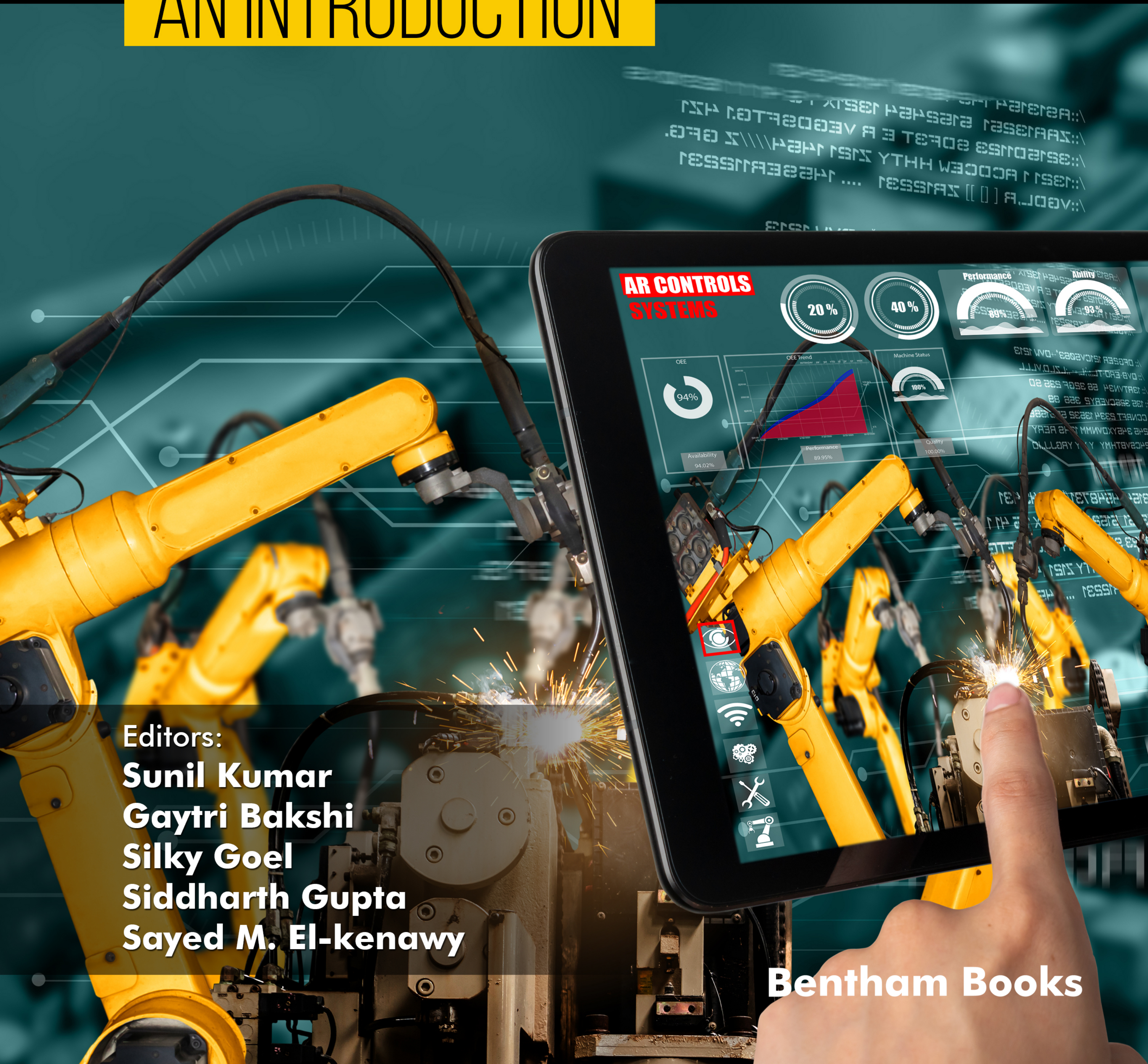
INDUSTRIAL INTERNET OF THINGS:

AN INTRODUCTION



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Industrial Internet of Things: An Introduction

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PREFACE

Machine learning approaches are highly considered in almost each application domain area. The continuous growth of computational approaches motivates the editors to work in this area. The editors worked and gather various book chapters based on the "Industrial Internet of Things: An Introduction" and selected a few chapters for this book.

The book content categorizes into various subdomains starting with an introduction to computational techniques, and the importance of computational techniques in Industrial IoT. Various challenges and issues related to computational techniques in Industrial IoT. The book also covers currently hot areas of IIoT that are mainly healthcare informatics, transportation system, *etc*. Case studies also related to designing and testing the IIoT frameworks were also highlighted. The book shared the implications of waste management for boosting the national economy. Some legal policies were also discussed before concluding the book.

The editors have good knowledge in the area of machine learning and deep learning techniques. The research interest of Mr. Sunil Kumar is deep learning in information analysis in the agricultural domain; Ms. Gaytri Bakshi is working in the area of deep learning approaches for Industrial information processing; Ms. Silky Goel has an interest in computer vision and deep learning techniques. Mr. Siddharth Gupta is keen interested in image processing with machine learning approaches. Mr. El-Sayed M. El-kenawy has been working in advanced ML techniques. This book is edited by these five editors with a good review process.

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This book is based on the flourishing aspect of IoT technology in the industrialization of the upcoming economy of India. Machine learning techniques are playing a revolutionary role in these various arenas of industry. IoT with machine learning cultivates smart industrial systems and has brought the economy, intelligence and lifestyle to yet another level. I am very grateful to have a wonderful team for encouraging each other to constantly work together and put endeavours in the correct direction. With great pride we present the book "Industrial Internet of Things: An Introduction".

We would like to thank all the reviewers who peer reviewed all the chapters of this book. We would like to thank the editorial team of Bentham Science Publishers, for their immense support in the process of publication. Finally, we would like to thank all the authors who have contributed chapters to this book. This book would have been impossible without your efforts.

We hope that this book will enlighten a reader about both technologies, their amalgamation, their applications as well as their standardization rules into the industry sector. Moreover, it will open up doors for other researchers to come up with their own ideas. Once again, we would like to thank everyone who was a part of this effort.

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DEDICATION

To all the ones who have zeal for IoT and machine learning for research and innovation.

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Industrial IoT

CHAPTER 1

Algorithms and Activation Function-IoT

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Abstract: In this new industrial era, IoT is an emerging technology. Industrialization has entered an entirely novel phase with the fusion or incorporation of deep neural network methods with machine learning (ML). Both sustainable living and economic prosperity have resulted from this. Predictive analysis has been both a boon to humanity and an improvement in the caliber of work produced. It has created an opportunity for people to improve society and assist the poor in numerous ways. IoT and ML integration enables humanity to create a single home on this planet.

Keywords: Algorithm, Activation function, IoT, ML.

INTRODUCTION

Engineering is an application that has taken into account the principles of maths and science to solve real-world problems. Humans have evolved technology with engineering to aspire to the next level of a smart and intelligent world. With the advent of technology, engineering has been given a new shape in terms of providing services as well as production. Engineering has dominated every industrial sector, such as civil, mechanical, automobile, chemical, electrical, electronics, computers, and instrumentation & communication. Technology in itself is an advanced version and the practical implementation of principles laid down by science. Scientific principles are embedded to create smart frameworks, which in turn develop smart systems. This has led to the fruition of the term Internet of Things, where the Internet as an architectural backbone connects everything within a system in terms of communication and actuation. IoT is an ecosystem that, enables humans to study and understand the physical environment in terms of digitization. The framework comprises sensors as the most atomic entity with a communicating protocol that connects the sensing node with the edge device and then later connects the entire system to the cloud. The received

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data is analyzed by applying algorithms of AI and ML to predict or perform actuation [1] (Fig. **1**).

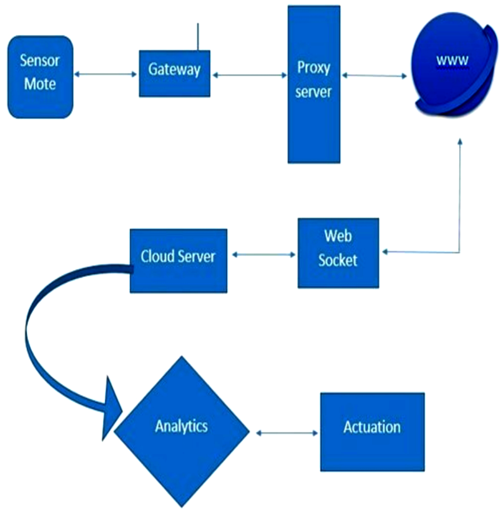

Fig. (1). IoT framework implementation [1].

IoT architecture is a layered architecture encompassing four layers, and its service-oriented architecture in each layer has multiple functionalities, as shown in Fig. (**2**).

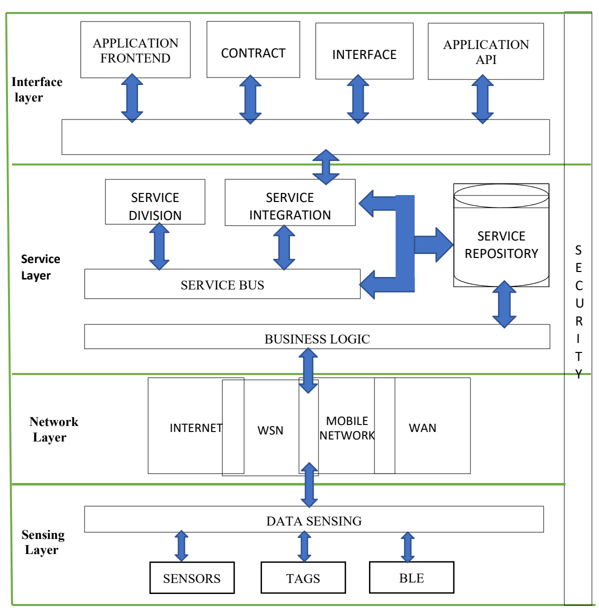

Fig. (2). Service-Oriented Architecture of IoT.

With the aim of reducing human intervention and maintaining sustainable development, IoT covers almost all the industrial sectors along with their services, as shown in Fig. (**3**).

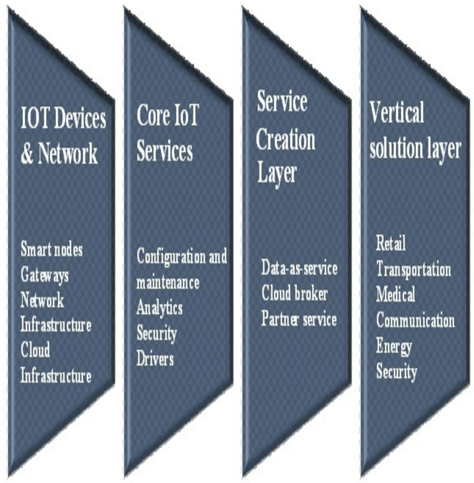

Fig. (3). IoT Service Layer.

INDUSTRIAL IOT VERSION

Almost all of the industrial sector has undergone a wider transformation with the advent and implementation of IoT. It has brought an immense revolution of modernization and intelligence to every industrial sector. In the degrading environment, the concept of sustainable development has also been inculcated. The industrial sector is now heading from version 4.0 to version 5.0 with the perceptions of smart, intelligent, and innovative solutions and services. The following sectors have different aspects of adopting IoT and embedding it with machine learning (ML) algorithms to quench public demands and develop a sustainable environment.

Building Infrastructure and Home Automation

This sector deals with creating smart setups, which include public sector buildings, urban development, and smart cities. Such cities deal with sustainable living with smart things that work independently and make life secure and easy [2]. This sector even works to develop secure devices that can continuously monitor the tensile strength of walls, bridges, and buildings [3 - 6]. The integration of ML with IoT investigates and predicts the construction outcomes with associated materials using strength models before the beginning of construction [7].

CHAPTER 2

Deep Learning-Based Prediction Model for Industrial IoT: An Assured Growth

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Abstract: Industry 5.0 is a revolutionary change for the traditional industrial domain with an amalgamation of interactive computational techniques. However, the Industrial Internet of Things (IIoT) is referred to as communication between various battery-enabled physical devices. The present IIoT sector faces issues like complex decision-making, enhancement of productivity capabilities, management of the cost of assets, uninterrupted connectivity, and security. Traditional computational techniques were partially successful in finding an appropriate solution for existing issues in IIoT. In this study, the author highlighted a deep learning-based prediction model that further assists the industry while making major decisions. This approach is currently used for various problems in agriculture, healthcare, coal and petroleum, entertainment and sports, surveillance, and retail and marketing industries.

Keywords: Artificial intelligence, Healthcare, Industrial IoT, IIoT, Machine learning, Smart industry, Smart agriculture, Smart education, Supply chain management.

INTRODUCTION

The term "Industrial Revolution" implies adopting smart ways and features that can change the workflow of traditional industries. The Industrial Revolution, which began in the late 18th century (1760-1840) with the invention of machinery such as steam engines, marked a significant milestone in human achievement. The introduction of the first weaving loom in 1784 led to the emergence of various small industries catering to both individual clients and large organizations [1]. This digital transformation, encompassing IIoT stakeholders and the application of Industry 4.0 and 5.0, has captured the attention of industry owners, spurring increased investment in the IIoT market. The market size grew to approximately $124 billion in 2021 and is poised for further growth this year [2, 3]. Such an increase in IIoT infrastructure set up by the industries further requires an intelli-

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gent data analysis system so that the streams of data generated by the IIoT devices can be processed and analyzed to derive the information that is important for the industry's growth.

As Fig. (**1**) depicts, deep learning (DL) is a division of machine learning (ML) and artificial intelligence (AI) [4]. Both machine learning (ML) and deep learning (DL) are derived from artificial neural networks (ANN), which are key technologies that form the basis of the Fourth Industrial Revolution (Industry 4.0) [5].

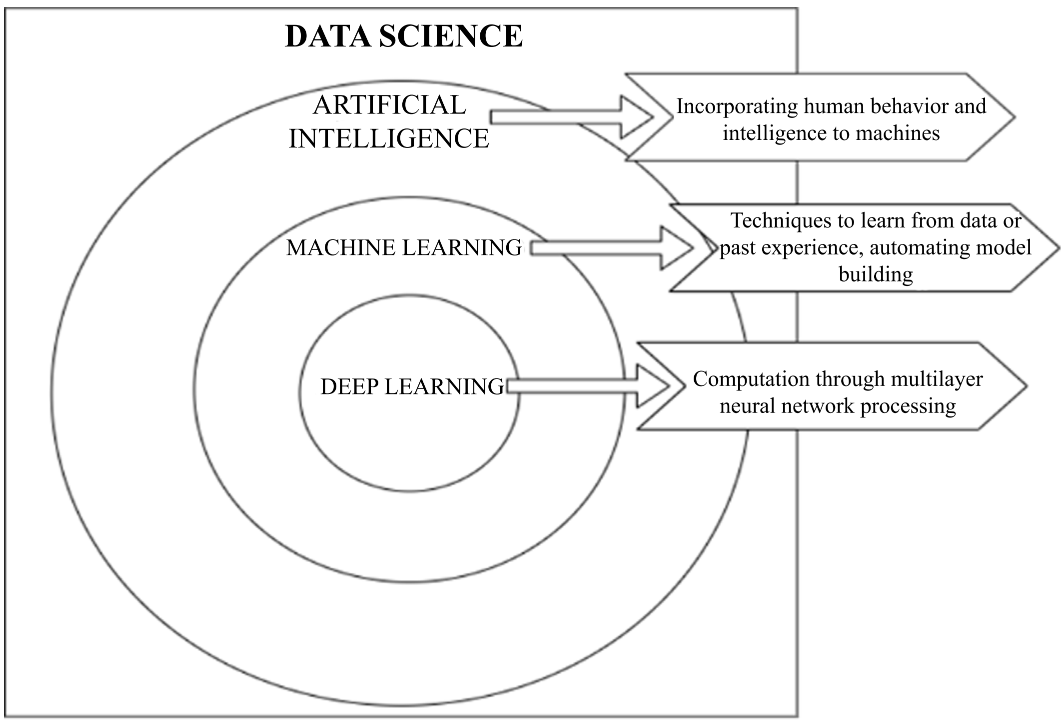

Fig. (1). Layers of computational techniques.

DEEP LEARNING: DEFINITION

DL can be defined as a technique that allows a machine to perform what is natural in humans. DL operates on the premise that similar to human babies, it gradually learns from its surroundings and the resources provided to it. This process continues, and the knowledge base develops as babies grow.

This unique property that humans have is the key to DL algorithms. The success rate in problem-solving through deep learning is very high. The concept of driverless cars making them so accurate is decision making, following board signs, and stopping to let pedestrians pass; all these have become possible because of DL. In some instances where a machine must deal with classifying objects in images, DL has simply left the humans behind, which is commendable [6].

Another definition of Dl is "DL is an AI that imitates the way humans gain certain knowledge." DL has high importance in data science, and it includes figures, data, numbers, and predictive modeling as it eases data processing and makes it quicker.

François Chollet, a French software engineer and creator of the Keras deep-learning library, released in 2015, defines AI as an effort to automate intellectual tasks normally performed by humans. A simple definition of AI by Merriam-Webster (an American book publishing company) is "A branch of computer science dealing with the simulation of intelligent behavior in computers" [7].

DL is studied as it has a proficient collection of techniques. The emulsification of DL methods in industries can optimize smart manufacturing processes by incorporating information processing into its multilayer architecture. This facilitates the smart optimization of industry resources. The deep learning properties, for instance, pattern identification, self-learning capabilities, decision making, and above all, automatic feature learning, make it worthwhile as an implementation of a separate algorithm is not required [8].

Deep learning has extraordinary self-learning properties that allow it to learn from data. DL is in a boom these days. DL has a whole set of learning algorithms; it is not just an algorithm. It can be applied to various complex problems and prediction models.

WORKING MODEL OF DEEP LEARNING

Deep learning works on feature extraction of the raw data by implementing multiple hidden layers to derive all the required properties of input data. DL works by transforming the input into DL. It is considered more effective than machine learning in terms of high performance in data extraction, and with the support of highly advanced high-end hardware, its potential has significantly improved [9].

As shown in Fig. (**2**), the layers in the DL model are the smallest unit of constructive elements, which are associated with a weighted input value that is converted using some functions; further, these values are presented to other layers as an output. Layers altogether construct the whole deep learning model. DL approach can be imagined as a function of artificial intelligence that mimics the human brain to process data.

CHAPTER 3

IoT-Enabled Smart Production and Sustainable Development

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Abstract: Internet of Things (IoT) technology is a prominent approach for handling present-day issues in various sectors for sustainable development. The agricultural sector is considered the backbone for the sustainability of a nation and plays a vital role in biodiversity sustenance. Precision farming or precision agriculture is the practice of maximizing crop yields and making the agricultural profession more profitable. Precise and timely input of various agricultural parameters through smart and advanced technologies like IoT, AI, image processing, drone-based cameras, computer vision, smart portable devices, GPS, and others provide precision farming a real playground for implementation. The practice of precision farming can boost the efficiency, sustainability, and profitability of farmlands. An automated irrigation system (AIS) is an advanced technology that uses sensors, controllers, and automation to efficiently manage and optimize the watering of plants and crops. While AIS offers numerous benefits, some challenges and problems can also arise, such as in terms of sensor accuracy, connectivity and communication, power supply, maintenance and system updates, cost and implementation, and user understanding and training. Therefore, it is a hard requirement for an intelligent automated system with IoT capabilities that can precisely track and manage water and energy consumption. In today's world, automation dominates human existence. In this chapter, we suggested a comprehensive framework for an IoT-based smart and automated irrigation system to address the drawbacks of conventional systems like drip irrigation and pot irrigation, which cause soil erosion and water wastage. Water is sprayed across the crops in the field by an automated irrigation system to spread it like a downpour. Installing an AIS allows for time- and water-saving water utilization.

Keywords: IoT, Sustainable development, Smart irrigation, Smart farming.

INTRODUCTION

IoT is a system that connects appliances like electrical devices, mechanical devices, computing devices, sensing devices, *etc.*, through the internet to control,

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monitor, and analyze the working of these devices with minimized human interaction. First, the data from devices (like sensors, *etc.*) is transferred to the IoT gateway; the gateway aggregates the data and transfers it to the cloud. Then, the data is monitored, analyzed, and processed. Finally, the result is sent to the user. Everything is somehow connected to the internet. We have always heard of smart city plans. These systems include IoT at some point because we need an internet connection to create a smart environment and make it easy to access and discover a device or app. IoT is a system of related computer devices connected to the Internet. IoT is a network of tangible objects such as buildings, vehicles, and connected furniture to share their data. These items can be identified specifically by their IP address or RFID tag [1, 2].

A descriptive feature of IoT is the idea that an object can be connected to the internet without human contact; for example, a home-sensing sensor will send information to an application on your phone. IoT is a network of embedded objects and electronic devices, software, sensors, and communications so that these objects can collect and exchange data. The IoT system can include a variety of devices, such as smartphones, smartwatches, dynamic trackers, cars, buses, and trains. The idea behind IoT is to connect virtual objects to the internet for monitoring and remote control.

APPLICATIONS OF IOT

The main aim of IoT is to reduce the work load on humans. It is a technology that makes our daily life easier by automating processes, using smarter devices, working faster, reducing cost, *etc.* A few areas or things where IoT is useful are smart watches, smart cars, smart hospitals, smart homes, *etc.*, as depicted in Fig. (**1**) [3].

The detailed description of some major applications of IoT is explained below in the following sub-sections [4, 5].

Industrial Automation

Automated processes save human energy, time, and cost. Tasks that are repetitive or share a similar pattern can be automated so that the system works automatically. Industries use automation in most of their work to scale their business. Industrial robotization is one of the generally huge and normal utilization of IoT. Robotization of machines and instruments empowers organizations to work in a proficient manner with modern software devices to screen and make enhancements for the next process. Industrial robotization further develops precision and proficiency, diminishes mistakes, is simple to control, and is some what open through applications. Machines can work in more brutal conditions than people; mechanization of machines and instruments diminishes labor supply necessities for explicit errands. The connected factory idea is a viable answer for enhancements in every aspect of the activity. Significant parts, such as machines, apparatuses, and sensors, are connected to an organization for simpler administration and access. Outline of cycle stream, screen downtime, status checking of stock, shipment, plan upkeep, stop/stop a specific interaction for further examination, and so on are possible by remotely utilizing industrial IoT arrangements.

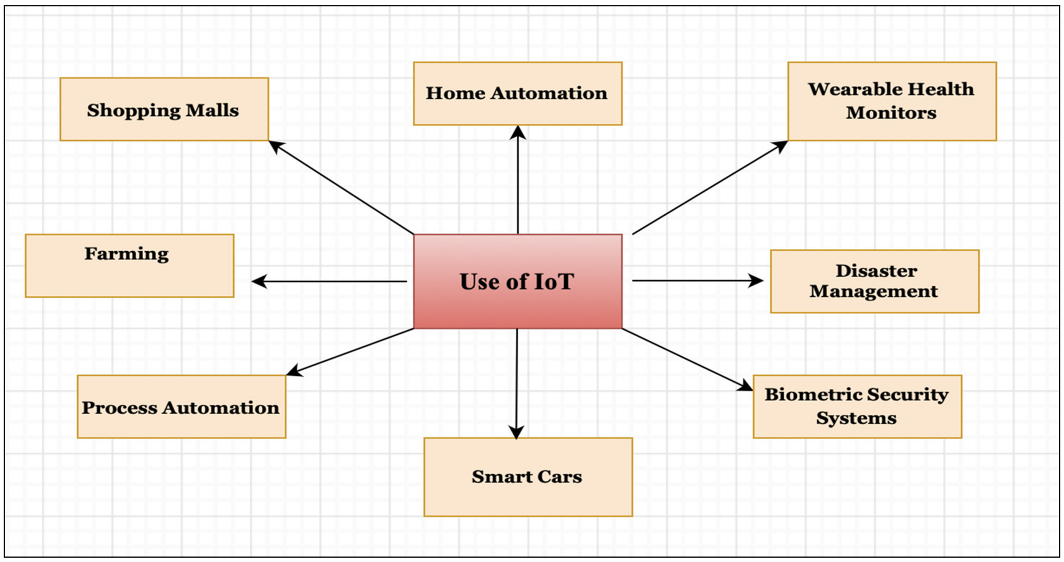

Fig. (1). Application areas of IoT.

Smart Robotics

Many organizations are creating insightful advanced mechanics frameworks for IoT-empowered industrial facilities. Savvy advanced mechanics guarantee the smooth treatment of apparatuses and materials in the assembly line with exactness and proficiency. Predefined particulars can be set for the most extreme accuracy (up to a few nanometers scale for certain applications) utilizing smart, automated arms. The human-machine interface plan will lessen the intricacy of activities, and it will reflect in future IoT-empowered assembling as further developed usefulness. Robots can be modified to perform complex errands with very good quality embedded sensors for constant examination. These mechanical technology networks are connected to a protected cloud for observation and control. A designing group can get to and break down this information to make speedy moves for item upgrades or forestall a surprising disappointment because of a machine issue. Real-time tracking of information, components, *etc.*, helps industries to manage and monitor their work. Delivery-based companies can also

CHAPTER 4

A Suggested Framework for the Prevention of Physical Attacks on IoT Devices

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Abstract: In today's interconnected world, where most devices are connected to the internet and constantly sharing data, the increasing number of IoT devices presents challenges for large companies to develop secure IoT systems.. With the progression of interconnected systems, the risk of hampering security is also a big concern. In the current scenario, it is very easy for attackers to initiate any kind of security breach. The attack will be either on its software, firmware, or hardware level. This chapter deals with the hardware security of the IoT system, which is also termed physical security. Various security threats related to the physical security of an IoT device are described. Various consequences have been mentioned that can occur due to these attacks. With these physical attacks, a lot of severe loopholes can be created in the current ongoing research and development of these interconnected systems.

Keywords: Hardware security, Internet of things (IoT), IoT attacks, Invasive attack, Non-invasive attack, Physical security, Semi-invasive attack.

INTRODUCTION

With the growing trend of IoT devices in the current market, Gartner Inc. predicted that the number of IoT devices would grow from 5 billion in 2015 to more than 25 billion by 2020 [1]. The term IoT was first quoted by Kevin Ashton in 1999 in his presentation for the P&G (Proctor and Gamble). Before that, the concept of interconnected devices was also in the IT market. As for now, when all the firms, including new startups, are adopting this technology, a mindset needs to be prepared to keep regular checks on the security of these systems. In a recent Gartner study, they mentioned the challenges IoT will face in the upcoming years.

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'Security' and 'privacy' topped the list as the most severe challenges, and by 2023, most of these security hazards will be shielded [2]. But this will only happen if we put our effort into identifying these problems in the current systems. The glitches in the current systems include immature protocols, ever-changing threats, complex vendor landscape, and lack of skills. IoT security is not a technical problem that needs to be resolved, but it is a complete concept that needs to be revised for a proper understanding of its security problems. This paper is divided into four sections. The first section introduces the reader to the IoT (Internet of Things) and its growing influence. Section two depicts various aspects of IoT security. Section three describes various security attacks, out of which the focus of this paper is on the attacks related to hardware and its security. The reader gets a deep insight into how the glitches within the architecture lead to the downfall of both hardware and, eventually, the entire system.

IOT SECURITY

IoT attacks [3] can be used for different purposes depending on the goals. Some of the most prominent reasons are data and the impact on the services of the service provider. They try to steal secrets from the device either to produce a competitive product or to steal data and services. Some of the major threats are:

Data Security

In an IoT ecosystem, data is the most important asset and the most vulnerable component. Important and valuable data can be stolen from IoT devices (hardware components) and can be used to develop competitive products or to steal data from them.

Denial of Service (DoS Attack) [4, 3]

In this attack, the intruder/hacker puts malicious code into the device's firmware or software component. Also, it can be injected into the hardware, which can damage the product because the vendor must face the damage cost. Also, a DoS attack involves flooding data to the server to crack it or to increase its response timing.

Brute Force Attack [3]

Random attempts of keys to overpass the authentication process is what brute force is all about. To overcome the attack, companies use various cipher algorithms. Multiple levels of authentication are applied to reduce the chances of hitting and trial. Various malwares are developed to implement brute force attacks. One of them is Morsi botnet malware, which came into the picture in

2016. Constantinos kolias *et al.* [5] have stated how these malware tools have exploited the IoT system.

Distributed Denial of Services (DDoS [3])

In a DoS attack, the intruder/malicious attacker tries to bypass the security to use or consume the resources and manipulate the work. Such an attack that compromises numerous nodes and gateways is called a DDoS attack. Some of the DDoS attacks involve sending or transmitting data (malicious) to the server from various modes to affect its services. Some of the prominent DDoS techniques are UDP, FLOOD, KMP/ANG FLOOD, SYN FLOOD, Ping of death, and zero-day DDoS. Krushang Sonar *et al* [6]. have stated various attacks of DDoS on various levels of IoT architecture.

IP Address Piracy

IoT technology is all about a heterogeneous network of connected devices *via* their IPs. If an IP can be attacked by a malicious user, it can access the entire data of IoT devices as well as the entire system and can also affect its data traffic. Most of the IP piracy takes place at the protocol level (Network layer). RPL (routing protocol for low power and lossy networks) has recently been standardized as the widely used protocol for IoT. It works on IPV6 protocol, so it supports various protocols like 6lowPAN and CoAP. RPL can be implemented on Contiki OS (IoT's most known OS) to implement data nodes and IP stacks. Various attacks include selective-forwarding attacks, sinkhole attacks, Hello flood attacks, and worm mole attacks. Walgreen Linus *et al.* [7] have highlighted various IDS implementation and RPL attacks in an IoT environment.

Cloning And Overbuilding [8]

One of the biggest challenges is cloning. It is a scenario in which, without putting any effort, opponent companies try to copy the product. With this, they make a profit and increase their sales. Cloning a device is just reverse engineering. Also, sometimes companies put their claim on some other companies' products as their own. These are not attacks but a challenge that will come into the picture with the growth of the IoT market.

CATEGORIES OF ATTACK

IoT is a technology that is ubiquitous, popular, and widely adopted by the world. It is based on WSN and data gathering. It is a technology that does not have any technological restrictions and has the capability to be implemented in every sector. The wide scope of IoT makes it more vulnerable [9] than any other

Machine Learning and Collaborative Technologies

CHAPTER 5

Use of Artificial Neural Network in Segmenting Clinical Images

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Abstract: Inaccurate detection of tumors, fractures, and breast cancer in clinical images has become one of the major issues in the medical field. Variations or errors in medical reports caused by operators, machines, or the environment become a common cause of delay or incorrect diagnosis. Therefore, correct segmentation of areas of interest in clinical images like X-rays and MRIs is highly required. To solve this problem, many researchers have provided various state-of-the-art automatic or semi-automatic methods of segmentation. Artificial neural networks play a significant role in increasing the accuracy of clinical image segmentation. In this chapter, the workings of ANN and the difference between gradient and stochastic gradient descent are discussed. Also, the application of ANN in tumor, fracture, and breast cancer segmentation is discussed using authentic and publically available datasets. This chapter mentions the results and confusion matrix of some state-of-the-art methods. This chapter will help readers know about ANN, the use of gradient and stochastic gradient descent, the application of ANN in segmenting clinical images, and the confusion matrix.

Keywords: ANN, Clinical images, Deep learning, Segmentation, Tumor segmentation.

INTRODUCTION

In the past few decades, a lot of work has been done in various medical fields. Most of the work is related to increasing accuracy in predicting tumor size, cancerous tissues, and fractures. MRIs [1] and X-rays [2] play a pivotal role in predicting the affected area. The manual detection or segmentation of these clinical images is a lethargic and time-consuming process, majorly in the segmentation of tumor size and cancerous tissues. Manually segmenting the MR images depends on the experience of machine operators. Therefore, reports may vary depending on machine operator experience and other parameters as these reports are paramount for doctors to start the diagnosis of the patient. Therefore,

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the uniformity and accuracy of these reports are essential. To overcome the mentioned problem, many researchers proposed various state-of-the-art methods of segmenting MR images with high accuracy. Most of the research in the area of medical imaging is shifting from machine learning to deep learning, majorly to artificial neural networks [3 - 6]. ANN [7 - 9] provides very high accuracy in segmenting the infected area in MR images and predicting the tissue class. In this chapter, we majorly discuss the segmentation of brain tumors, lung cancer, and breast cancer based on MR images.

Brain Tumor Segmentation

A tumor is an abnormal division of cells that grows in an uncontrolled way [10]. Based on the growth of the tumor, it can be distinguished as benign (noncancerous) and malignant (cancerous) [11]. During the segmentation of MRIs, only the malignant part is considered. Brain tumor segmentation is basically carried out for segmenting the core, enhancing, and completing the tumor [12]. Most of the researchers use a deep learning-based ANN approach to provide a fully automated method for brain tumor segmentation using a publically available BraTS dataset.

Lung Cancer Segmentation

Lung cancer is considered the second largest disease that causes maximum mortality [13, 14]. The disease spreads at a high rate, as observed by comparing year-on-year data [15]. Cancer tissue segmentation in the early stage is most important for better diagnosis of the patient. Accurate segmentation of cancer tissue helps doctors to provide better medication to the patient. However, the manual segmentation of medical images requires a lot of effort and time. Further, the accuracy of manually segmented images depends on the expertise and experience of the radiologist. This raises a great demand for some automated approaches to perform lung cancer segmentation with high accuracy. A neural network [16, 17, 18], which mimics the human brain, can be used for the classification of cancer tissues with high accuracy.

Many researchers proposed various methods for lung cancer segmentation using the ANN approach.

Breast Cancer Segmentation

According to the data provided by WHO, breast cancer is one of the most common causes of death in women [19, 20]. Timely and accurate detection of MCs (Micro calcifications) plays a vital role in the proper treatment of breast cancer [21]. However, due to the small and nonuniform shape of MCs, their detection is a challenging and time-consuming task. Due to these difficulties, manual detection of MCs can easily be prone to errors. Therefore, an accurate and automated approach for the detection and segmentation of breast cancer is very much required. Many researchers have given various state-of-the-art works for breast cancer detection [22, 23]. It has been found that the ANN approach provides significant accurate results in the classification of breast cancer tissues. ANN is a collection of artificial neurons connected with each other using synopsis, where information travels from the input layer to the output layer, with multiple hidden layers in between.

ARTIFICIAL NEURAL NETWORK (ANN)

It is a network of connected artificial neurons that mimic the human brain. ANN has one compulsory input and output layer with a variable number of hidden layers in between.

The Neuron

The concept of deep learning is to mimic the human brain [24]. Neurons are brain tissues that are connected in some structure to receive information from various sensors of the human body and to provide an output signal to perform various tasks. A structure with a single main neuron in terms of machine/deep learning is shown in Fig. (**1**), where some neurons in the input layers are connected with the main neuron in the center.

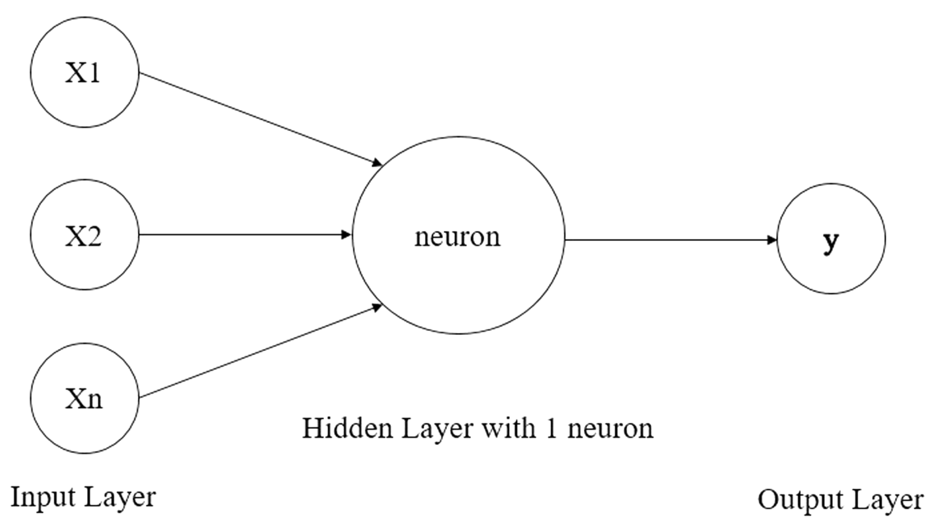

Fig. (1). Simple network with input/output layer and single neuron in the hidden layer.

CHAPTER 6

Role of Artificial Intelligence (AI) and Industrial IoT (IIoT) in Smart Healthcare

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Abstract: Information technology has shown its presence in every sector that requires automation and intelligence. Traditional healthcare is a major sector in which lots of advancements are needed. AI and IIoT are two main IT-based advanced technologies that are required in many phases to convert traditional healthcare to smart healthcare. The two major requirements of a smart healthcare system are data collection and data analysis, and both of these requirements can be fulfilled by AI and IIoT technologies. IIoT can help collect healthcare data in an automated way using various sensors and other hardware devices. The use of AI-based algorithms and software to replicate human cognition in the analysis, display, and comprehension of complicated medical and healthcare data is referred to as artificial intelligence in healthcare. Artificial intelligence can be utilized to perform the same tasks in a more efficient and cost-effective manner. It is always preferable to prevent a disease than to cure it. Artificial intelligence-based apps can assist users in leading a healthy lifestyle and being proactive. When customers realize they have power over their own health, they are more motivated to live a healthy lifestyle. This chapter describes the role of artificial intelligence (AI) and the Industrial Internet of Things (IIoT) in smart healthcare and telemedicine.

Keywords: Artificial intelligence, E-hospital, Industrial IoT, Smart healthcare, Telemedicine.

INTRODUCTION OF INDUSTRIAL IOT (IIOT)

The Industrial Internet of Things is the extended version and evolution of the Internet of Things in industries. It lays a focused emphasis on big data, machine learning, and m2m (machine to machine) communication that, in turn, helps improve efficiency and reliability in the operations of industries and enterprises. The IIoT includes robotics, medical devices, software production processes, and

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industrial applications [1]. Industrial IoT (Industrial Internet of Things) is an extension of the Internet of Things that focuses on connecting devices to a network and then collecting and analyzing data. Industrial IoT is still in its infancy and has not yet reached its full potential [2]. However, it will continue to develop as more industries adopt it. It will enable many new business models, such as predictive maintenance, asset tracking, and automated control systems. Industrial IoT is a network of physical objects, sensors, and actuators that are linked to the internet and share data. Industrial IoT has been around for decades, but it was not until recently that it has become mainstream. It is now being used in manufacturing and production to reduce costs and increase productivity. Industrial IoT is the connection of physical objects to the internet. These physical objects can be anything from a car and a pacemaker to a coffee cup. The advantage of these devices is that they can connect and communicate with each other without human intervention. The future of Industrial IoT is in the convergence of AI and IoT. AI will be able to provide data-driven insights into how these devices interact with each other and their surroundings [3].

Some major applications of IIoT are given in the following points [4, 5].

1. It is used in the mining industry. With the help of IIoT, we can make such a device that can sense any type of harmful gases and can alert the authorities out there so that any harm can be avoided.

2. In mining, any small fire can trigger large damage to the mines and, in severe cases, can bring the whole mining cave down, so to avoid this, IIoT can play a major role.

3. Sensor's network comprises different gas sensors.

4. RFID tags of tracking miners.

5. It is also used in the healthcare industry. Traditionally, it is not possible for doctors to monitor patients continuously; the doctors need to visit the patient and then only he/she can monitor the health conditions of the individual.

6. But now, with the advent of IIoT, this process is made a lot easier with the use of sensors. Nowadays, doctors can monitor patients continuously, and alerts can be generated frequently to avoid any severe cases or the death of patients even after reaching them on time.

7. Connectivity of the healthcare devices to the internet helps in locating each device and also knowing the status of the connected devices.

INTRODUCTION OF ARTIFICIAL INTELLIGENCE (AI)

AI stands for artificial intelligence. Just as human intelligence is the intellectual capability of humans to learn, adapt, or understand situations in one's environment, artificial intelligence is the ability of machines, stimulated by human intelligence, to understand technology and programs according to the technical situations that can make any task faster and easier. AI or machine learning systems are fueled by such a vast amount of data that they can provide services to humans anytime and anywhere. From auto-correcting any word in one's mobile to helping any handicapped with his daily life, AI has acted as the most useful innovation for world change. Moreover, advanced AI is helping the world of scientists to explore more of the Universe through satellites surrounding outer space, which is eventually helping all of us to know about the happenings of past, present, and the near future [6, 7]. The evolution of artificial intelligence (AI) is likely to become more pandemic in various fields, for example, education, healthcare, fraudulent acts, *etc.*, to monitor and detect situations for actions. (Fig. **1**).

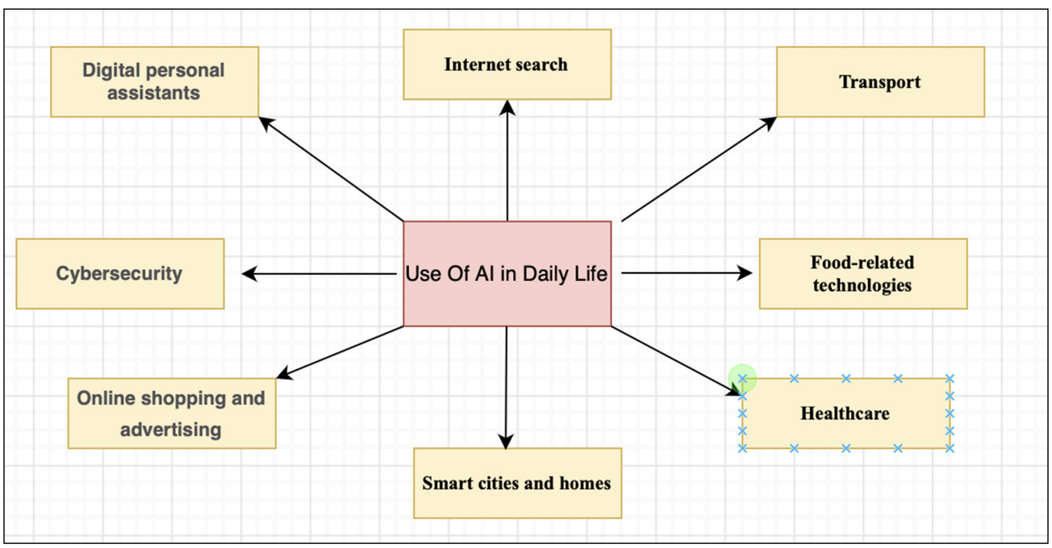

Fig. (1). Applications of AI.

ROLE OF AI IN INDUSTRIAL IOT (IIOT)

IIoT is a network of physical devices, vehicles, buildings, and other items that are connected to the internet. It is used to collect and analyze data from these devices. The use of AI in IIoT is expected to increase in the next few years [8 - 10].

CHAPTER 7

Deep Learning and Machine Learning Algorithms in the Industrial IoT

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Abstract: One of the latest industrial revolutions is deep transformation and human progress, which has led to the "Automation of Everything". The physical world, along with digital interfaces and data analysis, is connected *via* an interconnected network of computers. This change holds the key to unlocking trillions of opportunities in the coming ten years. Productivity has improved greatly in digital and physical industries, which leads to improved quality of life and sustainability. There are loads of challenges due to the massive amount of data being collected by sensors in the current world of IIoT. This chapter aims to review the various deep learning and machine learning technologies, algorithms, and their effect on IIoT. Several applications of machine learning in gaining useful insights from IoT data are also discussed in this chapter.

Keywords: Analytics, Deep learning, Industrial IOT, ML.

INTRODUCTION

Industries such as healthcare, transportation, manufacturing, and energy, which rely heavily on operational technology, are forced to change due to the Industry 4.0 revolution. Fog and edge computing technologies were previously needed [1] by IIoT for proper connectivity within Industry 4.0. However, there is one more interconnected element that is crucial for IIoT analytics.

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Deep learning and machine learning not only add value but also improve the analytics of IoT platforms and big data. There are three types of data in Industrial IoT. 1) Raw data (data that is unstructured and unprocessed), 2) Metadata (data pertaining to data), and 3) Transformed data (data that is transformed). The algorithms listed below use each of the three types of data for identification, categorization, and decision making. When combined with big data analytics, deep neural networks can be used for drawing useful information for decision making. In the areas of real-time analytics and streaming data associated with edge computing networks, the use of artificial neural networks is essential for effective decision-making.

There are many applications of IIoT in healthcare, retail, automotive, and transport. Production, customer satisfaction, and reliability can be improved in many industries with the use of IIoT. The initial goal of IIoT was to improve current processes and augment the existing infrastructure, but later, completely new and improved services and products were created.

The impact of IoT is well-known in many industries. The Internet of Things (IoT) creates many opportunities for improved operations, new and improved services and products, and progressive business models. Deep learning and ML algorithms will have a great impact on the satisfaction, production, and reliability of customers that will depend on incorporating applications, devices, software, and key technologies. Anything that requires vigilant integration and orchestration needs a great deal of technology.

Equipment, machinery, intelligent devices, and automation embedded systems that perform simple as well as complex tasks without the help of humans are made smarter by the use of these technologies [2, 3]. It should also be noted that smartness in the enterprise should also include enhancements in areas such as cognitive automation, smart data discovery, the workplace, and many others.

A digital twin is a copy of any process or a physical thing like a wind turbine. It is often referred to as a product of IoT that has exponentially expanded these types of devices and also a similar amount of data that can be used to look up the design, efficiency, and a lot more factors. It is necessary for a digital twin to update continuously and "learn" about any changes. There have been a lot of changes in the industry marketplace due to IoT and its solutions.

This chapter compares a variety of ML and DL techniques and their applications in analytics solutions, which are being rapidly adopted in industrial and enterprise data applications. Assessment of various new business models and their solutions is also done, along with forecasting for revenue and unit growth for IIoT and analytics. This chapter particularly pivots on the challenges that come along with real-time performance, interoperability, security, and energy efficiency. An overview of potential research directions and other research efforts done to solve challenges associated with IIoT is also provided in this chapter.

IIOT ANALYTICS OVERVIEW

The Industrial Internet of Things is primarily divided into four components:

Things- The machines and systems that are used in numerous industries are constantly monitored and are used as a source of data.

***Intelligent Edge Gateway-* The** edge gateway acts as the intermediate step between the industrial machinery and the IoT cloud platforms.

IoT Cloud- Data analytics, deep learning, ML algorithms, and various artificial intelligence techniques require extremely large amounts of data. The IoT cloud is the core Internet of Things platform. All the data that flows in an IoT device is handled by the cloud itself. Some of the important capabilities of the IoT cloud are event processing, big data processing stream analytics, and extremely powerful machine learning capabilities. Various services such as authentication, platform APIs, and various SDKs are also offered by the cloud.

Business Integration and Applications- These systems work on the backend and integrate several IT systems to make sure that the necessary data is received by the machines to complete all the processes. ERP, QMS, planning, and scheduling are some examples of such systems (Fig. **1**).

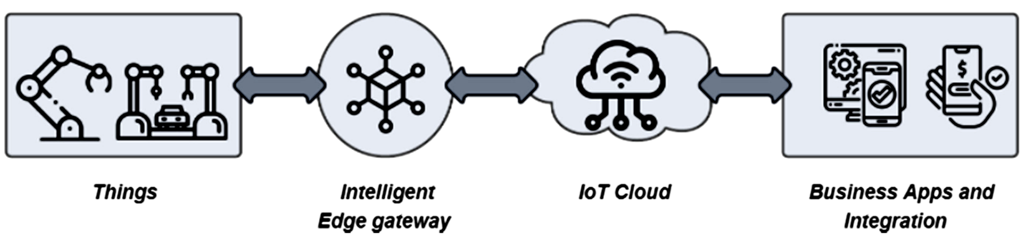

Fig. (1). Industrial Internet of Things architecture.

Depending on the type of outcome and the end product generated, data analysis may be roughly classified into three categories: predictive analysis, descriptive analysis, and prescriptive analysis (Fig. **2**).

Designing and Testing the System in IIoT: Case Study

CHAPTER 8

Adoption of IoT in Healthcare During Covid-19

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Abstract: COVID-19 has shattered existence and implemented a change in the strategies, priorities, and activities of people, organizations, and governments. These progressions are the momentum for the advancement of technology. In this chapter, the discussion is about the pandemic's effect on the reception of the Internet of Things (IoT) in different areas, specifically healthcare, smart cities, smart buildings, smart homes, transportation, and industrial IoT. Industrial IoT (IIoT) healthcare has essentially decreased the expenses for monitoring and safeguarding individuals at home by helping to improve human healthcare quality. Despite its significant convenience and advantages, it faces challenges related to security and protection from the perspective of bilateral fine-grained access control as well as the genuineness and tamper resistance of shared health information.

Keywords: COVID-19, Healthcare, Internet of things, Industrial internet of things, Smart healthcare devices.

INTRODUCTION

IoT assists in supplying physical items with Internet access and data transmission and reception capabilities. The IoT concept has evolved into and through a variety of technologies, including embedded systems, AI, machine learning, and sensors. It relates to the idea that hospitals would get smarter over time, with various fixed or wireless Internet devices. When the information is being gathered by smart devices, the necessary task can be completed. Smart cities, cars, gadgets, theatre sets, residences, and related healthcare are all receiving IoT applications. The use of IoT in the healthcare industry depends on a variety of medical devices, sensors, artificial intelligence (AI), imaging, and diagnostic tools. These devices can be improved based on their quality and productivity both in established businesses and in emerging ones.

The Internet of Things (IoT) enables the movement of information over or across the Internet by connecting all computational, mechanical, and digital systems

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without the need for human involvement. This technology is seeing a boom in terms of surveillance during the COVID-19 pandemic medical services. Currently, a lot of people pass away because of inaccurate health information. This technology uses sensors to quickly warn users of any health-related issues in real time. All COVID-19 patient-related data is stored on the cloud. This technology records a person's actions and issues warnings about various health issues.

There is a basic requirement for the necessary tools to ensure a successful operation in the medical industry. IoT has a high capacity for performing effective activities and analyzing recovery from surgery. During the COVID-19 pandemic, the IoT improved patient care. With the Internet of Things, continuous monitoring efficiently prevents numerous diabetic complications, cardiovascular breakdown, pulse, and other fatalities. To seamlessly transfer the anticipated health data to the doctor, smart medical equipment is connected *via* a smartphone. These devices also collect information on oxygen levels, blood pressure, weight, and the quantity or amount of sugar, among other things.

Body temperature, heart rate, and saturation levels are the main parameters that are watched at the hospital to ensure that patients recover quickly. The use of IoT applications for monitoring various parameters enables the technology to be used for the COVID-19 patient's quick recovery. It is also helpful for the hospital to observe patients who are placed under observation. The IoT device transmits the health parameters it collects to the cloud, where any specialist can access them to review the patient's medical history. IoT provides emergency services in addition to monitoring health parameters. These services include dispatching an ambulance from the closest clinic to the patient, tracking the location (GPS) of the patient by the hospital, and establishing communication between the patient and the doctor. Different biosensors are attached to various boards, including Node MCU, Android, and Raspberry Pi, to check this parameter. Similarly, we can activate a warning system for the patient to remind him to keep an eye on health indicators that will be transmitted to the clinical administrators and the local health station. The BH1790GLC optical sensor monitor, pulse rate sensor, BM-CS5R heart rate monitor, and wearable heart monitoring inductive sensor from ROHM are used to detect the pulse in IoT-based system applications [1]. The IoT-based medical services application uses the LM 35, MAX30205, GTPCO-033, NTC indoor regulators, and RTD sensors, among other IoT-checked metrics, to measure body temperature [2]. An Internet of Things (IoT) application was developed to collect data on healthcare that uses the ontology method. In order to treat the patient in a remote location, doctors will put together the ontology. All the doctors in need of a quick solution found this method to be simple. This data may be stored on the cloud for additional examinations by doctors. With the help of the Internet of

Things, we can provide emergency services like ambulances, blood, and specialists who are available to come to work. The use of IoT is significant in this pandemic. The Internet of Things (IoT) is a developing technology that assists in the discovery of new drugs and clinical treatments. IoT builds networks of devices like sensors and boards that enable the management of medical services [2]. The data that is uploaded to the cloud is protected. As it gathers the patient's data and information without human interaction, the accuracy rises. When deciding a patient's treatment in an emergency, this knowledge is useful.

The Internet of Things, in other words, is the arrangement of interconnected devices and processes that accept all network components, including hardware, software, and network connectivity (IoT). IoT is more than just a concept; it underpins a fundamentally good architectural framework that, at long last, makes integration and effective information flow between the person in need and the service providers possible. The ineffective reachability to the patients is currently the second-biggest obstacle after the invention of a vaccine, and it is the root of a considerable portion of the problems. The IoT concept makes patients more accessible, which makes it easier to give them serious consideration in the hope that they can beat this sickness. In light of the current pandemic situation, where the number of infected individuals is increasing daily worldwide, it is crucial to make use of the appropriate and coordinated services offered by the Internet of Things system. Additionally, where the Internet of Healthcare Things (IoHT) or Internet of Medical Things (IoMT) are linked to the current issues, IoT has been employed proactively to satisfy needs in a number of domains. Updated and improved data on settled cases can be found by upholding the

IoHT/IoMT rules. The Internet of Things (IoT) offers several benefits during the COVID-19 pandemic. It helps ensure that individuals who have come into contact with the virus are promptly placed in quarantine. It is seclusion that is beneficial for a foundation for observation. The web-based network allows for efficient monitoring of all high-risk patients. Biometric readings, including heartbeat, blood pressure, and glucose levels, are taken using this technique. The clinical staff's productivity has increased as their duties have grown, thanks to the successful implementation of this innovation. The comparison may be more useful and less expensive now that COVID-19 is widespread. Processes related to IoT for COVID-19 are creative, novel ways to combat the COVID-19 pandemic and solve significant problems in a lockdown situation. Continuous information and other crucial patient data can be collected with the help of this innovation. IoT is used in COVID-19's initial steps to gather health data from various organs of the afflicted patient and deal with using the virtual administration framework for all the information. This invention aids in information control and completes the report cycle. Concerns about the overall influence of IoT on COVID-19 settings,

CHAPTER 9

Tackling and Predicting Pandemic through Machine Learning and IoT

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Abstract: "The ongoing COVID-19 situation has been challenging for the existence of humans."It has consistently surpassed the numerous physical and mental activities that humans engage in, compelling them to live within increasingly constrained boundaries. In this chapter, the use of the Internet of Things (IoT) and machine learning (ML)-based framework to tackle pandemic situations in healthcare applications has been discussed. ML and IoT-based monitoring systems track infected individuals using past information, helping with isolation. The system involves parallel computation to track and prevent pandemic diseases through predictions and analysis with artificial intelligence. The execution of ML-based IoT in the pandemic circumstance in healthcare applications has shown performance in tracking and preventing the spread of the pandemic.

Keywords: Artificial intelligence, Internet of Things, Machine learning, Pandemic.

INTRODUCTION

The recently discovered coronavirus causes a highly contagious illness known as COVID-19. It was first reported in Wuhan, China, in December 2019 and has since spread to 216 countries worldwide. There have been over 10.6 million confirmed cases, and tragically, more than 1 million people have lost their lives to this disease. These censuses are promptly expanding and the calamity is developing gradually. Healthcare services severely need innovative technology to help them in these circumstances [1]. The healthcare sector is anticipating that advancements in technology will conquer crises during emergencies. Specialists all around the world are accompanied by different procedures that can come up with a solution to these challenging circumstances. It has turned into an extremely difficult task because clinical data about the disease is not accessible yet, and the

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data is changing over the period of time. With this restricted information, numerous researchers accompanied different supportive innovations utilizing different ML algorithms.

In developing nations, there is a lack of clinical units for tests related to COVID-19, which might result in more contamination. ML methods can provide initial assistance in monitoring individuals for various illnesses such as heart disease, diabetes [2], coronary illness, various disorders, cancer, and COVID-19. ML is at the edge of numerous advanced technologies. Recognizing potential cases quickly can help ensure that individuals receive necessary medication and treatment as soon as possible. ML procedures are used to track COVID-19 patients at high risk.

This chapter centers around the significance and effect of ML in the battle between humans and COVID-19. It gives a complete review [3] of the technologies that came up to battle against COVID using machine learning algorithms. The chapter portrays the significant role played by machine learning in the most critical circumstances. Presently, these developments are battling against COVID-19 and will be a significant method for combatting any future pandemic.

Wearable technology that monitors a patient's physiological state is just one example of how the Internet of Things (IoT) has changed the healthcare sector [4]. Numerous advanced computational innovations like blockchain, Internet of Things (IoT), artificial intelligence (AI), machine learning (ML), and unmanned aerial vehicles (UAVs) are effectively used to handle COVID-19 issues, for example, early diagnosis, CT scan diagnosis, contact tracing, vaccine development, remote monitoring, telemedicine, drug development, and virus modeling. COVID-19's harmful effects are being mitigated by the use of artificial intelligence and data science.

HOW THE COMPUTATIONAL SOLUTIONS ARE BEING USED TO FIGHT THE BATTLE AGAINST COVID.

Detection of COVID-19

The RT-PCR test is considered the most effective method for diagnosing COVID-19 [5]. However, due to the rapid increase in the number of expected patients worldwide, there is a shortage of testing kits. As a result, many computational systems are being used to accurately diagnose people. These computer models may not be as reliable as traditional biological diagnostic methods, but in emergency situations, they have proven to be quite useful and are increasingly being used as a screening approach for detecting the virus.

Detection Based on Images

For picture recognition and classification, convolutional neural networks (CNN) [6], a well-known deep learning technique, are used. CNN has been widely used in computational healthcare services for leveraging medical imaging to diagnose a number of ailments. In a comprehensive analysis, GoogleNet was among the well-known open-source CNNs that Ardakan I *et al.* examined for the COVID-19 diagnosis. They made sure that their systems could recognize COVID and other situations related to the virus's spread. The CNN architecture was created using Xception, AlexNet, and MobileNet-v2. The most accurate model was ResNe-101, which had a precision of 99.51 percent.

Voice-based Diagnosis with Deep Learning and Machine Learning Technologies

Various technologies were utilized for diagnosis based on a person's voice. In recent months, a few COVID-19 speech deep learning and machine learning techniques have been used to develop diagnostic tools [7]. A group at Carnegie Mellon University (CMU) has developed a program that analyzes a person's voice test to determine whether they have COVID-19 or not. Despite this, they emphasize that the app should only be used as a screening tool to allow for the most accurate diagnosis. Symptomatic patients should choose the RT-PCR test due to the limited availability of PCR test kits.

The recognition of the cough caused by COVID-19, as well as other types such as non-disease related coughs, is also one of the major issues to be tackled. The structure includes both the COVID-19 diagnostic engine and a cough detector. The category for the cough is carried out using the final framework. The task of the cough detector is to determine whether the incoming sound contains a cough. The ESC-50 public dataset, which includes a wide range of natural and human sounds, trains the cough detector [8]. It used about 1800 coughing human sounds and about 3500 background sounds from this collection of data. This cough detection system computes the 120-band Mel spectrogram of the recorded cough sound. The image is then changed or transformed to an image in a grayscale that measures 320x240x1. A convolutional neural network analyzes the image created as an output or result and determines whether the sound is a cough or not.

If a cough is heard, the related image is taken into consideration as part of the COVID-19 diagnosis and analysis. This framework is made up of a cluster of different deep learning and machine learning algorithms. The system is legitimate and accurate, and the reports “Coronavirus likely” or “Coronavirus unlikely” are true if all of these algorithms reach the same conclusion. Test inconclusive is displayed, indicated, or proclaimed as the system's output if the outputs do not

CHAPTER 10

Deep Learning and IoT Revolutionizing Transportation Management: A Study on Smart Transportation

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Abstract: In our day-to-day life, we often refer to transportation as the movement of products or people from one place to another . On the other hand, management is all about controlling resources required by transportation to achieve desired objectives and goals. Transportation management plays a critical role for an individual and company. Applications for transportation management are becoming smarter as a result of the development of technologies like the Internet of Things (IoT), and connected devices are enabling their exploitation in all spheres. Hence, with the use of these technologies, the volume of data is also increasing many-fold. There are many techniques, such as machine learning (ML), deep learning (DL), and artificial intelligence (AI), that can be applied to collected data to get insights into the data and further enhance the capabilities and intelligence of the applications. Nowadays, transportation management is more efficient with the use of both deep learning and Internet of Things techniques.

Keywords: AI, DL, ML, Transportation management.

INTRODUCTION

Nowadays, deep learning and IoT play a pivotal role in improving the effectiveness and efficiency of transportation management. There are numerous research studies in these areas, which state that with the use of deep learning techniques, organizations can improve their capabilities and the intelligence of the applications. With the help of deep learning based applications, travelers can obtain appropriate and precise traffic information that allows them to acquire suitable traveling paths, traveling modes, departure times, *etc.* With the integration of IoT, we can optimize the performance of traffic. Based on the current scenario, we may assume that, by using IoT technologies and devices, we

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can enhance the benefits of transportation systems. The problems of the transportation systems, such as traffic congestion, route optimization problems, pollution, security, and problems with optimal use of fuel, are not only related to individual countries, but they are global problems. In this chapter, we started our discussion on the role of transportation in the growth of GDP, challenges of traditional transportation management, deep learning models and applications in smart transportation, and IoT enabled applications in smart transportation.

Role of Transportation in GDP growth

The automobile industry is a major contributor to India's GDP growth. Its contribution to GDP growth was 6.7 percent in 2016 and is predicted to rise to 12 percent by 2026. This industry will become one of the most important contributors to job creation. According to the Automotive Mission Plan, this sector was predicted to provide 10 million employments by 2022 (Source: Automotive Sector Skill Council, National Skill Development Corporation). According to World Bank data from 2014, 32 percent of the population lives in urban areas, which is predicted to rise to 40 percent by 2030, contributing up to 75 percent of GDP (Smart Transportation - transforming Indian cities, 2016).

Challenges of Traditional Transportation Management

There are so many challenges in transportation management. This may be due to not choosing the optimized route or problems in tracking the consignments.

Route Optimization Problem

Inefficiency of route management directly affects the delivery time of the order. It not only affects the delay in the delivery of the order but is also subject to vehicles stuck in traffic congestion and high maintenance costs of the vehicle.

Consignments Tracking Problem

The inability to track a consignment may be another problem due to traditional call-based tracking methods. One must organize a dedicated team to make multiple calls for consignment tracking.

Increase in Transportation Cost

Transportation cost is another key factor in transportation management. It is really a big challenge to manage or optimize the cost of transportation. There are many problems with the manual management of the transportation processes. The effect of manual transportation management increases the cost of transportation management due to the requirement of more workforce, delay in delivery, and not using the vehicle's capacity completely.

Intelligent Transportation System Framework and its Applications

Understanding the foundation of intelligent transportation system (ITS) applications allows us to identify the various data components of ITS more clearly. The ITS platform provides a framework for planning, defining, and implementing various ITS applications. The ITS architecture describes how data and information move through the system and the services it provides [1].

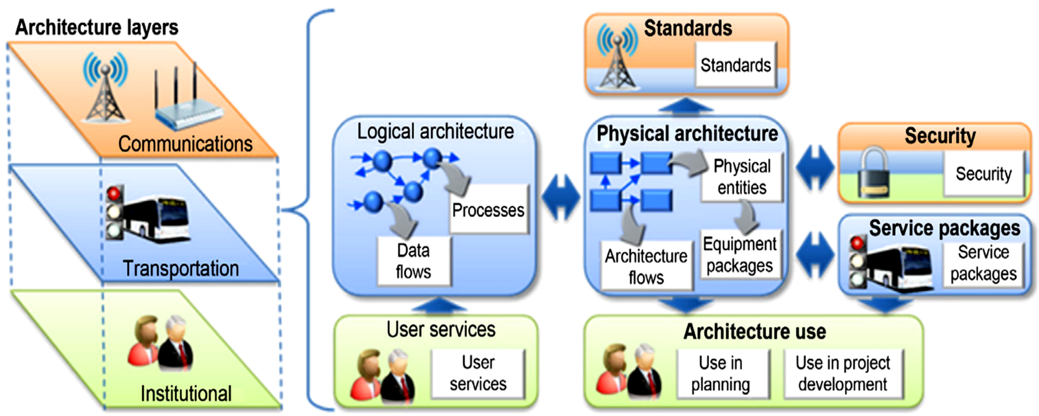

Fig. (1). Different components of ITS architecture [1].

In an ITS architecture, user services specify what the system is expected to perform. There are different components of ITS architecture.

- User services.
- User service requirements.
- Logical architecture.
- Physical architecture.
- Service packages.
- Security.
- Standards.

User services

User services are the building block that specify what the system is expected to perform. These services are portrayed from the eyes of stakeholders and users. There are several user services, and these are categorized into the following different groups:

Current Progression of IIoT Using Machine Learning

CHAPTER 11

Machine Learning in the Healthcare Sector

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Abstract: The healthcare sector caters to millions of people and makes a significant contribution to the local economy. The inclusion of artificial intelligence and machine learning in healthcare is not only benefiting society but also overcoming various challenges associated with it. Artificial intelligence is a branch of computer science that is used to induce human-like intelligence into machines. Machine learning is a subset of artificial intelligence that makes machines capable of learning and giving the desired conclusions without explicit programming and human support. Machine learning in the healthcare sector is making huge advancements and yielding positive results. The increasing applications of machine learning have earned it a valuable spot in the healthcare sector. From specialized robots in hospitals to automated software for disease prediction and detection, machine learning is taking over almost all areas of healthcare with the aim of reducing the workload of medical experts and also delivering services to individuals at home with cost-effective solutions. With the advancement of technology, the introduction of portable systems has led to the availability of enormous amounts of medical data, which is difficult to analyze by human experts because it takes a lot of time, effort, and analytical costs. Machines are better in speed, endurance, and pattern identification as compared to humans. With the introduction of machine learning in healthcare, the task of managing massive data has become easier as automated machine learning models not only help in data analysis but are also capable of detecting underlying data patterns that may be difficult for clinical experts to come across. Machine learning can ease the task of identifying and detecting various diseases by providing complex algorithms such as Artificial Neural Networks (ANNs). With the introduction of neural networks, the analysis can be done on various data parameters given their ability to self-learn, memorize, and provide quality treatment. Machine learning not just focuses on the physical well-being of an individual but also their mental health by coming up with artificial-intelligence-based mood trackers and self-assessing applications for stress diagnosis. One of the major applications of machine learning is to detect and identify dangerous diseases, such as diabetes and cancer, that are difficult to detect at the initial stage and are detected at subsequent stages when it is too late. The use of early detection systems can save many lives by providing timely treatment of patients. Another important application of machine learning in the healthcare field is the introduction of bionic microchips. The

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fusion of bionics and machine learning will bring a revolutionary change in the healthcare sector. One such example is implanting bionic chips in the brain to monitor brain activity for the identification of neurological disorders like epilepsy. The AI-enabled bionic hand uses a man-machine interface to interpret the patient's intent and send the commands to the artificial limb, thus helping the patient make more natural movements and controlling the prosthetics more precisely. There is a tremendous use of machine learning and artificial intelligence in providing customized solutions to patients, as one solution does not cater to many patients. Therefore, customized solutions according to their medical history are a feasible choice. Machine learning plays an enormous role in drug discovery by improving decision-making in pharmaceutical data through high-quality data. It provides immediate assistance to the patients using the healthcare chatbot systems that suggest immediate solutions to them. There is no area left in the healthcare industry of which machine learning is not a part. Machine learning in the healthcare industry can yield efficient and timely results without any human intelligence. This is just the beginning. Machine learning in healthcare has a bright future that will revolutionize the field of medicine and healthcare.

Keywords: Healthcare, IoT, ML.

INTRODUCTION

Artificial intelligence is a budding technology. There is no area left where artificial intelligence has not earned a valuable spot. One such sector is healthcare, where artificial intelligence is yielding promising results. Artificial intelligence imparts human-like thinking ability to a machine to accomplish a particular task. Machine learning is an emerging trend in the healthcare industry [1]. Machine learning is the branch of artificial intelligence that gives a machine the ability to think, identify patterns, and make decisions without any kind of explicit programming and human intervention [2]. As technology is advancing day by day, the complexity of machine learning algorithms is gradually increasing, resulting in the fast processing of complex and high dimensional data. With the introduction of machine learning algorithms such as neural networks, complex automated models can be created for detecting data patterns and also certain hidden data patterns that may not be identified by clinical experts. The inclusion of artificial intelligence in the healthcare sector is to analyze and make deductions by identifying the underlying patterns in the clinical data. With the advent of technology, the demand for portable systems to monitor a patient's health has increased, resulting in a massive collection of medical data. This huge clinical data is very difficult to be analyzed by clinical experts, and a lot of human effort and analytical costs are involved to give a clear deduction. To simplify the task of data analysis and decision-making, the role of machine learning is enormous as with its ability to learn from the data and detect the patterns, automated machine learning models can predict and diagnose several disorders, thus helping the clinical experts by reducing their workload and also giving the benefit of cost-effectiveness. The introduction of artificial intelligence in healthcare is helping to enable the human task for a better digital future. There are various applications of AI and ML in the healthcare sector for revolutionizing the services given to patients and assisting the team in performing their tasks with better precision. The whole idea of involving machine learning in different sectors is to balance the workload efficiently and have automated algorithms assign tasks that can cut off the redundant methodologies originally performed by human experts. This time can be saved by clinical experts for further research and innovation, while processing and analyzing tasks can be effectively done by automated machine learning models. This load balancing will not only help save an ample amount of time but also save a lot of computation and analytical costs. The shift of machine learning technologies over the cloud has made it more flexible to provide powerful functionality for data analysis and decision making. Artificial intelligence is not just enhancing the physical well-being of an individual but is also focusing on mental well-being [3]. The rapid increase in healthcare-based chatbots and AI-based applications for monitoring stress and helping with anxiety control has seen a drastic shift in people wanting to get services in this field. Due to the portability and flexibility of these systems, people have become more confident in seeking remedies for issues such as anxiety and stress instead of personally visiting centers for medications from clinical experts. A broad range of applications has made machine learning an integral part of the healthcare industry, and its consistent growth in medical research and analysis will not only digitize trends but also shape the future.

CHALLENGES FACED BY THE HEALTHCARE SECTOR

The health sector faces several challenges using traditional methods of analysis and clinical decision-making. Many areas do not have proper medical services for the patients or the services burn a hole in the pocket and make it difficult for the people to avail medical services at a nominal cost. Many a time, diagnosis of diseases at later stages makes it too late for treatment or medication to cure them. The challenges faced by the healthcare sector [4, 5] without the involvement of artificial intelligence and machine learning are as follows:

Massive Clinical Data

As society becomes more and more digital, the amount of data generated and collected increases and accelerates significantly. There is a huge availability of clinical data for detection, prediction, and diagnosis, such as medical images, wearable device data, electronic health records, *etc.* Analyzing this ever-expanding data becomes a challenge, and it is time-consuming for clinical experts

CHAPTER 12

IoT-Based Intelligent Transportation System through IoTV

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Abstract: Since India gained independence, the number of vehicles in the country has increased by 170 times, while the road infrastructure has only expanded nine times in proportion. The rate of vehicle population growth is approximately two and a half million per year. Road fatalities far exceed those from rail, air, and terrorism, and it is predicted that by 2030, road accidents will be the fifth largest cause of human deaths. Technology, specifically IoT-based intelligent transportation systems (ITS), can address the challenges posed by inadequate road infrastructure and development. International consortia can collaborate to develop solutions tailored to such conditions. This chapter presents facts related to Indian transport and road accidents and proposes an IoT-based intelligent transportation system, termed IoTV, to improve transportation and reduce accident rates. The authors recommend an IoTV solution for ITS in their paper.

Keywords: Automobile, Intelligent transportation system, IoT, IoTV, Road infrastructure, Road accidents.

INTRODUCTION

The emergence of radio communication and its recent technology has given a new platform to scientists and researchers in network communication. The wireless technology do not need any centralized control and can manage, rearrange, organize, and even repair the nodes/links by itself. The present development in ad-hoc network technologies and dedicated short-range communication has given rise to vehicular ad-hoc networks (VANET). In VANET technology, there will be communication through wireless means for vehicle-to-vehicle (V2V), infrastructure-to-vehicle communication (I2V), and even road-to-vehicle (R2V) communication. The basis of this communication has evolved from existing mobile ad-hoc networks (MANET). The future transport network architecture will

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rely on the intelligent transportation system (ITS). Critical tasks such as the safety and security of vehicles/passengers, network congestions, smoother traffic monitoring and controlling, *etc.*, will be managed by ITS [1].

The "Crash Avoidance Matrices Partnership (CAMP), Advance Driver Assistance System (ADASE), FLEETNET, and CARTALK" are some of the famous applications that were developed by various automobile manufacturers and governments through public-private partnerships [2]. This network of vehicles makes a communication system for drivers as well as vehicles that avoids acute situations such as road obstacles and accidents, driver assistance systems, sudden emergency brakes on highways, traffic jams, and sudden increases in vehicle speed, along with the clear pathways for ambulance, police, VIPs, fire brigade, *etc.* VANET is also able to provide luxury applications like an infotainment system at an on-board display of vehicles, weather reports, vehicle health monitoring and status, *etc.* Fig. (**1**) shows the overall working of the VANET structure.

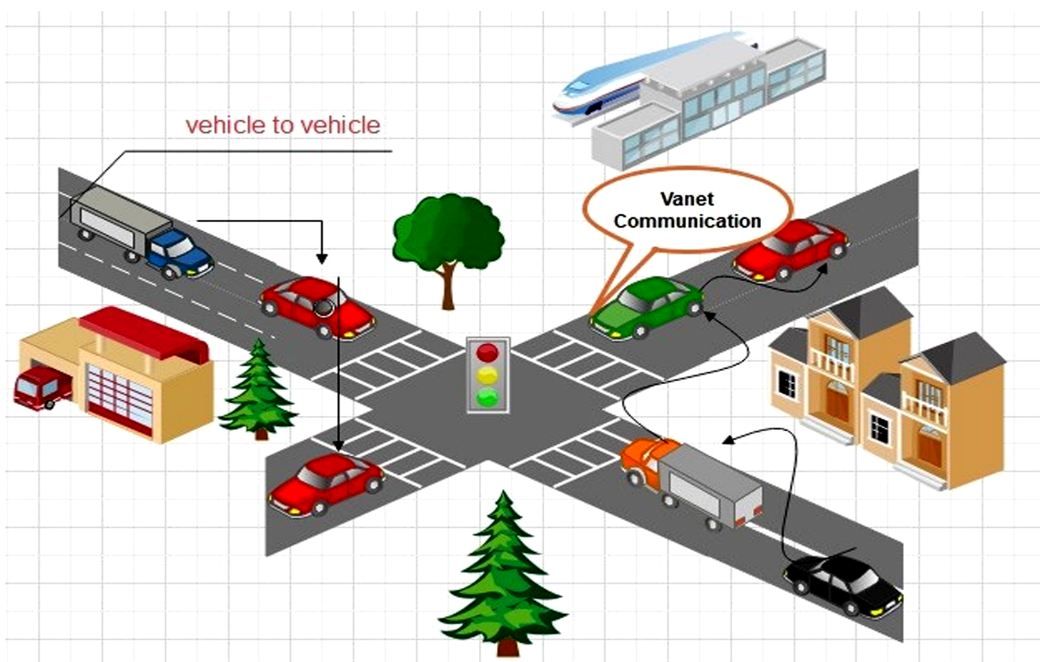

Fig. (1). VANET structure.

The Internet of Things (IoT) has also emerged as one of the most important technologies that will be used in all areas in the coming days. This will act as a nervous system for any of the communication technology. IoT can provide communication among any of the available devices, equipment, or components. This compromises the connection of intelligent systems on the internet with seamless connectivity at any time and anywhere to anyone in the system. It has been estimated that by 2025, the traffic data flow will grow 1000 times more than before, and over 50 billion IoT devices will establish an intelligent network [3].

IoT is a combination of network devices that communicate with each other and gather data from various sensors and data processing and web-based applications. The sensors are used to detect the data and gather the relevant information. This data is transmitted through the network equipment on the cloud for further processing. Various web technologies are used for data mining, leading to the extraction of relevant information. This derived information can be made useful by some dedicated applications that may be installed on some workstations [4]. These online IoT-based devices are made available through a combination of hardware and software that can fulfill the users' demands at 24/7 availability. This makes the availability of the services for all desirable users at several locations but at the same [5].

ITS will also consist of interconnected vehicles and their related infrastructure. This compromises VANET, the combination of devices that work on IoT, vehicles, and all the IoT-based routing equipment that works for VANET. IoT will soon introduce new characteristics in VANET, such as vehicle-to-sensors (V2S), vehicle-to-person (V2), vehicle-to-roadside setups (V2R), and vehicle-t--intelligent transportation infrastructure (V2I), and this is known as vehicle-t--everything (V2E) [6]. In this chapter, the author proposes the Internet of Things for vehicles *i.e.*, IoTV.

The IoTV architecture and its framework can be applied to connect V2V, V2I, and ITS for managing and processing autonomous vehicles within VANET [7]. IoTV is best suited for situations where humans may not be able to work at their full potential, like natural disasters such as earthquakes and landslides. Autonomous vehicles can then diagnose the affected region and find vacant routes to inform the ambulance, and in this way, free passage can be provided. The same can also be applied to efficient routings in intelligent transportation systems where VANET deploys Swarm Intelligence techniques like ACO [8], PSO, firefly, *etc* [9].

The Authors propose the IoTV paradigm through a framework capable of providing efficient communication for autonomous automobiles. The paper focuses basically on the following major points.

Implication of Waste in Boosting Economy

CHAPTER 13

Role of Industrial IoT for Energy Production Using Byproducts

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Abstract: Energy production from fossil fuels is limited as fossil fuel resources are limited on Earth. We have to find alternate resources for energy production. Energy production from waste material or by-products can help us in two major ways: by reducing waste on Earth and by producing energy without affecting conserved resources. Industrial IoT (IIoT) is an advanced IT-based technology that can help us detect the most useful waste and determine its availability in different places. It will also help us automate the complete lifecycle of energy production from by-products and distribute it to the required places.

In this chapter, we will discuss the role of Industrial IoT in the production of consumables from waste products/by-products. We will explain the various applications of IIoT in this whole process and the challenges faced in integrating this technology into it.

Keywords: Energy production, Industrial internet of things (IIoT), Waste management.

INTRODUCTION

Gases are mostly considered harmful to all living beings and have become one of the major concerns of the world. Mostly, the gases that are generated from factories and other working environments are fatal and hazardous to health. There are many gases as well that can be very useful for us, mostly noble gases and natural gases, such as helium, neon, *etc.* Most of the population is careless regarding their health and hygiene. Due to poor eating habits, many health issues have been reported. This often leads to the need for medication or hospitalization

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if the conditions worsen. In severe cases, individuals may require oxygen for breathing, which can be administered using helium, especially for those with asthma. Helium can also be useful for welding purposes and magnet production and can be considered a great example of mono and diatomic gases for the protection of welding companies. Electricity is the most important for us for performing tasks such as working on our computers, watching television, and reading and writing purposes, which can be done using electronics and electrical appliances [1, 2]. We need electricity and power to carry out various activities and tasks using energy resources, which help produce electrical energy. One of the energy resources is geothermal. Sometimes, cooling of the machines is needed for their proper working so that they do not get overheated as they stop working or get damaged. Modernized energy systems are now generally being used for the improvement of security and efficient functioning using smart city theories and conceptions. Effective management of building systems such as lighting, heating, and air conditioning can reduce energy costs and promote increased comfort during a person's prolonged stay in a room. The links between the work of intelligent tools and the amount of energy costs are necessary for alternative implementations for their improvement [3].

INTERNET OF INDUSTRIAL THINGS (IIOT): AN EXTENSION OF IOT

IoT is an IT and electronics-based advanced technology that uses digital devices like sensors for collecting data, cloud-computing platforms for storing captured data, and AMIL (Artificial Intelligence and Machine Learning)-based algorithms for analyzing the stored data [4, 5]. The physical and digital components present in the system, which can be both centralized or distributed, provide networking and computational functioning. CPSs, in general, are used as devices that have the capacity to determine the possibility of changing the actuator's state or to draw the attention of the human operator according to the environment being sensed. ICS has some similarities to the current traditional information technology systems where the systems are isolated, running various control protocols with the help of the hardware and software that are specialized where components are not physically connected to the IT networks and systems [6, 7]. The propriety solutions have been replaced by low-cost internet protocols. In a central location, adjustments are made to open or close switches, monitor alarms, and collect data. SCADA applications are formed of the following elements: the machine to be controlled and monitored, which can take up the power plant, a water system, a network and system of traffic lights, and the other is the platform system. The industrial machinery sensors and actuators are connected to the local processing and the internet. Industrial IoT provides and helps companies use devices, such as sensors, software, and machine-to-machine learning, to gather and analyze operation management and add value services. IoT can also be defined as interconnected objects and devices that manage, mine, and access the data they generate. The objects that are connected with each other are sensors and actuators, which can have some special functionalities and are able to communicate with the other equipment for generating, exchanging, and consuming data. In the virtual network, each object is represented as a node, which is continuously involved in the transmission of a huge volume of data about itself and its surroundings. Devices such as locks in smart bikes and smart kettles cannot be considered for industrial purposes. Connecting the network with the cloud aims to connect industrial assets [8].

The Industrial IoT (IIoT) is an extension of IoT, which includes sensors, communication networks, storage platforms, analytical platforms, and robotic components for the automation of industrial processes. IIoT comprises embedded systems, cloud computing, edge computing, generic technologies in smart factories, and other related software. IIoT is usually built for smartphones and wireless devices, basically for connecting the engines and sensors to the cloud network. There are certain taxonomies for the industrial IoT, such as device-centric, stack-centric, IoT sensors, IoT-based smart environment, and IoT architecture. In order to meet the 4G mobile telecommunication standards by the International Telecommunication Union-Radio Communications sector (ITU-R), which usually focuses not only on the throughput and latency rates but also on the ultralow cost, which enables adoption at a large scale that is economically feasible, the deployment of the device is enabled by coverage extension on the basis of versatility and reliability. Mostly, the challenges faced by the IIoT are due to data security [9]. Data security is how we manage and keep the data safe and protected from attackers and other criminal activities who can easily grab the information from the data that has been leaked or extracted by some unfair means. For the upcoming development of the 5G technology, ultra-reliable low-latency communications have been used for the development of 5G. Three-level integration in industrial IoT can be achieved by using different suppliers to integrate cross-technologies of smart devices. Different enterprises make use of integrations related to cross-domain businesses from various industries and sectors. IoT in healthcare is where different technologies of various fields, such as communication and interconnected apps, allow the functioning of devices, sensors, and people as a whole smart system for monitoring, tracking, and storing patients' information related to their healthcare for ongoing care [10].

IIOT FOR WASTE MANAGEMENT

IoT devices, along with machine learning, have made great improvements in various fields, and one of these fields is the waste management system.

List of Acronyms

AAL Ambient Assisted Living
ADASE Advance Driver Assistance System
AI Artificial Intelligence
AMED Agency Medical Research and Development
ANN Artificial Neural Networks
AoA Angle of Arrival
ARTS Advanced Rural Transport System
ATIS Advanced Traveler Information System
ATMS Advanced Traffic Management System
AVCS Advanced Vehicle Control System
BAN Body Area Networks
BC Block Chain
BDA Big Data Analysis
BS Base Station
CAMP Crash Avoidance Matrices Partnership
CDSS Clinical Decision Support System
CMU Carnegie Mellon University
CNN Convolutional Neural Network
CVO Commercial Vehicle Operations
DDoS Distributed Denial of Services
DL Deep Learning
DNN Deep Neural network
DoS Denial of Service
DSM Digital Soil Mapping
EDA Electro Dermal Activity
EEPROM Electronic Enable Read Only Memory
GAN Generative Adversarial Networks
I2I Infrastructure to Infrastructure
I2V Infrastructure to Vehicle
ICU Intensive Care Units
IIoT Industrial Internet of thing
IMU Inertial Measurement Unit

IoHT Internet from Healthcare Thing
IoT Internet of Things
IoTV Internet of Things for Vehicle
ISS Intelligent Smart System
ITS Intelligent Transportation System
JST Japan Science and Technology
KNN K-nearest neighbor
M2M Machine To Machine
MANET Mobile Ad hoc Networks
MC Micro Calcification
ML Machine Learning
NCB National Bio-economy Council
NFC Near Field Communication
NHS National Health Services
NITE National Institute of Technology and Evaluation
OT Operational Technology
PCA Principal Component Analysis
PLC Programmable Logic Controller
RAMS Road Asset Management System
RSU Roadside Unit
RVC Road Vehicle Communications
SCAP Security Content Automation Protocol
UAV Unmanned Aerial Vehicle
USB Universal Serial Bus
V2I Vehicle To Infrastructure
V2I Vehicle To Transportation Infrastructure
V2R Vehicle To Roadside
V2S Vehicle To Sensor
V2V Vehicle to Vehicle
VANET Vehicular Ad hoc Network
VCC Vehicular Cloud Computing

SUBJECT INDEX

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