Solar energy is widely used in many applications including domestic and industrial applications (Kabir *et al*., 2018). The Photovoltaic (PV) converter panel's defects can be diagnosed by AC circuits and visual inspection of faults is

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also performed by (Pourhossein & Asadi, 2019). Defective solar panel disposal is a crucial factor, as its recycling process is a tedious technique, and advanced methodologies require recycling process (Xu *et al*., 2018). The microcrack is a defect in solar panels and it degrades the performance of PV panels. Electroluminescence (EL) imaging is utilized for the monitoring of defects and discrete Fourier transform is employed for the processing of images (Dhimish& Holmes, 2019). The deep convolution neural network was employed by Chen *et al*., (2020) for defects' detection in PV panels that has an efficiency of 94% [1 - 5].

The image processing algorithms are utilized in (Dantas *et al*., 2020) for the detection of dust particles on the panels. The accumulation of dust particles in the solar panels minimizes the arrival of sunlight on the panels. The deep learning techniques are found to be proficient in the detection of different types of faults(Al-Mashhadani *et al*., 2021). The edge detection techniques namely, Prewitt and Canny are found to be proficient in the detection of faults in solar panels, and good accuracy was obtained in the detection of micro-cracks (Zhang *et al*., 2021). The optimization-based segmentation gains prominence in the detection of faults and in a study by Lydia, Sindhu & Gugan, (2017), the fractional-order differential particle swarm optimization-based segmentation yielded proficient results. The classical K means clustering along with the elbow method for finding the optimum number of clusters generates efficient results for the detection of faults in thermal images of PV panels (Et-tale by, Boussetta& Benslimane, 2020).

The computer vision algorithms are deployed (Salamanca, Merchán& García, 2017) for the detection of defects in solar panel images. The convolution neural network algorithm along with the data mining classifier is utilized (Hwang, Ku & Chan, 2021) for fault detection in IR images. The fuzzy c means clustering is put forward in (Zhao *et al*., 2018) for the detection of open circuit and short circuit and has an efficiency of 96%. Unmanned aerial vehicles (UAVs) utilizing thermal imaging sensors are put forward (Vega Díaz *et al*., 2020) for fault detection in PV panel images. The defect localization in PV panel images was performed by UAV along with the infrared camera in real-time mode (Puttemans, van Ranst &Goedemé, 2016; Liao & Lu, 2020). The fault in PV panels was diagnosed by the Eigen vector-based technique (Liu *et al*., 2019). Section 2 discusses the localization of the defect in electroluminescent images of PV panels using fast fuzzy c means clustering [6 - 10].

MATERIALS AND METHODS

Data Acquisition

The dataset comprises 2,624 samples and each image is of dimension 300x300. Healthy and defective solar cells with various types are extracted from 44 different solar modules. The images are normalized and any misalignment induced by the camera lens used to capture the electroluminescent images was excluded before solar cell extraction (Buerhop-Lutz *et al*., 2018; Deitsch *et al*., 2019, 2021).

Analysis of Defects in Electroluminescent Solar Panel Images Based on Fast Fuzzy C Means Clustering Algorithm

In picture segmentation, clustering methods are becoming more important. There are two types of clustering: hard clustering (K means algorithm) and soft clustering (FCM). Although traditional FCM is widely used in various applications, this study provides a fast fuzzy c-means clustering method with low computing complexity. The histogram analysis is the emphasis of the quick FCM described in this study work. Dunn created the FCM algorithm, which was later updated by Bezdek. There are numerous variations in the standard FCM algorithm. The input photos were pre-processed with a median filter before clustering.

The objective function of classical FCM is expressed as follows:

$$O_{FCM} = \sum_{i=1}^{N} \sum_{j=1}^{c} u_{ij}^{f} D_{ij}^{2} \quad \textbf{(1)}$$

Where f represents the fuzzy index factor (f>1), Dij is the distance metric, C_j is the cluster centroid and u_{ij} represents the membership matrix.

The distance metric is represented in equation 2,

$$D_{ij} = \left\| x_i - C_j \right\|^2 \quad \textbf{(2)}$$

The membership function in the above equation should satisfy the below condition.

$$\sum_{j=1}^{C} u_{ij} = 1, u_{ij} \epsilon [0,1] \quad \textbf{(3)}$$

Clustering is the methodology of grouping pixels into classes with similar characteristics. The membership function decides the grouping of the pixels into a

CHAPTER 9

An Efficient Missing Data Prediction Technique using Recursive Reliability-Based Imputation for Collaborative Filtering Recommender System

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Abstract: Collaborative filtering recommender system is utilized as a significant method to suggest products to users depending on their preferences. It is quite complicated when the user preference and rating data is sparse. Missing value occurs when there are no stored values for the specified dataset. Typical missing data are of three categories such as (i) Missing completely at random, (ii) Missing at random, and (iii) Missing not at random. The missing values in the dataset affect the accuracy and cause deprived prediction outcomes. In order to alleviate this issue, the data imputation method is exploited. Imputation is the process of reinstating the missing value with a substitute to preserve the data in a dataset. It involves multiple approaches to evaluate the missing value. In this paper, we reviewed the progression of various imputation techniques and their limitations. Furthermore, we endeavored k-recursive reliability-based imputation (k-RRI) to resolve the boundaries faced in existing approaches. Experimental results evince that the studied methodology appreciably improves the prediction accuracy of the recommendation system.

Keywords: Collaborative filtering, Missing value, Missing value imputation, Prediction, Recommen dation system, Recursive imputation, Sparse data.

INTRODUCTION

As a result of the massive volume of online information available, there arises the prerequisite for information filtering techniques grounded on user curiosity and item combinations which are offered by the recommendation systems [1]. The volume of online information available in recent decades has risen dramatically.

Owing to this speedy progress, the problem of filtering the information by the recommender system based on the individual user's interest becomes a critical

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issue for the forth-coming customers [2]. A collaborative filtering technique is considered a preferred solution to predict user interest by their explicit data (ratings and reviews) [3]. A dataset with sparse data produces poor prediction which leads to lack of recommendation accuracy [4]. A missing value is a common issue that pacts with data and causes data analysis and biased results issues [5]. Missing data can be classified into three categories as follows: Missing Completely at Random (MCAR) – There is no correlation between missing data with observed and unobserved data [6]. In Missing at Random (MAR) – information is missing independently with observed data but not with unobserved data. In Missing not at Random (MNAR) – the information is missing independently from unobserved data itself [6]. Missing data issues can be resolved by two factors including the deletion of instances and missing data imputation. The deletion method or data removal method is performed eliminating the entire record that confines one or more missing data. It presents un-stable outcomes by deducing statistically analyzed samples [7]. To overcome this problem, data imputation is processed in which the statistical value is manipulated to replace the missing data in the record [8]. There is several data imputation techniques that are utilized by the researchers. Rest of the paper is organized as follows: Section II demonstrates several works taken in the field. Section III describes the variety of data imputation techniques. Section IV portrays the proposed imputation methodology. Performance evaluation and experimental results are demonstrated in Section V and the paper is concluded in Section VI.

RELATED WORK

Caio Ribero *et al.* studied the data-driven missing value imputation approach and tested that approach in 10 various longitudinal datasets. The proposed approach presents feature-wise ranking of a set of missing value imputation techniques and the author estimated the proposed method in two sets of experiments [12]. Dieter William Joenssen *et al.* studied the hot deck missing data imputation method and simulation showed notable variations in donor usage limitations. The authors studied that the limitations of donor usage are better in some situations and unlimited usage of donors is better than in some other situations according to the circumstances [11]. Rouhia M. Sallam *et al.* proposed an enhanced collaborative filtering method-based recommender system with two approaches: Item-based collaborative filtering (KNN) and Singular Value Decomposition based Collaborative Filtering. The proposed methods were evaluated by RMSE and MAE. The proposed memory-based and model-based methods achieved RMSE and MAE values of 1.1969, 0.922 and 1.0187, 0.8077, respectively [5].

DATA IMPUTATION TECHNIQUES

Mean Substitution Method

Mean substitution is a simple imputation technique that consists of replacing each missing value with the mean of the known values of its respective variable [9]. Formally, if $Yi,_j \in Y_{miss}$, its imputed value is calculated as:

$$\widetilde{Y}_{i,j} = \frac{\sum_{k=1}^{n} R_{k,j}.\, Y_{k,j}}{\sum_{k=1}^{n} R_{k,j}} \quad \textbf{(1)}$$

Where $R_{k,j}$ are the respective values of the variable in the matrix of missingness R. One of the most important advantages of this method is the low computational cost because it's only necessary to compute each variable's mean [10].

It reduces the variability in the data because of the use of the mean value, as it's repeated several times in each variable. It also weakens the covariance and correlation statistics in the data because this method ignores the relationships between variables.

Hot-deck imputation Method

Hot deck imputation methods are a group of imputation techniques that aim to infer the unknown values of the samples, or respodents of the data using information of the dataset from the most similar respondants to the one that's being inferred. Given a specific sample that contains missing values, known as the recipient, the main idea of this group of methods is to select one sample, or a group of samples, within the dataset, which will be used to infer the recipient's missing values. Those samples are known as donors and usually, are selected in terms of similarity with the recipient, *i.e.,* in terms of distance. Each method proposes a specific methodology in selecting the recipient's donors and in inferring the unknowns [11]. Regarding the selection of donors, some of the methodologies that are being used include the use of distance functions or clustering methods, such as the k-Nearest Neighbors method, also known as k-NN, or k-Means method. Deterministic hot-deck method and random hot-deck method are the two types of hot-deck imputation methods.

Predictive Mean Matching Method

The Predictive Mean Matching method, also denoted as PMM method, is a random hot-deck method that consists of retrieving actual dataset values from the nearest observed values . In PMM, the recipient's nearest values in a specific

CHAPTER 10

Diagnose Breast Cancer on Mammography Using Self Supervised Decision Tree Algorithm

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Abstract: Women in India are diagnosed with breast cancer at a far higher rate than men. Breast cancer is the most common kind of cancer in women, accounting for more than half of all cancer cases. It is possible to minimize the mortality rate of breast cancer *via* early and precise detection. By utilizing mammography, early breast cancer detection, and assessment is currently possible. There is still a lot of controversy about mammography mass classifications, yet they are crucial for helping radiologists make accurate diagnoses. Using convolutional neural networks (CNNs), it has become possible to classify and segment images in a meaningful way. Unlabelled picture data, on the other hand, presents challenges, and while manual labelling is inefficient, pre-trained CNNs also perform poorly on genuine medical images. In this research, we propose the use of Transformer-Based Networks (TBN) in computer vision. Transformer-based vision models have been found to outperform convolutional models in previous studies as well. A self-supervised learning (SSL) technique called the Decision Tree Algorithm (DTA) is proposed in this study for processing mammography images for diagnostic purposes. The Decision Tree Algorithm works effectively with categorical and continuous dependent variables. In this study, the population was divided into two or more homogeneous groups based on the most important traits and independent factors. According to this article, a previously trained model can be enhanced by transitioning from making predictions on uniformly tiled regions to making predictions on the complete image. There were two studies that utilized the Kaggle archive breast cancer sample pool, the second of which used 286 samples. In the initial experiment, the decision tree was 100 percent accurate, but in the follow-up investigation, it was only 97.9 percent accurate.

Keywords: Convolution neural network (CNN), Decision Tree Algorithm (DTA), Self supervised learning (SSL), Transformer based network (TBN).

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INTRODUCTION

Cancer develops as a result of unchecked cell proliferation in the body. Cancers of the breast and skin claim the lives of more women than any other among those who live in the United States. Cancer fatalities among women and Hispanic women have decreased over time, but it is still the second most common cause of cancer deaths among women in the United States. Breast cancer is not contagious, as far as we know. Cervical cancer has been connected to HPV infection, but no viral or bacterial illness has been associated with breast cancer. Nearly half of all breast cancer cases are the result of women who have no additional risk factors for the illness other than their gender (female) and age (over 40 years old). Women who smoke and those who use postmenopausal hormone therapy are all at risk for breast cancer. Being overweight or obesity, a family history of illness, radiation exposure, and a history of pregnancy are all additional risk factors for breast cancer [1 - 5]. Breast cancer kills an estimated 685,000 people throughout the world each year, according to the World Health Organization. At this rate, a quarter of the 7.8 million women diagnosed with breast cancer in the previous five years will be alive in 2020. This form of cancer claims more DALYs (disability-adjusted life years) than any other. Worldwide, breast cancer strikes women of all ages after puberty and the incidence increases with age. Breast cancer death rates did not change much from the 1930s to the 1970s. It wasn't until the 1980s that early detection programs and a wide range of treatment choices were used successfully to eradicate invasive illnesses [3]. To describe an X-ray image of the breast, “mammograms” are commonly used. Mammography is a screening tool used by doctors to look for early signs of breast cancer. In order to catch breast cancer, early, doctors rely heavily on routine mammograms. By using mammography, breast density can be determined. The results of a mammogram may also reveal whether your breasts are dense or not. More than 90% of breast cancer patients in high-income countries survive for at least five years following diagnosis, compared to 66% in India and 40% in South Africa. Countries with limited resources and access to standard technologies should adopt early identification and treatment in high-income countries. The WHO has previously included the vast majority of breast cancer drugs on its Essential Medicines List (EML). Breast cancer could be significantly improved worldwide if we follow current best practices [6 - 9]. Age-standardized mortality from breast cancer decreased by 40% in high-income countries from the 1980s to 2020. In countries where the disease has been curtailed, the annual mortality rate from breast cancer has dropped by 2-4 percent. A yearly mortality rate reduction of 2.5% could avert 2.5 million breast cancer deaths between 2020 and 2040 [10]. Mammography is the most effective means of detecting breast cancer in the early stages of its development. A mammogram is a type of X-ray that focuses on the breast for examination. Breast cancer can be detected by a doctor up to two years

before a patient feels a lump. Women between the ages of 40 and 45 should get a mammogram every year, according to the American Cancer Society's guidelines. Mammograms and MRIs should begin for high-risk women at the age of 30 [11 - 17].

List of Breast Cancer Risk Factors

Many experts believe that the following are risk factors for breast cancer. In contrast, the vast majority of breast cancer cases cannot be related to a single cause. Your doctor should know about any special risks you face.

Age: The danger of breast cancer rising with a woman's age is well documented. Breast cancer affects over 80% of women over the age of 50.

Personal Breast Cancer History: A woman's chances of getting breast cancer in the other breast rise if she already has it in the first.

Cancer in the Family: A woman's risk of breast cancer rises if her mother, sister, or daughter is diagnosed at a young age with the disease (before 40). It's possible that you'll be more susceptible to breast cancer if you have other relatives who have the disease.

Genetic Mutation: Carrying these genes increases the woman's lifetime chance of getting breast cancer by an order of magnitude. There may be other genetic variants that affect the risk of breast cancer.

Childbearing and Menstruation History: When a woman has her first child, her chance of breast cancer increases.

- Young women who begin menstruation are likewise more vulnerable (before 12).
- Menopausal women who are in their forties or fifties (after age 55), women who have never had a child.

If you're interested in how the brain works and how it may be studied, deep learning can be a good place to start. As a subset of artificial intelligence's machine learning, “deep learning” may be applied (AI). The opposite is true when the dataset is large enough for deep learning to be effective. From any complex patterns in the data, it can draw relevant inferences. Even unstructured data, such as a text corpus or social media activities, can be processed by deep learning since it is so well organized. Reinforcement learning, supervised (labeled data), and unsupervised (unlabeled data) deep learning solutions are available in computer vision (unlabeled data) [18, 19]. In most cases, however, the usefulness of the data

CHAPTER 11

Study of groundwater contamination and its Impact: a Review

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Abstract: The groundwater cycle is one of the most vital elements of life. This is the sole cardinal provenance of potable agricultural and industrial water. Underground water may be of good quality for cooking and drinking (potable) or it can be medium quality (domestic and industrial) or have another inappropriate quality for any use due to various contaminations. Heavy metals, minerals, and other factors can be present in the water. Septic systems can be contaminated by natural and artificial sources. There are many artificial polluting sources, such as chemicals, fertilizers, and mining activities, and there are also natural ones, such as seawater intrusion, geothermal brine seepage, and rock water leaching. Health hazards are associated with contaminated water. Groundwater contamination can lead to degrading surface water systems, loss of water supply, poor quality, or even no, and drinking water. It is well known that water is an essential part of life, and all animals, including humans, need water in order to persist. Throughout this paper, we have examined the health effects, environmental impacts, and prevention of groundwater contamination.

Keywords: Aquifers, Bioaccumulation, Eutrophication, Geothermal brine infiltration, Groundwater contamination.

INTRODUCTION

Groundwater contamination is a global issue due to its impact on human and ecological health. Groundwater is the water found under the surface in rock and soil pores, as well as in fractures within rock formations. The scarcity of surface water and precipitation makes groundwater an important source of fresh water in arid and semi-arid regions.

The average global population drinks about one-third of the groundwater. Geomorphic formations and human activities influence groundwater composition,

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but urbanization, industrialization, agricultural chemicals, and population pressure are serious threats. Eventually, groundwater contamination can affect human health and the environment negatively. When petroleum products, road salts, and chemicals enter the water beneath the Earth's surface, they cause the water to become contaminated, unfit for human consumption, and potentially unsafe for environmental use [1 - 5]. Pesticides and fertilisers, road salt, and harmful compounds from mining sites can all pollute groundwater. Groundwater may potentially be contaminated by motor oil. In addition to mining and open dumping of both home and industrial trash, there are other natural sources that can be found as shown in Fig. (**1**).

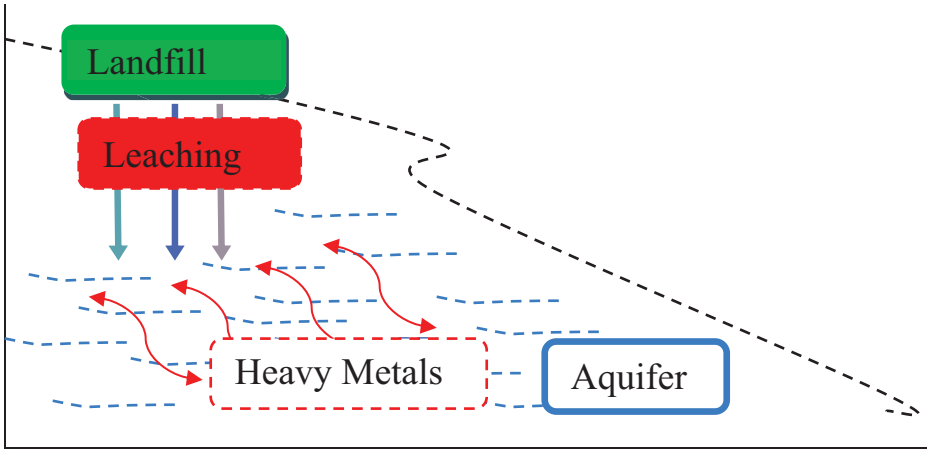

Fig. (1). Groundwater contamination from a landfill source.

Chemical pollution has been a recurring theme in groundwater research for more than three decades. Groundwater contamination differs from surface water contamination in that it is undetectable, and recovering the resources is currently difficult. There are various contaminants present in groundwater, the majority of which are colourless and odourless and result in chronic and difficult-to-detect effects on human health. Due to the geological strata in which groundwater is located, it takes a long time for contaminated groundwater to be naturally purified, so remediating the water can be challenging. Despite the fact that natural wastewater purification can take decades or even centuries, groundwater restoration can take decades or even centuries even when the water supply is completely discontinued. Chemical, biological, and radioactive contaminants are among the increasing contaminants detected in groundwater. They can all be grouped into three general categories: contaminants with natural origin, contaminants with chemical composition, and contaminants with radioactive origin.

- Chemical Contaminants –Cations like Ca^{2+} and Mg^{2+} and anions like F, So42 and Cl are included which are causing problems for human population and the environment. Toxic metals and metalloids do so through their toxic properties. Metalloids including selenium and arsenic occur in groundwater as well as chemical elements like zinc, cadmium, zinc, mercury, and lead. Exposure to these elements in high concentrations can cause acute or long-term effects including fatalities. Water is contaminated by a high concentration of organic contaminants, several of which are human carcinogens or endocrine disruptors. More than 200 organic pollutants have been found in groundwater so far, and that figure is certain to rise.
- Biological Contaminants – This category includes algae and microbes, including bacteria and viruses, and more. Species of bacteria and viruses found in animal and human faeces amount to more than 400 types and more than 100 kinds, respectively. Many illnesses can be caused by consuming contaminated water, such as diarrhoea, epidemic, and enteric fever. In cases of eutrophication like those of lakes and reservoirs, algal contamination is quite common, but in groundwater, algae are not commonly found at high biomass levels.
- Radioactive Contaminants – The presence of radionuclides in groundwater may be the result of geological processes; however, they may also be the result of nuclear power plants, the testing of nuclear weapons, or the disposal of medical radioisotopes. On the other hand, the presence of radioactive contaminants in groundwater at concentrations high enough to endanger human health is an extremely uncommon occurrence [6 - 7].

ANTHROPOGENIC AND NATURAL SOURCES ARE BOTH POSSIBLE SOURCES OF CONTAMINANTS

Some of the natural sources of groundwater contamination include brackish water, water of poor quality, and mineral deposits. Of these contaminants, arsenic and fluoride are the most dangerous due to the fact that they are found naturally in rocks and are then released into groundwater as the rocks weather. In some cases, the contamination of natal sources can be traced back to irresponsible management of mineral resources or inappropriate irrigation practices. Examples of this include acid mine drainage, which happens when mineral resources are mined, and leaching, which happens when hazardous chemicals are exposed to an excessive amount of heat and moisture, as shown in Fig. (**2**).

CHAPTER 12

Biofertilizers: A Non-polluting Technology for Environmental and Agriculture Sustainability

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Abstract: Improvement of agricultural practices for enhanced productivity has been the driving factor for Green Revolution. Its introduction has led to modernization in farming with the use of high yield variety seeds, chemical fertilizers, pesticides, *etc.* Excessive usage of these chemicals, due to urbanization, has led to the deterioration of soil quality, depletion of essential nutrients and microbes present naturally in the soil, and cause water pollution. The use of fertilizers has been found to be very effective in achieving food production goals, but the widespread use of inorganic fertilizers seems to have a significant impact on soil physicochemical parameters, as this approach causes the exhaustion of essential minerals in the soil, which depletes soil fertility. As a result, adopting an alternative method that will act as a replacement and treatment has become critical in order to overcome this difficulty. The introduction of biofertilizers could be a boon for the agriculture industry as they are cost-effective, improving soil health by replenishing the soil with nutrients and enhancing the growth of plant growth promoting microorganisms. Plants are also protected from brininess and aridity by biofertilizers. Biofertilizers are also environment-friendly and do not cause any hazards. Biofertilizers, when used as a supplement, have been shown to protect plants by releasing antibiotics that can fight against various plant infections.

Keywords: Agriculture, Biofertilizers, Eco friendly, Hazards, Microorganisms.

INTRODUCTION

Agriculture and its products have been the one and only factor of sustenance for us humans since evolution. It is one of the most important factors that contribute to the economy of a country.

India is one of those countries whose economy thrives on agriculture. It is the most commonly practiced occupation in India. Due to the increasing population,

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the high demand for food and other products has put pressure on the agriculture industry. Since production using traditional methods is limited only to a minimum number of families, farmers have sought out advanced farming techniques rather than traditional methods. For high-yield production, farmers have turned to chemical fertilizers, the use of hormones, and other synthetic minerals whose excessive usage has had negative effects on the soil health, plants and even on the people utilising it. Scientists have come up with environment-friendly solutions which would enhance productivity without harming the surroundings. The use of biofertilizers instead of chemical fertilizers has reduced pollution and other hazards such as biomagnification. The goal of employing biofertilizers is to boost the population of these microorganisms while also speeding up the microbial activities that aid in the supply of nutrients that are easily digested by plants. Microorganisms are recovered from air, soil, water, or rhizosphere and concentrated for field usage [1 - 5]. Microorganisms start producing agricultural metabolites in response to specific environmental circumstances. Plants could use them to maintain a variety of metabolic processes.

BIOFERTILIZERS

Biofertilizers contain microbes or secondary metabolites produced by microbes that enhance the growth of the plant and improve the health of the soil. These colonize the rhizosphere and help plants in their nutrient uptake by making the nutrients easily available to their roots. They are also involved in maintaining symbiotic relations in the soil as shown in Fig. (**1**). Therefore, unlike chemical fertilizers, biofertilizers do not degrade the environment and cause pollution [6 - 9].

Role of biofertilizers in agriculture:

1. Increase soil fertility by helping in the fixation of atmospheric nitrogen.

2. Produce plant growth substances, hormones, and secondary metabolites.

3. Help in the mineralization of soil and in the decomposition of nutrients.

4. Can be used as an alternative source for chemical fertilizers as it is cost-effective.

5. For the remediation of damaged soils.

6. Used to replenish minerals and bacteria that aren't always present in the soil or are in small amounts.

7. Aid in agricultural residue management as well as nutrient overspill or leaching.

8. The use of microbial inoculants will help to reduce the dependency on chemical fertilisers and improve the efficiency of the fertilisers.

9. Auxins, cytokinins, biotins, and vitamins are hormones that are necessary for plant growth and are released by biofertilizers.

10. Produce antibiotics that can prevent a variety of plant infections.

There are different types of biofertilizers based on the microbes used such as:

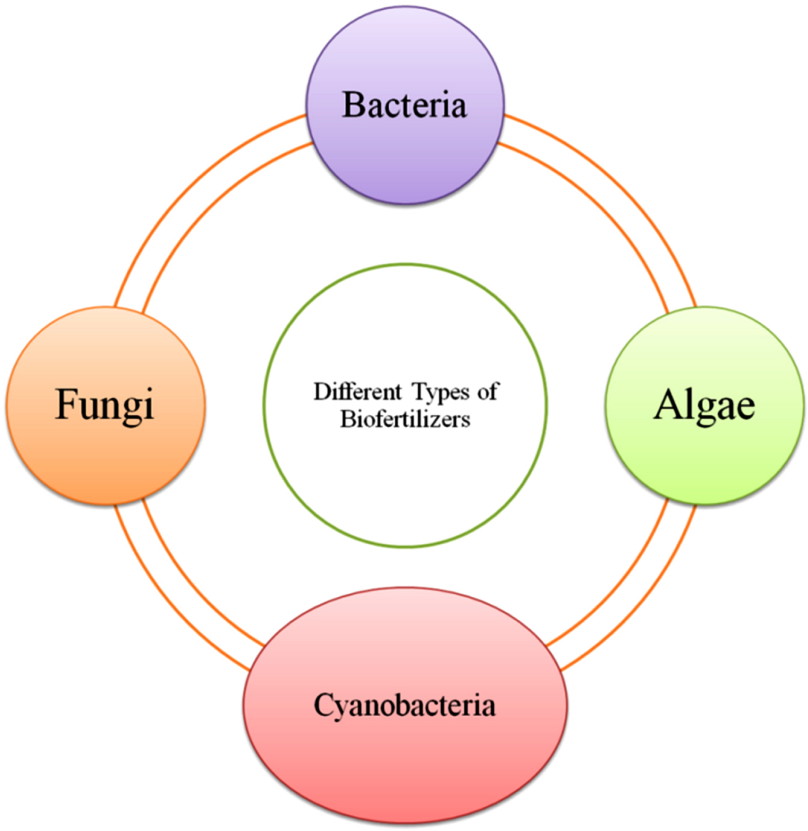

Fig. (1). Different types of Biofertilizers.

- Bacteria- Rhizobium, Azotobacter, Azospirillum
- Fungi- Arbuscular mycorrhiza
- Cyanobacteria- blue green algae
- Algae

CHAPTER 13

Organic Farming: An Ecofriendly Approach for Sustainable Development and Agriculture

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Abstract: India is an agricultural country. 75% of the population is directly dependent on agriculture for their living. Modern farming uses enormous amounts of pesticides and chemical fertilizers which disrupt soil fertility and cause water hardness and genetic variation in plants. In this paper, we are going to focus on organic farming and its benefits. Quality crops are produced through organic farming without influencing the health of the soil. Therefore, organic farming provides macronutrients and micronutrients to the plants and improves the different characteristics of the soil. Organic agriculture helps the farmers get synced with climate change. The change of climate makes the growth condition more difficult. To overcome such a situation, the earth holds and removes the required greenhouse gases in the soil. Eco-agriculture has a higher ability to reduce environmental change, largely because it's higher in lowering the emission of gases like CH_4, NO_2, and CO. The confirmation of cultivation practices as expected in natural horticulture gives an assurance of natural standards and guidelines. This additionally permits the upheld reception of new and successful practices pointed to working on the relief of environmental change. Besides, natural agribusiness is profoundly versatile to environmental change, compared to regular farming. In any case, a more noteworthy acknowledgment of the capability of natural farming for alleviating environmental change is required. Future techniques for working on the adequacy of natural farming in relieving environmental change are introduced and talked about.

Keywords: Biological pest control, Crop rotation, Green manure, Integrated organic farming, Polyculture, Pure organic farming, National Program for Organic Production(NPOP), Organic farming, Soil management, Weed management.

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INTRODUCTION

Organic farming is an agricultural process that uses more natural resources or alternatives instead of chemical fertilizers.

Pest control uses only organic manure like plant or animal wastes. It uses cow dung or green manures, crop residues, *etc.* Organic farming is a production system of crops that avoids the use of synthetic and chemical inputs like fertilizers, pesticides, and growth regulators. So the production technique of crops or yields without using these chemicals is called organic farming. In accordance with the USDA study team's definition, "Organic farming is basically a production framework which completely forbears from the use of substances which affect the soil health (the main concern should not be to reduce nutrient content). It mainly depends on animal manures, crop residues, organic debris, mineral grade, rock preservatives, plant protection, and crop rotation. In other words, it enhances AGRO-ECOSYSTEM health. It repairs, improves, and maintains the ecological balance. Organic farming is a sort of agriculture where crops are grown without the use of chemical pesticides or fertilisers, and instead rely on natural processes. It also prioritizes animal welfare in livestock production by limiting the utilization of hormones and antibiotics. Biodiversity, biological cycles, and soil biological life are all improved by organic farming. The notion of organic farming dates back to early 1900s, when British botanists F.H King, Sir Albert Howard, and Rudolf Steiner popularized it [1 - 5]. Crop rotation, biological insecticides, and animal manure, they reasoned, would result in a comparably better agricultural system. Masanobu Fukuoka, a Japanese microbiologist, abandoned his position as a research scientist in 1940 and dedicated the rest of his life to the cause. There are two types - pure and integrated organic farming. The former uses organic fertilizers obtained from natural sources such as bone, blood meal, *etc.* Instead of inorganic chemicals that can harm the soil quality, crops and people who consume it. Integrated organic farming integrates pest and nutrient management to polish off ecological and economic requirements and importunity. Organic farming is practiced all over the world using various methods and techniques including:

- **Rotation of crops:**

Crop rotation is a method of not cultivating the same crops on the same land every year. Instead, to keep the soil healthy, different crops are cultivated in rotation.

- **Manure (green):**

Green manures are crops that are uprooted and turned into the soil while still green, with the goal of providing organic matter and nutrients to the soil.

- **Compost:**

Compost is made up of organic materials that have been recycled, as well as decomposing plants and food waste. It has a high nutritional content, which improves soil quality and crop productivity.

- **Polyculture:**

Polyculture is an agricultural method in which a variety of crops are grown in the same area of land at the same time. It increases yields, improves soil quality, protects against low crops, and suppresses weeds.

- **Management of the soil:**

After crop cultivation, the soil loses its nutrients. Soil management is critical for replenishing lost nutrients. Bacteria are employed in organic farming to boost nutrient levels and make the soil more fruitful.

- **Biological pest management:**

Pest population growth and expansion must be regulated in order to maintain soil quality and safeguard crops. As a result, organic farmers can use other creatures that rely on parasitism, predation, or other natural methods to biologically control pests.

- **Controlling weeds:**

Weeds are undesirable plants that suck nutrients from the soil that crops require. Organic farming primarily employs two techniques: mulching and mowing, with the goal of lowering rather than eliminating weed development. Weed development is inhibited by mulching, which uses plant remains or plastic films on the soil surface to prevent weed growth. Mowing is a technique for removing weeds and limiting their development.

- **Livestock:**

The usage of domestic animals helps to ensure the long-term viability of agricultural land.

Reports suggest that energy consumption can be minimized by 30.7% per unit of land and the fuel for transportation can be reduced by using internal farm inputs.

CHAPTER 14

Synthesis of Starch from Carbon Dioxide Leads to Sustainable Bio Based Society

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Abstract: Carbon dioxide is one of the unfavorable gases which will be released into the atmosphere in different ways such as the burning of fossil fuel, factory emissions, vehicle smoke, *etc*. Carbon dioxide is a greenhouse gas that will lead to global warming, climatic changes, and acid rain. Photosynthesis is the production of starch and oxygen with the help of carbon dioxide and water under sunlight in the chloroplast. It is a natural phenomenon carried out by plants. Moreover, this is one great activity conducted by plants, because they absorb harmful gases and release oxygen, which is very helpful for the process of living for all organisms. A team of Chinese scientists found a way to synthesize starch artificially in 2021, which is a great achievement in the field of science. Therefore, here they collected carbon dioxide gas from the atmosphere in order to conduct these reactions. This is a very effective method where the useless, toxic, and harmful gases like carbon dioxide are converted finally into a useful product. Therefore, this can promote the formation of a sustainable bio-based society.

Keywords: Starch, Carbon dioxide, Photosynthesis, Renewable Energy, Oxygen.

INTRODUCTION

Photosynthesis is a naturally occurring process where carbon dioxide and water are taken by plants as raw materials in the presence of sunlight to convert them into glucose and oxygen.

This occurs in the chloroplast.

$$\longrightarrow 6CO_2 + 6H_2O \longrightarrow C_6H_{12}O_6 + 6O_2 \quad \textbf{(1)}$$

Photosynthesis occurs mainly in 2 reactions,

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1. Light reaction
2. Dark reaction

NADPH and ATP are produced in light reactions, and the ATP and NADPH produced from the light reactions are used to reduce carbon dioxide in dark reactions. NADPH is used as a hydrogen carrier whereas the energy will be stored as ATP. During the light reaction, one chlorophyll pigment molecule will absorb one photon and it will release one electron. The electron which was released is taken by pheophytin and passed to quinine molecules. The chlorophyll molecule will regain the electron which is lost by the process called photolysis, where water is broken down to form oxygen and H^+. There are two types of photo systems, namely,

1. PSI
2. PSII

Photosynthesis actually begins from PSII where light energy will be absorbed by the chlorophyll and the electrons will absorb the electrons and move to PSI *via* an electron transport chain. Due to the H^+ gradient, H^+ moves into the thylakoid membrane. Therefore, the concentration inside the thylakoid membrane will increase. PSI absorbs additional light energy and the electrons in the PSI will get energized and escape from PSI and move down from the 2nd electron transport chain. Then, the escaped electrons and H+ are used to reduce NADP to NADPH. Here oxygen is released as a by-product [1 - 5].

DARK REACTION

Here, the process will convert carbon dioxide into carbohydrates. This occurs within the stoma.

Calvin cycle is divided into 3 major phases, namely,

1. Carbon dioxide fixation
2. Carbon dioxide reduction
3. Regeneration of RuBP.

Carbon Dioxide Fixation

6 NADPH molecules and 6 ATP molecules are used in this step. Here, a carbon dioxide molecule is captured by attaching to RuBP with the help of the Rubisco enzyme and forms 2 molecules of phosphor glycerate.

Carbon Dioxide Reduction

Here 6 molecules of NADPH and 6 molecules of ATP from light reactions are used. Here, two molecules of 3PG will convert into G3P where ATP is converted into ADP and 6 NADPH is converted into NADP+.

Regeneration of RuBP

Here, a net gain of 1G3P will be converted into glucose and other molecules, whereas most of the G3P will gain 3 ATP molecules from light reactions to regenerate RuBP. In order to form a glucose molecule, the cycle has to form at least 6 times. Therefore, this whole process is carried out inside a bioreactor in a different pathway called ASAP for producing starch artificially from carbon dioxide. Starch is the main product produced here. It is a storage homo polysaccharide, where the repeating monomer is alpha-D glucose. Moreover, it is a plant storage homo polysaccharide. There are 2 structures of starch,

1. Amylase: It is a water-soluble molecule that has alpha (1-4) glycosidic bonds where the branches are unbranched. 15-20% of amylase is present in starch.
2. Amyl pectin: It has both alpha (1-4) glycosidic bonds as well as alpha (1-6) glycosidic bonds. They are water-insoluble. 80-85% of amyl pectin is present in starch.

METHODOLOGY

In order to simplify the process, the Chinese Academy of Science has simplified this into 4 different sections.

1. C1 module
2. C3 module
3. C6 module
4. Cn module

All above reactions are chemo-enzymatic reactions. All reactions take place under a bioreactor. Accordingly, the water is photolysis inside the bioreactor in order to form hydrogen and oxygen gas [6, 7].

$$H_2O \longrightarrow H_2 + O_2 \quad \textbf{(2)}$$

CHAPTER 15

Remediation Using Organism: A propitious Approach for Contaminated Soil

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Abstract: Soil contamination, otherwise called soil pollution in simpler terms, is caused due to the presence of anthropogenic substances, majorly chemicals in the natural soil habitat. It is frequently caused by contaminants from industrial and agricultural activities or because of improper disposal of waste. Heavy metals like lead and arsenic; chemicals like pesticides, fungicides, insecticides and petroleum hydrocarbons are the most common chemicals involved in soil pollution. Soil pollution is now a global concern due to its impact on the environment and majorly human health. Industrialization, mining, and overuse of chemical fertilizers are the major causes of contamination of soil and pose a significant threat to the environment. One way to restore soil to its original state is soil remediation. It is the process of cleaning and reviving the soil with external help. It is the process of removing toxicants from the environment to protect the health of both the population and the environment. There are three major soil remediation techniques that are generally used - soil washing, bioremediation, and thermal desorption. Bioremediation is a method of using living organisms in remediating the soil that is, removing contaminants, pollutants, and toxins from the soil. Bioremediation includes the remediation of the soil by bacteria, yeasts, or fungi called mycoremediation. Remediation can also be brought about by mycorrhizal fungi which are associations of fungal species with roots of higher plants. Vermiremediation is the remediation of soil with the help of earthworms.

Keywords: Anthropogenic, Bioremediation, Mycoremediation, Porous media soil contamination, Soil Washing, Soil remediation, Thermal Desorption, Vermiremediation.

INTRODUCTION

For ages, humans have overexploited all natural resources for their own comfort. Pollution has become a major question for the survival of species. Soil is the major source of food production and also the backbone of many countries' econo-

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my. Rapid growth in industrialization, mining, and the overuse of chemical fertilizers has led soil pollution to become a global issue. Because of industrialization, heavy metals have become a major threat to the environment. All around the world, there are 5 million sites of soil contaminated by heavy metals or metalloids with concentrations above the regularity levels. Soil loses its fertility and directly affects agriculture; it decreases the production of food and its quality. The release of heavy metals with no proper treatment is very hazardous to the lives of people and their health; this can lead to biomagnifications and can also get accumulated in the food chain. Cadmium, mercury, chromium, and arsenic are some heavy metals belonging to metals and metalloids including transition metals, lanthanides, and actinides possessing biological toxicity [1 - 5]. Therefore, it is important to remediate soil for better food productivity and environmental health safety. Transporting the polluted soil for disposal at landfills, excavating the soil physically, oxidation of soil by means of chemicals, and use of soil stabilizers are various methods to remediate soil. Metal bioremediation through microbes is a low-cost, eco-friendly, and highly efficient method as shown in Fig. (**1**).

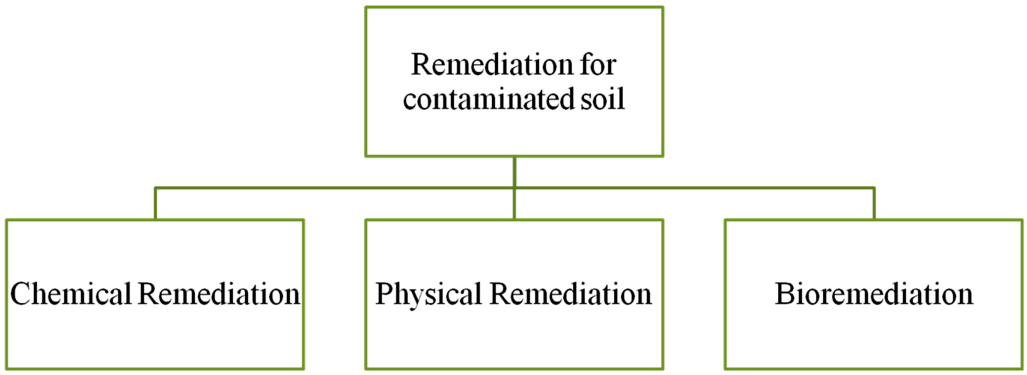

Fig. (1). Role of Organisms in Soil Remediation.

Bioremediation, an extended application of biodegradation, refers to the process of soil remediation with the help of microorganisms. Soil remediation is the restoration of soil by removing, detoxifying, and degrading soil pollutants; when these activities are undertaken by microorganisms, it is known as bioremediation as shown in Fig. (**2**).

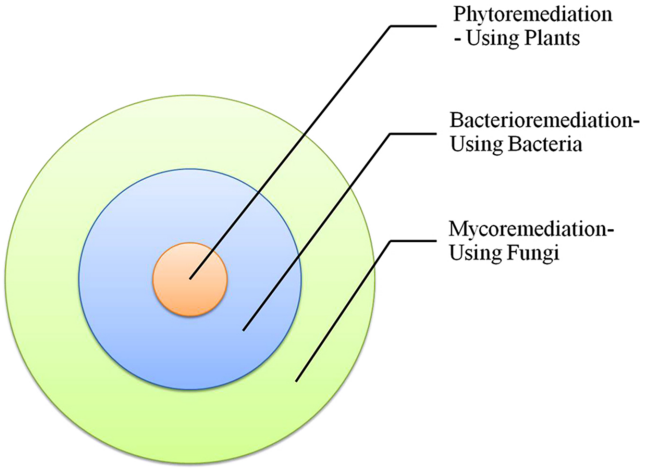

Fig. (2). Bioremediation mechanism using different Organisms.

The characteristics with the help of which microbes are capable of altering the chemical and physical properties of the pollutants may be inherent or genetically engineered [6 - 10]. Prominent changes induced in contaminants by microbes include change or breakdown in structure *via* redox reactions, pH changes, adsorption, *etc*. The pollutants are treated as a substrate for the growth of organisms, and use the energy produced in the process of degradation to fuel their metabolism. *Via* bioremediation, the contaminants are converted into less dangerous end products like H_2O and CO_2. Microorganisms change xenobiotics and inorganic contaminants, partially or completely, into compounds that have decreased solubility, toxicity, and mobility.

There are two different types of bio-remediation:

- *In-situ* - this involves on-the-spot remediation at the site of pollution either by preexisting microorganisms or newly introduced microorganisms. Nutrients required might be added to the soil in addition.
- *Ex-situ* - bioremediation is carried out in controlled lab conditions or places exclusively designed for the purpose.

Microbial remediation of soil is prominently used for the degradation of hydrocarbons and heavy metals.

MICROBIAL DEGRADATION OF HYDROCARBONS

Oil spills, accidental or intentional, are troublesome as it is extremely difficult to remove the oil from the soil. The degradation of these oils depends on the nature

CHAPTER 16

Waste Management Techniques for Sustainable Development: A Review

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Abstract: Any substance that is not in use or is unwanted is called a "waste". Waste management is the proper control of waste in order to protect it from environmental hazards. Industrial waste, commercial waste, domestic waste, agricultural waste, and electronic waste are a few types of waste that can be categorized. Environmental problems such as water pollution, air pollution, and soil pollution are a few different problems that can occur due to the improper management of waste. Landfill incineration, waste compaction, composting, vermicomposting, recycling, plasma gasification, and conversion of waste into energy are some innovative methods of waste management that are discussed in this work.

Keywords: Cow dung, Incineration, Landfill, Plasma gasification, Vermicomposting, Waste.

INTRODUCTION

Waste management can be defined as the proper collection, transportation, and disposal of garbage as well as other sewage and waste products. Improper management of waste products will lead to a lot of environmental problems such as water pollution, air pollution, and soil pollution.

Considering underwater pollution, the reduction of the BOD value can be seen as a major issue that will lead to the death of plants and animals. Due to the accumulation of garbage, it will lead to higher amounts of nitrate levels which will lead to the accumulation of anaerobic bacteria which will be leading to an increase in the BOD value. Clean water should be having a BOD of less than 5ppm, whereas polluted water has a BOD of 10ppm. The oxygen amount that is present in water is called the dissolved oxygen level, which is represented as DO. The algal blooms and sewage that enters the waterway will lead to a decrease in

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the dissolved oxygen levels. When the LEVEL of water bodies decreases more than a particular limit, it will lead to mass fish kills. Air pollution is another form of pollution that can occur due to the burning of waste. Burning of waste will be leading to the release of carbon dioxide, carbon monoxide, sulphur dioxide, sulphur trioxide, nitrogen dioxide, and methane which will lead to global warming, acid rains, *etc.* Most of the times, people find the burning of garbage as a solution to waste management, which is totally incorrect. Burning of garbage will lead to many other environmental hazards which are very dangerous. Soil pollution is caused by the accumulation of garbage on the soil [1 - 5]. This will lead to a change in the pH condition of the soil, changes in the organic and inorganic ion balance in the soil, addition of toxic ions into the soil, *etc.* Biogas production, landfill, incineration, waste compaction, composting, vermicomposting, recycling, and plasma gasification are some of the waste management methods that can be used. Landfills are land areas where the wastes which cannot be reused or recycled, are buried underground for a longer period of time. Due to the burial of garbage under the ground, the construction of buildings cannot be done for 20 years of time. Therefore, the land can only be used as a playground, walking path, garden, *etc.* Incineration is the method of burning garbage into ash. This method is not considered an environmental-friendly method due to the release of toxic as well as greenhouse gases such as carbon dioxide, carbon monoxide, sulphur dioxide, nitrogen dioxide, *etc.* Waste compaction is the method in which waste products like plastic bottles are provided with pressure and they are compacted into bricks and recycled. This process helps to prevent oxidation of certain metals and it will reduce the airspace which is needed while making transportation and positioning easy. Biogas production is another waste management method that is very effective. Most of the times, household waste can be used in the preparation of biogas. Biogas is prepared by the collection of animal and plant waste into a biogas tank which is kept closed for about 3 months. Here, methane is produced as one of the major gases which can be used for cooking purposes. At the same time, this method is not considered an environmental-friendly method due to the evolution of greenhouse gases. Composting is done by the burial of decomposable garbage under the soil layer and allowing it to decay due to the action of microbes such as fungi and bacteria. This will result in the formation of manure which is rich in nutrients. Compost soil can be used as the best alternative to chemical fertilizers. Vermicomposting is a process where biodegradable garbage is converted into nutrient-rich manure with the help of worms. The by-products that are released from the worms will be helpful in the growth of bacteria as well as fungi. Recycling is a process of using non-degradable items such as plastic again and again. In recycling, the waste products will be converted into new products/energy in the form of heat, electricity, or fuel. Plasma gasification is a method where the waste is converted

into syn gas with the help of plasma torches that are operated at + 10000F, which creates a gasification zone up to 3000 F. Here the molecular bonds of the waste are broken down due to the heat generated [6 - 10]. These are a few of the effective methods of proper disposal of waste in order to prevent the planet Earth from pollution.

METHODOLOGY

Biogas Production

The waste matter along with water and cow dung was put into the mixing tank, move through the inlet and will move to the digester. Nothing will be going from the dome. When the digester is filled up, the excess will go through the outlet and move to the overflow tank. When it is full, it is kept close for 3 months. Methane will get collected in the dome and comes from the biogas pipe. Carbon dioxide, coming through the carbon dioxide pipe, can be collected in order to produce dry ice. Here, the dome is present inside the earth, but in the floating dome type, the dome is present outside the earth. Methane can escape faster than carbon dioxide and carbon dioxide can be separated.

Landfill

Daily collected trash is put into a large hole dug inside the land. Heavy machinery like bulldozers is used to compress the trash in order to place it in the landfill. There are different types of landfill liners, such as compact clay liners and plastic liners. The compact liners will help to prevent waste leak into the environment. These liners are normally denser. The plastic liners are made up of dense plastic and other materials which are synthetic. Normally, this line is 30- 100 miles thick. Plastic liners are usually used in municipal solid waste landfills. A drainage system is present in order to filter specifically where the liquid produced by trash, called leachate, is separated from any rainwater. These leachate collection systems will filter the liquid waste by using pipes, gravel, and layers of sand. Groundwater monitoring stations help to check for the chemicals present in the landfill. The gas collection system is present in order to collect harmful gases released such as methane in order to produce electricity. Carbon dioxide is filtered out as a liquid filtering process. At last, the capping of the landfill is done with the help of a plastic liner. After capping the landfill with a plastic liner, the landfill is covered with 2 feet of soil. After that, the plants such as grass and plants that do not penetrate the roots are planted on top of the soil layer to prevent soil erosion due to the rainfall as well as heavy wind. Until 20 years of time, buildings should not be constructed in landfills. But parks and walking paths can be created.

CHAPTER 17

Sensor-Based Vehicle Fuel Theft Detection System Using Microcontroller

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Abstract: Vehicle fuel theft is one of the key worries of many bike and automobile owners these days. We've all heard stories of fuel being taken from our motorcycles or automobiles, and some of us have even experienced it ourselves. The primary goal of this detector is to prevent such an occurrence. A simple, cost-effective method is suggested here for maintaining vehicle fuel security when the vehicle owner is present anywhere on the planet. This style detector digitally displays the amount of gasoline in the fuel tank. When the gasoline is stolen, a buzzer sounds, alerting the bike's owner. The goal of this project is to utilize it to monitor fuel security. When this system detects an instruction, it sends an alert to the vehicle's owner. When the owner of a motorcycle, automobile, or truck enters the key into the ignition lock and turns it on, a signal is sent to the microcontroller. Because the microcontroller recognizes that the bike/car has started, it will not monitor the fuel level. With this project, we've included a bike ignition key. When the key is taken from the ignition lock, the level sensor is activated. As soon as the individual exits the vehicle, the key is removed, and the system is triggered.

Keywords: Detector, Microcontroller and Vehicle, MODElSIM, Sensors.

INTRODUCTION

The current state of affairs in the realm of microcontrollers may be traced back to the development of integrated circuit technology. This advancement has enabled the storage of hundreds of thousands of transistors on a single chip. That was a need for the development of the microprocessor, and the earliest computers were

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built by adding external peripherals like memory, input-output lines, timers, and other components. Integrated circuits were created when the package's capacity was increased further. Both a CPU and peripherals were included in these integrated circuits. That's how the first microcomputer chip, or what wouldeventually be known as a microcontroller, was created. In many aspects, a microcontroller varies from a microprocessor. The first and most critical consideration is its functioning. Other components, like memory or components for receiving and transmitting data, must be added to a microprocessor before they can be utilized. In layman's terms, this implies that the microprocessor is the computer's brain. Microcontrollers, on the other hand, are meant to be all of these things in one. Because all essential peripherals are already incorporated inside it, no further external components are required for its usage. As a result, we save time and space while building gadgets. The top polarizer of a Texas Instruments calculator has been removed and put on the top, making the top and bottom polarizer perpendicular [1 - 5].

The colours are reversed as a consequence. In the voltage-on state, the optical effect of a TN device is significantly less reliant on fluctuations in the device thickness than in the voltage-off state. As a result, TN displays with minimal information content and no backlighting are often used with crossed polarizers to make them seem bright even when no voltage is applied (the eye is much more sensitive to variations in the dark state than the bright state). The majority of LCDs from the 2010 period are used in television sets, monitors, and smartphones, and they contain high-resolution matrix arrays of pixels that can show arbitrary pictures with backlighting on a dark backdrop. Different layouts are utilised when no picture is presented. TN LCDs use parallel polarizers for this, while IPS LCDs use crossing polarizers. IPS LCDs have largely supplanted TN LCDs in numerous applications, including smartphones like the iPhone. The alignment layer material and the liquid crystal material both are included.

The AVR employs Harvard architecture, which has a distinct memory and buses for programme and data in order to promote speed and parallelism. Single-level pipelining is used to execute instructions from the programme memory. The next instruction is pre-fetched from the programme memory while the previous one is being executed. Every clock cycle, this idea allows instructions to be performed. In-System Reprogrammable Flash memory is used for the programme memory. With a single clock cycle access time, the fast-access Register File has 32 x 8-bit general purpose working registers.

This enables Arithmetic Logic Unit (ALU) operation in a single cycle. Two operands are output from the Register File, the operation is performed, and the result is saved back in the Register File - all in one clock cycle. For Data Space

addressing, six of the 32 registers may be utilised as three 16-bit indirect address register pointers, allowing for more efficient address computation. One of these address pointers may also be utilised as a lookup table address pointer in Flash program memory. The 16-bit X-, Y-, and Z- registers, which are detailed later in this section, are among the newly introduced function registers [6 - 10].

Arithmetic and logic operations between registers, or between a constant and a register, are supported by the ALU. The ALU may also do single register operations. The Status Register is updated after an arithmetic operation to reflect information about the operation's outcome. Conditional and unconditional jump and call instructions, which may directly target the whole address space, enable programme flow. The majority of AVR instructions are written in a single 16-bit word format. A 16-bit or 32-bit instruction is present in every programme memory location. The Boot programme part and the Application Program area of the Program Flash memory space are separated into two pieces. For write and read/write protection, each section has separate lock bits. The Boot Program section must include the SPM instruction that writes to the Application Flash memory region. The return address Program Counter (PC) is saved on the stack during interruptions and subroutine calls. Because the stack is functionally allocated in the general data SRAM, the stack size is limited solely by the overall SRAM size and the SRAM utilisation. In the reset function, all user applications must initialise the SP (before subroutines or interrupts are executed in the I/O space, the Stack Pointer SP is read/write accessible. The data SRAM is readily accessible to the AVR architecture's five distinct addressing modes. The AVR architecture's memory spaces are all linear and regular memory mappings. The control registers of a flexible interrupt module are located in the I/O space, with an extra global interrupt enable bit in the Status Register. In the interrupt vector database, each interrupt has its own interrupt vector. The interruptions are prioritised according to the location of their interrupt vector. The greater the priority, the lower the interrupt vector address. For CPU peripheral tasks like Control Registers, SPI, and other I/O functions, the I/O memory area has 64 addresses [11 - 15]. The I/O Memory may be accessed directly or through the Data Space locations $20 - $5F, which follow the Register File.

PROPOSED SYSTEM

Our project is based on AVR AT Mega 32. It is the main part of our project. The LCD Display is attached to the AVR Microcontroller's port D (Do and D7). AVR AT Mega 32 ground and Vcc pins, respectively. And the switch is attached to the Ao pin, which functions as the vehicle's key. The Ai pin of the AVR Microcontroller is also linked to a level sensor. The buzzer and SL 100 are linked to port C7.

CHAPTER 18

Biochar for a Sustainable Future

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Abstract: Biochar is a charcoal that is used for soil amendment. It is made up of wood, bones, and other organic substances including dried manure which is produced by a process known as pyrolysis under a lower amount of oxygen. Biochar can be used to improve the fertility of the soil which results in increasing the crop yield. It has a honey-comb-like structure which will help in the increase of the water holding capacity, and nutrient retention as well as by stopping the soil particles from getting compacted with each other. Infertility in the soil occurs due to the addition of different types of pesticides, weedicides as well as a lot of chemical substances. Therefore, biochar can act as a promising solution for the infertility of the soil while indirectly increasing crop yield.

Keywords: Aeration, Biochar, Charcoal, Pyrolysis, Soil Fertility.

INTRODUCTION

The use of biochar is now being studied as a way to improve soil quality and fertility for agricultural yield, to provide ecosystem services such as the immobilization and transformation of pollutants, and to mitigate climate change by sequestering carbon. Carbon-rich biochar is produced by heating feedstock in a confined container with little or no oxygen accessible. There are a wide variety of feedstocks for biochar synthesis, including wood, organic and industrial wastes, and plant-based materials (*e.g.*, leaves, husks, seeds, and cobs). Due to changes in feedstock and pyrolysis characteristics (temperature, speed, and duration), not all biochars are created equally. Experimental research shows that biochar application modifies soil characteristics in addition to carbon sequestration. When using biochar, soil quality might be affected by its different features. It has been shown that adding biochar to soil increases soil pH, cation exchange capacity, and the amount of extractable minerals including Na, K, Ca, and Mg. These improvements are advantageous to nutrient retention and fertility in the soil. Add-

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itional modifications to soil microbial communities and activities, such as carbon mineralization and nutrient transformation, could result from the addition of biochar. For example, bulk density and physical conditions for plant development are improved by biochar in addition to soil chemical and biological qualities. This study focused mostly on soil water content changes. To maximize crop yields, soil water retention is essential. This is because plant water absorption and transport are directly influenced by soil water retention, and *vice versa*. Soil water retention may be affected by biochar application due to its high porosity, hydrophilic domains, and large specific outer area, which have been shown in experiments to influence soil water retention. This effect is likely due to these factors. Experiments using diverse biochar properties, soil types, experimental settings, and durations might produce varying outcomes, which makes it difficult to compare the findings between researchers and extrapolate the findings to new contexts. The degree to which biochar alters soil water retention quality is also a subject of substantial debate despite the amount of research on the subject of biochar-soil interaction [1 - 5].

METHODOLOGY

The process of making biochar is a simple method based on a technique called pyrolysis in a lower amount of oxygen level. A pit was dug in the ground. Dried wood, dried plant materials, bones, *etc*. were added to it. They were burned at a very high temperature by reducing the amount of oxygen. When burning, we can predict what is burning inside by observing the smoke, for instance: - if the flame is white in color it means it is water vapor. If the flame is yellow in color, it will show the burning of resins and sugars. If it turns grayish blue and when the smoke becomes thin, make sure to cover it with a little amount of soil to lower the air supply and leave it for a few hours. After that, the organic matter is smoldered into charcoal chunks, and then put some amount of water onto the fire.

Inoculation of Biochar

The biochar which was prepared by using the above method was obtained. After that, a little amount of nutrients was added to it. Powdered seaweed as well as molasses were added to it and mixed very well. Molasses would act as food for the microorganisms which would encourage the microbes to populate. It was kept for about a week and after that, the biochar was mixed with the chicken stool. This would help to break down the oil in the biochar into very small particles. The above mixture was kept for about 3-4 months and after that, it was ready to put into the crops.

Liquid Activation of Biochar

The biochar which was prepared by the earlier steps was taken. Few amounts of water were added to it in order to moisten it. A little amount of pressure was added to it so that the water does not come onto the surface of the biochar. The water was filtered carefully. Now the water would help to soak all nutrients and minerals that are present in biochar. After that, it was kept for 3-4 hours. Next, it was dried well and it was mixed with active biochar along with the rest of the minerals. Now the biochar is ready for usage.

RESULTS AND DISCUSSION

Soil Activation

Soil-dissolved organic matter is not greatly affected by biochar throughout the data collected; however, soil microbial biomass is significantly increased by 12 percent. Biochar has a large impact on soil NH^{4+} and NO^{3-} concentrations, with corresponding percentage changes of -6 percent. There has been a 28 percent increase in soil microbial biomass due to biochar, in accordance with prior meta-analyses of 16 types of research. Soil microbes involved in soil nitrogen cycling respond well to the addition of biochar to the soil. Because of its fine porous structure, high outer area, hydrophilicity, and mineral nutritional value, biochar provides a better environment for bacterial growth and development in soil. A lack of extractable inorganic nitrogen and refractory organic nitrogen in biochar makes it an ineffective source of readily accessible nitrogen. In the presence of biochar, soil nitrogen availability is reduced, which may be due to high soil inorganic nitrogen absorption, high plant nitrogen absorption, and high soil ammonia volatilization loss.

Absorption of Nitrogen by Plants

Biochar increases plant nitrogen absorption by an aggregate of 11 percent, resulting in a 12 percent increase in plant biomass and a 2% decrease in the percentage of nitrogen in plant tissue. In acidic soils, biochar tends to boost plant biomass and nitrogen absorption, while it has a minimal impact in neutral or alkaline soils. Therefore, biochar has the greatest influence on plant biomass and nitrogen absorption in soils with weak structures. Manure biochar has a greater effect on plant growth and nitrogen absorption than either wood or straw biochar. Over-application of biochar may greatly decrease plant biomass and nitrogen absorption, and the connection between biochar application rate and plant biomass or nitrogen absorption forms a convex curve. Several processes are responsible for the increased plant production and absorption of nitrogen caused by biochar. Soil pH might be raised to a more neutral level with the help of biochar, hence

CHAPTER 19

A Review of Bioremediation of Soil Contaminated with Heavy Metals

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Abstract: Toxic and hazardous contaminants generated and accumulated as a result of industrial activities, improper waste management, and other anthropogenic factors, have become one of the major environmental threats. Heavy metal contamination, in particular, has long-lasting negative impacts on different life forms. In plants, it can disrupt the water and nutrient uptake mechanisms, photosynthesis, and other metabolic pathways, adversely affect the vital soil microflora, and can also make its way to the food chain, thereby resulting in the deterioration of human health. Although several chemical and physical treatment options have been developed, these conventional methods are expensive and may not be feasible for large-scale remediation. Bioremediation is therefore considered s a better eco-friendly alternative for solving this issue and for potentially reducing the toxic metal concentration in polluted resources. This review, in brief, discusses the scope of bioremediation for contaminated soil, the various metal-remediating microbes found, the different mechanisms of bioremediation used, and many more.

Keywords: Bioventing, Bioslurping, Contaminants, Environment, Remediation.

INTRODUCTION

Industrialization, urbanization, and the rapid increase in population have resulted in the large-scale deterioration of the environment due to the generation of hazardous wastes. Improper handling and disposal of these wastes have a detrimental environmental impact.

The contaminants are broadly classified as inorganic and organic pollutants. The indiscriminate use of potentially toxic chemicals, endocrine-disrupting agents, to name a few, has not only resulted in pollution and degraded human health and aquatic microbiota, but has also increased the cost of wastewater treatment.

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The non-biodegradability and toxicity of these contaminants make their management extremely crucial. The accidental and intentional releases of xenobiotic compounds and harmful gases as a result of industrial and anthropogenic factors have contaminated water, air, and soil resources to a great extent. Among the numerous contaminations, heavy metal contamination of soil has become one of the most serious threats causing irreversible ecological damage owing to its potential risk of buildup through the food chain. Unlike air and water pollution, which can be regulated by dilution and other purification techniques, it is not easy to remediate soils polluted with heavy metals. In fact, some soils were found to take one or two hundred years to be remediated. Some of the common sources of heavy metals are fertilisers, pesticides, mulch, sanitary sewage, chemical wastewater, and industrial mining wastewater. Heavy metals that are causing the most concern in the industry include mercury (Hg), zinc (Zn), lead (Pb), *etc.* They are highly toxic contaminants present in fertilisers that have many adverse effects such as the inhibition of microbial activity, poisoning of plants eventually leading to death, carcinogenic effects on humans, *etc.* Cd is a toxic contaminant in the soil whose concentration increases with the increased use of phosphate fertilisers and compound fertilisers. Cd may cause calcium deficiency by damaging the metabolism of calcium, resulting in cartilage disease, cataracts, osteoporosis, *etc.* Pb can have a detrimental effect on almost all major systems of the body such as the nervous system, urinary system, immune system, *etc.* Ni and Cu compounds are carcinogenic in nature. Several remediation techniques have been proposed to remove toxic metals. Some of them are: soil leaching where heavy metals are washed off from the soil using specific reagents, adsorption using clay minerals, electron kinetic remediation, precipitation, vitrification, heat treatment, stabilization and solidification, incineration, electro-winning, soil washing, *etc.* Although the methods outlined above are successful, they are costly, non-eco-friendly, and not feasible for large-scale applications [1 - 5]. This has paved the way to switch to cost-effective, eco-friendly bioremediation methods which involve the utilization of plants and microbes to remediate the soil. Bioremediation is a powerful and promising alternative to conventional approaches that focus on clearing pollution by enhancing the natural degradation process, making it environment friendly. This approach has received high public acceptance [6 - 8].

BIOREMEDIATION

The terminology bioremediation is an amalgamation of “bios” which means life referring to living forms and “to remediate” which implies resolving a problem. “Bioremediate” refers to the utilization of living forms, which may or may not be microscopic to treat environmental problems such as the contamination of soil and water. It can also be defined as the employment of living microorganisms to

breakdown substances that contaminate the environment, thereby preventing its pollution. In other terms, it is a method to eliminate contaminants from the environment which could either belong to terrestrial, aquatic, or both, in order to restore the natural environment and avoid further pollution. An extensive way to outline the definition of bioremediation would be that it is a technique of cleaning up environments polluted with toxic substances or compounds by exploiting various metabolic processes of microorganisms by transforming these toxic substances to less- toxic substances or compounds by either chemical or biological methods. For bioremediation to be carried out successfully, pollutants must be degraded by the enzymatic action of microorganisms, thereby transforming them into less harmful/harmless products. Bioremediation can be effectively carried out when its application is involved with changes in the physical parameters of the environment, which will favor microbial growth and degradation. Bioremediation techniques were developed with the objective of remediating petroleum hydrocarbon contaminants either by immobilization or converting them into products with no significant risk or innocuous to the environment and humans, such as water/water vapour, CO_2, *etc.* The process of bioremediation, which is carried out on a site can be improved by supplementing it with fertilisers, along with nutrients or using a consortium of microorganisms. This enhances the process due to which it can be called as engineered or enhanced bioremediation. Another technique, namely, intrinsic bioremediation, employs already found native microbial communities, which make this technique a more economical remedy. Furthermore, microbial activity, which is indigenous to a particular land, has been found to detoxify the soil more efficiently, irrespective of the severity of contamination. Thus, in a given ecosystem that is polluted, microbial communities that are capable of utilizing or resisting toxic compounds tend to dominate over other organisms. In contrast to microbial communities living in a comparatively less stressed environment, these communities are far less diversified. After the soil of the land/site has been infused with fertilizers and/or seeded with a consortium of microorganisms, physical parameters such as temperature, oxygen level, and amount of water can be controlled to increase process rates and mitigate detrimental impacts on the environment, such as air pollution.

Factors Affecting Bioremediation

The process of bioremediation is majorly influenced by the following factors:

1. Presence of pollutant degrading microbial community.

2. Contaminants available for the microbial population to degrade.

3. Physical parameters

CHAPTER 20

Sustainable Agriculture Practices: Empowering Farmers

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Abstract: Environmental preservation and protection are anticipated benefits of sustainable agriculture. It often serves as a remedy for soil degradation and other loss of natural resources. Worldwide, there is still poverty and there are individuals who don't have a full day's worth of food because of the use of chemical pesticides and fertilisers. In order to preserve our ecology and environment, this worldwide problem must be addressed. Furthermore, since soil is a finite resource, it must be handled with care to prevent deterioration. The whole chemical agricultural system is changed by sustainable agriculture. In order to address a huge growth in the human population, the green revolution was what began it all. Chemical fertilisers were used to speed up crop production, which produced an excess of food grains. However, it also requires low-income workers to borrow money and use it to purchase fertiliser and pesticides during the early phases of crop production.

Keywords: Components of sustainability, Climate change, Organic farming, Sustainable agriculture.

INTRODUCTION

Due to the massive usage of artificial fertilisers in the modern world, crop growth times are now shorter. Numerous inorganic fertilisers have been produced for crop development and the production of delicious fruits and vegetables. Chemical fertilisers have a long-term effect on the fertility and conditions of the soil.

An alternative to this degrading ecology is organic fertilisation, which refers to fertilisers made from both plant and animal sources. Excretory wastes from animals including cattle, poultry, rabbits, fish, and pigs are included in animal derivatives. After the harvest of the crops, it is possible to use the natural flora that grows on a plot of land as fertilisers. Organic farming and the use of organic fertilisers are essential to address the current expanding population. By supporting a variety of insects, worms, and soil microorganisms including bacteria, fungi,

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and other organisms, they serve as a transitional element in preserving biodiversity. The green revolution, which aimed to modernise agriculture and farming, is where the usage of synthetic fertilisers first emerged. As a consequence, excessive agricultural simplification has had a harmful impact on the environment, human health, and other animal species. When compared to conventional fertilisers, organic fertilisers are also known to boost the amount of sugar in particular plants. Taking into account that today's organic agricultural land fields are expanding annually and acting as a substitute for traditional agriculture, they guarantee to enhance the soil's ecological and physical characteristics. These organic fertilisers represent a step in the direction of productive and sustainable agriculture [1 - 5].

Goals of Sustainable Agriculture

● The principal goal of practical farming is to satisfy human necessities and food items.

● The raw material components like cotton silk, leather, wool and so on utilized for dress guarantee people trust over it.

● Ensures the utilization of nonrenewable assets in an efficient way.

● Secures and improves the environment and other floral and faunal species in that ecosystem.

● To keep up with soil fertility, limit water use, and control contamination of crops that are developed by utilizing reasonable advanced horticulture strategies.

● Utilizing natural and organic assets to control bugs and illnesses.

METHODS OF SUSTAINABLE AGRICULTURE

Crop Rotation

Crop rotation is a practice of cultivating a series of different crops on the same piece of land in order to replenish the nutrients of the soil and make sure the soil remains fertile for further cultivation.

• Prevents depletion of supplements in the soil. In addition, it controls bugs and diseases over plants.

• In crop rotation, the cereal yields like wheat, maize, paddy and millet are developed with leguminous crops like pulses, peas, beans, groundnut and clover,

and so on, in a similar field. The rotation of crops saves a great usage of nitrogenous manure.

• Leguminous crops used during the rotation of yields can fix environmental nitrogen with the assistance of their nitrogen-fixing microorganisms like Nitrosomonas, and Nitrobacteria and there is no need to add nitrogenous manure to the soil.

Organic Farming

It is a distinctive farming method that promotes the health of the soil ecology and the small animals living there. This method involves the use of biofertilizers and biopesticides in horticulture. It lessens reliance on the use of synthetic substances. Fig. (**1**) illustrates how it enhances and maintains the agro-environment and natural landscape while preventing overexploitation and pollution of renewable and non-renewable resources.

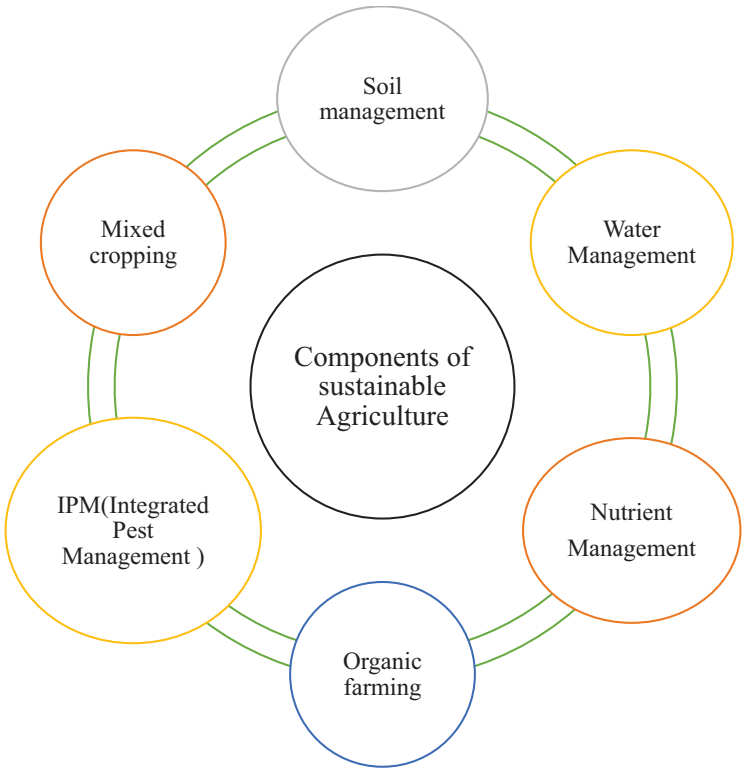

Fig. (1). Components of sustainable Agriculture.

CHAPTER 21

Rate of Corrosion and its Methods: A Review

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Abstract: Weight loss approach was used to investigate the corrosion characteristics of various metals found in varying concentrations of solutions containing acids. The degree of these metals' corrosion in 1–5 M HCL solutions was investigated for 24 hours. The order of metal corrosion is zinc > galvanized iron > copper >, whereas the order of aqueous media corrosion is HNO_3 > H_2SO_4 > HCl. It has been observed that increasing concentration increases the corrosion potential. Further investigation into the dynamics of corrosion has demonstrated that the rate of reactivity in terms of metals rises with increasing solution concentration when the half-life decreases.

Keywords: Acid concentration, Duration of exposure, Reaction rate, Weight loss.

INTRODUCTION

Metals and metal alloys frequently encounter extremely aggressive solutions such as acids and bases due to their extensive application in local and large-scale industrial manufacturing and storage activities and processes.

They are prone to corrosion attacks, the amount of which is determined by numerous elements such as medium or solution concentration, period of exposure, as well as temperature conditions, among others. In general, corrosion occurs when a substance (metal, ceramics, and rubber, polymeric, and cement structures, for example) interacts chemically or electrochemically in relation to the surrounding environment, resulting in the metal's slow deterioration, disintegration, or, in extreme cases, structural failure. Corrosion is very damaging and happens in virtually any given environment, including air (O_2, H_2, ammonia, and other corrosive gasses) and water combinations, industrial environment (fumes, alkali, acids, and so on), freshwater and salty water, and diverse organic, medium of inorganic solutions. Corrosion can develop at a slow or quick rate, as well as the rate of occurrence can be assessed using many ways, the most prom-

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inent of which is the weight loss method. In this procedure, a sample of a certain substance which is known as the "coupon" is subjected to a process in the environment for a set amount of time. After that, this specimen is taken for examination, which begins with a weight loss measurement throughout the exposure period. This is then stated as the rate of corrosion. Corrosion can raise operating costs by expanding unplanned downtime and decreasing the equipment's life, and it can even result in injury or death to the operator. According to a study, corrosion control accounts for 25% of maintenance costs. Revenue lost due to postponed manufacturing was a large component of this expense, so there have been adapted different methods to prevent and delay the corrosion rate. Most of the time, coating techniques are used to prevent corrosion. Impurities such as rust, dust, oil, scales, and so on are commonly found on metal surfaces. Impurities must be eliminated to achieve adhesion, cohesiveness, smoothness, and uniformity of coating. It is achieved by dipping the coating surface in an acid bath. This metal pretreatment procedure is known as acid cleaning or pickling [1 - 5]. Pickling is commonly used to remove scale using the oxidation process. For example, Fe dissociates into Fe^{2+} and $2e^{-}$. As a pickling solution, dilute HCL is employed. Metal ions and rust are dissolved by immersing the metal plate in acid; this type of breakdown is known as corrosion. The corrosion rate increases as the time spent dipping in acid increases and the acid concentration increases [6, 7].

CORROSION AND ITS TYPE

Corrosion, which is derived from the Latin word CORRODERE, is described as "the destruction or degradation and subsequent loss of metals or alloys caused by a chemical or electrochemical attack by the surrounding environment." That is, pure metal gets transformed into undesirable metallic compounds.

Metal is transformed into metal ore.

The principal causes of metal corrosion are atmospheric, air, water, and the metal's conducting surface.

e.g., i) Iron rust (the production of hydrated ferric oxide ($Fe_2O_3.nH_2O$), resulting in reddish brown scales), ii) Copper vessels with green scales [As a result of the creation of basic cupric carbonate ($CuCO_3$ + Cu $(OH)_2$)].

Metal corrosion happens as a result of either a direct chemical assault or an electrochemical attack on the metal by the corrosive environment.

• Dry corrosion occurs when corrosion occurs due to direct chemical assault (in the absence of moisture) solely in the presence of atmospheric gases such as O_2, N_2, H_2S, and SO_2.

• Wet corrosion or electrochemical corrosion occurs when a metal corrodes owing to electrochemical assault in the presence of moisture or a conducting media.

Factors Influencing Corrosion Rate

1. Primary factors (factors related to the metal)

• Nature of the metal (Electrode Potential).

• The surface state of the metal (or) the nature of the corrosion product.

• Anodic and cathodic area (area effect) or relative size of anode and cathode.

• Polarization of electrodes.

2. Secondary factors (factors related to the environment)

• pH of the medium.

• Temperature.

• Humidity.

• Presence of impurities.

• Electrical conductivity of the corrosive medium.

Types of Wet Corrosion

Differential Metal Corrosion (Galvanic corrosion)

When two dissimilar metals come into touch with each other in a corrosive conductive media, this happens. The corrosion resistance of the two metals differs. A potential difference is created, which causes a galvanic current to flow. The metal with the lowest potential electrode (the more active metal) serves as the anode, whereas the metal with the higher electrode potential serves as the cathode. The potential difference between the two metals is what causes corrosion. The greater the difference, the greater the rate of corrosion. The anodic metal corrodes, while the cathodic metal is unharmed.

CHAPTER 22

Bioplastic from Renewable Sources: A Novelty Approach to Sustainable Development

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Abstract: At present, with an increase in the human population, the amount of plastic consumption has multiplied, and with it, pollution levels are alarmingly increasing day by day. Plastic can be labelled a disaster as it threatens the whole world. Since this is a big problem for our environment, there may be a call to find a change for traditional plastics. Therefore, bioplastics are the perfect option as they can be synthesized from various active biodegradable wastes. Bioplastics are formed from various renewable biomasses, including starch, biopolymers, cellulose, and aggregates of various compounds. These plastics can be easily synthesized and can be easily degraded compared to conventional plastics. So, the synthesis of it becomes a crucial challenge.

Keywords: Banana peels, Hydrocarbon plastic, Polymerization, Renewable, Sodium hydroxide.

INTRODUCTION

Plastic pollutants have continually been a first-rate difficulty on this globe with regard to the fitness of our planet and in addition to its inhabitants. The synthetically produced petrochemical merchandise makes use of fossil fuels for manufacturing and transportation without delay, thereby contributing to greenhouse fuel line emissions. Plastics are synthetically made polymeric substances. These are made *via* the polymerization of complicated natural substances and may be molded into diverse forms, films, thin filaments, and fibers by making use of enough pressure and heat.

As synthetic plastics are shaped by cross-connected monomeric units, this offers polymers thermal stability and rigidity. Plastics like PVC, polystyrene, polyethylene, and polypropylene are used majorly for production plastics and can be majorly labeled under high-density plastics or low-density plastics. Around one

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hundred forty million heaps of primarily petroleum-based polymers are produced and used in the production of plastics each year all over the world. Synthetic plastics usually have plasticizers as their base and colorants. These materials have massive consequences on health and the surroundings, even though the consequences have now not been studied completely but pose a notable change to the planet. They are non-biodegradable and are no longer effortlessly broken down on an applicable time scale, inflicting landfill problems, toxicity, and leading to the Biological Oxygen Demand (BOD) problems [1 - 5]. This disturbs the carbon chain and adversely impacts biodiversity. Moreover, burning causes air pollutants and the emission of greenhouse gases. When synthetic plastics are disposed of, hardly 10% of the plastic is recovered by means of recycling for low-grade merchandise and the leftover components are released to dirt and it takes a long time to degrade at the same time as few don't degrade at all. Petro-plastic pollutants have a notable effect on the reproduction pattern of better tropic organisms and the feeding of those organisms. Synthetic plastic waste idealizes pathogen dispersal by means of permitting a colonizing colony, especially in aquatic systems. Heavy metal pollution and antibiotics adhering to surfaces may assist in organizing antibiotic resistance and is likewise a first-rate difficulty for scientists who're operating on the degradation of plastics. So, there may be a constant want to alternate the contemporary industrialization and way of life to a sustainable manner and to locate an opportunity to this problem. The apt answer could be to begin the use of bioplastics rather than synthetic plastics. The preparation of bioplastics from different varieties of banana peel waste is a recent trend and seems to be an effective solution because the peel contains certain minerals such as calcium, potassium, zinc, sodium, iron, and magnesium. Starch is a crucial factor in banana peels, so extraordinary types of banana peels were used in conjunction with cornstarch to develop a bioplastic film. This film can be made from banana peels with extraordinary concentrations of various chemical compounds and then heating the combination in an oven at a temperature of 130°C. Organized sheets can be examined for chemical interactions with various substances using infrared spectroscopy, the transparency of the film can be checked using UV spectroscopy, and the crystalline nature can be examined using the X-ray diffraction method. When we synthetically assemble bioplastics, we also need to find a way to degrade the film which we create. Microbial enzymes are the most important for the degradation of bioplastics. Certain microorganisms from various taxa might aid in degradation. By using mainly starch-based additives, we can effortlessly degrade the film in almost 28 days as determined by scientists how bioplastics are converted into water and carbon dioxide through enzymatic metabolism [6 - 8].

BIOPLASTICS

Researchers are seeking to remedy this alarming state of affairs in our surroundings with bioplastics. Those are effortlessly composted and the results spoil down into herbal results. Biomass typically includes uncooked substances which include vegetables, fats, oils, sawdust, wooden chips, agricultural residues, meal waste, *etc.* Bioplastics may be divided into the maximum important groups: completely biodegradable plastics and primarily bio-based plastics. Bio-based plastics are acquired from biomass (plants) which include corn, starch, and cellulose. Biomaterials for bioplastics may be acquired from plant biomass, that's fermented or produced through microorganisms and include additives collectively with cellulose, starch, hemicelluloses, lignin, or vegetable oil, which can be in all likelihood to be made from atmospheric carbon dioxide through photosynthesis into bioplastics. Few are derived from proteins. Polylactic acid (PLA), a polymer that's primarily based on starch, is one of the maximum essential substantial bioplastics. Biodegradable plastics are those that spoil over the years into gases which include carbon dioxide (CO_2) and weeds or compost and are structurally vulnerable to degradation through microbes and incorporate an ester group (RCOOR); this is vulnerable to degradation through enzymes.

Properties of Bioplastics

These exhibit flexibility and heat resistance and can be made by modifying the polymer structure, making blends, or incorporating other molecules, including plasticizers such as phthalates, into the polymer. Chemical properties are not the most practical elements that determine timely degradation. Polylactic acid (PLA) has a slower degradation rate than poly-3-hydroxybutyrate (PHB) despite having nearly the same melting temperature and transition rates. As derivatives of the PHB polymer, when developing bioplastics, it must be ensured that the product is strong enough to withstand its intended use and timely degradation. They are currently used in packaging, agriculture, textiles, and scientific products.

Banana Peel Bioplastic

The simple substances needed to produce bioplastics consist of macromolecules and smaller molecules, as well as fatty acids, sugars, and polymeric disaccharides. Different types of bioplastics are made from cellulose, starch, poly--hydroxybutyrate (PHB), and polylactic acid. Among the above, starch is the one typically used to produce bioplastics as it is a renewable input and, unlike synthetic bioplastics, results in a low intake of nonrenewable materials and much lower greenhouse gas emissions. Starch-based plastics are environmentally safe and help act as a promising material for bioplastics' manufacturing due to their high strength, grease, and fuel line barrier. Starch is the main source of natural

CHAPTER 23

Photocatalyst Based on TiO_2 and Its Application for Environmental Remediation: A Challenge to Sustainable Development

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Abstract: This is an overview of the photocatalyst TiO_2 which gets activated under UV rays. Its use in wastewater management is discussed. TiO_2 is a semiconductor that uses the transient nature of electrons and holes to produce radicals such as OH• and HO2• to degrade organic pollutants, inorganic pollutants, and pathogens, particularly into carbon dioxide, water, and oxides of organic compounds, respectively. The oxides are recycled back into the biogeochemical cycle. TiO_2 differs in its structure such as anatase, brookite, and rutile, and hence its properties. Besides this, there are several methods of its preparation that can be obtained through natural sources or synthetic preparation. To enhance the outcome of wastewater treatment, TiO_2 is doped or modified with certain elements. These include nonmetal Dopants such as porous minerals, carbon materials (fiber, graphene, activated carbon), polymer materials (PLC, PE), nitrogen, *etc.*, and metals such as precious metals (Ag, Pt), ions (Fe^{3+}, Mo^{5+}). Composite modifications are also done. The formation of hetero junctions is one such method that enhances the activity of TiO_2 to increase the photo response in the visible and infrared regions. Co-doping is also done such as N and Co-doped TiO_2. Certain parameters which affect the efficiency of TiO_2.> are discussed briefly along with the limitations it has. The degradation rates of some doped TiO_2 acting on methylene blue and Rhoda mine B are recorded and a case study on the degradation of butachlor using Degussa-25 is discussed briefly. While degradation, a new byproduct, *i.e.*, carboxylic ions (such as acetate and formate) was also found but later on, after undergoing photo-Kolbe's reaction, CO_2 was formed along with regenerated TiO_2. Here, peroxide ions played a major role in degradation as due to the presence of common salt, there was a competition to occupy the active holes of TiO_2. Hence, OH• became non-selective.

Keywords: Additives, Green technology, Photo catalyst, Pollutants, Titanium dioxide.

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INTRODUCTION

One of the biggest challenges being faced by human society is the depletion of potable water, which is paramount to the existence of life. Rapid industrialization and overpopulation have led to the generation of copious amounts of wastewater.

It is a complex matrix containing pathogens, priority pollutants (organic or inorganic compounds), nutrients (nitrogen, phosphorus, *etc.*), suspended solids (soil, grits), and biodegradable organics. Numerous techniques have been applied to eliminate pollutants during wastewater treatment. Out of them, photocatalysis, an advanced oxidation process (AOP), is highly considered as it is a green technology that implements the oxidation of organic pollutants using light irradiation. Moreover, it offers several advantages such as being cost-effective, temperature stable, freedom to design catalysts for specific wastewater compositions, and is highly efficient. The mechanism underlying photocatalysis is the conversion of photon energy to chemical energy. This process involves a photocatalyst that absorbs the photon energy to give off electrons by excitation. This generates an electron-hole pair which helps in the formation of products (chemical energy). Semiconductor photocatalysts are preferred as they have electrons and electron holes as free charge carriers which can be involved in redox reactions. TiO_2 (a light-sensitive semiconductor) is specifically favored as the photocatalyst due to its efficient photo activity, environmental friendliness (nontoxic substance), low cost, and stable nature. It can catalyze photoinduced redox reactions that are useful for the degradation of volatile organic compounds (VOCs). Titanium dioxide is an inorganic compound obtained from Ilmenite ore (idealized formula- $FeTiO_2$) which contains around 45 to 60% TiO_2. Pure TiO_2 is obtained either from the ore or an enriched derivative called titanium slag [1 - 5]. It exhibits polymorphism and exists in three crystalline phases, namely- anatase, brookite, and rutile. In all of its three phases, it exhibits an octahedral geometry. Herein, the 3 titanium centers are bounded by 6 oxide anions. The anatase phase is more photo-catalytically active than the rutile. Degussa P25, a combination of 70% anatase and 30% rutile, are suggested for use as a photocatalyst. TiO_2 has the potential to degrade environmental pollutants by photocatalysis. In water, it generates hydroxyl radical, a reactive oxygen species (ROS). Hydroxyl radicals are powerful oxidizing agents. They cause cell lyses and damage to nucleic acids and proteins in microorganisms. TiO_2 chelates heavy metals and oxidizes organic compounds into nontoxic compounds- CO_2 and H_2O. However, a wide band gap of 3.2 eV restrains its ability to absorb solar-terrestrial radiation in the UV range. Approximately, only 5% of the solar spectrum accounts for UV radiation. Moreover, its photo-catalytic activity gets restricted by the swift recombination of electron-hole pairs. TiO_2 during wastewater treatment shows decreased affinity towards organic pollutants (mainly hydrophobic organic pollutants). The presence

of inorganic salts decreases the photocatalytic efficiency of TiO_2. To overcome the above-stated issues, TiO_2 undergoes modifications to strengthen its photo-catalytic properties. It is done by different methods such as doping, fabrication of composites, surface modification, *etc.* Photocatalytic activity is significantly enhanced by increasing the surface area of TiO_2 as more particles get exposed to the solar spectrum. Therefore, titanium dioxide nanoparticles are used in wastewater remediation. ZrO_2-TiO_2 doping slows down electron-hole pair recombination, strengthens the material, and increases the surface area. Nanocomposites such as magnetic 3D TiO_2@HPGA (Hierarchical Porous Graphene Aero gels) can facilitate the processes of mass and charge transfer. Their magnetic properties can be used to separate them from wastewater by applying an external magnetic field. TiO_2@HNT improves the light absorption properties of TiO_2. HNT or hallo site nanotubes are alumina-silicate clay minerals. Fe-doped TiO_2 helps in the degradation of 4-tert-Butylphenol, which is carcinogenic to humans, plants, and animals. To narrow the band gap of TiO_2, non-metal doping by sulfur has been used, which intensifies the photo catalytic activity. 3D sulfur-doped TiO_2, also known as eco-TiO_2, is used for this purpose [6 - 8].

STRUCTURE AND SYNTHESIS OF TITANIUM DIOXIDE

Structure

Titanium dioxide is a molecule with a bent structure. The bond between oxygen and titanium is covalent. The bond length is 1.635Å and the bond angle of 111.75 degrees. The oxidation state of titanium is 4+ here. TiO_2 nanoparticles are approximately less than 100 nm in diameter. Titanium dioxide has three phases of crystalline structure, they are

• Anatase: it has a yellow or blue hue if impurities are present, otherwise it is usually white or colorless. It is more active compared to rutile and brookite. It is a polymorph of titanium dioxide. The structure of anatase is a tetragonal crystal structure. It is not optically active and has a metallic appearance. It is metastable at all temperatures and pressure. It is the first phase of polymorphism that is anatase as it has low surface energy. The anatase phase is more photo-catalytically reactive than rutile. Degussa P25 is a combination of 70% anatase and 30% rutile. It is suggested to be used as a photocatalyst over others.

• **Rutile**: It is the most abundant of the three naturally occurring forms of titanium dioxide. It has a reddish-brown hue and a hard metallic crystalline structure. It is often surrounded by other minerals. It is synthetically prepared by the flame-fusion method; this rutile is majorly used as gem as it has a high refractive index and shows the brilliance of a diamond. It also has a tetragonal structure but a little

CHAPTER 24

Bioplastics for Sustainable Development: An Eco-friendly Approach

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Abstract: Plastics are primarily composed of polymers and contain additives that allow them to inherit properties like durability, thermal insulation, electrical insulation, and density. Studies have shown that approximately half of all conventional synthetic polymers in the market are used as short-term products, during disposal, they end up in landfills and oceans where large amounts of plastic are washed ashore, sinked or floated, and fragmented into micro plastics which can harm and kill various organisms before making their way through the food chain. The term bioplastic is an abbreviation for bio-based polymers. A bio-based polymer can be shaped by components that stem from an organic source or its derivatives. In this paper, we will discuss the types, production, advantages, and disadvantages and applications of bioplastics.

Keywords: Bioplastics, Biodegradable, Cellulose-based plastics, Polymers, Starch-based plastics.

INTRODUCTION

Plastic has been around in the environment for the past few decades, extending into the last century, it is unanimously regarded as the most versatile and widely used material for packaging and storage across the world. Plastics are primarily composed of polymers and contain additives that allow them to inherit properties like durability, thermal insulation, electrical insulation, and density. Furthermore, they are also resistant to heat, organic solvents, and microorganisms.

Studies have shown that approximately half of all conventional synthetic polymers in the market are used as short-term products, during disposal, they end up in landfills and oceans where large amounts of plastic are washed ashore. Plastic sinks or floats and is fragmented into microplastics which can harm and kill various organisms before making their way through the food chain. Durabi-

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lity, which is deemed the most notable property of plastics, is also its biggest downfall. Today's society holds an inherent ambivalence towards conventional plastics as they have brought about a dire environmental crisis which turned into a leeway for the advent and popularization of bioplastics [1 - 5]. As a bypass to the traditional plastics, a modified bio-based option that is more environmentally safe, is now viable in the market. The term bioplastic is an abbreviation for bio-based polymers. A bio-based polymer can be shaped by components that stem from an organic source or its derivatives. The parent material which makes up the bioplastic includes organic sources that can be reobtained such as oils, fats, wood chips, saw dust and reprocessed garbage. Polysaccharides and proteins such as gluten, chitosan, and cellulose are processed directly into bioplastics. Meanwhile, others are generated biologically through the fermentation of sugars or lipids from plants or animals and alternatively, we have chemically synthesized bioplastics from sugar derivatives or lipids.

HISTORY

As early as 1500 BCE, people belonging to Meso-American cultures were using natural latex and rubber to make containers and waterproof clothes. The Great London Exhibition held in the year 1862 witnessed the first ever thermoplastic called Parke sine invented by Alexander Parkes and it was obtained from nitrocellulose. It was found to possess high flammability. German chemists 35 years later in 1897 created milk-based bioplastics called 'Galalith' which to date can be seen in buttons. Leo Baekeland received the National Historic Chemical Landmark for regulation, according to a 2016 experiment. The year 2018 saw numerous inventions in the field of bioplastics. 'Project Effective' was launched with the purpose of replacing nylon with bio-nylon, the first bioplastic car prototype was made, and the first packaging of fruit was also made [6 - 8].

CLASSIFICATION

The widely accepted definition of a bioplastic is a polymer that is biodegradable or produced from biological components (bio-based) or one which can be both. This highlights the fact that not all bioplastics are biodegradable or bio-based. Certain plastics such as PBAT that is non-bio-based, are biodegradable. There are plastics that are manufactured from bio-based sources, but the process of polymerization turns them into non-biodegradable plastics.

Bioplastics can be classified based on the source of their monomers into:

• **Polysaccharide-based bioplastics** - This category of bioplastics has shown that they can easily withstand mechanical stress, high temperatures, structure, rigidity, long life span, and distinctive optical characteristics.

• **Cellulose-based plastics**: Primarily comprised of cellulose esters like nitrocellulose, cellulose acetate, and other derivatives (celluloïd). They are mostly preferred because of their low density, non-abrasive, combustible, nontoxic and low-cost properties, but extensive chemical modification is needed to induce thermoplastic behaviour which leads to an environmental footprint of these materials and reduces their biodegradability.

• **Starch-based plastics:** They possess qualities like hydrophilicity, cost-effective nature, abundance, and renewable characteristics. The brittle nature of starch-based bioplastics makes them unsuitable for engineering. During the process of plasticizing starch, plasticisers can be used and some examples of the plasticizers used are glycol, glycerol, and sorbitol. By fixing the amount of these additives, this type of plastic can be customized to meet customer needs.

• **Alternative polysaccharide-based plastics:** Apart from the generally used polysaccharides that can be processed into plastics, including chitosan and alginate. A dissolvable material, chitosan, is also an effective film-forming material and dissolves easily in mild acidic conditions. By blending with acid, it can be processed into plastic by thermo-mechanical methods. Examples include: starch/polylactic acid, starch/Ecoflex, and starch/polycaprolactone blends.

• **Protein-based plastics:** In addition to using proteins from different sources, bioplastics are also made from wheat gluten and casein, which are useful raw materials for different biodegradable polyesters. The use of soy protein in the plastic industry goes back to over a hundred years; it is considered yet another source of bioplastics. As soy proteins are hydrophobic and are relatively expensive, their usage in bioplastic processing is impractical; however, making blends of soy protein with a number of biologically degradable polyesters can alter their sensitivity to water and make them more cost-effective.

ALIPHATIC POLYESTERS

(a) Polylactic acid is a type of transparent plastic that is derived from maize or dextrose. As it is of plant origin, it is susceptible to degradation, but it shows efficient performance under high temperatures and prevents the formation of air bubbles across the membranes. It is an omnipresent plastic filament and can be seen in the manufacture of fibers, films, cups, plastic containers, and bottles.

(b) Poly-3-hydroxybutyrate is a type of polyester that is obtained from microorganisms that process polysaccharides and wastewater.

(c) Polyhydroxyalkanoates, are made by the fermentation of polysaccharides and fats by a microbial consortium. PHAs act as food vacuoles in bacteria where they

CHAPTER 25

NanoRemediation: Novel Approach for Environmental Cleanup

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Abstract: Nanotechnology is an advanced emerging science that has application in mostly the fields of industry, environmental issues, biotechnology, health, and medicine. NanoRemediation is a technique that uses nanoparticles for bio remediation. It is mainly used to treat wastewater soil, contaminated environmental materials, groundwater, and sediments. In this technology, nano titanium dioxide or non-toxic nano particles are used. In essence, chlorine-containing organic waste is removed using nano remediation. Although this method is a good technology, it is still present in investigational stages and has been applied mostly in laboratories.

Keywords: Ground Water, Nano remediation, Nano particles, Nano titanium dioxide, Waste water.

INTRODUCTION

Many activities such as refining oil, pharmaceutical production, and plastic production can negatively impact the environment. The pollutants from these methods can be toxic, reactive, and damaging to the environment and to human health too.

Remediation methods include water “pump and treat” and soil excavation. These repair methods may cost a lot of money and can be intrusive. Therefore, nanotechnology can act in a lot of areas such as healthcare, energy, industry, electronics, and the environment. NanoRemediation is the process of

i. First, nanoparticles will contact with the contaminant.

ii. After that, it will detoxify the contaminant.

iii. At last, it will immobilize the contaminant.

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The targeted materials removed by using nanoparticles are pesticides, organic solvents, heavy metals, and pharmaceutical waste. Here, when the nanoparticles contact with the contaminant, they will degrade the contaminant or sequester and immobilize the contaminant. Not only that, some nanoparticles can absorb the pollutants on their surface and redox reactions occur and once this happens, we can filter out the contaminants [1-5]. The most commonly used materials for remediation can be nano zerovalent iron or titanium dioxide. The two materials act through the redox reaction mechanism. These reactions help to convert the toxic substances into non-toxic forms by [6-8].

1) Dichlorination of organic solvents.

2) Transformation of fertilizers.

3) Detoxifying pesticides.

4) Immobilizing metals (*Eg*: Ar)

PROPERTIES OF NANOREMEDIATION SOURCE

Magnetic iron nanoparticles can absorb onto the surface of contaminants and therefore we can filter them out and can treat the water asshown in Table **1**.

Table 1. Nanoremediation Source.

Particle Name	Type of Nano Particles	Target Contaminant	Process for Contaminant Removal
1) Carbon- Iron	Nano scale zero valent iron (Nzvi)	Halogenated organics	Adsorption+ Reduction
2) Fer MEG12	Nano scale zero valent iron (Nzvi)	Halogenated hydrocarbons (*eg*: chloromethane)	Reduction
3) NANOFER255	Nano scale zero valent iron (Nzvi)	Halogenated hydrocarbons and heavy metals (*eg*: chloromethane)	Reduction
4) NANOFER STAR	Nano scale zero valent iron (Nzvi)	Halogenated hydrocarbons and heavy metals (chloromethane)	Reduction
5)Nano Goethite	Iron oxide nano particles	Heavy metals and organics (*i.e.*- pesticides, fertilizer)	Oxidation + Adsorption of heavy metals

Italy, the USA, Taiwan, and Canada make use of these above nano particles for remediation. Although they are very useful, there are certain challenges in nano remediation:

1) Nanoparticles do not cause harm to other organisms.

2) They react with the soil, sediments and groundwater and ensure that the nano particles do not disperse.

Moreover, nanoremediation can be called a cost-effective and efficient method to remove harmful materials from groundwater and soil, which is also beneficial to environmental outcomes. Environmental pollution is an undesirable factor that causes harmful conditions for living organisms. Water, soil, and air are the 3 sites for environmental contaminants.

Disadvantages

1) Not cost-effective.

2) Toxic material production.

3) Not effective.

Nanoparticles are small and unique in size, therefore, they can combat environmental pollutants. *Eg*: titanium, carbon nano tubes, titanium dioxide, and metal oxides [6-10]. Due to the lower size and higher surface area, they have higher reactivity, therefore they can be used in the bio-remediation as shown in Table **2**.

Table 2. TiO_2 (Titanium dioxide).

	Common Characteristic Properties like	**Advantages**
TiO_2 (Titanium Dioxide)	1. Semi conductivity 2. Photocatalyst 3. Electronic property	1) Less expensive 2) Easily available 3) Low toxicity

Synthesis of Titanium Dioxide

1) Sol-gel technique

2) Sol-method

3) Hydrothermal method

4) Chemical method

5) Vapour deposition method.

CHAPTER 26

Pioneering Technique to Mitigate Environmental Contaminants Involving Bioremediation

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Abstract: Bioremediation is a type of biodegradation that involves the phenomenon of biological transformation of organic compounds by living organisms. Biodegradation mainly involves the conversion of complex organic compounds into simpler and non-toxic compounds. Bioremediation is a natural and genetically engineered technology that involves cleaning up polluted air, water, and soil using various forms of life such as bacteria, fungi, fishes, algae, animals, and plants. Bioremediation includes biotransformation which is the incomplete biodegradation of organic compounds and it is employed for the synthesis of commercially important products by microorganisms. The other names which can be used for bioremediation are biotreatment, bio-reclamation, and biorestoration. Bioremediation is mainly used for the degradation of xenobiotics. Xenobiotics are substances that are man- made or synthetic that take a very long time to degrade. They are also known as recalcitrants. Some examples of recalcitrants are pesticides, herbicides, refrigerants, solvents, and other organic substances. Accumulation of these substances in soil, water, air, and water causes so many problems. Therefore, we can use bioremediation to remove these chemicals from the environment. So it will be a very good solution for the environmental problems caused by toxic chemicals.

Keywords: Bioremediation, Biodegradation, Biovolatization, Bioaccumulation, Contaminants.

INTRODUCTION

Environmental pollution is a major problem that has been faced by most of the countries in the world. After the industrial revolution, the rate of environmental pollution has increased because most countries are now industrialized and the use of fossil fuels, chemicals, and plastics increased. Burning of fossil fuels leads to air pollution and the release of fossil fuels to water bodies and ocean leads to water pollution because it is very toxic to aquatic organisms. The use of chemical

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fertilizers, pesticides, and weedicides causes so many problems for all organisms including humans, animals, plants, and microorganisms [1 - 5].

When we add these chemicals to the soil, they will directly affect the soil by accumulating in the soil and causing pollution. Not only the soil, they also affect the groundwater and directly come in contact with humans through consumption, thereby leading to so many health problems like kidney diseases and cancer. Moreover, due to this, aquatic organisms face various difficulties and they will die because these chemicals are very toxic to both plants and animals. When these chemicals enter the soil, the animals that are helpful for our agriculture will also be harmed. Therefore, the fertility of the soil is also lost. Infertility of soil leads to so many problems. From this, we can see that environmental pollution due to these toxic chemicals has become a global threat. Therefore, we have to find a solution to this problem. For this, we can use bioremediation as a solution to this problem. It is an environmentally friendly and easy method to remove toxic and non-biodegradable pollutants from the environment. Using microorganisms for bioremediation is a new trend that has been introduced by environmental specialists. The predominant microorganism that is used for bioremediation *is Pseudomonas.* But some other microorganisms like *Rhizobium, Mycobacterium, Alcaligenes,* and *Nocardia* are also used. Not only microorganisms but also animals, plants, and algae can be used. There are different types of bioremediations based on the site of cleaning, biological origin, and the type of organisms [6 - 8].

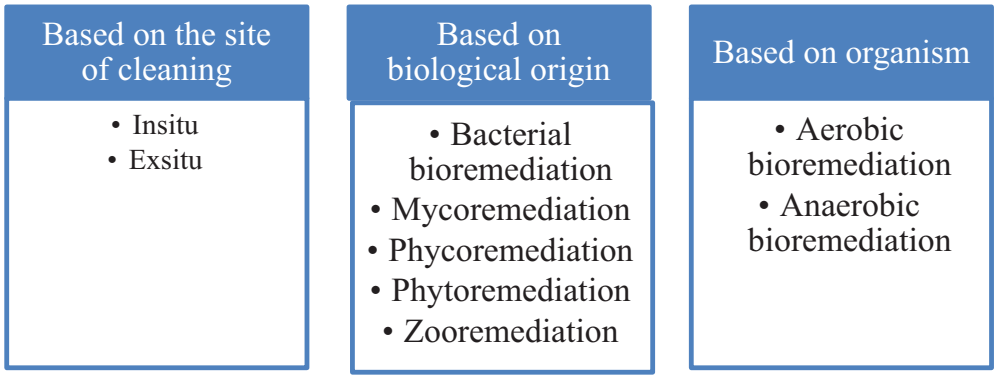

Fig. (1A). Bioremediation.

There are several factors affecting bioremediation which depends on the chemical nature of the degradable substance, the ability of the organism, nutrient and oxygen supply, temperature, and pH. If we take aliphatic compounds, they degrade easily compared to aromatic compounds and are difficult to degrade due

to the presence of cyclic structures and long-chain or branched compounds. Water-soluble compounds are easily degradable. Particular strains of an organism can degrade one or more compounds. Sometimes the synergistic action of two or more organisms will be more efficient in bioremediation. This is known as the consortium of microorganisms for biodegradation. As an example, the insecticide parathion can be degraded more efficiently by the consortium of *Pseudomonas aeruginosa* and *Pseudomonas stulzeri.* But in general, the degradation of these pollutants is not advantageous for the organisms. These pollutants cannot act as a source of energy or a source of carbon for the organism. Recalcitrant like pesticides, weedicides, synthetic polymers, refrigerants, and toxic organic compounds cannot undergo degradation because of some reasons.

These are some examples of pollutants that can be degraded by certain microorganisms as shown in Table **1**.

Table 1. Microorganism.

S: No	Microorganism	Pollutant Chemicals
1	*Pseudomonas sp.*	Aliphatic and aromatic hydrocarbons, alkyl amino oxidizes, alkyl ammonium, benzene, naphthalene, anthracene, xylene, toluene, Malathion, organophosphates
2	*Mycobacterium sp.*	Benzene, branched hydrocarbons, cycloparrafins
3	*Alkali genes sp.*	Polychlorinated biphenyls, alkyl benzene, halogenated hydrocarbons
4	*Corynebacterium sp.*	Halogenated hydrocarbons, Phenoxy acetate
5	*Cunninghamalla*	Polycyclic aromatics, polychlorinated biphenyls

Microorganisms carried out bioremediation through various metabolic effects. Some of them are detoxification, activation, degradation, conjugation, *etc.*

a. Detoxification: The process of microbial conversion of toxic compounds to a non-toxic one.

b. Activation: Compounds that are nontoxic or less toxic substances may be converted into toxic ones.

c. Degradation: Conversion of complex compounds to simpler compounds that are harmless.

d. Conjugation: The process where the conversion of simple compounds to more complex substances takes place.

Mainly bioremediation is used to degrade xenobiotic or synthetic substances which take a long time to degrade. There are many sources of xenobiotics.

CHAPTER 27

Research Challenges in Renewable Energy Sources

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Abstract: Today, the main driver of socioeconomic development is energy. However, the interest in renewable energy is important because of the increasing level of environmental concern. Due to the ongoing depletion of fossil fuels, this alternative energy source is steadily growing in popularity. It is the energy that is derived from the sun, wind, rain, *etc*. Solar energy has one of the greatest potentialities for conversion into electric power among unconventional, renewable energy sources. To improve efficiency, a solar system should produce as much electricity as possible. So we keep the solar panels aligned with the sun for optimum power production. This chapter discusses the production of electricity from solar energy. By appropriately positioning the panel in line with the position of the sun, the suggested method assures the maximum efficiency of the conversion of solar energy into electricity.

Keywords: Electric vehicle, PV and MPPT, Renewable source, Solar.

INTRODUCTION

The relationship between man and the sun is long-standing, and the sun has had a significant impact on human history. Even some ancient civilizations believed in the mystical power of the sun. Hsieh (1986) claimed that the sun undergoes a massive nuclear reaction that converts four million tonnes of hydrogen into helium per second. Only a very small portion of the energy produced by the sun will reach the Earth. For the sun to remain structurally stable, the energy it radiates must match the energy it creates. The relative constancy of the earth's surface temperature serves as a proof of this stability throughout the last 3 billion years. The earth's orbit around the sun is slightly elliptical, causing the distance between the two to change over the course of the year. The earth and sun are 91.4 million miles apart in January compared to 94.5 million miles apart in July; this results in an annual disparity of 3%-4% in the irradiance at the edge of the

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atmosphere. Oxidized sediments and fossil remains show that the water fluid phase has been present throughout this time. Even though the amount of energy that the earth gets from the sun is really little, there is still a tremendous amount of energy there. The rate at which the earth receives radiation is 1.73 1017 J/s, and the total amount of radiation in a year made up of 365.25 days is 5.46 1024 J. At sea level, about 1 kW/m^2 of energy is received, according to Boylestad and Nashelsky's study in 1996. All currently utilised energy sources and how they are used by humans have significant ties to the sun [1 - 5].

As the price of fossil fuels fluctuates, renewable energy is quickly gaining prominence as an energy source. Therefore, it is crucial for engineering and technology students to understand and value the technologies related to renewable energy at the educational level. Solar energy is one of the most widely used forms of renewable energy. The most abundant source of energy is solar energy. Both directly and indirectly, it is accessible as solar insolation and wind energy. Electromagnetic radiation is one form of energy that the sun emits. Its potential is 178 billion MW, or roughly 20,000 times more energy than the world needs. Some of the solar energy evaporates some water, which results in rain and the formation of rivers and other things. Some of it is used in the process of photosynthesis, which is vital to the survival of life on Earth. Since the beginning of time, man has attempted to harness this limitless source of energy but has only been able to access a tiny portion of this energy up until this point [6 - 10].

Numerous studies were carried out to create some techniques to raise the effectiveness of solar panels. A solar panel tracking system is one such approach. This paper discusses a microcontroller-based sun-tracking system. Because the solar panel can always be kept perpendicular to the sun's rays, solar tracking makes it possible to generate more energy. Since several years ago, tracking systems for solar panels have been under development. It is desirable to have the solar panels that monitor the sun's position as it crosses the sky throughout the day, ensuring that the panels are always perpendicular to the solar radiation emitted by the sun. This will probably increase how much electricity the system absorbs. There are three main ways to increase the effectiveness of PV systems. The first strategy is to boost solar cell production efficiency; the second one is associated with energy conversion systems that use maximum power point tracking (MPPT) management algorithms; and the third strategy is to use solar tracking technology to capture the sun's energy to the fullest [11 - 15].

RENEWABLE ENERGY SOURCES

In this study, we generate power using a sun-tracking device. In this study, a light detection sensor detects the amount of sunlight and converts it into energy, with

intensity closely correlated with output. Using a stepper motor and microprocessor, the solar panel rotates in accordance with the position of the sun. Currently, solar electric power generating systems use fixed solar panels with low generation efficiency. The paper's objective is to add solar tracking to the already installed fixed solar panels, keeping a constant maximum power production. Thus, we may improve the conversion efficiency of solar electric power production by employing this tracking system. We utilize a PIC microcontroller for solar tracking for this purpose.

The expanding need for energy, the ongoing depletion of fossil fuel reserves, and the growing concern about environmental contamination have propelled humans to research new methods for producing electrical energy from clean, renewable sources, such as solar energy, wind energy, and others. Solar energy has considerable potential for conversion into electrical power, able to provide a significant portion of the world's electrical energy demands. Solar energy is one of the non-conventional renewable energy sources. Solar energy is free, almost limitless, and emits no harmful byproducts or greenhouse gases. The fundamental and most common unit of measurement for all natural and human labour is energy. It is primarily a gift from nature to humanity in many ways. The amount of energy used directly relates to how far humanity has come. As the world's population continues to expand, humankind's quality of living rises, new nations industrialise, and the need for energy grows daily. Although fossil fuels are the main source of energy, their limited supply and the extensive environmental damage brought on by their widespread use, particularly in the form of acid rain, urban air pollution, and climate change, strongly support the use of renewable, environmentally friendly, and nonconventional energy sources.

A power plant with a steam-powered main engine is known as a thermal power station. Steam is created when water is heated, and the steam turbine spins and then powers an electrical generator. The steam is used for many purposes; it is known as a Rankine cycle when the heated fluid is condensed in a condenser and returned to the heating source. The many fuel sources are responsible for the biggest diversity in the design of thermal power plants. Because these facilities transform various sources of thermal energy into electricity, some people prefer to use the phrase “energy centre.” In addition to producing electricity, some thermal power plants also provide heat energy for desalination of water, district heating, or industrial uses. Thermal power plants that burn fossil fuels are a major source of human CO_2 emissions, although many varied and extensive efforts are being made to minimise these outputs.

A solar tracker is a tool used to direct solar photovoltaic panels, daylighting reflectors, and focusing solar reflectors or lenses toward the sun. As the sun

CHAPTER 28

Recent Trends in Renewable Energy Sources, Challenges and Opportunities

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Abstract: A particular region's rapid industrial development necessitates the construction of numerous facilities. These include, in particular, production, warehouse, and commercial buildings along with office and social structures and the necessary supporting infrastructure. New industrial facilities must be built in expansive areas that are suitable for this kind of development. It goes without saying that the majority of locations with favourable ground conditions and location have already been developed, necessitating the implementation of this type of investment in less desirable locations. Due to the specific implementation challenges caused by this, it is necessary to properly improve and prepare the subsoil in order to construct the buildings and other objects that make up the entire investment safely.

Keywords: Energy, Industry 5.0, Monitoring, Contamination and Policy.

INTRODUCTION

Chemical contamination is a common issue, despite the fact that most postmining dumps, when properly treated, can have very good strength and deformation properties. Dump sites frequently contain hazardous chemicals that can endanger people. Additionally, groundwater contamination is frequently seen. In this situation, the dangerous substances must be removed. Of course, it must be kept in mind that the environmental requirements for industrial areas are less stringent than those for sites designed for residential construction or outdoor spaces. Self-ignition is yet another issue with post-mining land reclamation. The risk of spontaneous combustion exists due to the presence of coal in the form of various granules and other materials (such as pyrite). In order for this to happen, the supportive content of dumps, embankments, or ground-cavity fillings need to

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have access to oxygen (*e.g.*, contained in the air). Then endogenous fires start, posing a serious threat to the nearby population's safety. Investments in these areas can result in significant material losses.

The aforementioned circumstances highlight the demand for proper ground recognition in regard to industrial investments in such regions. There is a need to conduct specialised tests in addition to the conventional *in situ* tests used on a subsoil made up of native soil, such as drilling, sounding, and laboratory testing of the collected samples. Examples include thermal tests, soil, and water chemical tests, analyses of the negative effects on steel or reinforced concrete structures embedded in the ground, and other tests based on which it will be possible to determine potential impacts on the future object. Such specialised tests, such as large-scale test loads, can give a realistic picture of the characteristics of the soil medium, based on which it will be possible to predict the behaviour of an object located on soils characterized by high heterogeneity, and in terms of the strength and deformation properties of the soil medium [1 - 5].

For investment in the development of postmining areas, appropriate soil improvement will be necessary. It should be noted that a full soil replacement is not practical due to the prohibitively expensive costs (large amounts of soil would need to be removed and replaced with developed grounds, like construction embankments), as well as the grave environmental consequences. In order to properly prepare the subsoil beneath the foundations while leaving the soil in its original location, it is crucial to use effective methods of soil improvement. In all areas of production, the demand for biodegradable and renewable products is rising, and the enormous amount of emissions produced by the fuel industry presents a challenging problem that needs to be addressed. A sustainable energy source known as biodiesel is produced using lipids derived from the biomass of plants, animals, or microbes. In order to find the most environmentally friendly way to produce and use biodiesel, the industry has gone through several stages of development. The best sources and procedures have been tested, and the solution is steadily but surely getting closer.

Initially, it was planned to use plants like corn, sugar beets, and palm trees as the primary raw materials for biofuel production. Plant cultivation reduces productivity in terms of g/L/day because it needs arable land and time to grow. Additionally, this method was not sustainable due to the fact that it needs a lot of fresh water for plant growth, which is a problem due to the global food shortage. Although fresh water is not necessary for the production of lipids by microorganisms, it can do so under a variety of conditions. Following this revelation, the use of oleaginous microorganisms as a source of lipids became popular. Scientists from all over the world have recently become interested in

these microorganisms as a potential source of renewable bioenergy, and a variety of other highly valuable ingredients for the pharmaceutical, nutraceutical, food, and cosmetic industries, including omega-3 fatty acids (DHA, EPA), pigments (astaxanthin, lutein, and squalene), vitamins, and proteins. It is known that microorganisms naturally produce lipids. Some of these oleaginous microorganisms accumulate more than 20% weight of lipids. These microbes are capable of producing the majority of fatty acids, including saturated, monounsaturated, and polyunsaturated fatty acids with short hydrocarbonated chains (C6) to long hydrocarbonated chains (C36). Whether lipids produced by oleaginous microorganisms are used as a feedstock for biodiesel production or as nutraceuticals depends on the fatty acid composition. While microalgae bacteria and yeasts produce the majority of lipids, throustochytrids, fungi, and some microalgae are well known for producing very long-chain PUFA.

Oleaginous yeasts and microalgae are beneficial microorganisms for the synthesis of lipids, among other things. There are various types of oleaginous yeasts in the genera Yarrowia, Candida, Rhodotorula, Rhodosporidium, Cryptococcus, Trichosporon, and Lipomyces, some of which can accumulate lipids up to 80% w/w of their dry cell weight. These oleaginous yeasts' lipid metabolism is also well-known. Oleaginous yeast strains have been grown on a variety of waste materials and nonedible lignocellulosic biomass without competing with food sources in an effort to increase the economic viability of microbial lipid production. For instance, Rhodosporidium toruloides-1588 was grown on a hydrolysate of hardwood and softwood sawdust that had not been detoxified in order to produce lipids as a feedstock for biodiesel production. In another instance, Candida tropicalis produced lipids when grown in wastewater from an olive mill.

In contrast to plant cultivation, the growth of microalgae can be scaled up easily in fermenters or bioreactors. Microalgae can grow in a variety of ways, including *via* autotrophic, heterotrophic, mixotrophic, and photoheterotrophic modes of nutrition. In an autotrophic environment, microalgae produce biomass and valuable metabolites using an inorganic carbon source and energy from photosynthesis, whereas, in a mixotrophic environment, organic carbons take the place of the inorganic carbon source. Some microalgae can grow under heterotrophic conditions by using an organic carbon source in darkness rather than an inorganic carbon source and light. Chlorella can easily be grown in nonedible lignocellulosic biomass or waste materials obtained from industrial sources. Microalgae can convert 9 to 10% of solar energy into biomass in autotrophic cultivation, with a theoretical yield of about 77 g/m2/day, or 280 tons/h/year. This yield may be slightly lower in large-scale outdoor or indoor cultivation.

CHAPTER 29

Industrial Internet of Things: A Transformation

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Abstract: In recent years, the IIoT has piqued the interest of academic and industrial researchers. When IT was combined with industrial automation and control systems, the term IIoT was coined. It provides an integrated development environment for businesses to create intelligent interconnected systems that leverage a variety of IoT devices to connect the cyber and physical worlds with greater availability and scalability. IIoT includes networked smart electricity, industrial, medical,, and transportation. In terms of technology, Consumer IoT and Industrial IoT are not similar. In this chapter, the evolution of industry, recent research, and applications in IIoT are discussed. This chapter aims to assess the current state of IIOT in the current context and make some research recommendations for future researchers.

Keywords: Business, Consumer, Environment, IoT, IIoT, Industry.

INTRODUCTION

The IIoT is a broad category of IoT. The IIoT is the application of the IoT to industries such as manufacturing, oil, and gas industries. Other names for it include Industrial, Internet, and Industry 4.0. The fourth industrial revolution, often known as Industry 4.0, is the trend in manufacturing technologies that emphasises automation and data sharing. It is a collection of computers, smart gadgets, and sensors that collect and share massive amounts of data. This collected data is transmitted to a central cloud server known as a Data Center, where it is combined with other data and then presented to the end users using graphics so that it is an easy-to-understand language. The IIoT will transform manufacturing by allowing it to capture and access a vast amount of data at a far faster rate and at a more efficient rate than ever before. A number of forward-thinking organisations have begun to deploy IIoT in their factories by employing intelligent and linked devices. The evolution of the industry, the research, and applications of IIoT are discussed in the upcoming sections.

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INTERNET OF THINGS (IOT)

IoT is a network of physical devices or objects connected to the Internet and has sensors embedded in them. These gadgets are used to communicate data from one device to another, without the need of human-to--to-machine interaction or human-to--to-human interaction. The Internet Protocol (IP) address is used to identify the device connected to the Internet in the IoT [1]. Those devices are utilised on a daily basis. The integration of a number of communication technologies is required for the deployment of an IoT application. Some of the most critical challenges that IoT developers face are confronted with include a power supply for devices, identity, addressing, scalability, security, and standardisation.

Several IoT products and services have already been released. As a result, IoT is fast evolving now-a-day. According to this report, 35 billion IoT devices were installed by 2021 and 75 billion will be installed by 2025 globally. On the other hand, the impact of IoT is not limited to the value given by certain linked items. When a device is linked to other devices, it becomes a part of a network and its potential can be enhanced even further. At this juncture, the IoT's future is bright and expectations are high, and Major challenges need to be addressed, not just technologically but also financially, as the newly introduced linked device increases the number of critical strategies and difficulties.

Since IoT solutions are fast growing in almost every facet of daily life, there are many IoT applications that have been developed. Smart industry, intelligent production systems, and networked production sites are some of the major areas of application covered under the term Industry 4.0.

INDUSTRY

The industry is the sector of the economy that produces highly automated and mechanised material products. The goods and services that industries produce are generally categorised as automobiles, textiles, food services, and mining. To convert raw materials into a finished product through manufacturing, the industries require input raw materials from other industries along with the input from economy. The level of industrial production is the leading predictor of the economic health of a country.

EVOLUTION OF INDUSTRY

Industry 1.0: (1784)

During the 18th century, the introduction of steam power and mechanisation of industry ushered in the First Industrial Revolution. The amount of time it took to create threads with simple spinning wheels, the mechanised version produced eight times the volume. Steam's power was already well known. The use of steam power for industrial purposes was the most significant innovation in increasing human productivity. Instead of using physical power, steam engines were used to power the weaving machines. Allowing people to travel enormous distances in less time brought about even more profound changes.

Industry 2.0: (1870)

The Second Industrial Revolution began in the nineteenth century with the invention of electricity and assembly line production. During 1863-1947, a slaughterhouse was made in Chicago inspired by Henry Ford, where pigs were strung from conveyor belts and each butcher was solely responsible for a piece of the slaughtering procedure. Henry Ford applied these principles to the automobile industry, completely transforming it in the process. Previously, a full automobile was made in one location; now, vehicles are built in phases with a conveyor belt, which is significantly faster and less expensive.

Industry 3.0: (1969)

The introduction of memory-programmable controllers and computers to partially automate this process kicked off the 3rd Industrial Revolution in the 1970s. Because of technological advancements, the entire production process was automated without the need for human interaction. This was well-known in the form of robots that obey preprogrammed instructions without the need for human interaction.

Industry 4.0: (Present)

Now is the time to deploy Industry 4.0. It is defined by the use of communication and information technologies in industries. It depends on the improvement of the 3rd Industrial Revolution. Computer-based production systems that benefit from a network connection and, in some ways, have a digital twin on the Internet. These allow them to communicate with other systems as well as output data about themselves. This is the next step in the production automation process. As a result of the interconnection of all systems, "Cyber-physical production systems" have emerged.

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Prof. (Dr.) Kaushik Pal has vast academic experiences, skills and research background. He is on the editorial board of significant SCI or SCOPUS - indexed journals, and international publishers. He has reviewed around 150 articles. Prof. Pal is an expert group leader as well as the associate member of various scientific societies, reorganizations and professional bodies. He contributed around 10-plenary, 25- keynote and 30-invited lectures worldwide. As an expert group leader, he belongs to worldwide professional research collaboration and spans engaging him in many R & D Industrial organizations and national and international scientific societies.