INTELLIGENT SYSTEMS FOR IoE BASED SMART CITIES

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Intelligent Systems for IoE Based Smart Cities

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FOREWORD

The continuing dispersal of Internet of Things (IoT) technologies is opening new opportunities, and the foremost amazing application is the smart city concept, which is endlessly progressing in many dimensions. Generally, a smart city can be defined as integrating IoT and other Information Communication Technologies (ICT) into city management, controlling, or monitoring to address the exponential rise in urbanization and population, therefore significantly improving people's living standards. The smart city model is also strictly associated with the aspects of sustainability. But with the evolution of the Internet of Everything (IoE), which provides connectivity not only among things, but also among people, data, and processes, smart cities will become smarter. The IoE enhances connectivity and intelligence to about every entity in the system, including things, data, processes, and people, giving it special functions. This integration will have a vivid impact on every aspect, from city management to planning, controlling, and health.

Intelligent Systems for IoE-based Smart cities are emerging as a primary need for Cyber-Physical Systems (CPS) across the world. Advances in Artificial Intelligence (AI) and Machine Learning (ML) algorithms have played an important role in the progress and automation of city operations and in supporting the development of CPS in cities. Extensive use of intelligent decision-making and data-driven modelling under uncertainty are establishing the basis for advancements in public services, safety, connectivity, transportation, and health services. The examples include improved public transportation systems, advanced traffic solutions, energy modelling, smart emergency response and autonomous driving, being some of the applications that have benefited from the methodologies of principled decision-making.

This book focuses on the characteristics, requirements, issues, challenges, and development of intelligent systems for smart cities based on IoE. The allied topics, including data science and open-source data sets for IoE-based smart cities, decision-making for IoE-based smart cities, design of intelligent systems for IoE smart cities, and challenges in deployment, equity and fairness in IoE smart cities, and security and privacy in AI for smart cities are being addressed in this book. Since the smart infrastructure paradigm is now shifting from IoT to IoE, this book will certainly be appealing to readers. The fusion of three main technologies, including intelligent systems, smart cities, and IoE, has been presented in this book, which is a relatively unique approach.

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PREFACE

There are many challenges affecting decision-making for Cyber-Physical Systems in smart cities. With the initiation of IoT, sensor data is being produced at high speed and in large volume that is hard to process and make conclusions from it. Requirements of the smart cities dictate that a large amount of processing occurs on edge, making it imperative in a way that fast and tractable methods of decision-making are designed. Concurrently, there is an increasing requirement for automated applications to be secure, fair, and resilient. Moreover, with the advent of the Internet of Everything (IoE), which tends to integrate things, people, data, and processes, it is essential to develop smart and intelligent systems that facilitate smart cities in the IoE environment. The book aims at covering all the necessary aspects of the development of intelligent systems for IoE-based smart cities.

This book has been organized into three sections where **Section 1** consists of four chapters highlighting the technological aspects related to smart cities, **Section 2** presents intelligent systems in IoE/IoT-based smart cities and includes four chapters, and **Section 3** comprises three chapters that focus on utilizing cloud and blockchain in IoE/IoT based smart cities.

Chapter 1 of the book first introduces smart cities, and then it elaborates on the technical aspects of the physical layer in a smart city environment, enabling the utilization of the Internet for the operation of various devices. **Chapter 2** focuses on identifying the most prominent enabling technologies in making smart computing environments intelligent. The ten foremost intelligence-enabling technologies – predictive analysis, deep learning, artificial neural network, big data analytics, intelligent edge, human-computer interaction, computer vision, explainable artificial intelligence, natural language processing, and robotics in context to a smart computing environment, have been discussed in this chapter. **Chapter 3** analyses the role and importance of Smart sensors and actuators along with their applications, challenges, and opportunities, followed by various future trends in the domain of the smart city. **Chapter 4** explores numerous IoE applications which are also concerned with smart cities. This chapter discusses existing technologies that have a great contribution to the development of various prominent areas of smart cities. The chapter also identifies and categorizes several challenges that are being faced by the stakeholders and officials in the construction of smart cities.

Chapter 5 focuses on a definite area of AI called Natural Language Processing, which helps and enhances human lives living in smart cities. These use cases and various applications, scopes, techniques, advantages, disadvantages, and future scopes of NLP in the context of smart cities have been discussed in this chapter. The goal of **Chapter 6** is two-fold. First, it intends to analyze the security issue in VANET by reviewing the most important vulnerabilities and proposed countermeasures. In a second part, it introduces a comprehensive Machine Learning framework to design VANET IDs. It has used the framework to evaluate the performances of several Machine Learning techniques to detect position attacks using the VeReMi security dataset. In **Chapter 7**, through the use of trilateration, an application has been devised that takes the help of Wi-Fi signals and does position fixing in an indoor environment. The trilateration method is implemented to calculate the unknown position of a device under the environment. It collects all the Wi-Fi signals and finds the exact matches with the database to calculate the user's actual position on the map. **Chapter 8** of the book emphasizes the deep-seated relationship between IoT and sensors from the perspective of state-of-the-art research. It offers discussions on the usage of various types of sensing devices, associated data, and their contribution towards solving specific research problems in the respective IoT-based applications. This includes the Video Camera, Inertial Measurement

Unit (IMU) Sensors, Ultrasonic Sensors, Electrocardiogram (ECG) Sensor, Passive Infra-Red (PIR) Sensor, Electromyogram (EMG) Sensor, and some commonly used sensing devices for Environmental and Agricultural Smart system development. A pertinent case study is also included in this chapter to demonstrate the role of sensors in the development of IoT-based systems.

Chapter 9 focuses on the Internet of Things, cloud computing, and data mining, and tries to find the connection between them in terms of users, services, and applications. The goal is to identify how data analytics can be applied to real-life IoT and cloud-based applications.

Along with explaining the security requirements in smart cities, **Chapter 10** proposes a security framework focused on providing secure access control and authentication services delivered over the cloud-based system used in smart cities. This chapter also covers the concepts on convergence of IoE and cloud computing in smart cities and challenges faced by future generation cities employing IoE.

Chapter 11 here provides an insight into how blockchain technology works for smart contracts, which deliver numerous services in Smart cities ecosystems in more reliable, data secured, and beneficial for the population in Smart cities. The chapter has contributed to the planning of Smart cities planners, developers, architects, and thinkers for the usage of smart contracts for delivering various services in the smart city's governance.

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CHAPTER 1

On Physical Layer Design for Smart Cities

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Abstract: In the future, the real world will convert to a smart world around 2025. One could predict that there will be a changeover from 4G LTE to 5G NR. In pandemic conditions, 4G LTE has been found to provide good online support, such as accessing the Internet for education, administration, banking, official works, *etc.*, anywhere in the real world. But there are some limitations, such as operating machines in industries, and driving vehicles on the road with the help of the Internet. These facilities will be provided by 5G NR as there is a large difference between 4G LTE and 5G NR. In 4G LTE, only Mobile Broad Band (MBB) is present, but in 5G NR, there are three terms, *i.e.*, Enhanced Mobile BroadBand (eMBB), Ultra-Reliable and Low Latency Communication (URLLC) and massive Machine Type Communication (mMTC). As a result, the city will convert into a smart city. It is possible by applying intelligence in various technologies. Applying intelligence will lead to the improvement of smartness in the environment, mobility, building, home, administration, health, education, *etc.* The smartness of the item includes the utilization of the Internet in various devices, which means the Internet of Things (IoT). In previous times, humans communicate with humans, but in IoT, a human will communicate with the device. In the future, it will be realized using NXP Semiconductors. NXP semiconductors manufactured various chips, which should be beneficial for the formation of smart cities. In the near future, facilities will be increased in a more massive manner than the present time. By 2030, the goal will have been fully attained, and IoT will have evolved into the Internet of Everything (IoE), meaning that everything will be made possible by the Internet. Device-to-device communication will be a possibility in IoE side-by-side. This outlines how 5G to 6G will change.

Keywords: 3GPP (Third Generation Partnership Project), 4G LTE (Long Term Evolution), 5G NR (New Radio), EMBB (Extended Mobile Broad Band), IoT (Internet of Things), MMTC (Massive MachineType Communication), NXP (Next eXPerience) Semiconductors, URLLC (Ultra Reliable Low Latency Communication).

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Arun Solanki and Anuj Kumar Singh (Eds.)

INTRODUCTION

Telia Sonera had previously introduced 4G technology in Finland by the year 2010. Third Generation Project Partnership (3GPP) standardised LTE-Advanced [1]. High data speeds, decreased latency, seamless connections, improved Quality of Service (QoS), distribution across heterogeneous networks, capacity in high network infrastructure, and simple infrastructure are some of the characteristics of LTE [2]. Between 4G and 5G, there is a connection made through LTE-Advanced [2]. High data speeds, decreased latency, seamless connections, improved Quality of Service (QoS), distribution across heterogeneous networks, capacity in high network infrastructure, and simple infrastructure are some of the characteristics of LTE [2].The advancements made possible by Radio Access Networks (RAN) in 5G technologies are basically made possible by LTE-Advanced. Microwave frequency (sub-6GHz) is used for LTE-Advanced. Nevertheless, 5G uses both microwave and millimeter wavelengths, therefore, the range of frequencies is 6 GHz to 100 GHz. By 2020, 5G will be commercially accessible and will essentially be an end-to-end support system. In this place, a society is created where connections and mobility are made possible. Massive MIMO, which is an upgrade of the MIMO seen in 4G LTE-Advanced, is used in 5G technology.

Radio Access Networks (RAN) advancements in 5G technologies are made possible by LTE-Advanced. Microwave (sub-6GHz) frequency is used for LTE-Advanced. In contrast, millimeter and microwave frequencies are used in 5G, resulting in a frequency range of 6 to 100 GHz. A complete support system will be provided by 5G technology, which will be ready in 2020. A civilization that allows for connections and mobility is created in this instance. Massive MIMO, which replaces the MIMO used in 4G LTE-Advanced, is a 5G technical innovation.

There are significant differences between 5G and 4G in terms of several important needs [3]. Whereas 5G's peak data rate is 20 Gbit/sec, 4G LTE's peak data rate is 1 Gbit/sec. In 4G, the user-experienced data rate is 10 Mbit/sec, while in 5G, it is 100 Mbit/sec. Mobility for 4G is 350 km/h, whereas it is 500 km/h for 5G. The required latency for 4G is 10 ms, whereas for 5G, it is less than 1 ms. In comparison to 5G, which has a connection density of 106 devices per square km, 4G has 105 devices per square km (Fig. **1**).

The Microwave Horn antenna (Fig. **2a**) can be used for 4G LTE's microwave frequency (sub-6 GHz), whilst the Millimeter-wave Dish Antenna (Fig. **2b**) can be used for 5G NR's millimeter-wave frequency (28 GHz). The two antennas were compared in SMIT. It has been noted that there is a significant disparity between their received signal strength indicators, which are given in dBm and are, respectively, -97.2 dBm for microwave and -43.8 dBm for millimeter-wave [4]. In comparison, there is also a significant difference in the Signal Noise Ratio (SNR), which is 31 dB for microwaves and 49 dB for millimeter waves [4].

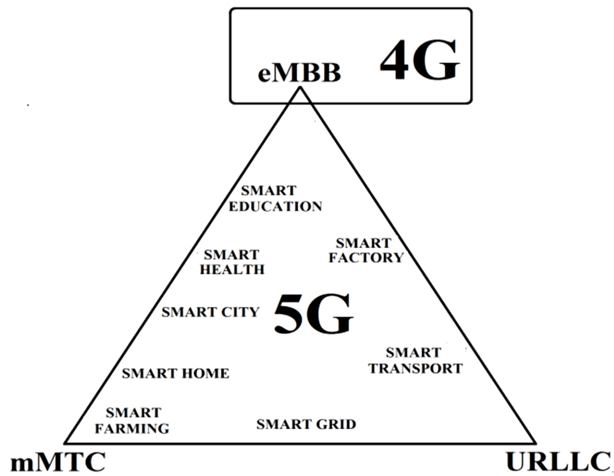

Fig. (1). 4G *vs*. 5G.

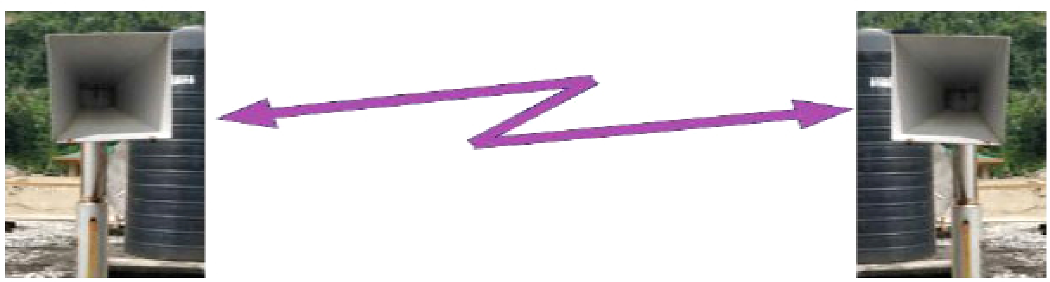

Fig. (2a). Microwave horn antenna.

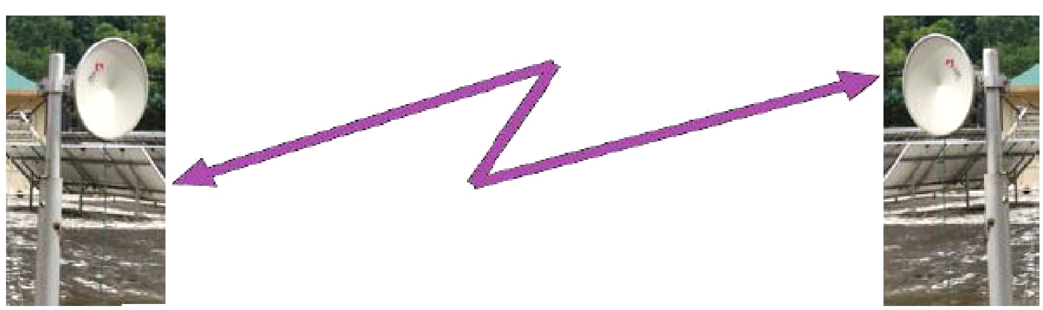

Fig. (2b). Millimeter-wave dish antenna.

CHAPTER 2

Enabling Technologies for Intelligent Systems in Smart Computing Environment

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Abstract: Smart computing environments have evolved with the dawn of the Internet of Things, incorporating pervasive or ubiquitous computing. Besides using sensors and smart devices, the main objective has been to make these environments intelligent by utilizing different kinds of artificial intelligent methods and algorithms. Making a system intelligent requires inclusion and implementation of various tools and technologies to facilitate artificial intelligence. This chapter focuses on identifying the most prominent enabling technologies in making smart computing environments intelligent. The ten foremost intelligence-enabling technologies – predictive analysis, deep learning, artificial neural network, big data analytics, intelligent edge, human-computer interaction, computer vision, explainable artificial intelligence, natural language processing and robotics have been discussed in this chapter.

Keywords: Artificial intelligence, Computer vision, Deep learning, Edge intelligence, Enabling technologies, Explainable artificial intelligence, Human-computer nteraction, Intelligent systems, Smart Computing.

INTRODUCTION

The human age is in the process of transition from "Society 4.0, also labelled as Information Society" to "Society 5.0 declared as Super Smart Society ought to be people-centric largely". Society 4.0 refers to the economic and social processes influenced by the apparent "4th Industrial Revolution," which concentrated on the massification of technological advancement around the globe. The advent of Big Data and the processing of massive volumes of data about people at the compassion of enterprises are two important characteristics of Society 4.0, as is the establishment of an Economy of Orders that fostered different forms of labour using various kinds of digital platforms. Industry 4.0, also known as Intelligent

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Industry, is a real-world concept that involves the digitalization and transformation of industrial operations, either through sensors or information systems, to make them more efficient [1]. Cross-discipline exchange of information and knowledge was not there in Society 4.0, and collaboration was challenging. While in Society 5.0, virtual cyberspace and tangible physical space have a high level of convergence. Persons have been able to access and use the storage services offered by the cloud in virtual cyberspace via the Internet in Society 4.0, and thus will access, obtain and analyze vital information.

In Society 5.0, in the physical environment, a large volume of information from the devices and sensors is collected in virtual cyberspace. Intelligent systems and Artificial Intelligence techniques analyze this large volume of data in virtual cyberspace, and the outcomes are communicated to humans in tangible physical space in numerous ways. Thus, Society 5.0 is going to be an ecosystem that will ensure long-term viability in all dimensions, including social, economic, political, and environmental, with an emphasis on people and value generation. Owing to the rapid transition in the present society and integration of it with the latest AI-based technologies, it is significant to understand the role of new-age intelligent systems in building people-centric super smart Society 5.0.

Intelligent and Smart Environment

We use the term "environment" to refer to any location in our immediate surroundings. Although some individuals contemplate virtual environments, we mainly denote tangible physical spaces in each of their forms, like a house, a building, a street, a field, a sea or space region, and so on. When we use the term "intelligent" in reference to environments, we typically mean Artificial Intelligence achieved by using various tools and techniques. An Intelligent Environment would be one where self-programming and pre-emptive mechanisms (*e.g*., artificially intelligent agents) help facilitate the actions of multiple interconnected control systems (controlling different aspects of an eco-system) to create dynamic comprehensive and integrated features and functions that improve occupant experiences [2].

Basic Principles of Intelligent Environment

Further, to describe what we mean by Intelligent Environment, a list of key principles that we feel any Intelligent Environment should strive for, are listed below [2]:

- To be intelligent enough to identify and recognize a condition where it can provide help.

- To be able to discern when it is appropriate to assist.
- To provide support based on the requirements and preferences of individuals being assisted.
- To meet its objectives deprived of requiring the technical expertise of the user in order to get an advantage from its assistance.
- To consider the safety of the user first at all times.
- To safeguard the user's privacy.
- To follow those principles that perhaps the users are holding the charge and the system follows, not the other way around.
- To be able to act independently.
- To be able to work without enforcing modifications on the environment's feel and look, and also the occupants' normal routines.

From these principles, it can be analyzed that a proactive attitude is needed in an intelligent environment, which is constantly figuring out how to assist the users. The field of Intelligent Environments is determined by the comparative ripeness and the success level attained in a variety of distinguished computer science domains shown in Fig. (**1**). The potential applications of intelligent and smart environments include healthcare, education, transportation, smart offices, intelligent supermarkets, energy conservation, smart cities, smart industries, *etc*.

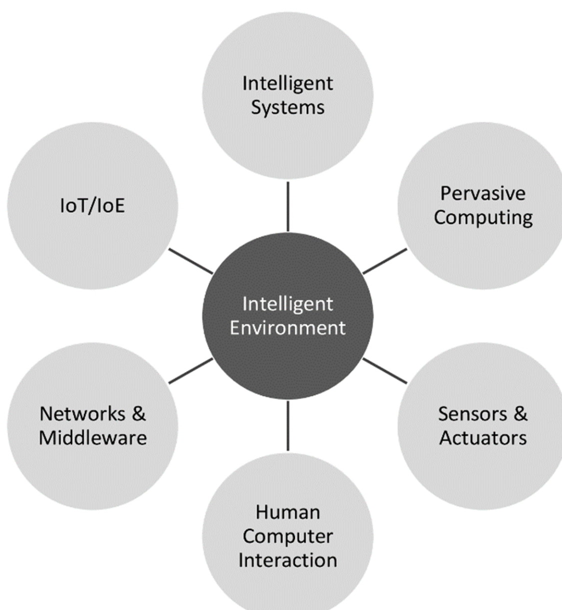

Fig. (1). Association of intelligent & smart environment with other disciplines.

CHAPTER 3

Smart Sensors and Actuators for Internet of Everything Based Smart Cities: Application, Challenges, Opportunities, and Future Trends

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Abstract: Cities across the globe are installing sensors, actuators and other devices, to become safer, greener, sustainable, and efficient with the hope of improving the urban interests of people. Sensing and collection of records are at the heart of any smart infrastructure, which can display itself and act on its own intelligently. Using sensors to screen public infrastructures, including bridges, roads, and homes, presents cognizance that enables more efficient use of resources based on the facts amassed by those sensors. As smart sensors, actuators, *etc*., play a critical role in the smart infrastructure, this chapter explores the smart sensors and actuators in IoT-enabled smart cities. As the domain of smart cities is emerging in the present days with a huge number of research opportunities for the researchers, also data collection and sensing play their role at the heart of the infrastructure. This chapter will critically explore the role and importance of Smart sensors and actuators and their applications, challenges, and opportunities, followed by various future trends in the domain of the smart city.

Keywords: Actuators, Artificial intelligence, Big data, Internet of everything, Internet of things, Machine learning, Sensors, Smart city, Sensing.

INTRODUCTION

With the rapid growth in population density in city environments, infrastructure and facilities are needed to meet the desires of inhabitants. As a result, devices, which include sensors, actuators, smartphones, and smart devices, have grown significantly, attaining the huge enterprise goals of the Internet of Things (IoT) through being joined and setting up all devices. Over the Internet, it has been difficult to combine these digital devices in the past. Similarly, collecting that

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information for daily action organization and enduring growth planning in urban areas is essential. For example, specific information about the public real-time location and usage, parking space occupancy, transportation such as traffic congestion, and other information such as weather conditions, road conditions, air and noise pollution, water pollution, and energy consumption. It needs to be collected continuously [1]. In the past, various technologies have been applied according to the characteristics of each application. The required technology covers a wide range of ranges from the bodily layer to the information and alertness layers. The continuous development of generations has created new possibilities. It simplifies normal existence and provides extra green services and manufacturing tactics. With digitalization, "smart" is the center of continuous technology development. In reality, the advanced Internet of Things era is seen as one of the primary columns of the 4th Industrial Revolution. Huge innovation capacity and useful blessings to the populace, on the alternative hand, each development assignment makes use of restricted resources and leaves behind a one-of-a-kind environmental footprint, especially one-of-a-kind types of pollution. Future traits in diverse regions, together with engineering, agriculture, and medicine, depend on the Internet of Things (IoT) expertise, and some ability programs of Internet of Things generation in different unexplored areas are, however, unknown [2]. Or it is unclear how to deal with them, which clearly shows that this will carry out more research activities in difficult areas to bring new great benefits to society. Therefore, the relevance and significance of future Internet of Things technology may be very clear and anticipated to play an important role [3]. A smart city is a very broad domain, so there are plenty of research opportunities in this domain. Smart cities have several components represented in Fig. (**1**). These components work together to achieve the objective of the smart city implementation.

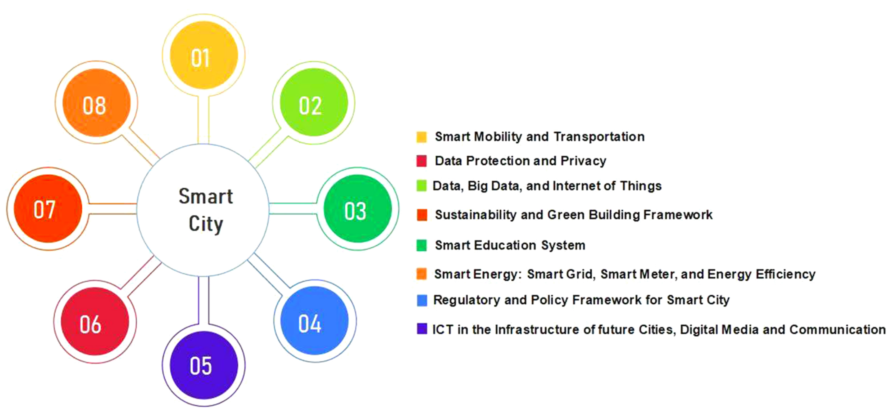

Fig. (1). Smart city with its components.

It should be emphasized that there is no doubt about what the Internet of Things technology brings, such as bringing various beneficial advantages to the community and refining the complete value of life expectancy. Internet of Things technologies can change our lives and habits, so each technology has certain problems and shortcomings that need to be scrutinized and investigated [4, 5]. In order that let everyone recognize the enduring implications of the speedy development of the Internet of Things, some vital facts need to be emphasized while discussing the IoT generation.

- The IoT technology has increased the utilization of partial possessions and unprocessed resources, some of which are deficient (such as certain precious metals used in electronic products).
- Electronics prices have become more acceptable, production has increased, and ultimately more resources have been used. In this sense, the reflective effect is possible.
- The long-term impact of IoT technology on the environment is unknown. It takes a lot of energy to the establishment of construct and process of IoT policies.
- E-waste is expected to increase because of the large variety of IoT-based total gadgets anticipated to exist in the near destiny.
- In some sectors, Internet of Things technology can impact society due to reduced human demand and limited direct social contact. This is an essential and important aspect for everyone.

The focus of the above points is not to suggest and create a negative attitude towards the Internet of Things technology, but for a careful analysis of the global aspects and to be a valuable opportunity for humankind to be intelligent of the Internet of Things technology which ensures the sustainable development [6]. The application of the internet of things in the domain of smart cities is represented in Fig. (**2**).

The world is changing rapidly. In other words, development in the technical sense is growing rapidly. In the current world, according to the economic prospect, all technological developments are costly. This can be achieved with the extensive use of limited fossil resources and produces a variety of environmental impacts. The population is steadily increasing at an annual rate of about 1.1%, and the current population exceeds 7.7109 [7]. As mentioned above, the population is concentrated in cities. By 2050, the United Nations predicts that about 68% of the population will live in cities (UN, 2018). As urbanization accelerates, urban infrastructure is expected to face significant pressure. Therefore, new technology

CHAPTER 4

IoE in Smart Cities: Applications, Enabling Technologies, Challenges, and Future Trends

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Abstract: The innovative concept of smart cities drives economic growth and provides a standard of life through better services to the citizens. The incorporation of advanced technologies in smart cities projects smart outcomes that can be provided to the citizens. In the growth of smart cities, various public sectors, such as education, health care, and communication are adopting recent technologies such as IoE, Cloud/Fog computing, and Big data. These existing technologies integrate various IoE-based networks to manage various activities of smart cities. Many smart city projects are being implemented in different countries. Although various challenges are being faced, still, recent technologies are extensively being deployed in various projects of smart cities. To provide solutions to smart cities many standards have been implemented globally. These standards provide various solutions and concrete guidelines for the proper functioning of smart cities. The concept of smart cities is also facing some challenges in their planning, design, and implementation. Security and privacy of the IoE systems is one of the major challenges faced in the projects of smart cities. The main objectives of smart cities are to provide smart solutions to humans for their daily life problems and to create a sustainable environment. Researchers are developing various models of smart cities that can be implemented in real life to support the sustainable development of smart cities. This chapter explores numerous IoE applications which are also concerned with smart cities. The chapter discusses existing technologies that have a great contribution to the development of various prominent areas of smart cities. The chapter identifies and categorizes several challenges that are being faced by the stakeholders and officials in the construction of smart cities. At the end of the chapter, some research directions have also been discussed that can be helpful in the implementation of IoE-based applications and their deployment in smart cities.

Keywords: Big data, Cloud computing, Internet of everything (IoE), Information Communication and Technology (ICT), Machine learning, Smart cities.

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INTRODUCTION

With the advancement of smart cities and to improve their operational efficiency some solutions are required. These solutions are essential to increase the productivity of smart cities and minimize their maintenance cost [1]. Various IoE-enable devices are being equipped in smart cities, such as TV, mobile phones, smart door locks, and other electronic appliances. IoE plays a major role in Industry 4.0 revolution. From the intensive analysis of the current scenario of smart IoE networks, it has been predicted that by end of the year 2021, approximately 20.8 billion IoE-enabled devices will be interconnected across the world [2]. In the ongoing projects of smart cities, software platforms play a major role in designing, implementing, deploying, and managing applications for smart cities [3]. These IoE-based applications have three main components such as (1) generation of useful data, (2) management of data, (3) effective handling of the application [2]. The waste management applications implemented based on smart city requirements can provide real benefits to citizens. Through these applications, they can know about the actual condition of the dustbins or waste containers in their society or nearby areas [4]. These applications provide data about the condition of waste containers to the teams of garbage collectors so that they can schedule and optimize their routes in pickup services [4]. Integration of intelligence to the IoE sensors and actuators in the development of smart cities regularly keeps tracking the environmental conditions.

The intensive work on standards-based information technology infrastructure can satisfy the requirements of smart cities. In such types of infrastructures, recent technologies such as machine learning, artificial intelligence, and analytics tools can be used to provide better solutions to problems [1]. Widely known organizations such as international standards organizations ISO [2], the International Electrotechnical Commission (IEC) [3] and the International Telecommunication Union (ITU) [4] develop different standards to set a benchmark and to measure the performance of smart cities. Citizens in smart cities can improve their standard of living through proper management of transportation [5], traffic control [6], air pollution [7], waste management [8], health care [9], public safety [10], water [11], energy [12], and emergency management [13]. Fig. (**1**) shows the model of the smart city. Initially, smart cities implement a data-sharing platform with the public. Information shared with the public can be related to the new policies of the government and other private sector companies, fire detection, crime prevention, floods, and climate prediction [14]. To connect the cities with the citizens, pervasive wireless connectivity through a unified framework is highly desirable [15]. Low power wide area networks in smart cities are integrated with IoE-enabled devices, which are cost-effective and consume less power in their operation. Integration of recent technologies such as LTE Cat M, NB-IoE, LoRa, and Bluetooth contribute their major role in the connection of smart cities [16]. A heavy investment related to IoE-enabled hardware and software is required to build smart cities and to generate high revenue from them. Through proper implementation of privacy and security in smart cities, the government can generate high costs from service revenues. Attackers can capture control and hamper the functioning of integrated IoE devices in smart cities, such as CCTV cameras, locking systems, traffic lights, *etc*. To get rid of such type of privacy concerns, third parties in private or government sectors must explore the trade-offs between shortcomings and effectiveness in security.

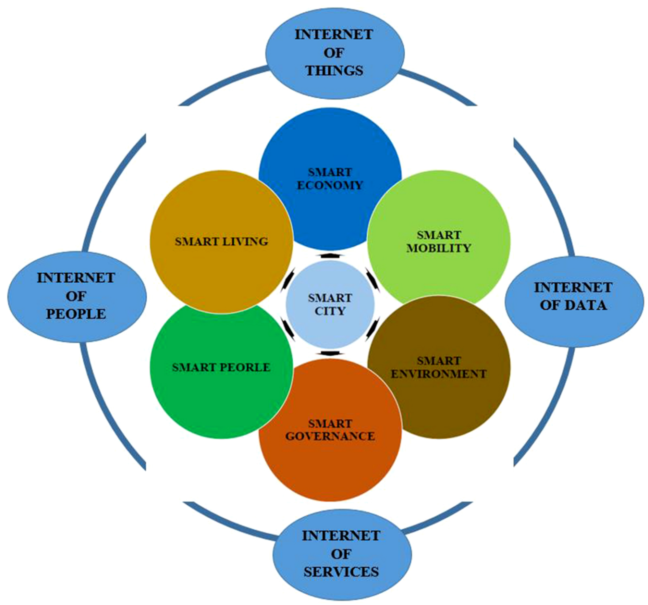

Fig. (1). A smart city model.

Smart cities of any country can generate various types of requirements that can be fulfilled through the implementation and integration of cloud-based applications. These applications can be accessed by equipped IoE devices in smart cities. Mainly two types of services are being provided to smart cities to fulfill their requirements. The first type of service is mainly provided to the end-users and various IoE devices which are equipped in smart cities. The second type of service is concerned with the administration of smart cities by their existing municipal system [17]. According to [18], it is estimated that by the end of 2025, the market size of smart cities will be USD 2.57 trillion. The ultimate objective of

CHAPTER 5

Smart Cities Emergence with Artificial Intelligence- Natural Language Processing

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Abstract: In this digital world integrating smart city concepts, a smart city is a technically advanced metropolitan region that collects data using various electronic technologies, voice recognition methods, and sensor devices. It would not be wrong to say that this smart city is based on the Internet of things (IoT) and artificial intelligence (AI). The IoT and AI are closely related. IoT systems generate big data, and data is at the heart of AI and machine learning. Simultaneously, as the number of linked devices and sensors expands, the importance of smart technologies is also growing faster in this domain. These technologies enable contextual understanding and allow smart devices to solve our problems. Today, the applications of computational intelligence in IoT products and smart devices used in smart cities vary. AI can be leveraged to drive efficiency and improve human living quality for the smart cities of tomorrow. NLP gives the powers to AI tools that recognize and respond in natural Language. This chapter focused on a definite area of AI called Natural Language Processing, which helps and enhances human living in smart cities. There are many use cases where this AI technology makes sense for smart cities. Computerized healthcare services assist policymakers in implementing smart cities in becoming brighter, using opinion mining and permission to remodel a house. These use cases are achieved and discuss various applications, scopes, techniques, advantages, disadvantages, and future scope of NLP of AI in Smart Cities.

Keywords: Deep neural network, Internet of things, NLP pipeline, Natural language processing, Smart cities, Text mining, Text summarization.

INTRODUCTION

Nowadays, a Smart city is a trendy concept for any developing nation. The Internet of things helps to achieve the purpose of nation-building and its citizens.

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With a massive number of homogeneous and heterogeneous systems, it would be possible to communicate transparently and seamlessly, whereas access to data will be selected for designing many digital services. Our life is now being affected by a new word, the Internet of Things. Now the world is becoming borderless. People are linked together by means of technology, goods, electronics, and web-enabled tools, resulting in the development of lucrative and creative new services. The Internet of things (IoT) is a system that connects devices to the Internet. A number of sensors provide access to the physical environment. As of 2011, the number of devices connected to the Internet (12.5 billion) had exceeded the number of humans on the planet (7 billion), which number the number of devices connected to the Internet is expected to be between twenty-six billion to fifty billion worldwide during the year 2020. Various countries, such as the United States, China, North/South Korea and Japan, have preparations to take advantage of IoT services. India is not ready to be left behind in this smart city race. IoT is ready to build faster. The center-sponsored scheme will drive entry into India as a mission. The central government gave a financial proposal of 48,000 crore rupees in support over five years and planned to set up a hundred Smart Cities buildings across the country.

LITERATURE REVIEW

The Internet of Things (IoT) has been established, ultimately resulting from the expansion of traditional networks, which connect billions of connected devices; information and communication technologies have become widely used in regular human activities in recent years and incorporated into urban strategies [1]. This type of technical innovation is regarded to be significant since it is used to bring answers to urban challenges [2]. Furthermore, various elements of people's health issues, transportation, energy usage, education, knowledge transfer, and governance are covered by digital information [3, 4]. With the advent of information and communication technology in urban development actions, the idea of a smart city, which is really the successor to preceding notions (for example, digital city and intelligent city), was proposed [5]. The phrase "smart city" has been around since the late 1990s, but it wasn't until the mid-2010s that it really took off and became widely debated in industry and academic journals [6]. Sustainable cities, smart cities, urban ICT, sustainable urban development, sustainability and environmental challenges, and urbanisation and urban expansion were all used to create this idea [7, 8]. Green building management helps in smart city development and provides the key to a sustainable global solution for smart building [9, 10].

Smart city applications come in a wide variety of shapes and sizes. The strategy for implementation is what they share in common. Municipalities should start a basic smart city platform- whether they want to automate rubbish collection or enhance street lighting. When smart city manager wants to increase the breadth of smart city services in the future, new tools and technologies may be added to the existing architecture without having to rebuild it [11, 12]. To be able to grow, the implementation should begin with the creation of basic architecture, which acts like a springboard for future expansions and agrees with introducing new services without sacrificing functional performance. A basic IoT system for smart cities is made up of four components [13].

The Smart Things Network

Like any other IoT system, a smart city uses smart objects with sensors and actuators. The sensors' primary objective is to gather and transmit data to a central cloud management platform. Actuators enable equipment to do tasks such as changing the lights, limiting water flow to a leaky pipe, and so on.

Gateway

A "tangible" element of IoT devices and network nodes, as well as a cloud part, make up every IoT system. Data cannot easily be transferred from one section to another. Doors - field gates – must exist. Field gateways make data collection and compression easier by pre-processing and filtering data before sending it to the cloud. A smart city solution's cloud gateway guarantees safe data transfer between field gateways and the cloud.

Data Lake

A data lake is a component of IoT. Its main work is to store the original form of data. When the data is needed for relevant insights, it is extracted and delivered to the big data warehouse, where data are stored in a well-structured format.

Warehouse for Big Data

A single data repository is referred to as a vast data warehouse. It includes exclusively structured data, unlike data lakes. Data is extracted, converted, and placed into the big data warehouse once its worth has been determined. It also saves contextual information on related items, such as whether sensors were installed or not and the device commands that control apps send to devices' actuators.

Fig. (**1**) shows how IoT components collect data from the environment and create big data. A sensor detects some environmental event and translates that into an electrical signal. An actuator is more or less the opposite of an electrical signal, and it causes some event in the environment. The Gateways help to store sensor

CHAPTER 6

Machine Learning-based Intrusion Detection for Position Falsification Attack in the Internet of Vehicles

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Abstract: Intelligent transportation system (ITS) is a promising technology to enhance driving safety and efficiency within smart cities. It involves public transportation management, infrastructure control and road safety. Its main purpose is to avoid risks and accidents, reduce traffic congestion and ensure safety for road users. Vehicular ad hoc networks (VANET) are core components of ITS where wireless communications between vehicles, as well as between vehicles and infrastructure, are possible to allow exchanging road, traffic or infotainment information. VANET is vulnerable to several security attacks that may compromise the driver's safety.

Using misbehavior detection approaches and information analysis demonstrated promising results in securing VANET. In this context, Machine Learning techniques proved their efficiency in detecting attacks and misbehavior, especially zero-day attacks.

The goal of this chapter is twofold. First, we intend to analyze the security issue in VANET by reviewing the most important vulnerabilities and proposed countermeasures. In the second part, we introduce a comprehensive Machine Learning framework to design a VANET IDS. We used the framework to evaluate the performances of several Machine Learning techniques to detect position attacks using the VeReMi security dataset. Experimental results prove that KNN, Decision Tree and Random Forest outperform Logistic Regression, SVM and Gaussian Naïve Bayes in terms of Accuracy, F-measure, Precision and Recall.

Keywords: Internet of vehicles, Intrusion detection, Machine learning, Position attack, Vanet security.

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INTRODUCTION

Vehicular Ad hoc NETworks (VANET) are core components of intelligent Transportation Systems (ITS). In VANET, vehicles are able to construct a self-organizing network to communicate with each other or with some road infrastructure [1]. VANET relies on two main components: Road Side Unit (RSU) and On Board Unit (OBU). Road Side Unit (RSU) is the roadside communication equipment. It provides internet access to vehicles and ensures exchanging application information between vehicles. On Board Unit (OBU) is the mobile terminal placed on the vehicle. It allows communication with other vehicles or with infrastructure equipment.

VANET enables different communication architectures, such as Vehicle-to-Vehicle (V2V), Vehicle-to-Infrastructure (V2I), Infrastructure-to-vehicle (I2V), Infrastructure-to-Infrastructure (I2I) and Hybrid communications [1].

In the vehicular plane, each vehicle is equipped with OBU. The latter allows V2V communications. The RSU plane facilitates V2I, I2V and I2I communications. VANET is intended for different applications such as infotainment, payment, Internet and cloud-based services. The service plane also involves the certificate authority (CA) or trusted authority (TA) of the PKI-based authentication system [2].

VANET has a highly dynamic topology due to vehicle movement. Target vehicles are reached depending on their geographical location, and signal propagation is affected by the environment, such as buildings, trees, wall panels, forests, *etc*. Moreover, energy, storage failure and computing capacity are not critical problems for VANET. In spite of that, the main challenge for VANET is processing huge amount of data in a real-time manner [1].

The main purpose of VANET communications is to improve transportation safety. In order to achieve this goal, security requirements such as authentication, integrity, confidentiality, non-repudiation and availability have to be ensured. Furthermore, safety and emergency messages are broadcasted and exchanged *via* wireless channels. As a result, VANET is subject to various security attacks.

Several existing works studied VANET security issues and introduced novel countermeasures that can tackle VANET vulnerabilities. Intrusion detection systems (IDS) are a commonly used approach to detect misbehavior and malicious activities Since few years, the adoption of Machine Learning (ML) techniques is attracting a growing interest because of their ability to detect unknown and zero-day attacks [3, 4].

This chapter has the following objectives:

- We review the most important communication standard protocols and architecture for VANET.
- We analyze the security issues in VANET by reviewing the most important attacks and countermeasures while focusing on IDS.
- We introduce a novel and comprehensive framework for ML-based IDS targeting position falsification attacks in VANET.
- We evaluate the performances of ML classifiers using the VeReMi security dataset.

The chapter is organized as follows. Section II is devoted to the background and related works on VANET communications and security issues. Section III depicts the proposed ML framework for IDS. Finally, section IV is dedicated to experimental results.

The following table depicts the main used acronyms throughout the chapter.

Table 1. List of abbreviations.

CA	Certificate authority
DCC	Decentralized Congestion Control
DOS	Denial of Service
ECDSA	Elliptic Curve Digital Signature Algorithm
EDCA	Enhanced Distributed Channel Access
I2V	Infrastructure-to-Infrastructure
IDS	Intrusion detection systems
ITS	Intelligent transportation system
OBU	On Board Unit
OFDM	Orthogonal Frequency Division Multiplexing
PKI	Public Key Infrastructure
RSU	Road Side Unit
SVM	Support Vector Machines
TA	Trusted authority
V2I	Vehicle-to-Infrastructure
V2V	Vehicle-to-Vehicle
VANET	Vehicular ad hoc networks
VeReMi	Vehicular Reference Misbehavior Dataset

CHAPTER 7

Implementation of Smartphone-based Indoor Positioning Application Using Trilateration

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Abstract: Positioning applications using GPS, A-GPS, and other technologies are now commonly found in most held hand smart devices. The advents in applications/tools such as Google Maps have made outdoor positioning and guidance much easier. Compared to outdoor positioning, Indoor positioning has always been more challenging. Indoor positioning faces an uphill task of proper Position fixing due to an array of issues that are otherwise absent in the outdoor environment. In this chapter, through trilateration, we have devised an application that takes the help of Wi-Fi signals and does Position fixing in an indoor environment. Indoor localization and positioning is still a challenging topic in Wireless Sensor Networks, and also it is vital because of its effects on monitoring, power consumption, *etc.*, for our work distance calculation of an object using the proposed path loss model, and Trilateration method is implemented to calculate the unknown Position of a device under the environment. It collects all the Wi-Fi signals and finds the exact matches with the database to calculate the user's actual Position on the map. It reduces the complexity of computing the distance of different access points from the user and reduces error. The tool was found to be quite promising in detecting the Position of the host device. Future work that can be extended from this work can include work with a path loss model, Multi-Sensor Fusion, to the inclusion of pattern recognition.

Keywords: A-GPS, Indoor positioning, Position-fixing, Trilateration, Wi-Fi.

INTRODUCTION

Smartphones have become a ‘part and parcel’ of life. Rapid growth in Smartphone technology made our work comfortable and easy. For ease to use and uncountable features, the uses of Smartphone users are increasing exponentially. The growth is observed both in software technology (Operating system based/third party applications) as well as in hardware variety and companies. The gradual increase in technological accuracy and decrease in the cost of handheld wireless devices

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propelled the functionality and availability of mobile stations. These factors, coupled with low price, has led many to switch to handheld mobile stations. It naturally created competition with desktops in use. Fig. (**1**) shows the international mobile *versus* desktop user base [1].

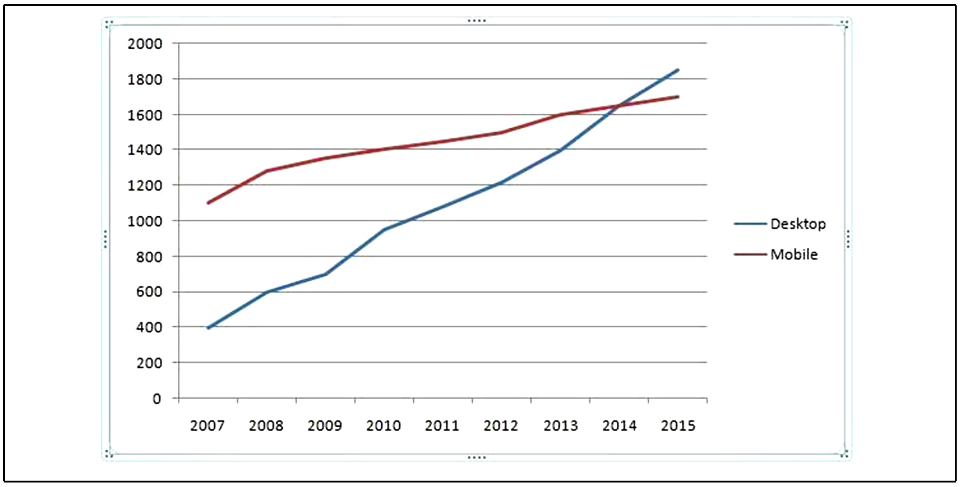

Fig. (1). Mobile *versus* desktop users in million-world wide.

The World Wide Web has been fueling growth in the fields of IOT, Information technology, and technology-enabled business areas. Statistics show that almost 95% of mobile station users prefer having internet connectivity. Fig. (**2**) shows the comparison of Internet users among Desktop, Mobile, and other connected devices.

Internet-enabled smartphones have become a commonly held hand mobile station that enables us to locate our position in the outdoor environment through a host of application programs using technologies such as GPS and AGPS, among others. Indoor positioning through the same device can be achieved by a host of other technologies. Though accurate indoor positioning is much tougher to achieve due to an array of problems, it can still be achieved. This work describes how the positioning was achieved in an indoor environment using the trilateration method. The chapter has been organized into the following sections: Section 2 lists the problem statement and technical challenges. Section 3 lists similar work done for indoor positioning in recent times. Section 4 discussed the methodology undertaken. Section 5 discusses the positioning technologies in brief Section 6 takes up, in detail, the development of the application, including the algorithm and the flowchart. Section 7 is used to show the snapshots of the client and server sides. Section 8 describes the Comparison Study (Existing Trilateration *versus* Implemented Trilateration). Section 9 deals with the conclusion. Section 10 takes up the future practical extensions of the work.

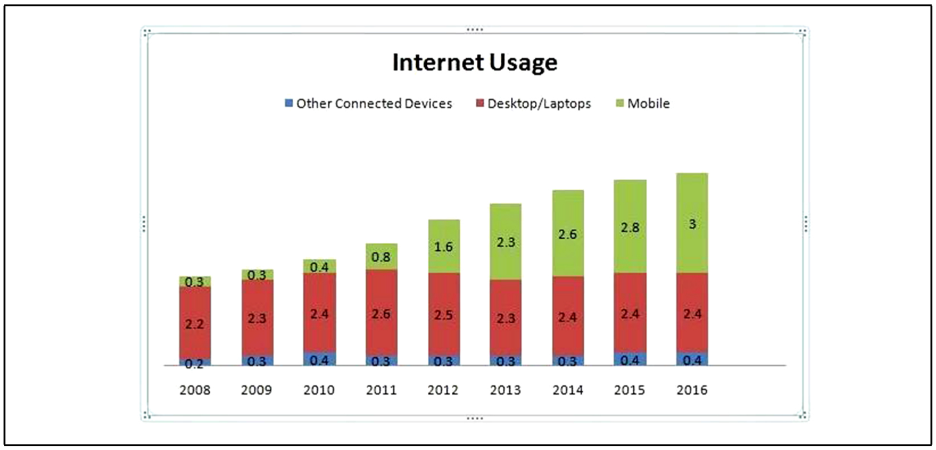

Fig. (2). Internet user.

Problem Statement and Technical Challenges

Opposed to outdoor navigation, the problem of Indoor navigation and positioning is quite challenging. Both of them aim to determine the actual position of an object or device accurately. The past few decades have seen positioning systems (GPS, GLONASS, *etc.*) widely used to track devices. Finding the best possible route to travel is one of the multitudes of applications that exist for positioning systems. In-door positioning and localization techniques are highly motivated by outdoor Positioning Systems but are a different challenge altogether. Outdoor positioning systems do not work properly in Indoor environments because of multiple factors such as high-story buildings, obstruction because of the roof, walls, and other obstacles that ultimately attenuate the signal coming from the satellites. After attenuation, the receiver receives fluctuating and faded signals, leading to a miscalculation of coordinates by GPS devices. To address the problem, an array of alternate techniques has been proposed for indoor positioning, navigation, and tracking. These include methods such as Assisted Global-Positioning-System, Wireless-Fidelity, Bluetooth, Zigbee, Beacon, and Radio-Frequency-Identifier (RFID). For our research purpose, we take up Indoor positioning and navigation using a received signal strength indicator (RSSI) based on IEEE 802.11. For position fixing, trilateration with the received signal strength indicator (RSSI) method will be implemented in a smartphone. The mobile platform can be a smart device with a low-quality WLAN antenna and low

CHAPTER 8

How the 'Things' Speak: The Usage and Applications of Sensors in IoT

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Abstract: The Internet of Things (IoT) has been massively revolutionizing human lives for the last few decades. The powerful and steady advancements in the field of science and technology have aided this process immensely. As a result, almost all aspects of our lives have grown smarter. Nowadays, life is almost unthinkable in the absence of IoT-enabled smart devices, such as smart televisions, smart computers, smart-phones, smart fitness trackers, *etc*. Needless to say, all these devices enjoy ever-growing popularity in this era of smart technology. This development is propelled by the existing digital communication backbone – the Internet. The very Internet, over which human communication started just a few decades back, is now being used by each and everything in our surroundings, be it natural or man-made. The advent and inclusion of IoT in recent times have highlighted how trees, crops, fruits, chairs and tables, electrical appliances, and all other objects around us can interact with each other. They are capable of communicating as freely as humans, and based on such communications, these things' can even behave smartly, individually, and in unison, by making informed decisions in real-time! Given that these things do not possess the gift of life naturally, their ability to express themselves comes from the use of numerous types of sensing devices, also called sensors. The intelligent manufacturing and easy availability of these miniature, cost-effective sensing devices have given a new shape to almost all aspects of our lives. The data regarding the behavior of things, as captured by sensors, is essentially what the things express, and it carries meaning in the particular setting. This data may then be processed and analyzed at the source, transmitted over the internet and processed in a cloud or remote machine. While in some day-to-day applications, the data is used directly for decision-making (for example, in smart electric appliances), in more critical problems, the data needs ample processing and analysis (healthcare, activity recognition, *etc*.). In the latter case, different mathematical model-based machine learning algorithms are utilized to learn hidden patterns or features in acquired data and extracted features. With the use of a trained learning algorithm called a classifier, the new data is then used for decision-making purposes. The choice of such algorithms is often dependent on the type of sensor data being used and the corresponding application area. Thus, it is seen that IoT-based systems find application in various domains, starting with research and development up to industry, agriculture, defense, *etc*. In reality, the progress of researchers in different domains leads to smart products that, in turn, make human lives easier. Research in several pop-

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ular verticals, such as Human Activity Recognition, Remote Healthcare, Remote Monitoring, Smart Automation, Smart Agriculture, *etc*., have yielded many such products. This chapter focuses on the deep-seated relationship between IoT and sensors from the perspective of state-of-the-art research. It offers discussions on the usage of various types of sensing devices, associated data, and their contribution towards solving specific research problems in the respective IoT-based applications. This includes the Video Camera, Inertial Measurement Unit (IMU) Sensors, Ultrasonic Sensors, Electrocardiogram (ECG) Sensors, Passive Infra-Red (PIR) Sensors, Electromyogram (EMG) Sensors, and some commonly used sensing devices for Environmental and Agricultural Smart system development. A pertinent case study is also included to demonstrate the role of sensors in the development of IoT-based systems. This study also highlights how little effort it takes to implement an IoT-based data acquisition system. The different popular application areas are discussed thereafter in terms of some broad categories. This is followed by the description of some of the standard metrics used for evaluation and benchmarking the performance of smart sensing systems. The future of sensing devices has been discussed, followed by the pertinent challenges faced by IoT-enabled smart systems in implementation. Finally, the concluding remarks are offered. The chapter aims to serve as a wholesome source of knowledge, and relevant information to researchers and practitioners who wish to indulge in the development of smart IoT enables sensing systems.

Keywords: Internet of things, Sensors, Smart applications, Sensor applications, IoT.

INTRODUCTION

The extensive usage of the internet framework has been making human lives more connected for a few decades, highlighting how instant communication can be achieved and utilized in social, business, education, and healthcare scenarios with ease. The Internet of Things (IoT) thrives on this same framework by replacing the human factor with things – both natural and man-made. However, a logical restriction in this process is that things, whether natural or man-made, cannot communicate; they lack the gift of life. Similarly, they cannot sense, think or speak. This is where the sensors pray a pivotal role in IoT. This is also noted from the conventional 3-layer architecture of IoT systems, which starts with the sensing layer as illustrated in Fig. (**1**). The data that is sensed in the first layer is then sent with proper network policies and frameworks to the application layer. In this final layer, the data is analyzed for making decisions and executing different applications based on the extracted information.

A sensor is an electronically controlled device that is capable of detecting particular events or measuring the changes in its immediate environment. For instance, the measurement of change in temperature or the detection of infra-red radiation-emitting object presence is a simple function performed by the temperature sensor and Passive Infra-Red (PIR) sensor, respectively. In application, the sensors need to be controlled with proper triggers and power provision so that they work as per requirement. For this purpose, micro-controllers or micro-processors are utilized, where the latter has the added advantage of immediate data processing and decision-making. In other cases, the microcontroller uses Bluetooth modules [1], Wi-Fi modules [2], or GSM [3] modules to communicate the gathered data to a server where the processing or analysis is undertaken. The sensors can also be grouped into two classes based on their usage, while some are deployed in the target environment for detecting any changes in the same, other sensors need to be fit onto specific objects or locations for proper sensing to take place. This also varies according to the particular application field in question. So to properly develop any IoT-based system, it is crucial to determine all the computational and logistic requirements involved in the particular problem. Accordingly, sensors and controllers or processors are to be selected and deployed. A widely used family of micro-controller circuits is the family of Arduino boards [4], whereas, for microprocessors, a popular choice is the Raspberry Pi family [5]

In this chapter, a detailed discussion has been conducted on the usage of various sensing devices in the different popular IoT-based research domains, such as Human Activity Recognition, Smart Healthcare, Smart Environment Monitoring, Smart Agriculture, *etc*. All mentioned electronic components and research work are duly cited for the benefit of the readers, students, and researchers so that they can utilize this work as a ready reference. Some sensor discussions include drawn images for a better understanding of the sensor working principle; readers may refer to the cited web pages for actual product images.

SENSOR PLACEMENT IN IOT-BASED SYSTEMS

Almost all IoT-based systems rely on the effective deployment of sensors, and this deployment can be categorized into two types. This section aims to highlight these deployment scenarios in brief.

Wearable/On-body sensor placement: In this sensor deployment scheme, the main concept is that the IoT-enabled system works outdoors. This essentially means that there is no fixed set of points or locations from where sensors can gather the necessary data. For instance, let us consider the example of a person walking outdoors. This is a general problem in the domain of Human Activity Recognition, where it is critical to obtain data regarding human movement and activity from sensors. However, since the premise is outdoors, it cannot be pre-determined where the person will move towards. In such situations, it becomes necessary to obtain the necessary data from sensors which are placed at fixed

CHAPTER 9

IoT and Cloud-based Data Analytics for Real Life Applications and Challenges

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Abstract: Due to the massive development in the field of Internet technology, data communication and its processing make it easy for people to access and interact with various physical devices around the world. It has led to many buzzwords, such as the Internet of Things, cloud computing, data analysis, *etc*. It is important to understand the relationship between them. Every day, many devices connect to the internet and share a large amount of data that needs to be processed for future reference. Therefore, the cloud concept plays a big role in storing such a large and fast operation. The use of this type of data depends on the personal needs of the end user. Some users' devices are the sources of their communication. For some, user data is important to understand customer behavior. For some users, how to manage massive data and devices are important. Similarly, few users pay attention to data to improve their goods and services. In this chapter, we focus on the Internet of Things, cloud computing, and data mining, and try to find the connection between them in terms of users, services, and applications. Furthermore, to get an insight into the data, this chapter consists of an introduction, research methodology, and conclusion.

Keywords: Big data, Big data analytics, Cloud computing, Data mining, Internet of things, Utility computing.

INTRODUCTION

The Internet of things produces a lot of data that may be used for further analysis and decision-making for the business. So, it is important to know the relationship between the Internet of things, the Cloud and Data Analytics. With the advancement of Internet speed and bandwidth, many devices are connecting daily, and this leads to a problem in terms of the huge amount of data produced by each device. The main challenge is how to deal with this data for the benefit of the business. Therefore, it becomes important to find different patterns from this data to get an insight into the business. It means there is a need to understand the relat-

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ionship between IoT, Cloud, and Big data. It is essential to know about these three concepts before going into detail.

IoT (Internet of Things)

It can be said collection of devices or appliances which are connected through the Internet. These devices may send and receive data and can be controlled from the other devices through the Internet [1]. Such generated data can be used further for decisions. Different patterns can be found and interpreted from such huge data using different data mining techniques. Generated data may be historical or real-time, but it depends on the individual how to use it. Machine learning, deep learning, data science, and statistical techniques can play a great role to handle such types of data.

Challenges in IoT: IoT is used in different areas like agriculture, transportation, traffic control, smart cities, healthcare, and many more. Besides its vast scope, it faces many challenges few of which are as follows.

Scalability: Billions of devices are connected through the internet and generate lots of data per unit of time. Therefore, storing and analysis of such real-time data is one of the challenges.

Security Issues: People are not aware of how to use such devices and how to secure the devices and data produced by these devices. This may lead to some problems in the future.

***Health Care Issues*:** Sometimes wearable devices are used to take care of the patient; time mishandling, technical error, or lack of knowledge may be life-threatening to the patient.

***Lack of Government Regulation*:** There is rapid advancement in this area, but still, government regulation is not so strong to keep our data and device security.

***Insufficient Bandwidth*:** Devices are connecting exponentially and producing huge data, and the transfer of such data from one place to another place requires high bandwidth. This time of demand for bandwidth will increase over time which is also a challenge.

***Electricity*:** IoT requires a 24x7 power supply, but in some countries, irregularity in electricity supply is also a major issue. Therefore, searching for and producing a new source of power is also a major challenge in this area.

Big Data

Data which is having features called 4Vs. like volume, variety, velocity, and veracity [2]. Volume means data is coming from different data sources, variety means data is in different formats, velocity means data is produced very fast and veracity means trustworthy quality data. There may be so many challenges in the case of Big Data related to data cleaning, transformation loading finally, processing for further interpretation. As the size of the data is increasing very fast, there is a need for some technology to store, process, and analyze. This technology is called Cloud computing and will be explained in the next paragraph.

Challenges in Big Data: IoT devices generate large amounts of real data that are difficult to store and manage. There are many tools available to manage such a large amount of data, but there are still a few challenges.

Lack of Knowledgeable Big Data Professionals: Big Data is very demanding nowadays, but there is a lack of professionals. There are several tools available, but people don't know how to use them. The company began to spend a lot of money on employee training. It produces many types of jobs, such as data scientists, data analysts, machine learning professionals, *etc*.

Data Size Increasing: The size of data is increasing day by day, and it becomes difficult to store and manage. For this, skilled professionals are needed.

Confusion in the Selection of Tools**:** With so many tools available on the market, it is sometimes difficult to choose the right tool according to the requirements.

Data Integration Issues: Collecting data from different sources and integrating it for analysis is also a daunting task. Data may have many forms, text form, image, audio, and video form. Therefore, the integration of various data is also an arduous task.

Security Issues**:** For a company or organization, protecting data is very important because it can cause huge financial losses. Insecure data may be stolen, or knowledge leakage may occur.

Cloud

It is an on-demand IT service of resources for storing huge data and powerful computation. It has multiple locations called data centers where different functions are distributed to handle huge data and process data [3, 4]. It reduces the cost required for software and hardware. We can sell up or scale down the IT services as per our requirements and anywhere as far as location is concerned.

CHAPTER 10

Cloud-Based Secure Framework for Service Authentication and Access Control in Smart Cities Architecture Employing IOE

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Abstract: Cloud Computing has evolved as a next-generation technology and used as an integrated technology solution or feature in many evolving computing areas. One of the areas is in the field of Smart Cities, employing the internet of things or everything. A smart city is similar to a next-generation city, where services are being provided to users just like in the cloud computing domain. The focus of using such a system is to provide smart services to users or people living around. In previous works, presented by authors around the world, many solutions in different domains related to smart cities are provided, catering to different needs of users but still, there is scope for better access control and authentication mechanisms for accessing various services provided to users over a cloud-based environment. Smart cities are based on the usage of online computing services provided by various ICT/IOT technologies. It also faces many challenges and security threats, just like services in a cloud computing environment. The work presented here will discuss the concepts of the convergence of IOE and cloud computing in smart cities and the challenges faced in future-generation cities employing IOE. Along with this catering to security requirements in smart cities, this work proposes a security framework focussed on providing secure access control and authentication services delivered over the cloud-based system used in smart cities.

Keywords: Access control, Authentication, Cloud computing, Internet of things, Internet of everything, Smart cities, Security.

INTRODUCTION

"Smart city" is a term known since 1994 when Cisco invests a large amount of around $25m for a period of 5 years to research different perspectives of smart cities. In 2008, IBM started its "Smarter Planet" initiative to identify the usage

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and suitability of applying sensors with analytics and networks for issues in urban areas. Since then, over the years, the ability of technology to provide a holistic or comprehensive view of all facets of city functionality/operations and improved quality of life has become a reality today.

The primary goal behind the concept of smart cities is to automatize and optimize their functions. Using smart data analysis and technology support amplifies economic growth, thereby improving citizens' quality of life. The salient factor in this would be using technology appropriately rather than how much technical support is available.

The primary goal behind the concept of smart cities is to automatize and optimize their functions. Using smart data analysis and technical support helps improves economic growth, thereby improving citizen's quality of life. An important factor in this would be, using technology appropriately rather than how much technical support is available.

A smart city, moreover, uses ICT (Information and Communication Technology) technology [1, 2] to provide the benefits of improved operational efficiency, thereby providing a better quality of service for the welfare of citizens of the city. There exist many formal definitions for a Smart City, like IBM, defines a smart city as "one that makes optimal use of all the interconnected information available today to better understand and control its operations and optimize the use of limited resources".

The main idea behind the concept is to identify and provide technology-based solutions to problems faced by people in urban areas. The smart city uses different types of software, UI's (user interfaces) and networks for communication mechanisms [1] alongside IoT (Internet of Things) to provide technology-oriented solutions to issues faced by citizens in their day-to-day life. The important term or technology concept used in smart cities is IoT. IoT is referred to as the network of physical objects like sensors or actuators for collecting useful information about various activities performed in cities which would help in driving decisions for the well-being of the citizens.

The main goals for the development of a smart city are:

- Improving transportation services,
- Reducing industrial or generic waste and preventing inconvenience to citizens living around,
- Improving social and economic standards and
- Maximizing social inclusion

Further, cloud computing also plays a vital role alongside IoT [1] as its features are, used as the backbone for effectively utilizing the power of IoT. An IoT system involves devices like sensors *etc.*, with limited storage, computation power and connectivity options, to provide enhanced support in terms of the above said features, the power of cloud computing can be utilized. Cloud computing is a system for on-demand network access to a shared pool of resources with expandable storage, high computational capability, and multiple supported connectivity options. So, an amalgamation of IoT with cloud computing would enhance the power of IoT for Machine to Machine inter-communication [3], providing a viable technology solution for issues of people. IoT is a major technology component in the development of Smart Cities, so using it alongside the cloud would solve inherent problem faced in Smart Cities functionality compared to when IoT is used alone.

IoT has remarkable effects in work and home scenarios, where it can play a leading role in the next future with features like assisted living, robotics, e-health, smart transportation, *etc.* Following it, in 2008, IoT was reported by the US National Intelligence Council as one of the six technologies with a potential impact on US interests towards 2025 [2]. The IoT ecosystem works by providing a system where internet-connected devices can sense/fetch data from the environment/equipment and further share it with other devices without the involvement of people/human intervention. It is also referred to as (M2M) Machine to Machine communication technology.

Number of devices that interconnected with each other in 2011 crossed the population of people in the world [3]. While the Internet of Things is still looking for its own form, its effects have already begun to make incredible advances as a universal solution for the connected scenario [4]. Due to the importance of IoT technology, various IoT-based applications have been developed, like Smart City, Smart Home, Smart Grid, Smart Health, *etc.* [5 - 8]. With massive urbanization in the world recently, using ICT to perform urban city operations has become quite an effective solution. The Smart City concept is selected based on other previously coined urban development models like digital city and telicity *etc.*, as it provides a better abstraction among others [9].

In smart cities, the services are provided to users over the internet just like we do in the cloud computing domain. So, likewise cloud computing systems, smart cities also possess or encounter the challenge of security vulnerabilities in the services provided by the system. Here in this work, initially, we have focused our attention on the identification of various vulnerable or susceptible entities involved in the smart city environment. As the services in the system are susceptible to security breaches or issues, a cloud-based solution for secure

CHAPTER 11

Blockchain Technologies and Smart Contracts in Smart Cities

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Abstract: Smart Cities are gaining attention due to the ever-increasing population. The increasing population and expanding urbanization resulted in increased congestion and numerous environmental problems. Due to COVID-19, more efficient urbanization increased the need for smart cities. To address the societal and efficient urban management challenges of these Smart Cities, advanced technologies like Blockchains can play vital roles. Smart Contracts are blockchain-based applications. Smart contracts are used to automate agreements without the involvement of a middleman. Smart contracts are executed by a network of computers once predefined conditions are met. The execution action can be in the form of the release of funds to parties, vehicle registration, sending notifications, and issuing a ticket. The information on the transactions completed is updated on the blockchain. This chapter provides insight into how blockchain technology works for smart contracts, which deliver numerous services in Smart cities ecosystems' in more reliable, data secured, and beneficial for the population in Smart cities. The chapter will contribute to the planning of Smart cities planners, developers, architects, and thinkers for using smart contracts to deliver various services in the smart city's governance.

Keywords: Blockchain technologies, Smart contracts, Smart cities.

INTRODUCTION

Blockchain is a technological invention that has disrupted the recent computer paradigm. With the help of blockchain and smart contracts, many applications that are notoriously difficult and complex, have been able to improve their service [1]. With tamper-proof smart contracts and algorithmic executions, blockchain technology allows decentralized consensus and potentially expands the contractual field. Meanwhile, achieving decentralized consensus necessitates the dissemination of knowledge, which changes the informational environment.

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Everyone today must adapt to digital platforms for information sharing, data services, buying, selling, and transactions, among other things, because of the advancement of contemporary technology [22]. These digital marketplaces facilitate the exchange of specialized data from producer to consumer and vice versa (activity of receiver). Digital material, on the other hand, needs proof of delivery (PoD) to show that the desired content number was provided to the consumer. The PoD also assures that digital content is provided to both parties without manipulation and exactly as requested. This safeguards both parties' rights while also building confidence in the event of a future occurrence.

There are currently a lot of digital markets where customers and digital artists may engage. Despite their prominence, these platforms still account for a sizable portion of income. As a result, the author only earns a small profit [23]. Other digital services with more brand and revenue share flexibility are also available, but the main issue with all existing solutions is that they are all centralized.

The centralized system has a single point of failure. In addition, there is a lack of transparency, and authority is not distributed fairly. As a result, they are more likely to be bribed. These solutions also rely on payments made through a Trusted Third Party (TTP). As a result, they are untrustworthy and unreliable. Blockchain technology, on the other hand, has enabled a decentralized proof of the delivery system. This distribution system is known for its tamper-proof and unchangeable qualities because of its decentralized distributed ledger. Due to its security properties, it is feasible to have transparency, traceability, and auditability.

Smart Contracts

As a result of their application on blockchain-based distributed ledger infrastructures, smart contracts have achieved widespread acceptance since they do away with the need for trusted third parties to carry out and be liable for automated transactions [2]. The contractual parties must have faith in and trade with the middlemen when smart contracts are implemented on a centralized system governed by intermediate agents. In the case of smart contracts that are implemented on a distributed ledger, the execution and recording of transactions are handled by a decentralized infrastructure that is protected by cryptography. The blockchain system, which is a sort of distributed ledger technology, is the subject of this chapter. This would enable us to have a better understanding of how bitcoin, blockchain, and smart contracts operate, which is critical in today's fast-paced environment.

Blockchain

There are two sorts of blockchain: public and private. The primary difference between a public and private blockchain is that the former functions in a decentralized open environment with no limits on the number of people who can join the network, whilst the latter operates within the boundaries set by a governing institution. Blockchain is a distributed ledger technology that is managed in a decentralized (usually autonomous) way. It was originally widely known as the technology behind the cryptocurrency Bitcoin [3]. It comes in several other forms, usually with the ability to store and run computer programs. This has resulted in applications such as smart contracts, which are characterized by tamper-proof contingent consensus-triggered payments and funding through the initial issuance of tokens. A block is a grouping of records, which are referred to as transactions or events. The decentralized ledger of the blockchain network is shared by all participants. During the verification and agreement process between the parties to the blockchain, these transactions are recorded in the ledger and added to the blockchain. The characteristics of the blockchain, such as decentralization, immutability, and encrypted (cryptographic) linkages, are all critical.

The decentralization of the blockchain distributes power across network contributors. It is a blockchain distinction that allows redundancy, unlike centralized systems controlled by a trusted third party [4]. Decentralization improves service availability, reduces the likelihood of failure, and improves service dependability by assuring uptime. The transaction entries in the public ledger, which are still spread throughout the nodes, are permanent and unchangeable.

Immutability (inalterability) is a key property of blockchain-based centralized database systems, which elevates data integrity on the public ledger to new heights. From a computer viewpoint, records are tamper-proof due to the presence of cryptographic links.

Each record's cryptographic connection is structured chronologically to ensure the chain's integrity across the blockchain. A digital signature verifies the integrity of each record using asymmetric key cryptography and hashing techniques. The integrity of a transaction block or record is jeopardized when it is modified, rendering the block and record invalid. The technology that underpins cryptocurrency appears to be promising. A global ledger, which is based on blockchain and maintains an account of all transactions, is one of the most fundamental components of cryptocurrencies. To comprehend blockchain, we

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