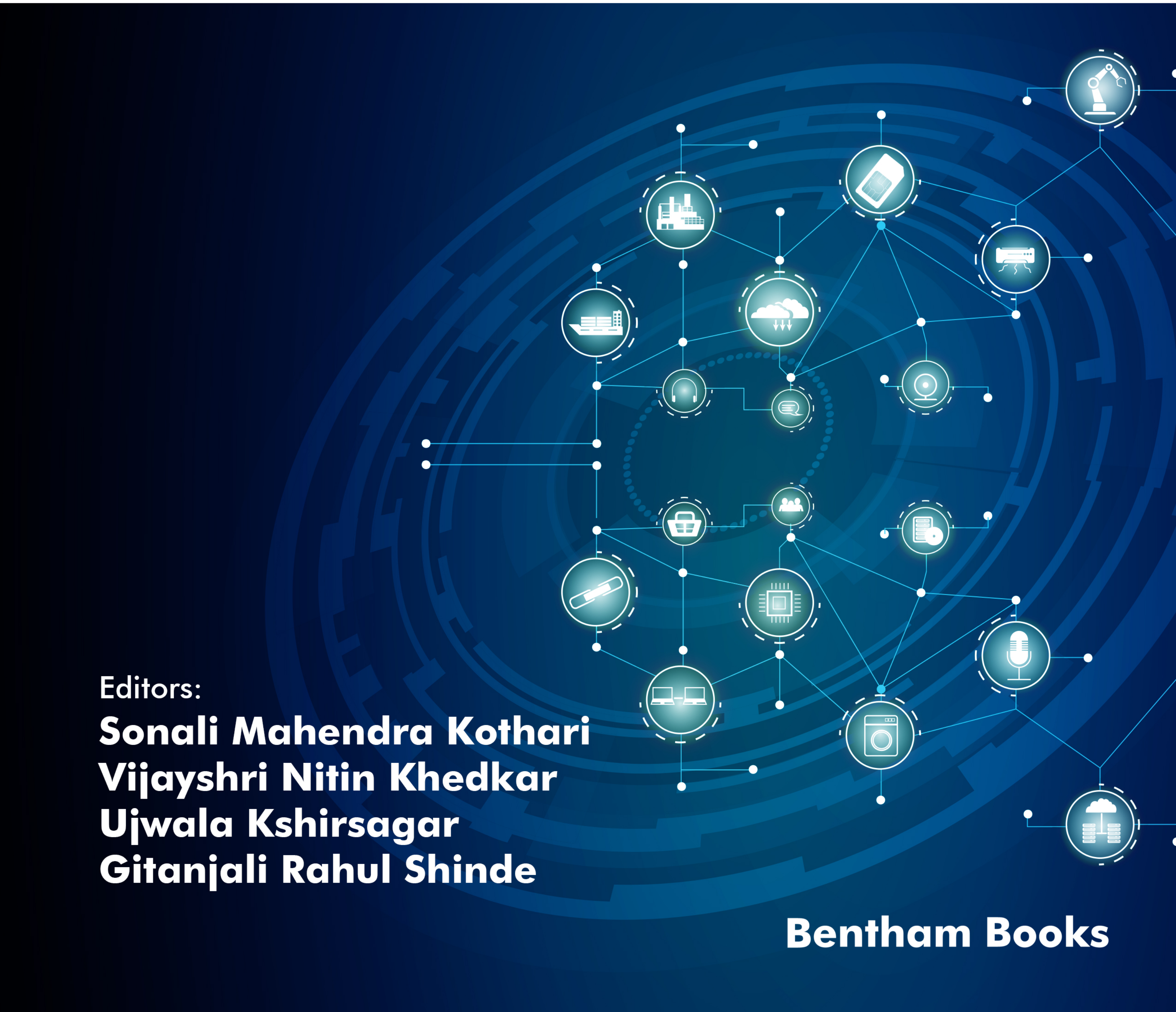
RESEARCH TRENDS IN ARTIFICIAL INTELLIGENCE: INTERNET OF THINGS



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Research Trends in Artificial Intelligence: Internet of Things

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Research Trends in Artificial Intelligence: Internet of Things

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FOREWORD

Artificial Intelligence (AI) in healthcare and biomedical applications is taking good shape nowadays. The convergence of AI, the Internet of Things, Blockchain and healthcare aims at delivering features such as scalability, security and privacy to high-level intellectual functions that are beneficial to the new era of digital information. In recent times, AI has touched major milestones by overcoming the challenges faced in realizing the full potential of projects in various fields such as smart homes, agriculture, smart cities, healthcare and medical, *etc.* Due to these transformations, the data is increasing at a faster rate in terms of size, complexity, variety, and heterogeneity, and in the sequel, computational intelligence, and machine learning the key contributors to improve business intelligence.

The book outline and contents show that the major coverage of the book includes a brief introduction to the domain, research challenges, literature review and state-of-the-art, different algorithms/techniques / deployment methods, data acquisition techniques including types of sensors used in IoT and communication, preprocessing and data cleaning, if required, application development and design issues, mathematical modeling of the engineering problems for ai based solution, different resources like datasets, APIs, software tools and packages evaluated or proposed, results, discussion and performance measures and future research directions. This will help readers to get detailed insights into the application of computational intelligence in the healthcare domain.

In addition to this, the communication and computing systems encompass every stage of professional and personal life, including education, healthcare, re- identification, transportation and social security. Data Science is used to analyze data from wearable trackers to ensure their patients' well-being, assist in hospital administration by reducing the waiting time and enhance public care. Cloud Security helps in the ease of scaling, increased reliability and availability, disaster recovery, and managing remote work. These key enablers for the healthcare and biomedical domain and more focus on IoT, big data and cloud will help readers to empower their research and learning in these areas.

Buyers, who belong to the category of researchers, will benefit from the state-of-art and future research directions provided in the book. Practicing engineers will benefit from the knowledge of the current challenges in technology, deployment methods and solutions. Post-graduate students will be introduced to new domains, and recent advancements in them. They will also be made aware of the rapid growth in technology and obsolesce.

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PREFACE

Artificial intelligence (AI) has grown in popularity in today's world. It refers to the simulation of natural intelligence in machines that have been programmed to learn and emulate human actions. AI is being used by huge companies all over the world to make the lives of end-users easier. The smart sensors and actuators are two key components of the Internet of Things (IoT). The IoT enables seamless connection to devices irrespective of time and location and hence it is an important component of what is known as the Industrial Revolution 4.0. One of the most significant advantages of the IoT is the reduction of human errors and manual labor, as well as the increase in overall efficiency and cost-effectiveness, both in terms of time and cost. This book offers recent research work going on in different domains where AI and IoT can be used. This book is a one-stop-shop for real-time work to solve engineering problems in various domains. The first few chapters are focused on the importance and amalgamation of IoT and AI for smart farming. It gives details about the basics of AI and IoT, and different algorithms available in AI and IoT for solving problems in agriculture. Healthcare is an important domain where early prediction of disease can save valuable human lives. In view of this, the second section of the book includes chapters focusing on research in the health care domain.

In today's era where enormous data are generated every day, it is very important to analyze the data and find solutions to various problems, and predict future trends. The next section of the book is dedicated to such recent trends and research in different fields where IoT and AI can help in making better analyses, and predictions. In the real world, data comes for various use cases and there is a need for source-specific data science models. The book includes chapters highlighting research work done by various authors in multidisciplinary domains considering the needs of today and tomorrow.

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CHAPTER 1

IoT and AI-based Smart Farm: Optimizing Crop Yield and Sustainability

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Abstract: The "Smart Farm" project is an IoT-based agriculture project aimed at optimizing crop yield and promoting sustainability in farming practices. By integrating various IoT devices and sensors, the project aims to improve the efficiency of farming operations, reduce waste, and enhance the quality and quantity of crop yields. The project focuses on using IoT technology to monitor and control various aspects of farming, including soil moisture, temperature, humidity, crop health, and livestock behaviour. By leveraging data from these sensors and devices, farmers can make more informed decisions about irrigation, pest control, and crop management, leading to increased productivity and sustainability. Overall, the Smart Farm project seeks to transform traditional farming practices into a more efficient, data-driven, and sustainable model that benefits both farmers and the environment.

Keywords: Agricultural robotics, Agricultural applications, Computer vision, Crop and soil management, Machine intelligence, Satellite drone.

INTRODUCTION

Agriculture is a critical industry that plays a significant role in global food security, economic development, and environmental sustainability. However, traditional farming practices often rely on manual labor, intuition, and guesswork, which can lead to inefficiencies, waste, and environmental degradation. In recent years, there has been a growing interest in using Internet of Things (IoT) technology to improve the efficiency and sustainability of farming operations. The "SmartFarm" project is an IoT-based agriculture project that aims to optimize crop yield and promote sustainability by integrating various sensors and devices into farming practices. By collecting and analyzing data from these devices, farm-

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ers can make more informed decisions about irrigation, pest control, and crop management, leading to increased productivity and sustainability. This project represents a significant shift towards data-driven, efficient, and sustainable farming practices that benefit both farmers and the environment. In this paper, we will explore the various components of the SmartFarm project, including the sensors and devices used, the data analysis techniques employed, and the expected outcomes and benefits of the project.

Agriculture involves five steps are as follows:

- Preparing the soil.
- Planting.
- Spraying applications, fertilizer or chemicals.
- Harvesting.
- Managing: Determining what you did well and what you'll do next year by collecting data for all of these steps.

Smart farming, also known as precision agriculture or digital farming, is an advanced agricultural system that uses technology to optimize crop production and maximize yields while reducing waste, energy consumption, and environmental impact. It involves the use of various technologies, such as sensors, drones, machine learning, and data analytics, to monitor and control every aspect of the farming process [1].

The main goal of smart farming is to increase the efficiency and productivity of agriculture by making data-driven decisions based on real-time information [2]. For example, farmers can use sensors to measure soil moisture, temperature, and nutrient levels to determine the optimal time to plant, irrigate, or apply fertilizers. Drones equipped with cameras and sensors can help farmers monitor crop growth, detect pests and diseases, and identify areas that need attention.

Smart farming also involves the use of precision machinery and robotics, such as automated tractors and harvesters, to reduce labor costs and improve accuracy. In addition, data analytics and machine learning algorithms can help farmers analyze large amounts of data to identify patterns and optimize farming practices for better yields.

Overall, smart farming is a promising approach to modern agriculture, as it has the potential to increase yields, reduce costs, and minimize environmental impact.

CHALLENGES AND ISSUES

Farming faces several challenges and issues that can impact crop yield, profitability, and sustainability [2]. Here are some of the most significant issues in farming:

- Climate Change: Climate change is causing extreme weather events, such as droughts, floods, and heat waves, which can impact crop yields and soil health.
- Water Management: Access to water and efficient water management is critical for farming, especially in arid and semi-arid regions. Water scarcity and inefficient irrigation methods can lead to crop failure and reduced yields.
- Soil Health: Soil health is essential for crop growth, but soil degradation from erosion, overuse, and chemical use can lead to reduced yields and nutrient-poor crops.
- Pests and Diseases: Crop pests and diseases can devastate crops, reducing yield and quality, and increasing the need for pesticides and herbicides.
- Labor Shortage: Farm labor shortages can lead to increased costs and reduced efficiency, especially during peak seasons.
- Access to Markets: Farmers may face challenges in accessing markets to sell their products, especially small-scale and subsistence farmers.
- Food Security: Despite advancements in farming practices, many regions still face food insecurity due to poverty, conflict, and lack of access to resources.
- Sustainable Farming: Ensuring that farming practices are sustainable and do not harm the environment is becoming increasingly important to consumers and policymakers.

Addressing these issues will require a combination of technological advancements, policy changes, and changes in farming practices to ensure that farming remains a sustainable and profitable industry.

PROCESS OF SMART FARMING

The “SmartFarm” project involves several processes that are aimed at optimizing crop yield and sustainability through the use of IoT technology [3]. Agriculture, which provides a country with the necessary fuel, food, fibre, and feed, is its foundation. Due to the significant advancements in bioinformatics, which permeate many areas of our lives, the important industry has grown more adaptable and sophisticated. A significant chapter in the history of global agriculture is that of “smart agriculture,” which began with the use of several cutting-edge technologies during various agricultural practises, including pre-cultivation, cultivation, seedling, fertilisation, weed detection, irrigation, pesticide

CHAPTER 2

Impact of Automation, Artificial Intelligence and Deep Learning on Agriculture Crop Yield

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Abstract: Every nation is concerned about the growing problem of agriculture automation. It is challenging to supply the food needs of the existing population due to rising numbers, frequent climate change, and scarce resources. Farmers are forced to wreak havoc on the land by applying dangerous pesticides more often since their old techniques cannot keep up with the growing demand. As a result, agricultural practices are significantly impacted, and the land gradually loses its fertility and becomes unproductive. The agriculture sector can benefit from technology like Artificial Intelligence (AI), deep learning, the Internet of Things (IoT), embedded systems, and automation. Artificial neural networks, the Internet of Things, fuzzy logic, machine learning, and other technologies may all be used to automate agricultural systems. Artificial intelligence technology is advancing quickly, and as a result, its employment is in a wide range of fields. Utilizing clever technologies, the agricultural industry has become able to regulate the field environment that is essential to the care of every plant. A suitable atmosphere and appropriate irrigation are provided by the plant's identification and suitable circumstances. In order to increase agriculture yields, it has become important to manage crops in controlled settings like greenhouses that can enhance the output. This chapter focuses on the use of artificial intelligence and IoT technology to improve the productivity of agricultural enterprises. AI technologies might help farmers overcome problems like weeds, pests, and climatic variability that lower output. Numerous uses of AI are now being deployed, such as automatic machine changes for weather forecasting and pest detection. The goal of implementing AI and IoT is to increase the possibility of producing healthy crops by recognizing damaged crops and crop yield growth.

Keywords: Agriculture crop yield, Artificial intelligence, Artificial neural networks, Automation, Drone, Deep learning, Fuzzy logic, Internet of things.

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INTRODUCTION

In this digital age, as technology advances, people are attempting to combine the functions of their natural and artificial brains. A whole new branch of artificial intelligence has emerged as a result of this continuous study. This is the method that allows people to build intelligent devices. The field of computer science, which includes AI, has the ability to be aware of its surroundings and should thrive to increase success rates. Based on prior experience, AI ought to be able to work. Machine learning, deep learning, CNN, ANN, IoT, and machine learning are some of the specialized fields that advance machine work and support the creation of more cutting-edge technology. The world's population has increased gradually and has already surpassed 7.7 billion people. By the year 2030, India's population is projected to exceed 1.5 billion, while the globe's population will increase from 7.7 billion in 2019 to over 8.5 billion. In the coming years, there will be a 70% rise in global food consumption and a major decrease in agricultural supply due to growing urbanization. By 2050, India will be the most populous nation on earth, and its domestic food production is already falling behind. The lack of planning, unexpected weather, incorrect harvest, irrigation technologies, and animals are the main causes of the decreased food output. Because of current global warming, nature has undergone a significant transformation. Because of the increase in the earth's average temperature, climatic conditions are unclear. The largest problem for farmers is persistent drought, not significant rain. Poor weather conditions cause farmers to earn 20–25 percent less money, according to India's yearly economic report.

One thought that comes to me is: What are all of these people going to eat? This inquiry is primarily directed at the agricultural sector. The population is not the only issue that modern farmers must deal with. What about the lack of workers and the need for eco-friendly food among consumers? Smart farming provides the solution to all of these issues. Software designed specifically for a certain site can save greenhouse gas emissions while also lowering the quantity of herbicides and fertilizers utilized (Impact of automation). Every nation's primary issue and the developing topic is agriculture automation. Given how quickly the world's population is expanding, there is an urgent demand for food. Farmers must apply toxic pesticides more often since their traditional methods are insufficient to meet the growing demand. This damages the soil and has a significant impact on agricultural operations, as the soil ultimately stays unfertilized. This chapter discusses several automation approaches and best practices, including the Internet of Things, wireless technology, artificial intelligence, machine learning, and deep learning. Crop diseases, improper storage management, misuse of pesticides, weed control, inadequate irrigation, and improper water management are a few issues affecting the agriculture sector. Machines were used to augment or replace human work throughout the industrial revolution. However, with the development of information technology in the twenty-first century, the idea of artificially intelligent machines was unavoidably born with the invention of the computer. The sustainability of any economy rests on the implementation of this technology in agriculture [1]. “Thing-to-thing” communication is what the word “IoT” refers to. System communication, automation, and cost-cutting are the three key objectives. AI is widely used in a variety of fields, including security, agriculture, economics, education, and many more. The machine learning process plays a role in the application of AI [2]. Agriculture used to be only concerned with growing crops and food [3]. But during the past 20 years, much has changed in terms of how crops and animal products are processed, produced, marketed, and distributed. Currently, agricultural operations provide the primary means of subsistence while increasing GDP [4, 5], contributing to national commerce, lowering unemployment, supplying raw materials for other sectors to produce goods from, and generally developing the economy [6 - 8]. It is essential that agricultural methods be examined with the goal of expanding creative techniques to sustain and enhance agricultural operations as the world's population grows geometrically. The use of technology in agriculture will be made possible by other developments like big data analysis, Internet of Things technologies, and artificial intelligence [9, 10]. Understanding concerns like the use of toxic pesticides, regulated irrigation, pollution management, and environmental repercussions in agricultural operations is urgently needed. It has been demonstrated that automating farming procedures increases soil productivity and improves soil fertility. Farm automation techniques can increase agriculture's profitability while simultaneously minimizing its environmental impact [11 - 13].

The use of computers in agriculture was first mentioned in a paper in 1983 [14]. The current issues in agriculture have been addressed using a variety of strategies, from databases to decision support systems [15, 16]. Agriculture is a dynamic industry, making it impossible to generalize problems and offer a universal fix. It can now accurately capture the intricate intricacies of each circumstance and offer the most appropriate answer using AI approaches. With the advancement of various AI approaches, extremely complicated issues are being handled gradually [17].

AI TECHNIQUES FOR PROBLEM SOLVING IN AGRICULTURE SECTOR

Following are some important AI approaches that may be utilized as targeted areas for issue-solving in the agricultural field:

CHAPTER 3

AIoT: Role of AI in IoT, Applications and Future Trends

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Abstract: Technology such as the Internet of Things (IoT), big data, cloud computing, fog computing, edge computing, and blockchain can be a perilous factor when it comes to encouraging the integration of new technologies. Artificial Intelligence (AI) is an integral part of agricultural and industrial development. This chapter describes the extensive evolution of AI and IoT. Researchers and practitioners will find this chapter essential for understanding AI and IoT, along with models, current status, future trends, and industrial development. There are a number of issues with AI, but overall, it is considered to be an advanced and revolutionary assistant in a wide range of fields. The purpose of this chapter is to present a comprehensive study on AIoT that explains the convergence of AI and IoT. Herein, we summarize some innovative AIoT applications that are likely too intense for our world.

Keywords: Artificial intelligence, Agriculture, Green development, Internet of Things.

INTRODUCTION

Researchers spent more than 50 years creating the autonomous learning capabilities of computers, starting with the development of computers that needed human manipulation in the 1950s. This development is a turning point for computer science, business, and society. In a way, computers have developed to the point where they are capable of finishing new tasks on their own. Future AI will communicate with humans using their native language, gestures, and emotions to adapt to them and learn from them. People will live in real physical space and remain in the digitally virtualized network as a result of the widespread

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use and interconnection of various intelligent terminals. The distinctions between humans and machines will already be blurred in this cyberspace [1 - 3].

- **Artificial Intelligence (AI)** is an intelligent machine that can simulate the intellect of a human by using this branch of computer science. AI seeks to replicate human qualities like perception, reasoning, comprehension, *etc*. in machines. In order to improve productivity and create new goods and services, intelligent systems in many different industries are built on extremely disruptive AI capabilities as shown in Table **1**.

Table 1. Key definitions.

Artificial Intelligence	Machines, devices, or systems that learn and perform new tasks.
The Internet of Things	It involves collecting, sending, and processing data from devices connected to the internet.
Artificial Intelligence of Things	Collects data and intelligence. After analyzing the information, AIoT will perform tasks without any human intervention.

- **The Internet of Things (IoT),** on the other hand, is a network of interconnected things or gadgets that, through software or sensors built into them, can gather and transmit data in real time. The use of IoT enables significant levels of automation across a variety of functions and sectors. IoT devices produce a ton of data from sensors and human input.

ROLE OF AI IN IOT

The IoT is transforming how we connect devices in our surroundings and throughout the cities, including long-distance communications. This type of network generates vast information about online activities happening every moment. The daily data generated by these networks are 5 quintillion bytes/1 Billion Gigabytes/ 5 Exabytes. The technologies, including Artificial Intelligence, 5G networks, and Bigdata, are the key to creating and managing these networks. IoT and AI are combined to form AIoT that a smart network of connected devices with AI, unleashing data's power better and faster than ever.

Artificial Intelligence and Machine Learning models set over connected devices like edge domains, cloud centers, *etc*., allow AIOT to collect real-time information through various sensors. This data can then be utilized for positioning, comparison, prediction, scheduling, and many more tasks. IoT provides AI with the data to feed the training algorithms, whereas AI provides IoT with perception and recognition capabilities. The two combined provide a platform for upgrading the economy sector, improving the industry, and optimizing the experience. In urban areas, AIoT businesses were implemented in mass around 2019. Several research articles and references present AI and Machine learning models being utilized in the domain of IoT [1].

In an IoT-enabled device, the environment is sensed, the data is captured, processed, and actions are taken. The action performed determines the intelligence of the device [1]. The goal of IoT devices powered by AI technology involves automation and adaptation. A few of the developments in current AIOT applications are described in this section.

VOICE ASSISTANTS

A voice service agent works as a personal assistant for users using cloud-based services. Smart devices within their proximity are controlled by them. They can also perform query replying like calling cabs, making restaurant reservations, *etc*. A few well-known assistants include Alexa from Amazon and Siri from Apple Inc [4].

ROBOTS

The development of robots that mimic humans and can communicate with them through the understanding, reciprocation, and expression of specific human emotions is one of the results of recent advances in this field of robotics [5]. An example is SoftBank's Pepper, which can understand human emotions such as anger, sadness, and joy. Hanson Robotics' Sophia can express emotions with over 50 facial expressions.

SMART DEVICES

Robots and voice assistants aren't the only IoT SO/devices that can help people with their tasks. Deep neural networks, transfer learning, computer vision, object identification, face and speech recognition, speech and expression recognition, and speech are all used by AI-enabled SOs. Using Honeywell's HD Wi-Fi doorbell, SkyBell, consumers may use their smartphone or voice assistant to open the door. The video camera on the doorbell alerts the homeowner when someone is at the door and streams a live view to their phone.

INDUSTRIAL IOT

In addition to being used in smart homes, IoT has a wide range of applications in various industrial sectors. In addition to identifying potential problems early, it can assist operators in making any necessary changes, from a small sensor to an entire facility. IoT-based industrial solutions such as Plutoshift are also available.

CHAPTER 4

The Role of Machine Intelligence in Agriculture: A Case Study

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Abstract: India's GDP is heavily reliant on agricultural products and business management. Therefore, it is crucial for the agriculture industry to comprehend the most common uses of artificial intelligence (AI) through case studies. To increase its production, this industry must overcome a number of obstacles, such as soil treatment, plant disease and pest effects, crop management, farmers' innovative methods, and the use of technology. The major ideas behind AI in agriculture are its adaptability, excellence, accuracy, and economy. It is critical to examine AI applications for managing soil, crops, and the environment, and plant or leaf diseases. Food security continues to be seriously threatened by deforestation and poor soil conditions, both of which harm the economy. The application's advantages, constraints, and methods for employing expert systems to increase productivity are all given particular attention. Businesses are utilizing robots and automation to assist farmers in developing more effective weed control strategies for their crops. See & Spray, a robot created by Blue River Technology, is said to use computer vision to monitor and accurately spray weeds on cotton plants. Crop and Soil Monitoring - Businesses are using deep learning and computer vision algorithms to interpret data taken by drones and/or software-based technologies to monitor the health of crops and soil. Crop sustainability and weather forecasting are accomplished *via* satellite systems. A Colorado-based startup employs satellites and machine learning algorithms to examine agricultural sustainability, forecast weather, and assess farms for the presence of diseases and pests. Utilizing predictive analytics, machine learning models are being created to monitor and forecast various environmental factors, such as weather variations. Drones and computer vision are used for crop analysis, while machine learning is used for identifying soil flaws.

Keywords: Agricultural robotics, Agricultural applications, Computer vision, Crop and soil management, Machine intelligence, Satellite drone.

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INTRODUCTION

The foundation of India's economy is agriculture. For more than 58 percent of rural households, it serves as their primary living area. The development and application of machine learning have improved agricultural benefits. Because artificial intelligence (AI) can be applied broadly to a variety of issues, particularly those that humans find difficult to handle effectively, it is gaining relevance extremely quickly. Therefore, farming solutions driven by AI help farmers produce more with less while improving quality and offering speedy go-to-market strategies for their crops.

In order to increase efficiency, agriculture is powered by AI, which examined its services in acquiring, comprehending, and responding to various situations. In order to increase production and efficiency, artificial intelligence technology is helping several agricultural industries.

The management of irrigation systems and soils is extremely important in agriculture. Crop loss and poor crop quality are caused by improper irrigation and soil management. To increase production, a smart management system is therefore required. The Internet of Things based smart irrigation system may automate the watering process by assessing the soil moisture and weather conditions. Because artificial intelligence is aware of previous weather conditions and patterns, soil, and its contents' quality, and the varieties of crops or yields to be cultivated, it may skip irrigation, one of the labor-intensive farming operations. The goal of automated irrigation systems is to boost average yields by utilizing real-time machines that can continuously maintain the correct soil conditions, considerably lessen the farmers' laborious tasks, and also has the ability to lower production costs. The awareness of AI would have a significant influence on reducing water loss for agriculture, which uses around 70% of the nation's freshwater.

Understanding Essential Agriculture Stages

Lack of information at each level of agriculture can cause new issues to appear or exacerbate existing ones, raising the cost of farming. The demand for the agricultural industry is exacerbated by the daily population expansion. From crop selection to harvest and product sale, agribusiness suffers from extremely high overall losses. Since knowledge is power, farmers may be able to make better decisions and lessen issues linked to agriculture by following the information regarding crops, the changing environment, and the targeted market. Information may be collected and processed using technologies including blockchain, IoT, edge computing, machine learning, deep machine learning, and cloud computing.

Applications of machine learning, computer vision, and IoT will assist to enhance the quality, raise production, and eventually increase the productivity and economy of farmers and related industries. The various stages required in Agriculture production are shown in Fig. (**1**).

Agriculture's Stages

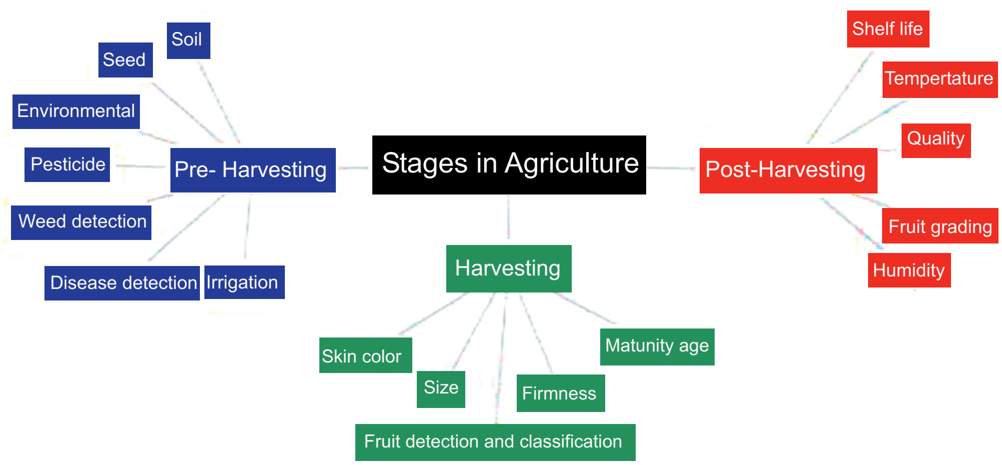

Fig. (1). Stages in Agriculture. Source: V. Meshram, K. Patil *et al*. Artificial Intelligence in the Life Sciences 1 (2021), Elsevier.

CASE STUDIES

An IOT-based System for Crop Irrigation

In smart irrigation systems using IoT, Gursimran Singh suggested machine learning technologies to improve irrigation water use by forecasting the future soil moisture of a field. To anticipate futuristic soil moisture, field real-time data from different sensors such as temperature, humidity, moisture of soil, and UV radiation are combined with weather forecasts through the internet. The analysis of several machine learning methods for forecasting future soil moisture shows the outcomes of several machine learning techniques. The system architecture of an IOT-based crop irrigation system is shown in Fig. (**2**).

CHAPTER 5

Optimal Feature Selection and Prediction of Diabetes using Boruta- LASSO Techniques

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Abstract: Diabetes prediction is an ongoing research problem. The sooner diabetes is detected in a human, the sooner lives and medical resources can be saved. Predicting diabetes as early as possible with easy to measures parameters with optimal accuracy is an ongoing problem. When dealing with large data, feature selection plays an important role. It not only reduces the computational cost but also increases the performance of a model. This study ensemble three different types of feature selection techniques: filter, wrapper and embedded. Ensembling Boruta and LASSO features give optimal results. Also, effectively handling class imbalance leads to better results.

Keywords: Diabetes Prediction, Ensembling features, Feature selection, SMOTE.

INTRODUCTION

Diabetes is a metabolic disease identified by the high insulin levels in the blood [1, 2]. Also known as diabetes mellitus, it often leads to complicated diseases like heart attack, kidney failure, stroke and nerves. Diabetes is grouped into mainly three types: diabetes type 1, diabetes type 2, and gestational diabetes. Type 1 Diabetes occurs when there is a lack of insulin in the body which permanently damages cells that produce the pancreas. The second type of diabetes is when the body cannot effectively use the insulin produced by it, and gestational diabetes is usually seen in pregnant women.

Identifying diabetes at an early stage is a strenuous task since most medical data are correlated, structured, nonlinear and intricate in nature. The use of machine le-

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arning-based systems has emerged in the field of healthcare [3, 4], not only for diabetes but for other diseases like coronary arteries, heart disease, and cancer. Machine learning-based systems can be used for feature selection and classification. A very important pre-processing step while training any data is variable selection. The main aim of this step is to filter out non-contributing features from the training dataset. Performing feature selection comes with many benefits: it deals with the problems related to dimensionality, avoids overfitting problems and reduces the total time cost for training the model.

Majorly, methods for features selection are categorised into filter methods, wrapper methods, and embedded methods [5 - 8]. Previously, authors have aimed at comparing various feature selection methods for varied domains. However, many studies have been developed based on one type of feature selection technique. There are different advantages and disadvantages of using a particular type of technique, and using a single type of algorithm has its own drawbacks. To overcome this drawback, the ensemble feature selection method is being explored recently. Ensemble-based feature selection techniques generate different subsets and get a final output. However, these studies are mainly limited to a single algorithm; not all three categories are considered in an ensemble feature selection. Also, many methods are being used for predicting or diagnosing diabetes. Mainly, these methods use advanced lab test results for prediction, which is time and cost-consuming. It is necessary to predict diabetes as early as possible using easy to measure features that can save time, money and health for health professionals and patients.

In this study, we focus on inspecting how different machine learning models behave and perform with different feature selection techniques along with various combinations of filter, wrapper and embedded feature selection methods. Also, identifying easy to measure features that do not require advanced lab tests for predicting diabetes as early as possible. This paper demonstrates that aggregation of Boruta and LASSO for feature selection and combining it with random forest gives better results for the data.

RELATED WORKS

A study [9] used decision trees, Naive Bayesian, Random forest, Support Vector Machine, and K nearest neighbour for predicting diabetes in an early stage based on data collected from UCI called PIDD dataset. The main aim was to select the correct attribute by iteratively checking the correlation between attributes. Different metrics were used for evaluating the models. RF and DT outperformed in terms of specificity. However, NB gave better accuracy. Various machine learning algorithms such as Logistic regression, gradient boost, and random forest were compared [10]. The main finding of this study was that logistic regression gave the highest accuracy of 96% with the private dataset used, which has features like insulin, BMI, Blood pressure, age, job type, and glucose. In comparison, gradient boost and AdaBoost classifiers gave 77% accuracy with the PIMA dataset.

Another study [11] proposed its own dataset for predicting type 2 diabetes. The class imbalance was treated by SMOTE technique, and for feature selection, Chi-square, and logistic regression were used. By comparing various ML algorithms, out of which the decision tree outperformed the proposed dataset. It was found out that smoking, healthy diet, blood pressure, BMI, gender and region were significant factors contributing to prediction accuracy. A study [12] used the NHANES dataset for predicting diabetes by extracting features like age, ethnicity, body mass index, fitness, drinking habits, smoking habits, nutrition intake, cholesterol, and calorie consumption. Moreover, linear SVM and bagged trees were compared, giving 88.5% and 87% accuracy. However, after removing outliers and missing values, the dataset was very small, which cannot be validated in real-time situations.

DATASET USED

A publicly available dataset from National Health and Nutrition Examination Survey (NHANES), which is cross-sectional ongoing survey data, was utilised for experiments. The survey collects health, nutrition, and lab examinations which consist of different measurements such as cholesterol, blood pressure and other specimens for lab testing. Survey participants were recognized as positive diabetic patients if any one of the following conditions were met:

i. Plasma fasting glucose >=126 mg/dL
ii. Glycohemoglobin >=6.5%
iii. Serum glucose >= 2000 mg/dL
iv. Responding ‘Yes’ when asked, “Did a doctor tell you that you have diabetes?”

Table 1. Detailed Description of Data set.

Feature Selection Techniques	AGE	RAC	EDU	GEN	WAI	MAR	HEI	LEG	WEI	BMI	CHO	HYP	DYS	SYS	HEA	EXE	ALC
ReliefF	✓	✓	✓	✓	-	✓	-	-	-	-	-	✓	-	-	✓	-	✓
Boruta	✓	-	-	-	✓	-	✓	✓	✓	✓	✓	-	-	✓	-	-	-
LASSO	✓	-	✓	✓	✓	✓	-	✓	✓	✓	✓	-	-	✓	✓	✓	-

CHAPTER 6

Empowered Internet of Things for Sustainable Development Using Artificial Intelligence

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Abstract: Everyone has been utilizing the Internet of Things in current years (IoT). Therefore, as the IoT has grown enormously, so too have concerns about Artificial Intelligence. Artificial intelligence (AI) is at the forefront of ubiquitous computing and is utilized to create intricate algorithms to safeguard networks and systems, including IoT devices. But to carry out cyber security assaults, hackers have learned how to make use of AI, and they have even started to deploy antagonistic AI. The goal of this research work is to comprehensively present and summarize the pertinent literature in these fields. It does this by compiling data from a few other surveys and research papers regarding sustainable development using AI, IoT, and attacks with and against AI. It also shows the relationship between IoT and AI.

Keywords: Artificial intelligence (AI), Cyber security Attacks, Energy management, Internet of things (IoT), Intelligent transportation systems (ITS), Smart irrigation, Water management using AI.

INTRODUCTION

The Internet of Things (IoT) has revolutionized the way we live and work by connecting everyday devices and facilitating communication between them. As the number of connected devices continues to grow, it is essential to ensure the security, efficiency, and reliability of IoT systems. Artificial Intelligence (AI) offers a wealth of opportunities for improving IoT, from enhancing security measures to optimizing performance. This study aims to explore various methods for securing, enhancing, and ensuring the reliability of IoT in the context of AI.

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This will include an examination of current techniques and technologies, as well as an evaluation of their effectiveness and limitations. The goal of this research is to identify the most promising approaches for improving IoT with AI and provide insights for future work in this area.

The field of computer science known as AI is concerned with developing intelligent machines that can carry out tasks that ordinarily require human intelligence, such as visual awareness, speech recognition, decision-making, and language translation. Large datasets can be used to teach AI systems to recognize patterns, predict consequences, and then be programmed to respond accordingly. The goal of AI is to create systems that can perform tasks that would normally require human intellect and make decisions and perform actions that are not explicitly programmed. Some common examples of AI include virtual personal assistants like Siri and Alexa, recommendation systems used by streaming services, and self-driving cars.

AI offers several opportunities for improving the IoT in the following ways:

- Security: AI can be used to improve security in IoT systems by detecting and preventing cyber-attacks. For example, AI algorithms can identify anomalies in network traffic and take action to prevent potential security breaches [1].
- Performance Optimization: AI can be used to optimize the performance of IoT systems by analysing data and making predictions to improve efficiency. For example, AI algorithms can be used to predict which devices will consume the most power and adjust their usage accordingly [2].
- Predictive Maintenance: AI can be used to predict when IoT devices will fail and schedule maintenance accordingly. This can help reduce downtime and improve the overall reliability of IoT systems [1].
- Automation: AI can be used to automate many tasks in IoT systems, freeing up time for human operators and improving overall efficiency [3].
- Decision-Making: AI can be used to make decisions in IoT systems, for example, deciding which devices to turn on and off based on usage patterns.

In Fig. (**1**), AI offers a wealth of opportunities for improving IoT by providing new ways to enhance security, optimize performance, improve reliability, automate tasks, and make informed decisions.

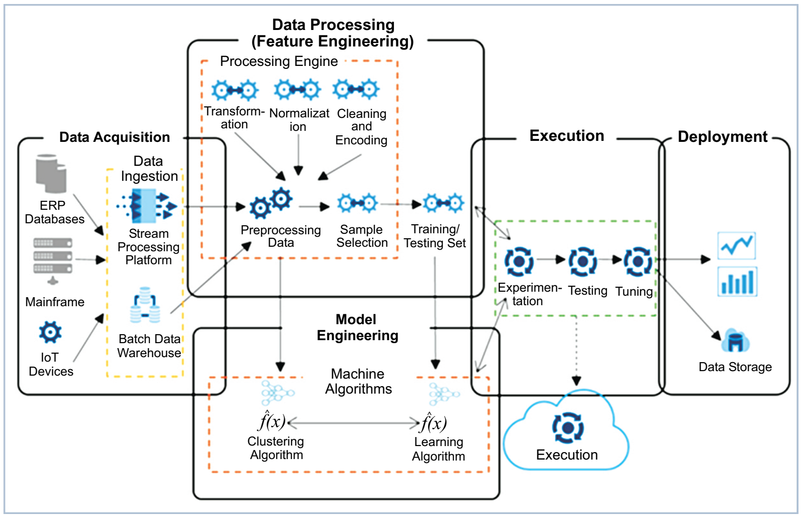

Fig. (1). Sustainable Security for the IoT Using Artificial Intelligence Architectures.

Artificial Intelligence

The ability of computers and other devices to carry out tasks that would ordinarily need human intelligence is known as AI, such as recognizing speech, understanding natural language, and making decisions [4].

An example of AI is a virtual personal assistant, such as Apple's Siri or Amazon's Alexa. These devices use Natural Language Processing (NLP) and machine learning algorithms to understand and respond to user requests for information, music, or other services. The more a user interacts with the virtual assistant, the more it learns about the user's preferences and behaviours, allowing it to provide a more personalized experience over time.

In Fig. (**2**), AI is used everywhere for example in self-driving cars, which use a combination of computer vision, machine learning, and sensor technology to understand and respond to their environment. These cars can detect obstacles, make decisions about the best route to take, and adjust their speed and trajectory accordingly, all without human intervention. As Artificial Intelligence is a broad field, the code will vary depending on the specific problem or task you want to solve with AI [3]. However, here in below Fig. (**3**) is a simple example in Python that uses a machine learning algorithm called a decision tree for classification:

CHAPTER 7

Digital Twin and Its Applications

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Abstract: Digital twin technology is an important part of the industry 4.0 revolution. Digital twins is a concept of integrating different smart technologies including integration of data and digitization. The vision of the digital twin technology is based on the philosophy that any component, assembly, system, process, product, or even environment can be replicated in terms of form, functionality and several other parameters in a digital way throughout different phases of its lifecycle. The Digital Twin concept is based on the highly growing information and communication technologies alongside conventional methods for getting better interconnection and integration amongst all the entities involved in a particular phase of the product lifecycle. The Internet of things (IOT) and artificial intelligence (AI) are crucial parts of the Industry 4.0 revolution. IOT proposes to embed electronics, sensors, network connectivity and different software platforms with products. Better integration between the physical and digital world is achieved by a strong network infrastructure that facilitates remote sensing, monitoring and even controlling of connected systems. This technology provides users with many benefits such as increased efficiency, reduced downtime, improvement in precision and accuracy along with cost saving.

This chapter includes an overview of digital twin-enabling technologies and their applications. The applications range from Artificial Intelligence, Internet of Things (IoT) to manufacturing.

Keywords: Artificial intelligence, Digital twins, Internet of things (IoT), Machine learning.

INRODUCTION

As the world is moving towards building smarter products, the technological advancements required to achieve this have taken strides in recent days. Among them, in industry, the concept of digital twin has attracted a lot of attention world-

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wide. It provides many advantages in the field of manufacturing like production and design, remote diagnostics, condition monitoring and operation in extreme conditions and services. It affects the design, structure and operation of the product. Digital twin majorly depends on accumulating data from sensing systems and presenting the data collected in real-time along with the modification and update with its physical model. With time, evolution is happening at a rapid pace, as is technology. The next generation technologies like advanced cloud computing, smart manufacturing, big data and AI are coming to the limelight, making life easier. As per several national manufacturing development strategies put forward like Industry 4.0, manufacturing based on cyber physical system (CPS) and industrial robotics is new. In order to bring such advancements to the industry, effective methods for maintenance, operation and monitoring are required. Also, to simulate plans or build what-if scenarios for the products, facilities, and processes we wanted to change before we actually put real-world resources behind, real-world implementation can be done with the promise of digital twins (DT).

From a temporal view point, there is a growing interest in DT and its evolution as shown in Fig. (**1**). As computing technology is developing day by day, CAD, CAM and CAE models are able to simulate the real-time changes in the virtual space. This prevents the spending of valuable resources and time by visualizing the data acquired from the models. After iterations, a final outcome can be decided based on the application and we may proceed with manufacturing.

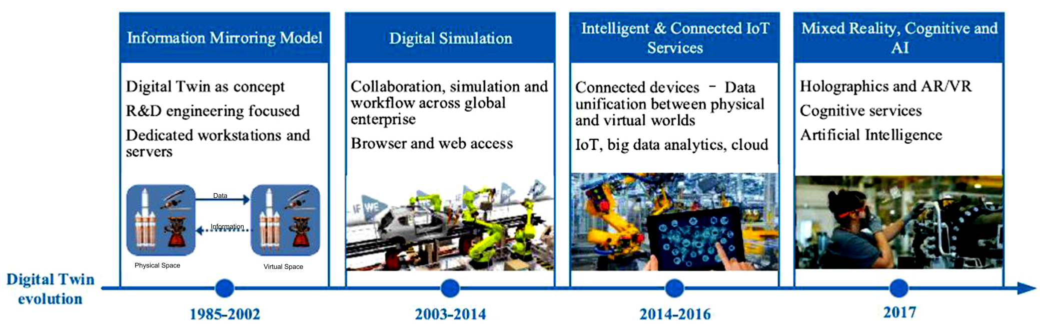

Fig. (1). Digital twin technology evolution with time [1].

The DT acts as a bridge between two spaces, that is the virtual space and physical space. By doing so, it eradicates the boundaries between them. The physical space is a real-life environment which involves several factors such as people, infrastructures and hardware with measurable properties such as mass, shape, size, *etc.* Each entity has its own positioning and follows physical laws and deals with uncertainty. The factors have their own physical functions and with proper organization, the tasks can be completed by considering the constraints on resources like time, cost quality, *etc.*

Augmented Reality (AR) and Virtual Reality (VR) are some of the technologies that can benefit from the implementation of a Digital Twin, due to the fact that it provides a virtual and realistic view of the environment in which the historical and real-time data flow is integrated with the human presence. However, considering the large amount of data and information in real-time that come from the Digital Twin model, it is difficult to provide users and operators with this information in an easy and intuitive way. In particular, AR does not replace the physical world but allows the user to see the physical world with overlapping virtual objects. Moreover, it gives users the opportunity to interact with the physical world to perform specific tasks or be alerted to possible dangers. The inclusion of these enabling technologies within Industry 4.0 implies their importance for modern factories. In general, an architecture that integrates the Digital Twin and AR/VR is composed of the following three main blocks:

A. Calibration: In order to obtain a clear and intuitive data visualization using AR devices, all the processing of historical data is as important as the data. In order to better manage the AR device, the 3D or 2D models must be perfectly aligned with the physical part. This process is called calibration.
B. Control process: The control process is a very important aspect for AR systems as it allows the user to interact with both the physical and the virtual part of the Digital Twin. After viewing the data in the increased process, users can use this information to support decision-making and directly control the physical part through the AR device.
C. Augmented process: The augmented process, through the AR devices, must provide users with an intuitive and clear AR view of the information coming from the Digital Twin. In practice, the AR device receives data from the virtual part, and after the calibration phase, it correctly presents this to the user.

Making use of the current technology, some challenges arise in using AR in the manufacturing sector. They can be summarized in four types:

1. Real-time data: There is a huge amount of real-time data exchanged between the manufacturing process, cloud and VR devices, and these have to be managed in order to support the users and operators in the correct way.
2. 3D and 2D modelling: Recognizing, tracking and following the target object(s) are extremely important for the quality of AR utilization.

CHAPTER 8

Ontology Based Information Retrieval By Using Semantic Query

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Abstract: The volume of data is increasing quickly in the modern day. Effective information retrieval techniques are needed to extract important facts from such a large collection of information. As a result, retrieval of information is the process of gathering valid data from a variety of sources. The majority of the time, information is retrieved from the internet using search queries. The aim of this research is to explore various issues existing in information retrieval techniques and to propose new techniques to overcome existing challenges in the field of Information retrieval.

Modern information retrieval methods have been examined, and it was discovered that they do not take semantic keyword knowledge into account when returning results. The semantic web is a development of the internet that enables computers to comprehend human inquiries in terms of their intent and produce pertinent responses.

This research mainly focuses on Ontology-Based Information Retrieval which can support semantic similarity and retain the view of an approximate search in a document repository using machine learning techniques. Further, this research works explores an adaptive update model for retrieving the information and proposes a semantic search model for the given user query. The objective of ontology-based semantic web information search is to increase the accuracy, precision and recall of user queries.

Keywords: Information retrieval, Machine learning, Ontology, Semantic web, Semantic query expansion.

INTRODUCTION

Huge data is generated in an integrated environment from multiple sources. The generated data is housed in a repository. The need to retrieve context-specific rel-

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evant data is a challenging need of the time. Information Retrieval (IR) is becoming a more popular technique due to the tremendous growth of data resources on the internet in many forms. The main motive of the IR system is to discover the relevant information and documents that fulfill the requirements of the user. As searching the documents through the internet has become an imperative part of people’s life, there is a great demand for obtaining such documents from a huge source of information which are appropriate to the information referred. Searching for information and documents from Web repositories through search engines gives many times irrelevant pages. This is because of the fact that search engines solve queries based on text pattern matching. This may sometimes output relevant as well as matched but irrelevant information.

Semantic web technology plays a significant role in retrieving relevant information. The semantic search tries to understand the user intention and improves the search accuracy and in turn appears in the searchable data space. Ontology plays a vital role in Semantic Web Technology. The component of the Semantic Web referred to as Ontology provides a common understanding of a particular term along with its relationship with the other terms in the query, where, the adaptive ontologies represent both the search domain and the user domain. This will reflect the search domain's ability to adjust to domain evolution semi-automatically. The obtained data in ontologies were used to strengthen the semantics of submitted queries as well as online data.

Likewise, the system automatically uses the chosen ontologies to enrich the produced query in accordance with the query enrichment criteria. Based on web data found in the graphs that validate the enriched query, the domain ontology is modified. The vision of the semantic Web proposes a situation where the information and administrations on the Web can be semantically translated and handled by machines to encourage human utilization. The semantic Web depends vigorously on the formal ontologies that structure basic information with the end goal of far reaching and transportable machine understanding. Semantic Web innovation depends on metaphysics as an instrument for displaying a conceptual perspective of the genuine and relevant semantic examination of documents.

Accordingly, the accomplishment of the semantic Web will be subject to the expansion of ontologies, which requires quick and simple designing of philosophy and evasion of a learning procurement bottleneck. However, there are certain challenges to which knowledge can or should be formalized.

The main purpose of this study is to propose an ontology-based information retrieval model that can retain the perception of an estimated search in a document repository and permit semantic query expansion similarity. In addition, this research investigates the creation of rank-based simultaneous history and knowledge update models and offers an adaptive update model for gathering information as well as a semantic query expansion model for the specified user query. Accuracy, precision, and recall are to be strengthened by ontology-based semantic query expansion and web information search.

Historical Background

Information Retrieval (IR) is the science and technology of efficiently allowing interested parties to obtain data from a repository of information. In information retrieval (IR), the task is to select information resources in vast repositories and satisfy customers' queries that reflect information needs. As things like text, image, audio, or a combination of all these, information resources are represented.

The basic aspects of the IR process are shown in Fig. (**1**). The user represents required information using query syntax during the conceptualization phase of IR. Only a minimal presentation of information complexity is required in the query. In practice, the user approximates the requirement for the inquiry by expressing numerous instances of the standout demand qualities, resulting in a set of terms that are tied to some coordinating terms. This frequently results in retrieval ambiguities, making it the major supply for the revision process.

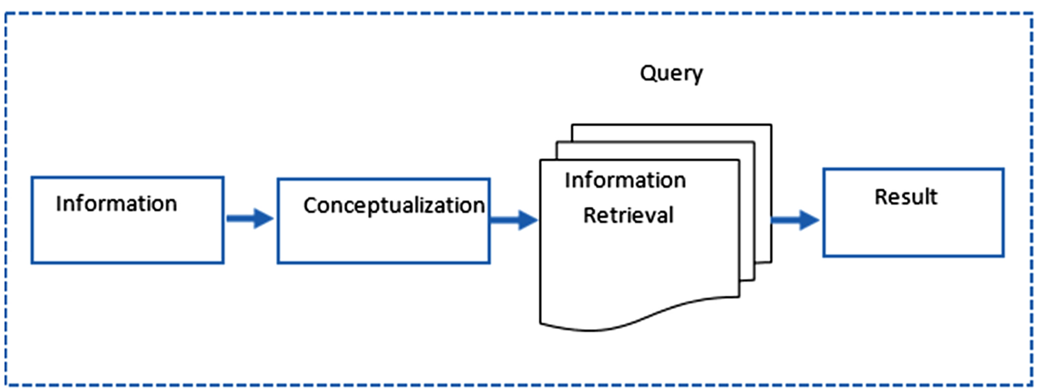

Fig. (1). Basic Information Retrieval Process.

CHAPTER 9

Paradigm Shift of Online Education System Due to COVID-19 Pandemic: A Sentiment Analysis Using Machine Learning

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Abstract: The COVID-19 epidemic has completely altered the environment and every aspect of every individual. The most affected part is the education system and the stakeholders associated with it. Organizations are currently being forced to adapt and alter their strategies in response to the new situation created by the COVID-19 epidemic. The proposed study gathers tweets on online schooling from social media sites like Twitter and Facebook comments in order to conduct a thorough sentiment analysis (SA) during the epidemic. The current study utilizes techniques for natural language processing (NLP) and machine learning (ML) to extract subjective data, establish polarity, and identify how people felt about the educational system prior to and following the COVID-19 crisis. The first step in the proposed study is to retrieve tweets using Twitter APIs before they are ready for rigorous preprocessing. One filtering method is Information Gain (IG). We will identify and examine the latent causes of the unpleasant feelings. We'll look at the machine-learning classification algorithm at the end. The proposed model will analyse the perceptions of people about the online educational system during COVID-19.

Keywords: COVID-19, Machine learning, Natural language processing, Online educational system (OES), Pandemics, Sentiment analysis.

INTRODUCTION

The Internet has developed over the past 20 years from being almost non-existent to being the biggest, most accessible database of knowledge ever made. It has changed the way people communicate, transact business, shop, socialize, and approach information and education. Education is becoming more accessible than ever because of online learning, which is revolutionizing the way traditional

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classes are administered. It is much more than just a fresh method of distance education.

Online education is a style of instruction where students use their personal computers to access the internet. Over the past 10 years, many unconventional students, such as those who choose to continue working full-time or raising families, have become more and more interested in online graduation and courses. The host university's online learning portal frequently provides online academic and graduation programs, some of which use digital technologies.

Schools, training facilities, and institutions of higher education have been forced to close in the majority of countries as a result of the COVID-19 lockdown and social isolation tactics. There has been a paradigm shift in how educators deliver high-quality education using a range of online channels. Online learning, distance learning, and continuing education have emerged as the panaceas for this unprecedented global epidemic, notwithstanding the challenges that both teachers and students must overcome. Both learners and teachers may experience a completely different learning environment when switching from traditional face-to-face learning to online learning, yet they are forced to adjust because there are few or no other options. Through a variety of online channels, the educational system and instructors have accepted “Education in Emergency,” forcing them to use a system for which they are not ready.

E-learning resources have been essential in facilitating student learning while universities and schools have been closed due to the pandemic. Staff and student preparation must be assessed during the transition to the new changes and supported appropriately. Learners who have a fixed mindset find it difficult to adapt and alter to a new learning environment, in contrast to students who have a growth mentality.

The survey by the Chicago Community Networks Study included not only a series of questions on organizational characteristics but also a roster of organizations identified by the research team and by locals as contributing to community development work in each organization’s neighbourhood [1]. India is not an exception to the difficulty of online learning for both students and teachers worldwide. Online courses have had a greater detrimental effect on a small percentage of students. Most teachers who taught English were unpaid during the shut-down of the school; embassies rejected offering student visas; and new teachers were not appointed by the school [3]. People are now using social media to express their emotions as a result. In order to examine the emotional current of Indian instructors and learners in light of these issues, this study will employ machine learning (ML) on Twitter tweets.

Technology will have a significant impact on education in the upcoming years. The Internet of Things (IoT) is reaffirming its critical role in the context of information and communication technologies and societal advancement. Institutions may improve learning outcomes with the use of IoT by offering more open learning opportunities, increasing operational effectiveness, and collecting real-time, actionable insight into student performance.

To our knowledge, this is the initial research to look at how COVID-19 has affected India's educational system using data from social media. Research will commonly use the social media sample approach. This study provides a helpful data analysis of the feelings at this point by assessing the emotions and the shift in positive and negative polarity throughout time.

HISTORICAL BACKGROUND

Social Network Analysis

Social Network Analysis (SNA) is a demonstrative strategy to reveal the connections inside an informal community that are likely to lead to further associations. It incorporates an arrangement of strategies and instruments to give a visual picture of the interpersonal organization and acts like an" authoritative X-beam" into the casual workings of a gathering of individuals. The essential spotlight is on the connections between individuals as opposed to the characteristics of the people [2].

Impact of Social Networks

Just one click away, the thoughts are shared with other people, paving the way to start a new journey in a new world. This technology is used for many other purposes, but communication is the main one and still persists. A new bond is created with common friends and similar people. It seems to be the perfect tool for those who admire each other, but some are worried about the impact of these social networking sites. There are two types of attitudes and impacts —positive and negative —that are realized by the users [3]. The impacts are mainly classified as follows:

- Positive Impact
- Negative Impact

CHAPTER 10

Image Processing for Autonomous Vehicle Based on Deep Learning

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Abstract: The automation industry is rapidly growing and coming up with new and improved techniques for reducing time and efforts. One such example is the autonomous cars which are said to be the future of the automobile industry since they would be driver less, very efficient and relieve the stress of daily commuting [1]. Advances in technology using the AI and deep learning techniques help in improving the safety of the passengers and also in minimizing the efforts of the driver. For the study of autonomous vehicles, a lot of data needs to be collected, some of which include warning signals, speed limits, obstacles, collision avoidance, *etc.* This paper shows how IoT devices *i.e.* cameras and LiDAR sensors help in data collection, how deep learning is a solution, and how image recognition methods that use deep learning can help in object or any obstacle detection. An image processing algorithm based on deep learning is proposed in which the image perception can be made by an optical camera communication technique that can be used for collecting the data. Hence it will highlight how deep learning is used in the field of image processing or image recognition.

Keywords: Autonomous driving, Camera, CCD, LiDAR, Convolution neural network(CNN), Deep learning, Image processing, Lane detection, LED area detection, Machine learning, Object detection, Vehicles, YOLO.

INTRODUCTION

Modern day cars are equipped with technology that assist drivers to avoid drifting into adjacent lanes, making unsafe lane changes, brake automatically if a vehicle stops ahead, and warn drivers of vehicles behind them and various other things. All of these features use a combined effort of software and hardware to help iden-

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tify certain safety risks. Autonomous cars are vehicles capable of driving without human input by sensing the environment and making decisions based on the conditions. The car can travel to any place a traditional car can go and drive with experience [2].

Levels of Autonomous Driving

Autonomous driving is classified into 6 different levels. This classification is done based on the amount of control that the computer or the AI has over the car or the amount of input that is required from the driver. Fig. (**1**) shows a representation of the different levels of autonomous driving based on the input required by the users.

Level 0 – The work is done by humans and there is no role of the computer.

Level 1 – The work is mostly done by a human and only the acceleration is done by the computer.

Level 2 – The ADAS (Advanced Driver Assistance System) can handle tasks like steering and acceleration, but human monitoring is required at all times.

Level 3 – The ADAS can perform driving tasks in limited areas, but human input is required in cases where the computer fails and asks the driver to regain control.

Level 4 – The ADS (Advanced Driving System) can perform all driving tasks independently in which human attention is not required.

Level 5 – Involves complete automation in which all the work is done by the vehicle in all conditions and requires no human attention or input.

Camera vs LiDAR: The Better Hardware for the Detection of Vehicles

LiDAR technology utilizes light pulses to detect and gauge the distance and range of objects, similar to how radar uses radio waves. This information is then used to inform the actions of self-driving vehicles, such as applying the brakes to avoid collisions. Additionally, LiDAR systems can generate 3D maps of the surrounding environment by emitting thousands of pulses per second and using on-board software to process the resulting data. These maps provide a comprehensive, 360 degree view that enables self-driving cars to navigate various road conditions.

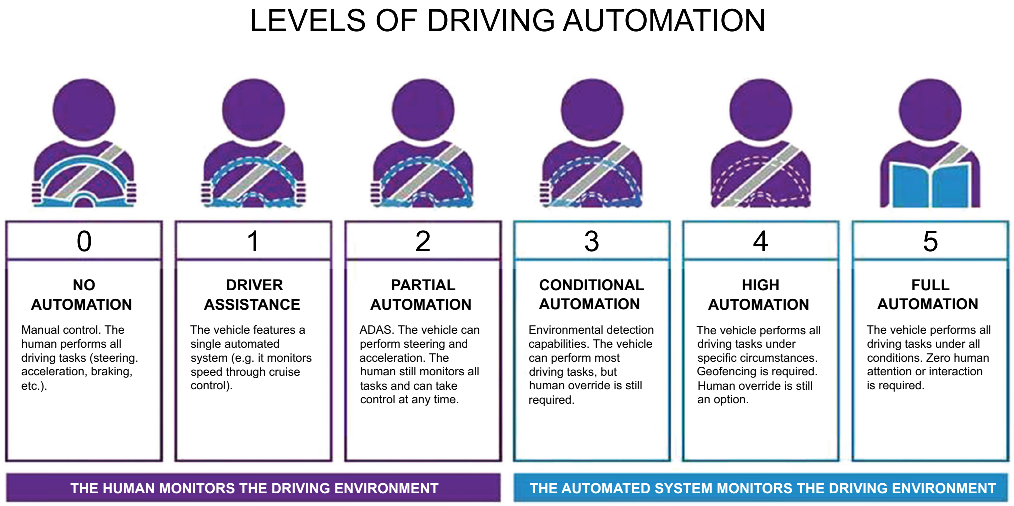

Fig (1). The 6 distinctive levels of autonomous driving.

Cameras on self-driving vehicles utilize visual data captured by the optics in the lens to inform the on-board software about the surrounding environment. With advances in computer vision algorithms and neural networks, these cameras are capable of identifying various objects and utilizing this information to guide the actions of the vehicle, such as avoiding collisions, slowing down in the presence of traffic, and safely changing lanes. Additionally, cameras may utilize OCR (Optical Character Recognition) technology to interpret and read text from road signs and other written materials. Table **1** gives a detailed difference between the two systems.

Table 1. Distinction between Camera and LiDAR System.

Camera	LiDAR
The camera has better advantages at visual recognition and working with AI to identify objects on the road.	LiDAR plots a virtual map in real time which gives it more precision while determining distance between objects.
The camera also has the capability to utilize OCR and read road signs.	Since LiDAR uses radio waves, it cannot read road signs.
Cameras are more reliable when used as visioning systems as they are good at imaging.	LiDAR's reliability is affected by wavelength stability and detector sensibility.
Cameras lack range to detect objects and weather conditions like fog can hamper this range further.	LiDAR systems have a better range since it relies on radio waves and harsh weather conditions like fog do not affect its capabilities.
Cameras are less expensive and compact to fit.	LiDAR is on the expensive side and looks bulky on the vehicle.

CHAPTER 11

Applications of AI and IoT for Smart Cities

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Abstract: Due to the rapid increase in urban population, the today's life of every citizen undergoes drastic changes. For the betterment of human life, Government of India had decided and announced the development of smart cities *i.e* the cities to be developed with all modern facilities in which people can use the internet for their daily activities. Smart city development would heavily depend on the Internet of Things (IOT) which combines three important aspects of Internet such as people-people interaction, people-objects interaction, and objects-objects interaction. Artificial Intelligence (AI) is another technology that provides the city equipped with efficient systems for security, safety, parking, *etc.*

The applications of AI enable IoT in smart cities that are discussed in this chapter such as Smart Home, Smart Healthcare, Smart Water, Smart Grid and Energy, Smart Transport, and Real Estate investment. Section 12.1 gives an introduction about the chapter that includes an introduction to Smart City, IoT and integration of AI and IoT. Section 12.2 discusses the potential use cases of AI and IoT in smart cities. Smart Home use case that includes smart management of equipment and human activity recognition is discussed. It also discusses Smart Healthcare which includes the fitness-tracking system, glucose-level monitoring system, body-temperature monitoring system, stress detection system, and oxygen-saturation monitoring system. Smart Infrastructure is also discussed which includes Smart Water, Smart Grid and Energy, and structural health monitoring. Smart Transport is also discussed in this chapter which includes the Vehicle Infrastructure Pedestrian (VIP), Smart Parking System (SPS) and Automated Incident Detection system (AID). The final section concludes the chapter by discussing the challenges in the smart city environment and future enhancements.

Keywords: Artificial intelligence, Internet of things, Smart city, Smart healthcare, Smart infrastructure, Smart home, Smart transport, Smart water.

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INTRODUCTION

Due to the complexity of the ecosystem such as increased population, climatic variations, pollution, scarcity of resources, heavy traffic, poor infrastructure *etc.,* cities have become unorganized. So, there is a need for using technology as a solution to all these issues. This paved the path for the development of smart cities [1]. By utilizing all the city resources, the quality of life should be improved and operational cost should be reduced. A smart city can be defined by various characteristics as shown in Table **1**. Each characteristic is defined based on the key aspects of the city.

Table 1. Characteristics of a Smart City.

Characteristics	Factors
Smart Environment(Natural Resources)	Smart Energy
	Smart Air, Water, Land, and waste Management
	Environmental Protection
Smart Society(Quality of Life)	Smart Health and Education
	Smart Safety and Security
	Smart Housing
	Smart Cultural Facilities
Smart Government(Governance)	Smart Public and Social Services
	Smart Participation in decision-making
Smart Economy(Infrastructure, Technology and Environment)	Smart Industry and Business
	Smart Tourism
	Smart Payment and Banking
Smart Mobility(Transport and ICT)	Local accessibility
	Innovative and Safe Transport Systems
	Availability of ICT-infrastructure

Internet of Things

The Internet of Things (IoT) is an interconnected system of physical items that are distinctively addressable and has various degrees of sensing and processing capabilities. Its main feature is to make the devices communicate through the internet as their common platform. The broad areas which are covered by IoT are the industrial sector, health sector, smart cities, security, agriculture, and emergencies among many others.

AI-Enabled IoT

AI is considered the science of agent design. By associating intelligence with the agent's behavior, a human-like mind without a human-like brain is acknowledged [2]. When the integration of Artificial Intelligence (AI) and the Internet of Things (IoT) is implied for a city, then the city is considered to be smart. Many practical innovations have been produced in such cities in almost all sectors [3]. By utilizing all the city resources, the quality of life is improved and operational cost is reduced. The major role of IoT is connecting the various digital and analog devices through the Internet with its unique identifier while the role of AI is to focus on devices making decisions through learning from their data and experience [4].

POTENTIAL USE CASES OF AI AND IOT IN SMART CITIES

Smart Home

The smart home is one of the inevitable components of a smart city. Gartner defines a smart home as "Smart Homes consist of a set of devices and services that are connected to each other and to the internet and can automatically respond to pre-set rules, be remotely accessed and managed by mobile apps or a browser, and send alerts or messages to the user(s) [5]."

IoT facilitates the interaction between connected household equipment and people, and integrating AI with it makes this interaction intelligent and smart. Industry giants like Amazon, Samsung, Apple, Google, *etc.* have leveraged this to offer smart home platforms that integrate well with third-party applications. Fig. (**1**) illustrates how IoT can be set up from the rooftop to the garage, which facilitates reduced carbon emission, energy consumption, and cost benefits along with other benefits. IoT environment is set up using a variety of sensors like motion, hydraulic, chemical, ambient, electric, identification, biosensors, and presence used for detecting motion, measuring liquid level and flow, physical quantities, electrical power, near field communication, health parameters, and presence of objects, respectively.

AI and IoT are combined together to provide effective solutions to daily household routines by collecting and analysing data through sensors and interactions [6]; for example, water leakage prevention, temperature control in rooms and water tanks, water usage monitoring, air quality control, automatic on/off of fans, lights, and air conditioners, recording of TV programs of user's taste, detection of trespassers, people behaviour monitoring, *etc.* As a smartphone is an essential component of a smart home, the user can easily monitor from a

CHAPTER 12

Analysis of RGB Depth Sensors on Fashion Dataset for Virtual Trial Room Implementation

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Abstract: This paper presents a Virtual Trial Room software using Augmented Reality which allows the user to wear clothes virtually by superimposing 3d clothes over the user. These sensors are valued particularly for robotics or computer vision applications because of their low cost and their ability to measure distances at a high frame rate. In November 2010, the Kinect v1 (Microsoft) release encouraged the use of Red Green Blue (RGB)-D cameras, and in July 2014, a second version of the sensor was launched. Because high-frequency point nuclei can be obtained from an observed picture, users can imagine employing these sensors to fulfill 3D acquisition requirements. However, certain issues such as the adequacy and accuracy of RGB-D cameras in close-range 3D modeling have to be addressed owing to the technology involved. The quality of the data obtained therefore constitutes an important dimension. In this study, the usage of the current sensor Kinect v2 is explored in the three-dimensional reconstruction of tiny objects. The advantages and problems of Kinect v2 are addressed in the first section and then photogrammetry versions are presented after an accurate evaluation of the generated models.

Keywords: Augmented reality, Depth Sensor, Fashion Recommendation, IOT, Virtual reality, Virtual trial room.

INTRODUCTION

As Vivienne Westwood has said, "fashion is very essential. It is enhanced life and worth doing well, like everything that brings joy". In the 14^{th} century, there were the first changes in fashion in European culture; subsequently, the number of fashion designers across the globe grew because of the industrial revolution [1]. In the 21^{st} century, every year fashion trends change. Trends in fashion influence

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local culture and climate change; yet these trend communities tend to be the world's leading fashion industry [2]. Unattended future popularity in fashion pictures must be predicted by a training prediction model to represent their trends throughout time [3].

The number of shopping malls owing to fast urbanisation is rapidly increasing and apparels is one of the best-known categories in shopping malls. The experience of cloth buying in shopping centres is mostly based on the availability of clothing that fit trends and hassle-free cloth testing. At the present time, in shopping centres or clothes stores, the trial of clothes is time-consuming because clients need to be in long queues and wait for their turn while they wear all the selected clothing and if they're not satisfied with the testing of selected clothes, they need to wait again in a queue with new clothes. The virtual test room is an Android application, which enables clients to choose clothing from the catalogue and try out to chosen garments on the virtual 2D/3D model [4]. The goal of the virtual test room is to maximise the accurate depiction and adjustment of the look and the customer preferences on the screen by overlaying the modelled clothes with the figure of the customer [5]. Two factors are thus necessary: information on the client's body size ("height, neck, breast, waist, hips, and arm measurement"), and the size of the chosen item of clothing, which should be taken into consideration. However, varying on whether it deals with 2D or 3D modelling, the method for adapting the garment to customer's body figure is different [6].

Due to the development in digitization and online platforms, Retail has undergone seismic changes over recent years [7]. A study claimed that the pace of change made possible *via* new technologies is accelerating [8]. One such technology, which "provides the shopping experience with the potential to revolutionise". By overlaying virtual components directly in the real-time environment, Augmented Reality (AR) may improve sensory impressions for customers [9].

Internet of Things (IoT)

IoT is a system of internet-based linked gadgets. It includes a desktop, a mobile, a laptop, mechanical equipment, sensors, household appliances, and automobiles. These gadgets are intended to exchange data *via* the internet with other devices. Many of the things around us are on the network in one way or another under the Internet of Things (IoT) concept. The new problem in which information and communication systems are invisibly integrated into the environment around would be tackled through Radio Frequency Identification (RFID) and sensor network technology. This leads to huge quantities of data being kept in a seamless, efficient, and easy-to-understand manner, processed and displayed. This model consists of goods and services that are supplied in a way such as conventional goods. With monitoring, storage, analytical tools, visualisation platforms and customer delivery, cloud computing may offer a virtual infrastructure for such utilities. Cloud computing's cost-based approach allows end-to-end service delivery, enabling companies and consumers to access apps from anywhere. It is an essential component of smart connectivity and context-friendly computing using network resources. The increasing availability of wireless internet connectivity such as Wi-Fi and 4G-LTE already demonstrates a development toward ubiquitous communication and information networks [10].

Components of IoT

However, all complete IoT systems are the same in that they represent the integration of six distinct components: sensors/devices, gateway, connectivity, data processing, analytics, and a user interface. Some of the major elements are required. The components are shown in Fig. (**1**) [10].

Fig. (1). Components of IOT.

- **Sensor**

The sensor is linked to the Internet of Things device to the outside world or a person. As the name implies, it detects changes and transmits data to the cloud for processing, as the name implies. Pressure sensors, temperature sensors, and light intensity detectors are examples of sensors that constantly gather data from the environment and send it to the next layer.

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