PRAGMATIC INTERNET OF EVERYTHING (IOE) FOR SMART CITIES: 360-DEGREE PERSPECTIVE

Editors:
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PREFACE

Pragmatic Internet of Everything (IOE) for Smart Cities: 360-degree perspective has emerged as a powerful paradigm for representing and solving complex problems. Pragmatic Internet of Everything (IOE) for Smart Cities: 360-degree perspective is the branch of Internet of Everything (IOE) concerned with coordinating behaviour among a collection of semi-autonomous problem-solving agents: how they can coordinate their knowledge, goals and plans to act together, to solve joint problems, or to make individually or globally rational decisions in the face of uncertainty and multiple, conflicting perspectives.

The inspiration and need for this book specifically on smart cities arose due to the sheer absence of any literature which amalgamates different perspectives, thereby giving a 360 degree perspective to the reader, even though there is plenty of literature available on the topic. An insight from subject matter experts from various vivid fields will not only substantiate the knowledge on the subject but, also give some inputs towards the implementation of practical ventures of the same. This process not only included excessive research and review of available literature and practical ventures but also included extensive surveys to get the gist of the topic from citizens of smart cities, along with the analysis of the same from a financial or business perspective and using policymakers' mind to optimize the same.

This book presents a collection of articles surveying several major recent developments in the Pragmatic Internet of Everything (IOE) for Smart Cities: 360-degree perspective. The book focuses on issues and challenges that arise in building practical Internet of Everything (IOE) for Smart Cities systems in real-world settings, and covers some solutions to the issues faced. It provides a synthesis of recent thinking, both theoretical and applied, on major problems of the Internet of Everything (IOE).

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CHAPTER 1

Investigating the Features of Physical Layer Structure for Employment of Smart City Models

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Abstract: In today's world, when everything around us is getting smart, be it the "phone" or "television", there is an utter need and high time for the cities to get smart to solve the major problems of mankind. It is a futuristic approach to alleviate obstacles caused due to day by day increasing population of India. It will help the government as well as the common people to fight daily life problems such as water scarcity, waste management, and lack of interconnectivity in a city that can cause serious problems like delayed responses to emergency situations. This paper mainly focuses on the salient features of the smart city "Dholera" in Gujarat, India. The city uses futuristic technologies like Artificial Intelligence (AI) and the Internet of Things(IoT) to automate city resources. It has AI-based smart grids, transportation, water and waste management. This paper explains why Cholera is a smart, intelligent and fast-responsive city and how it is a boon for the masses.

Keywords: Case Study, Employment Framework, IOT, Smart City.

1. INTRODUCTION

India today has a population of around 136 crores out of which 34% is the urban population. Today, urbanisation is increasing rapidly in India [1, 2]. Urbanisation increases the economy of the country and also contributes majorly to the growth of the country. But, is it sufficient for a city to be just urban to solve all the problems? The answer to this question is NO [3, 60, 61, 64].

As the population is increasing, and people are shifting more to urban cities, and the waste and water management problems are increasing day by day [4, 37, 48, 52, 53]. So, there is an utter need to convert cities into smart cities. This project is

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also called the Brownfield smart city project or the conversion of a barren land into a smart city is also called as Greenfield smart city project. We need some intelligent and smart solutions for problems that occur even in urban areas [5 - 7].

Let us consider the case of Mumbai, which is a metropolitan city in India. It faced heavy downpours in July 19, 2021, causing water logging in several low-lying areas in Kalyan-Dombivli, Ulhasnagar, Bhiwandi and Ambernath in Thane District [8 - 10]. Some people lost their lives as they got trapped in a massive mudslide. Also, according to news agencies, a 9-year-old boy fell and died in the open drain on Mira road. Had it been a smart city, the problem of water logging would have never occurred because of the excellent drainage system and such drastic incidents would have never occurred [11 - 13]. Let us consider another incident of Bengaluru's poor wastewater management system. Due to rapid urbanisation and development in Bengaluru, its groundwater is getting severely contaminated [71-73] as shown in Fig. (**1**).

Fig. (1). Water Logging [74].

Untreated waste from industries directly gets discharged into water bodies, polluting the water severely. This contaminated water when enters the ground, and later consumed, can directly cause fatal health diseases and if used for agricultural purposes, it can enter the food chain easily [14 - 16]. Many lakes in Bengaluru, such as Kaikondrahalli, Kasavanahalli and Kalkere lakes, have earlier also foamed, but the level of foam in Varthur and Bellandur lakes is alarmingly high. The foam sometimes overflows onto the roads, hindering the views of cars and other motor drivers leading to accidents. Some residents have reported skin irritation and many other life-threatening diseases. These issues can be addressed by using smarter solutions by encouraging the concept of smart cities in India. Smart cities make use of Information and Communication Technology(ICT) to overcome these problems and thereby enhance the standard of living [18 - 20].

Fig. (2). Froth in Bangalore City Causing Hindrance in Visibility [76].

Fig. (3). Smart City Infrastructure.

By making use of IoT along with Artificial Intelligence, we can collect data using sensors. Smart cities also have great infrastructure as shown in Fig. (**3**), to avoid problems like water logging, traffic management problems as shown in Fig. (**2**), waste-water and solid waste management problems. Smart cities also have separate residential and commercial areas for proper functioning and easier lives [21 - 24].

The Government of India has launched the smart city mission with the aim of developing 100 smart cities and many Greenfield cities across the country, making them citizen-friendly and sustainable. One of the cities in the mission is Dholera, which is India's first Industrial Greenfield city [25 - 28, 57, 68, 75].

Dholera consists of a smart water management system that solves waterlogging and wastewater problems [29 - 32]. It also has 4 ICT service centres, which will act as a central hub for all sensors. Supervisory control and data acquisition (SCADA), a computer system for collecting and analysing real-time data makes

CHAPTER 2

Pithy & Comprehensive Review of Practical and Literal Models

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Abstract: The development and success of various smart cities is contingent on the multiple models of expertise they employ and execute like a functional and smart infrastructure to handle traffic chaos, a sustainable water recycling system, a smart administration task manager, or an efficient waste management plant. The development and efficacy of various smart cities are directly dependent on the efficiency of multiple models it employees. Thus, the presented study aims to review, analyse and document the various models that perform mundane tasks "smartly", on the basis of key criteria namely: efficacy on the task in hand, power and time consumption, human interaction, upfront cost and operational task. These outcomes are then collated, and assayed by the application of various mathematical and statistical models to determine their performance as compared to the pre-existing non-technical approach of pursuing the same. Finally, the purpose of this study is to present a complete analysis of the performance of various models of smart cities to comprehend the profitability overall and provide suitable points to improve the same.

Keywords: Internet of Things, Smart Cities, Operational & Upfront Cost, Performance Quotient.

1. INTRODUCTION

With a growing global population and rapid industrialization, which is expected to increase by over 10% within the next three decades, culminating in three-quarters of the world's urban population by 2050, nations around the globe are opting to fortify their cities to cater to the citizen-centric requirements and the burnout this would put on existing urban services [1 - 3]. This will be done as per the United

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Nations Sustainable Development Goals '2030 [4]. As shown by the numerous public and commercial projects now underway, Smart Cities (SCs) have emerged as a significant endeavour by various governmental means in ensuring better accessibility and hospitability to the projected population growth and giving residents a better living standard [5 - 12]. It is indeed difficult to pin down an SC; though factually cities affirm to be “smart” depending on a range of metrics, such as incorporating novel e-governance initiatives, establishing social learning enterprises and community-based outreach programmes, reinforcing circular economy, and using web-based technologies for continuous improvement [1, 13]. In this study, we define SC concept as the use of a myriad of information and communication technologies (ICTs) to improve the quality of citizens’ living experience. This includes the ICT application in all of the previously mentioned areas, such as administration, transportation, accommodation, entrepreneurship, sustainable packaging, social cognition, community mobilization, and opportunity provision, among others. In an ideal world, the SC concept extends beyond the traditionally defined limits of a conventional city's organizational and social structures by enabling connectivity between them, allowing it to function more cohesively and effectively. When opposed to a typical city environment, SCs have numerous benefits (in terms of value): SCs are at the forefront of a cutting-edge technology that will assist governments in meeting their climate goals. SCs are concerned with SC management, smart transportation systems, and SC administration, to lower cities' greenhouse gas emissions and enable innovative technology to flourish for healthier and cleaner living. By 2025, SC projects will be worth USD 1 trillion, providing a significant financial incentive for governments as well as private enterprises to actively contribute to the technological revampments that enable SC growth [1, 14]. The goal of an SC project is to improve the quality of life for city residents and to contribute to the development of an inclusive society in which all viewpoints are respected and equal opportunities are offered. In the framework of smart cities, ICTs are a critical component of providing public services through improving citizen interactions with the city environment and making life simpler. There is an instance of the application of the computing frameworks on various SC projects [15 - 36].

The purpose of this work is to examine, assess, and record numerous models that execute routine activities “smartly,” based on important factors such as task productivity, resource and time consumed, interpersonal interaction, initial expense, and operating workload. These results are then compiled and analysed using a variety of modelling methods to assess their performance in comparison to a non-technical method to pursuing the same. Finally, the objective of this study is to give a comprehensive insight into the performance of several smart city models to understand their profitability from a broad perspective and to suggest ways to improve them.

2. COMPREHENSIVE ANALYSIS OF PREVIOUS WORKS

The continued success of various smart cities is dependent on the various models of expertise they employ and implement, such as a functional and smart infrastructure to handle traffic congestion, a sustainable water recycling system, a smart administration task manager, or an efficient waste management plant. The efficiency of numerous models employed by distinct smart cities is directly reliant on their development and efficacy. Comparative analysis of previous studies concerned with this perspective is tabulated in Table **1** as follows:

Table 1. Comparative Analysis of Previous Works.

Citation	Aim/Objective	Advantage	Drawback
Tsai, S. B., *et al.* (2021) [37]	The study concentrates on recent developments in advanced digital transport networks for IoT based SC applications, including both automated advancement and novel deployments.	Under blockchain technology, a long-term GCU implementation for transport systems is being established.	The fast railway sector's upstream marketplace has a pattern of inadequate enterprise participation.
Dahmane, W. M *et al.* (2021) [38]	The study intends to construct a competent modified methodology based on formal techniques and networking interpretations.	A system has been implemented that methodically creates a robust and stable Smart City Model (SCM) that can subsequently be incorporated and used by the building information model (BIM).	Realistic cases that are highly nonlinear have been used to demonstrate the efficacy of the proposed paradigm.
Kumar, N., *et al.* (2021) [39]	To optimize the flow of traffic, the study offers a traffic-light control framework built upon deep reinforcement learning.	It uses the real-time traffic environment's vehicle dynamics as input.	The efficacy of the cutoff guideline, which is implemented on the central site that creates traffic control signalling, has been questioned.
Viale, A., *et al.* (2021) [40]	The study intends to build a model that can achieve high performance with low latency in camera systems.	Using Dynamic Vision Sensors, the design consumes very little power than standard frame-based camera systems.	A low power setup is a must for the functioning of the model.

CHAPTER 3

Categorizing Obstacles in the Implementation of Smart Cities with Probable Solution Models

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Abstract: The development and implementation of smart cities can be a complex and challenging task as it becomes difficult to implement the notional concepts of smart cities that do not directly cater to the on-site problems. This study aims to identify and classify the various obstacles occurring in the development, planning & budget discussion of smart cities. It will deliberate wide purview of problems including standard difficulties like budget development that includes both capital upfront cost or Capex and operational cost or Opex, geographical & climatic challenges endemic to the city of development, employment & administration challenges like government permits, vendor availabilities, and technology troubles from IoT perspective. This study aims to categorize various issues into major five gradations namely: technical purview, location endemic purview, administration or employment troubles, pecuniary or financial issues and miscellaneous issues. Moreover, this study also provides a heads-up and detailed recommended steps to avoid the identified problems but presents specific case studies to show the significance and application of recommended solutions in multiple smart cities around the globe.

Keywords: Administration or Employment Troubles, Internet of Things, Pecuniary or Financial Issues, Smart Cities.

1. INTRODUCTION

Since the inception of the Smart City (SC) approach, various scholars have attempted to develop the most appropriate Information and Communication

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Technologies (ICTs)-based framework [1 - 6]. Because of the demands and practical circumstances in cities that have developed SC systems, all such applications have not followed a standardization and hence have specific attributes. Therefore, there is no one-size-fits-all framework for SCs; nonetheless, there exist a few prevalent archetypes that cater to the needs of cities [7]. The properties of the components in command of amassing, analyzing, and utilising data distinguish different configurations [8]. The most common ones are (1) cloud computing, (2) fog computing, and (3) edge computing, to name a few. These structures are modular and could be used in various sectors within the same city [9, 10]. Architectonic resolutions should be thoroughly examined in assessing their impact on the overall framework, as illustrated by Almeida *et al*. [11].

1.1. Cloud Computing

Cloud computing is a concept for providing on-demand networking accessibility to a virtualized environment element (*e.g*., platforms, processors, memory, algorithms, and functions) that could also be swiftly supplied and dispersed with negligible administrative intervention or network operator contact [12]. The framework can be divided into multiple strata. Reciprocity has been observed within multiple strata of the same archetype. The dissemination and simulation of relevant data are the foundations of the framework, which have been partitioned into categories. Kaur and Maheshwari [13] postulated a wellness programme as per the proffered paradigm when it came to the enterprises that utilised it. Biswas and Muthukkumarasamy [14] introduced a system for smart city authentication that leverages a cloud environment to combine blockchain with the Internet of things (IoT). Mazza *et al*. [15] provide a mobile cloud services paradigm for representing metadata concerning smart cities. Khanna and Anand [16] present a Cloud-based IoT-modulated supervised security system.

1.2. Fog Computing

As an outgrowth of Big data analytics, Fog computing was conceptualised by Bar-Magen Numhauser [17] in CISCO. The functionality and accountability of the program's base are improved significantly through this expansion. Additionally, the changes are due to the placement of data acquisition and interpretation units in the same access point as the data acquisition modules, resulting in reduced connectivity. The framework is deployed in systems having low power consumption, globally disparate platforms, or activities where sending information to the server and waiting for it to be processed is impractical. Bruneo *et al*. [18] provide a global telecommunications usage scenario employing the fog computing approach in terms of initiatives that utilised this framework. Chen *et* *al*. [19] devised a fog computing-based vibrant video feed computation technique that allows for reliable data analysis and accountability. To exchange interface signals between devices, Santos *et al*. [20] designed a truly operational nodal tracking system. Barik *et al*. [21] developed a fog computing-moduled platform enabling the collation of spatiotemporal predictive analyses.

1.3. Edge Computing

Edge computing is a framework based on the idea that if the information is captured at the program's interface, it ought to be more effective to interpret that information there as well. This one is analogous to fog computing, except that the fog sheds light on the architecture and edge on other aspects. This is vital to remember that the edges of the networks might not be the teensiest sensor, but rather the link between the centralised internet connection and cloud computing. Shi *et al*. [22] illustrate how this approach is distinct from the others and when it would be useful to adopt it all in the ventures that employed it. Taleb *et al*. [23] recommend a scheme that enables electronic edge computing to improve viewers' online streaming quality in SCs. Wang *et al*. [24] offer a surveillance platform that relies on powerful cloud topology. Fig. **1** is organized using the set of disseminating various implemented SC projects using fog [19 - 21, 39, 40], edge [22 - 24] and cloud computing [25 - 38] architecture.

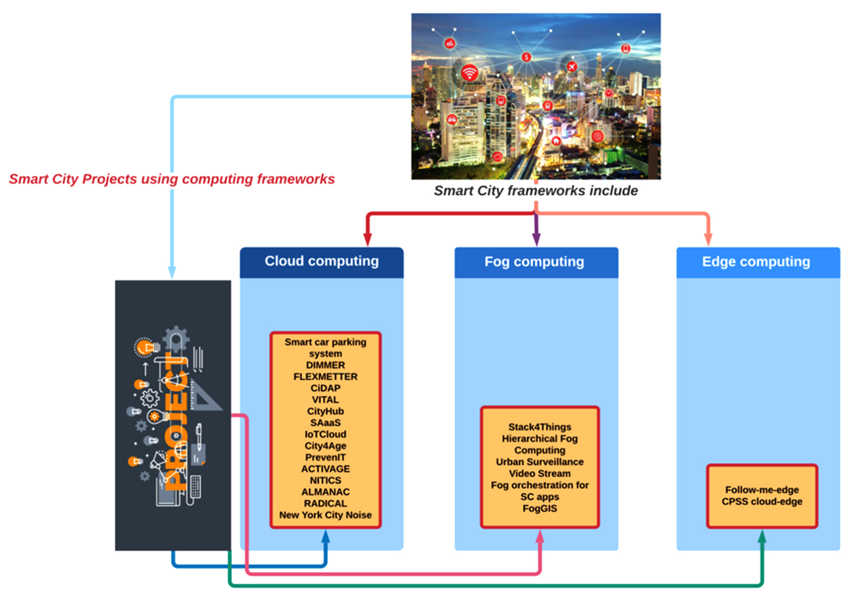

Fig. (1). SC projects using various computing architecture.

CHAPTER 4

Understanding the Future of Smart Cities from Technological and Commercial Point of View

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Abstract: While the development of smart cities is not an alien concept and in the last few decades, an increasing amount of investment both in terms of time and money is done, the pecuniary or financial benefit of this investment is still much uncharted. Like any other investment made, the return on investment plans and models are essential for further development. This research aims to explore, comprehend, analyse and further develop the return on investment in smart cities and various adjunct IoT and IoE-based models. The presented study primarily analyses and explores various possible financial benefits by deliberating multiple case studies of various smart cities and IoT-based projects worldwide. Additionally, a complete and detailed framework for each assayed case study is presented to comprehend the concept of RoI or return on investments which are distinct for every analysed case study contingent on numerous factors like investment, operational cost, area of application, *etc*. The presented study also aims to provide a comprehensive and comparative study between various plans of RoI for numerous case studies of smart cities and IoT-based projects.

Keywords: Internet of Things, Internet of Everything, Operational cost, Return on Investment (RoI), Smart cities.

1. INTRODUCTION

A smart city is a term that is used to describe a city that provides a better standard of living to its inhabitants by offering better public services and judicially uses the resources available thus reducing its environmental impacts. A formal definition

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of a smart city is an innovative sustainable city that uses various data and technologies together to improve the quality of life of its citizens and improve the efficiency of urban services [1].

Smart cities have become a necessity with a significant increase in the world's population in the past few decades and expectations for a better quality of life have also become a norm. By 2050, it is estimated that about seventy percent of the world's population will reside in urban areas. Urban cities currently consume more than seventy-five percent of the resources and energy available in the world and account for 80% of greenhouse gas production [2]. This emission along with other sources causes environmental pollution. The development of smart cities is a possible solution to this problem of rapid urbanization ad high population growth rates. The implementation of smart cities can help reduce water consumption, energy consumption, and carbon emissions and fulfil transport requirements [3].

All over the globe, smart cities are very different depending on their requirements, characteristics and components. Organizations like the International Organization for Standardization provide specific standards that are to be followed to maintain efficiency and safety. These standards help in the development of smart cities and can act as a guide for monitoring the functional performance of the cities [4]. For issues like security, climate change and transportation, these standards can act as guides for the development of potential solutions. Different factors are taken into account like resource management and business practices before these standards are formulated. By following them, we assess the performance of smart cities globally [5].

1.1. Components and Characteristic of Smart Cities

There are 9 important characteristics of smart cities. These characteristics include smart cities, buildings, smart transportation, smart infrastructure, smart governance, smart education and smart healthcare, and smart citizens as depicted in (Fig. **1**). The attributes of smart cities include urbanization and quality of life. Urbanization aspects for defence-related smart cities include technology, infrastructure and governance. The goal of a smart city is to improve the economic, social and environmental standards of a city as well as the people living in it [6].

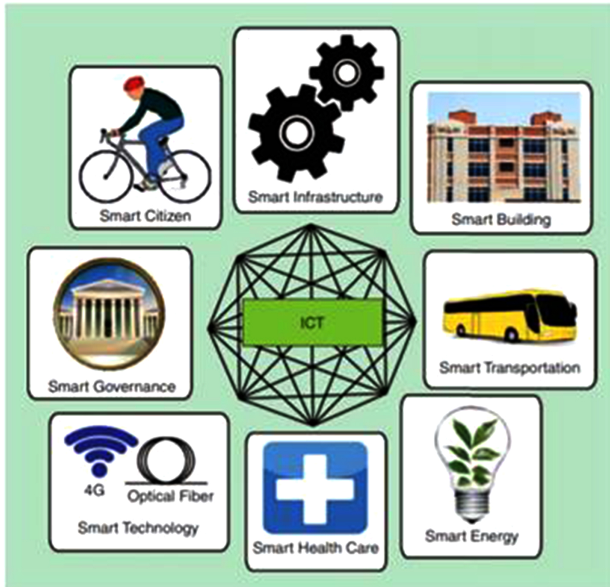

Fig. (1). Components of a smart city Image Source [1].

There are four core themes of a smart city: economic infrastructure, physical infrastructure, social infrastructure and institutional infrastructure as depicted in Fig. (**2**). The economic infrastructure signifies that the city can provide continuous job opportunities and economic growth for its citizens by using the best practices of e-commerce and e-business. It also includes novel innovations in manufacturing and industry [7]. As well as integration of new technologies to enhance the performance of existing systems. The physical infrastructure signifies that the city can sustain and function for future generations also. The institutional infrastructure includes the governance of cities and is associated with the participation of citizens in decision making, and the quality of public and social services that are available. To maximize the benefits available to the citizens regional and central governments must work in sync with each other. The physical infrastructure includes both natural as well as manufactured infrastructure that can help sustain the lives of present and future generations. Social themes include human capital and intellectual capabilities. Citizen responsibility plays an important role in sustaining a smart city and helps in the evolution of a city. In comparison with normal cities, the citizens of smart cities can grow to their potential to live a quality life [8].

CHAPTER 5

Dynamic Involvement of Deep Learning and Big Data in Smart Cities

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Abstract: Deep learning is an extension of Artificial Intelligence (AI) or cognitive learning that is used to optimize performance *via* the application of neural networks. And, big data analytics includes managing a plethora of continuous streams of data while obtaining valuable insights from them. Deep learning and Big Data analytics have been implemented in various avenues to obtain real-time optimized results, like biomedical applications, Computer Vision, and enhancing results for Internet of Things applications. This study aims to provide a deep insight into the application, performance, and values provided by Deep learning and Big-data analytics in the various intricacies of smart cities, smart governance and workflows in the same. Firstly, we provide applications or areas of smart cities that create Big-data, then provide techniques and literature where Big-data analytics is used to handle the same. Then, we present the different computing infrastructures used for IoT big data analytics, which include cloud, fog, and edge computing. Finally, we provide insights into various Deep learning modules that are successfully implemented in smart cities.

Keywords: Big Data Analytics, Deep Learning, Edge Computing and Neural Networks, Internet of Things.

INTRODUCTION

Recent times have observed a rapid growth in several new technologies like the smart grid, smart energies, and smart transportation. Among the major domains that take a leading role in information technology (ICT) include Big-data and the Internet of things (IoT) and Cloud computing (BIC). Without the evolution of IoT and big data analytics, the idea of a Smart City would have not been converted

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into reality [1]. A major tool towards this transition was Deep Learning (DL), a machine learning technique that was used for understanding and classifying data. The usage of Deep Learning was further extended to urban modelling and infrastructure of Smart Cities. Today, the concept of Deep Learning is majorly used in Smart Education and Smart Health Solutions.

IoT enables the people of smart cities to be connected with the help of Smartphones and other sophisticated gadgets that significantly help in upgrading their quality of lifestyle. Deep learning rapidly changes the way people operate by facilitating better transportation, connectivity, healthcare, and education [1].

Geographic information system (GIS) is used for improving the road network. It includes the software, hardware and other arrangements for the purpose of accumulating, storing and disseminating significant information regarding different places on Earth [2].

The implementation of machine learning and deep learning in smart cities promises a bright prospect for the development of smart cities. With the help of a training model that can provide correct results with similar features, the concept of deep learning can be implemented in a better way [2]. The researchers would also focus on integrating such technologies in smart cities that would significantly enable improved interactions of smart devices. In the days to come, deep learning will have a huge impact on several different aspects like smart education, smart governance, transportation, health management, security and privacy [3].

Deep learning uses a network of multiple hidden layers interacting with each other. It is an effective way to detect and identify different human activities that go on in smart homes. The devices used in smart cities are usually portable and allow the users to use them anywhere and carry them during travel. However, they may not be as handy for senior citizens. It is therefore evident that deep learning will bring drastic changes in the way the cities operate but people might take some time to get accustomed to it. The datasets that are used to develop deep learning applications are not readily available mostly [3].

INTERNET OF THINGS (IOT)

IoT Architecture: It consists of 4 stages: Hardware, connectivity and communication middleware, big data storage, and analysis and IoT applications. Wearable and wireless sensors create and capture data that is later transformed Fig. (**1**) into actions by the actuators. The collected data from wireless sensors are saved in the cloud which is then transferred from the hardware stage to analytics tools *via* communication middleware and network connection. The valuable information is extracted after the analysis of the big data generated by IoT [4].

Characteristics of IoT generated Big Data: The characteristics of big data generated from IoT devices with five V's features are as follows Fig. (**2**):

i. Volume: Novel methods are in need for the processing of a humongous amount of generated data to draw out some useful insights.
ii. Variety: IoT data can be either unstructured, quasi-structured, semi-structured, or structured type formats.
iii. Velocity: Different IoT sensors and DL devices can be used to generate, save and move the data at high speed *via* internet procedures.
iv. Veracity: The obtained data from IoT devices must be corrected and validated.
v. Value: The importance and analysis of the obtained big data represent Value.

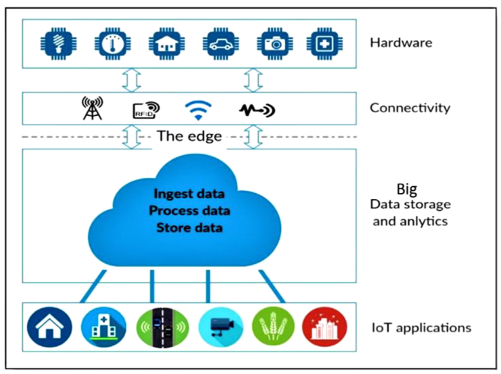

Fig. (1). Internet of Things- Architecture.

Fig. (2). The 5 V's of IoT generated Big Data.

CHAPTER 6

IoT Enabled Energy Optimization Through an Intelligent Home Automation

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Abstract: The benefit of IoT devices is that they allow for automation; nevertheless, billions of connected devices connected with one another waste a substantial amount of energy. IoT systems will have difficulty in wide adoption if the energy requirements are not adequately managed. This study proposes a solution for IoT devices to regulate their energy consumption. Both hardware and software aspects are taken into consideration. Using a mobile computer or smartphone with Internet connectivity to interact with actual scenarios has grown more prevalent as technology has advanced over the years. An intelligent home automation system based on android applications has been developed to save electricity and human energy. This study aims to create comprehensive Energy optimization through intelligent home automation utilizing widely available mobile applications and Wi-Fi technologies. The devices are turned on and off using Wi-Fi. Intelligent home, in the area of electronics, automation is the most purposely misused term. Numerous technological revolutions have occurred as a result of this demand for automation. These were more essential than any other technologies due to their ease of use. These can be used in place of household current switches, resulting in sparks and, in rare instances, such as fires. A unique energy optimization system was developed to control household appliances while taking advantage of Wi-Fi benefits.

Keywords: Automation, IoT, Optimization, Wi-Fi.

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1. INTRODUCTION

Because of the world's rapid population growth, power producers have had difficulty projecting electricity consumption. There will be a shortage of energy in a few years according to scientists. Energy generation is a costly option, taking a lot of time and money, but on the other side, energy consumption can be minimized by applying some preventive measures [1]. The last few decades have seen a plethora of research on energy consumption prediction and energy forecasting is the first step in optimizing energy use. As a result of our recent energy consumption, we must make a prognosis for the following hour, or month; as devices need the same amount of energy continually, using the concept of energy optimization in smart homes would ensure that the appliances are receiving the exact amount of electricity they require. Humidity, illumination, humidity, air velocity, and pollution levels are just a few factors that influence the optimization process [2].

The swarm-like collaboration of IoT devices is required for the successful deployment of IoT services as well as the development of renewable energy implementations. The primary purpose of IoT nodes is to gather information about the physical world. A battery-powered detector, a controller, and a communication network make up the hardware of an IoT device. The purpose of a sensor is to collect data from its surroundings. Data can include flow velocity, temps, pressure, physical motions, distances, weight, and so on. The data is then processed on the device before being sent through the communication network to other servers [3]. The essential components of the IoT environment are represented in Fig. (**1**).

Sensors are Internet of Things (IoT) devices that gather, process, and transfer data to its intended location. As a result, sensors are the IoT system's power hogs. The devices' limited battery life is a significant roadblock to full-fledged IoT usage. Large volumes of data can only be collected and processed at a higher cost of power usage. According to the study, the governing technology regulating IoT devices uses about 81 percent of an embedded system's total energy consumption. Unreliable software has been demonstrated to drive energy-efficient hardware inefficiently, which results in larger power consumption. Furthermore, the gadgets are unaware of a feedback mechanism that might notify consumers of an algorithm's power use [4].

In smart houses, a wide range of IoT applications can be explored. An intelligent home attempts to provide certain services which support the consumer's satisfaction and enjoyment, as opposed to a traditional home, which is a combination of simple housing and furniture to provide a place to live. As a result of IoT-related battery difficulties and the rapid increase in power requirements, many studies on alternative energy have lately been conducted. This form of novel energy generation, on the other hand, demands a long-term, large-scale investigation, making it a highly uncertain, forward-looking endeavor. To address these difficulties, autonomous and efficient network processing is required and a method for decreasing excessive energy consumption by precisely regulating IoT based on user usage patterns [5]. To address these concerns, IoT users' usage data must be studied, and an intelligent manager as a platform to monitor and manage this analyzed data is necessary. The term “intelligent supervisor” refers to a manager who provides services such as network technology to reduce energy usage, as well as services that create a customized environment for the user in line with the objective of a smart home. IoT platforms currently offer intelligent services; nonetheless, the great majority of these services process huge volumes of data and perform mathematical operations faster and more precisely than a human. By analyzing and assessing user data, a smart home intelligent manager maintains groupings of devices and provides user-customized services [6]. As a result, smart houses can foresee and plan for a variety of situations and scenarios. These forecasts and preparations allow IoT applications to be regulated and managed depending on the data received, reducing network utilization and energy losses. The purpose of this research is to employ a user-friendly, low-cost design that is also simple to install to control household appliances in a smart home. This technology makes the system unique in that it can be accessed from anywhere with an internet connection. The use of Arduino programs to offer the user with a remote control of multiple lights, fans, and appliances in their home, as well as data storage on the cloud, is presented. They will be able to operate on their own thanks to sensors. Sensors will allow them to be controlled autonomously [7].

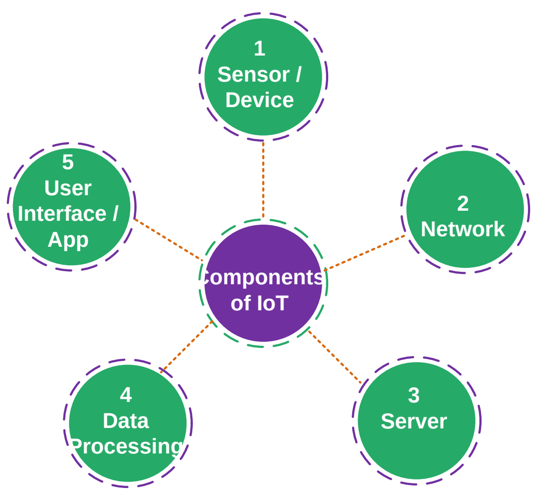

Fig. (1). IoT System Elements.

CHAPTER 7

Garbage Management and Monitoring System Using IOT Applications

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Abstract: The main purpose of this application, in addition to boosting the vision of a smart city, is to reduce humankind's effort and resources while simultaneously enhancing the vision. The squashing of the dustbin will occur on a regular schedule. It will be possible to manage waste more efficiently when these sensible garbage bins are implemented on a large scale and replace our previously designed dumpster, as it eliminates the need for waste to be piled up on the roadside in the first place. When managing the trash containers, wireless sensor systems in networks (WSN) in connection with the IoT technologies are used. On the other hand, sensors are used to monitor the container contents in real-time, with results displayed on the website, and the sensed contents are then evaluated to determine the optimal container distribution. This allows for the processing of a variety of waste types depending on the needs of the customer. As a result of installing ultrasonic sensors in each bin, garbage levels are continuously checked. As a result of this notification, the bin will be cleared.

Keywords: Internet Protocol, Sensible Garbage Bin, Ultrasonic Sensors.

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Satya Prakash Yadav, Sansar Singh Chauhan, Sanjeev Kumar Pippal and Victor Hugo C. de Albuquerque (Eds.)

1. INTRODUCTION

As cities continue to grow, waste collection agencies are overworked and unable to maintain themselves. Many objects, from cars to metal and machinery, end up at improperly managed and unsupervised dump sites, where they spread diseases and increase pollution [1]. When it comes to managing garbage after its generation, the majority of these solutions have proven effective. The issue of keeping cities clean is becoming increasingly critical as smart cities develop. Garbage production is out of control, and manual labor is required to remove that, but it is time-consuming.

As the world's population grows, so does the amount of waste produced. This has resulted in several potentially dangerous situations. Due to the massive amount of garbage accumulating on wide expanses of land, hazardous landfills are formed. Toxic fumes from the decaying trash fill the air, polluting the local ecosystem. Waste dumped in water bodies pollutes the oceans and seas that connect them, affecting the quality of drinking water and the life of aquatic animals. Because of this, harmful gases are released into the air, which harm the entire ecosystem [2]. As a result, waste management has become a major concern in the modern world. A lot of things can be modified and prevented if the waste created is appropriately handled at the source level. Fig. (**1**) displays the process flow diagram of the Smart waste Management System.

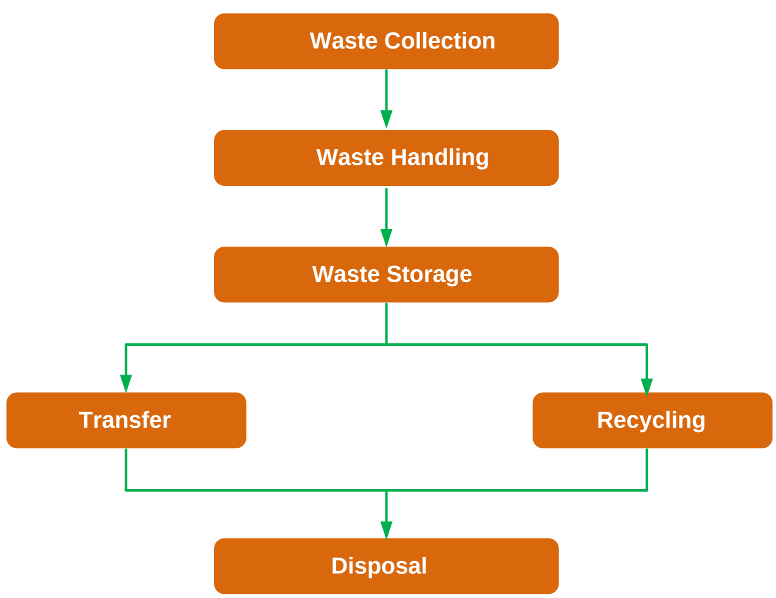

Fig. (1). Process flow diagram of Smart waste management system.

The newest report from the World Bank predicts that global waste would increase by 70 percent over present levels by 2050 unless urgent action is taken see Fig. (**2**), What a Waste 2.0: A Global Assessment of Proper Waste Management to 2050). 3.4 billion tons of waste is predicted to be generated annually in the next 30 years, which is increased from 2.01 billion tonnes in 2016. This is a result of increased urbanization and population growth. Only 16 percent of the world's population lives in high-income countries, yet they generate 34 percent of the world's garbage. A quarter (23%) of worldwide trash generation is generated in East Asia and the Pacific region. Moreover, by 2050, the amount of garbage generated in Sub-Saharan Africa is expected to triple, while the amount of garbage generated in South Asia is anticipated to nearly double.

Fig. (2). From now until 2050, a global scenario of waste management-Picture Source-World Bank (2018).

The percentage mentioned in Table **1** is as per the World Bank report in 2018. Municipal solid trash is divided into five distinct categories:

CHAPTER 8

Power Generation Prediction in Solar PV system by Machine Learning Approach

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Abstract: Solar energy is becoming more and more incorporated into the global power grid. As a result, enhancing the accuracy of solar energy projections is crucial for effective power grid planning, control, and operations. A fast, accurate and advanced estimation method is desperately needed to prevent PV's detrimental consequences on electricity and energy networks. For the optimum integration of solar technology into existing power systems, which benefits both grids and station operators, accurate prediction of solar production is crucial. The purpose of this research is to test the effectiveness of the machine learning model for projecting PV solar output. Using ANN in this research, weather parameters with the Power Generation for the next day appear to have been predicted. The evaluation findings suggest that the models' accuracy is sufficient to be employed with existing works and their approaches. Machine learning was shown to be capable of accurately predicting power while removing the difficulties associated with predicted solar irradiance data in this study.

Keywords: ANN, Machine Learning, PV System, Power System, Solar.

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1. INTRODUCTION

A lot of countries have done a lot of work in the power sector in recent years. Deep learning has opened up new possibilities and posed new obstacles in the field of power load forecasting [1]. The fundamental job of the power system is to supply users with a safe and dependable source of electricity [2]. As a result, energy forecasting is crucial for the power industry. Accurate power load forecasting is critical for saving energy, decreasing power generation costs, and boosting social and economic benefits. Energy load forecasting has grown increasingly important in the power system as power reform and marketization have progressed. The accuracy of power demand forecasting must also be improved for the power system's steady and efficient functioning. It is impossible to regenerate non-renewable energy sources including coal, oil, and gas in a short period as their consumption rate much exceed their regeneration rate. Consider fossil fuels, which not only have finite reserves and will eventually run out but whose price also rises daily [3, 4].

Renewable energy development has advanced largely as a result of the limited reserves of fossil fuels. Photovoltaic (PV) cells are the most common means of harnessing solar energy for electricity generation. Solar energy has a variety of advantages, along with its resistance to illustrative circumstances such as growing oil prices, its clean environment, and the minimization of imports and reliance on external resources. While solar cells are commonly recognized as a potential source of future energy production, their low return on investment and huge upfront costs limit their broad use. One cause for this is that the supply is unreliable due to the variable character of the weather [5, 6]. Remember that the amount of solar energy available each day has a significant impact on the amount of power produced by the system when sizing a photovoltaic system. As a result, the quantity of electricity created is governed by solar irradiance on a specific day, which is influenced by a range of geographical locations, periods, and weather systems. Solar output is the quantity of radiation from the sun inside the solar spectral region [7].

2. RELATED WORKS

- The most significant factor in determining the size of a solar power producing system is the daily mean solar irradiation. To estimate how much power will be generated by solar panels, consider the average sun irradiation in the area. This information may be used to estimate the size of the system as well as calculate ROI and system load. The mean solar irradiation Wh/m 2 has been predicted using a variety of regression algorithms and solar irradiance factors. This research compares forecasting using artificial neural networks (ANN) with traditional regression approaches. Additionally, we demonstrate that including azimuth and zenith parameters in the model results in significant performance improvements [2 - 4].

- The industry, according to this framework, should establish a standard for itself. Furthermore, by modeling future cloud positions using satellite-based data, short-term forecasting of solar PV energy output has been improved. Finally, the model's accuracy varies depending on the meteorological conditions of the forecasting area. As a result, training a model on a single site is likely to yield better results than training it on multiple sites at once. Similarly, because climatic conditions change annually, a model that is trained on a single meteorological season rather than many may perform better [8 - 11].
- The most important findings are that both machine learning and classical time series techniques have been routinely employed to forecast load demand. Similarly, for the price of power, a wide range of time series and ML approaches were used. The article also gives an overview of the methods employed in the competition for the forecasting of wind and solar electricity. In comparison to loading demands and power costs, the number of validated prediction models for turbines and solar PV modules' generated power is minimal. The application of ML approaches has been sporadic, whereas classical time series have been heavily relied upon. The algorithms Random Forest and Support Vector Machine are used for solar PV panels [12 - 14]
- Before estimating the power of a solar PV system, it is necessary to forecast sun irradiation. The aerosol index is used as input data for a neural network-based intelligent model. Based on daily weather classification, the artificial neural network applies the Nonlinear Auto-Regressive for Exogenous Input data technique to predict the upcoming day's 4-hour solar radiation outputs. Previously, models used temperature, moisture, prevailing winds, and wind speed data to calculate an exact prediction for PV power generation 4 hours in the future. The suggested PV forecasting model's projected outcomes are assessed using statistical measures like the Mean Square Error technique [15 - 17].
- An investigation into estimating the output power of solar photovoltaic (PV) plants using fuzzy logic and artificial neural networks is presented in this research. It is possible to make reasonable forecasts about the output of solar plants using fuzzy logic and high-performance computer processors. When used for forecasting, the ANN technique combines machine learning with pattern recognition to produce accurate results. It is the primary goal of the research reported in this paper to undertake solar PV plant production forecasting, which will be important for effective load management and for investigating the dependability of the electrical power distribution system [18 - 20].

CHAPTER 9

An Efficient Framework and Implementation of a Weather Prediction System

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Abstract: The majority of today's weather forecasting studies have been focused on complex physical models. These models are usually run on hundreds of nodes in a High-Performance Computing system, which consumes a lot more power. Despite the employment of these costly and complex tools, projections are frequently incorrect due to inaccurate beginning conditions, measurements or a lack of understanding of atmospheric dynamics. Furthermore, solving complex models like this often takes a long time. The Internet of Things has helped any field that deals with technology. Using an IoT device, a prototype based on a machine learning approach is proposed in this study with an efficient framework, and implementation of an automated weather prediction system based on Artificial Neural Network algorithms was designed and developed. This system includes a technologically advanced irrigation system for our convenience. Using ANN in this research, the weather for the next day appears to have been predicted. The evaluation findings suggest that the model's accuracy is sufficient for existing works and their approaches.

Keywords: ANN, Forecasting, IoT, Weather Prediction.

1. INTRODUCTION

All around the world, weather patterns change rapidly and continuously. People's lives are greatly affected by the weather. Weather monitoring enables data analysis and forecasting to provide important weather information. Predicting the weather is challenging since there are so many variables that affect weather changes. From the viewpoints of system architecture and information processing, existing weather monitoring and prediction systems can be characterized by taking into account system operations and processing technologies. Every aspect of our lives, from agriculture and business to travel and the daily commute, is inf-

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luenced by weather forecasts to a large extent. Climate change and its implications are affecting the entire planet, thus accurate weather forecasting is essential for smooth travel and safe operations [1].

Weather service is among the most challenging tasks in a country. Smart technology and web- development technologies are just used to implement the system in real time. Most of the solutions are interoperable with third-party IoT platforms such as ThinkSpeak, firebase, and others. We have, regrettably, conjured up our Graphical-based methodology and a Telemetry dashboard, which are both seamless to use and intuitive [2].

Every situation calls for accurate forecasting. As a result, the model parameters of the weather forecasting model must be handled differently. There is a connection between statistical approaches and data that does not follow a linear pattern, and on the other hand, is related to artificial intelligence methods. Neuro-fuzzy logic and neural networks are among the artificial intelligence learning paradigms. One of these is neural networks. The application of ANN improves weather forecasting accuracy. A lot of variables are included in the daily weather data, such as the temperature, humidity and rainfall amounts, cloud distance and size, wind speed and direction. Although all of these elements are nonlinear, combining them is necessary to determine the temperature, rainfall, humidity, and weather status for the following day. A complicated model is required for such applications, one of which is capable of producing results based on the patterns created from training data provided to the model. Selecting the input data and parameters for a weather forecasting ANN model is critical [3]. The input data must come from a specific location where the model is trained and evaluated to produce reliable results. It's also important to note that the volume of input data that goes into the model helps it perform better by generating outcomes that are very comparable to anticipated and actual output data. Because of any noise in the data, it must be cleaned up. All of the parameters are expressed in different units, and leveling simplifies the linkage of input to output parameters. Training and testing samples should be divided in appropriate proportions to allow for a precise estimate, verification, and validation of the findings. For reliable results, the neural network model must be well-structured. Nonlinear data can be more accurately predicted with the help of a multi-layer ANN. Any given neural network layer will have its activation function, which is dependent on the situation [4].

Due to their computational complexity, these models are too expensive to run. A different type of model is the data mining model, which is based on probabilities and/or similarity patterns, rather than historical data. Each category of prediction is similarly handled by the model, and the model is expected to have the modest level of accuracy. Modeled output may be required for daily weather forecasts as well as weekly or monthly weather plans. Hence, forecasting relies heavily on precision to obtain the greatest results out of the various models [5].

2. RELATED WORKS

- Many primary sectors, such as agriculture, rely on the weather for production. This rapid climate change makes traditional weather prediction methods less accurate and more time-consuming. Improved and dependable weather forecasting technologies are needed to solve these challenges. Economic and social conditions are affected by these forecasts. The major goal of this project is to create a weather forecasting system that can be used in remote places. Meteorological conditions are predicted using data analytics and machine learning methods such as random forest classification (RFC). We provide a reduced, accessible weather forecasting model [6 - 8].
- When it comes down to it, the weather is made up of many variables including rainfall and wind speed. For researchers, the environmental weather forecast is a challenging task that has attracted a lot of attention in recent years. There are a broad variety of weather figure methods that may be used to study the current weather or the weather through time by using accessible meteorological data. Determining meteorological characteristics with precision is becoming increasingly difficult due to their dynamic context [9 - 13]. To predict air characteristics, different machine learning algorithms are linked together in a network. Various applications based on Numerical Weather Prediction outputs are also examined.
- Within 24 hours, forecast models for wind farm production are presented in this work. Feed-forward neural networks are being used to provide accurate wind power predictions. Furthermore, the ideal architecture for each forecasting model is determined through sensitivity analysis by altering the main parameters of the artificial neural network. Based on the data gained, numerical weather prediction models are compared to actual weather conditions [14 - 16].
- The very first attempt to predict the weather quantitatively has required a greater workforce than the previous attempts have done. Since powerful computers and improved modeling tools were developed, weather prediction has returned to the early models. Then, in Weather Prediction, the simple-basic equations are used as forecast equations. As meteorological variables vary over time, equations can be used in our research to generate new values of those variables in the future for prediction. Short-range weather data from a particular station is used to determine the weather conditions in one particular area [17]. The results gained suggest that it is capable of predicting the weather conditions more correctly and precisely than any other method now available.

CHAPTER 10

Hybrid Machine Learning Techniques for Secure IoT Applications

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Abstract: Web sensing devices capture and transmit data from the physical environment to a central place using rapid advances in software, hardware, and IoT technologies. Depending on the source, the overall count of web-connected devices is estimated to be between 50 and 100 billion by 2025. The amount of data released will increase as the population expands and technology improves, which is already happening. The Internet of Things (IoT) technology connects and interacts with the physical and virtual worlds. A gadget linked to the Internet is called an IoT. Intellectual data handling and investigation are required to construct smart IoT requests. This article gives knowledge about the Machine learning (ML) algorithms available for dealing with IoT data challenges, using smart cities as the primary use case. This article looks at common IoT diagnostic applications. This research compares and evaluates the predicted precision and understandability of supervised and unattended ML models. These technologies are briefly addressed in desktop, mobile, and cloud computing settings.

Keywords: Cloud, Hybrid, Internet, Supervised, Security.

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1. INTRODUCTION

With recent advancements in Internet protocols and computing systems, it is now possible to communicate from device to device more easily than ever before using IoT. Sensors and actuators and physical items that are interconnected to the web [1, 2] are all included in this category. Computing has always aimed to make human activities and experiences easier and more enjoyable. The IoT requires data to either enhance service consumers or improve the operation of the IoT framework. To extract information, computers must be capable of retrieving unprocessed data from many network resources. Given that the IoT will be a significant source of fresh data, it will be critical in making IoT applications smarter. Massive volumes of data may be mined for patterns and fresh insights using technologies like data mining. These strategies apply to a wide variety of algorithms. Data types, models, and efficient algorithms that are appropriate for the data attributes are all determined as part of the data analytics methodology deployment process. Following our examinations, we may conclude: First and foremost, because data comes from a variety of sources, it is necessary to adopt or build algorithms that are capable of dealing with the information. Second, the large number of resources that supply real-time data raises concerns about the scalability and velocity of data. Finally, determining the most appropriate data model is crucial for pattern recognition and the IoT process. As a result of these issues, various new development opportunities have arisen.

Massive volumes of data need the development of innovative information processing methods that improve understanding, decision-making, and the automation of business processes [3]. The developing sensors are continually moving. The development sensors detect the start of development. The controller analyzes the data and sends it to relevant destination. It depends on Raspberry Pi's devotion and lawful activity by then. We need to introduce intelligent data to the world to solve the vast data issues. Smart Data is now defined as "data that may be used to solve problems and improve decision-making processes." [4]. Some Smart Home apps leverage IoT. It is utilized in an IoT-based Monitoring System [5, 6]. Bluetooth and WiFi are used to connect mobile devices with cloud servers. Bluetooth, however, now has a 10M correspondence zone. IR cannot travel through dividers or other obstructions. The application's vulnerability is in IR. We are using IoT to solve this issue. With the IoT, we can improve our lives by connecting Smart Homes, Smart Buildings, and Intelligent Cars. We're working on an IoT project for a smart city. We employ a development finder sensor to measure the traits, then examine the data and decide. The Raspberry Pi is a tiny processor that can handle sensor data safely. Finally, smart data can represent IoT data.

2. ML ALGORITHM

ML predicts unknown structural linkages in a system with minimum information. ML is utilized for projects like, copying and pasting knowledge from another source, learning by example and experimentation, and discovery [7]. Inductive learning can estimate an unknown function. Induction is based on a training set of data (or a data set). The issue domain model requires a set of attributes or variables xi with values i=1 to n. Some of these traits are unnecessary and detract from the performance of most learning algorithms. Aspect/feature selection methods aim to reduce irrelevant properties [8]. Machine–learning-based classifications are vital in decision support and to classify new situations into problem categories.

A proper classification is used as an example of the unknown correlation in classification ML. The observed system's output is approximated from its inputs. Less common knowledge representations include mathematical or logical formulations, decision trees, and hypersurfaces. The composite classifier's components must all outperform each other. To do this, the main elements must be precise and distinct. Appropriate attribute divisions must be created for each classifier to increase ensemble element variation.

2.1. Supervised and Unsupervised Learning

In supervised learning, the input dataset contains labels that are either “true” or “correct.” It then uses the ground truth to refine its estimations, and the process is repeated. Almost every ML algorithm seeks to minimize the cost or achieve a specific goal. According to standard practice, the cost function measures the difference between the algorithm and the ground truth. In case of unsupervised algorithms [9], it is not possible to link explicit labels to the training dataset because the training dataset does not contain any labels. To better understand the data, interpretations from the raw data are used to simulate the hidden or underlying structure and distribution [10].

3. INTRODUCTION TO IOT

The IoT is designed to help users all over the world save time, energy, and money by connecting their devices. This technique has the potential to reduce costs in a wide range of industries, including manufacturing.

As a result of large-scale investments and numerous studies that have been conducted, in recent times, the IoT has grown as a popular trend. Four

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