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An Investigation Study for Technologies, Challenges and Practices of IoT in Smart Cities

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***Abstract*— Smart cities have been outfitted with various electronic devices based on the Internet of Things (IoT) and have become smarter than before as a result of ongoing breakthroughs in sophisticated metering and digital technologies.**

The IoT is a network of physical things and technology that connects them without requiring human interaction. As a result, smart (or smarter) cities can be built all over the world. Smart city systems that encourage sustainable living, better comfort, and increased productivity for people have been made possible thanks to the IoT. This article's goal is to give a thorough overview of the ideas behind smart cities, as well as their purposes and uses. Additionally, this survey discusses the key elements and characteristics of a smart city as well as IoT technologies for smart cities.

***Keywords*— IoT; Smart Cities; Smart Grids; Smart Buildings.**

I. INTRODUCTION

Countries all across the world are attempting to determine how to prepare their cities for the inflow of people and the strain it will place on existing city systems [2]. Smart Cities have emerged as a major drive by many governments to make cities more navigable and friendly to predicted population expansion, as well as to improve the living experience of city residents [3–4]. However, due to the high degree of researcher interest in the topic, multiple surveys were uncovered throughout the literature search [5–9]. The authors examine big data for cyber-physical systems, including data collecting, storage, analytics, and security, as well as approaches to make it more eco-friendly. The authors in [6] address the difficulties of IoT deployment in Smart Cities and rank them according to the expertise they have at their disposal. There are a few differences between our work and that of [6] in that we don't rely just on the judgment of a single expert and hence don't limit ourselves to a certain application domain. IoT architecture and applications in Smart Cities are discussed in [5]. Case studies of towns with ongoing smart city programs are presented in [7–8] to give an application-oriented examination of specific systems built for various smart city components. Using big data for cyber-physical systems is discussed in [9], where the authors go over the many methods of generating and collecting data, storing it, analyzing it, and protecting it, as well as the measures necessary to make such systems more environmentally friendly to install. These systems can be used in a variety of ways. In contrast to [5–9]. We cover the current state of use and deployment of the numerous key components and technologies used in smart city deployments.

They also go over the systems' applications. Unlike [5–9], this study looks at all of the essential components and technologies utilized in smart city projects, as well as how currently being used and deployed. The rest of the paper is organized as follows. Section II represent an overview of smart city, section III illustrate the IoT challenges for smart cities, section IV represents the discussion, and section V demonstrate the conclusion.

II. OVERVIEW OF SMART CITIES

When we talk about "smart cities," we're talking about settings where smart items are used to handle a variety of activities like lighting, traffic control, connecting cities, energy consumption, and pollution control. The basic purpose of smart cities is to alter our perceptions of the world around us.

A. Smart city components

Fig. 1 depicts the various components that make up a "Smart city." The gathering of data, transmission/reception, storage, and analysis of that data are the four main components of smart city applications. A major motivator for sensor advancement in a variety of fields has been the demand for data collecting, which is application-specific. The second step is the transmission of data from the data gathering devices to the cloud, where it will be stored and analyzed. Many smart city projects include city-wide Wi-Fi networks, 4G and 5G technologies, and various types of local networks that can transport data locally or internationally. The third step is cloud storage, which uses a variety of storage systems to organize and organize data so that the fourth stage, data analysis, may proceed more quickly. The process of deriving patterns and inferences from gathered data for use in decision-making is known as data analysis. Fig. 1 depicted the components of the smart city.

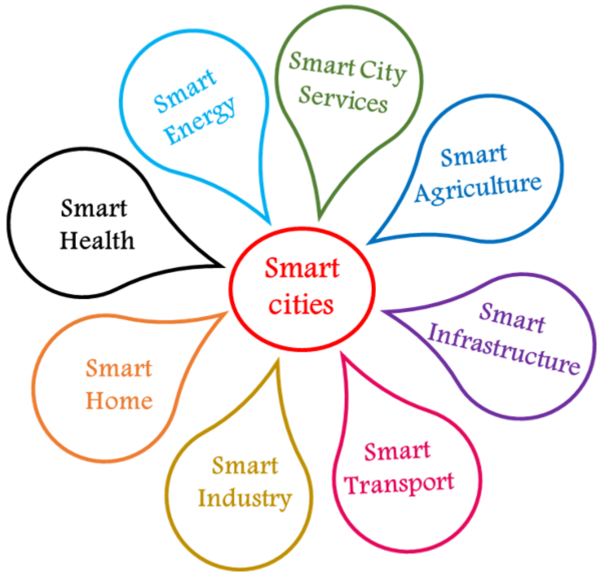

Fig. 1. Smart City Components

- *Smart Agriculture*

Smart agriculture (or "smart farming") involves the use of sensors placed in plants and fields to measure numerous parameters to aid in decision-making and prevent disease, pests, and other difficulties [10]. Precision agriculture is a subset of the smart agriculture paradigm, which entails the installation of sensors in plants to provide accurate measurements and, as a result, the deployment of precise care mechanisms.

- *Smart City Services*

"Smart city services" comprise services that assist a city's residents, such as water supply, waste management, environmental control, and monitoring. Water supply, trash management, environmental regulation and monitoring, and other operations that keep a city's residents alive are included in the scope of smart city services. Sensors can also be used to monitor pollution levels in cities and other environmental concerns.

- *Smart Energy*

A "Smart Grid," which uses ICT (Information and Communication Technology) to make current and newly constructed networks more visible, includes distributed energy generation and self-healing capabilities. Throughout the supply lines, real-time power information is transmitted to utilities at various sites on the grid until the client receives their service.

- *Smart Health*

Due to the widespread availability of mobile phones and health trackers [12], cloud computing can now be used to analyze real-time health data (ECGs, temperature readings, body oxygen saturation, and other biosensors), as well as daily activity data and detect abnormal movements using inertial sensors. As a result, healthcare expenditures will be lower and hospital pressures will be lighter.

- *Smart Home*

The Smart Home is an important part of Smart Cities since it is at the center of residents' daily lives. Sensors are put throughout a home to collect data about the building and its occupants to construct a "smart house." Possible sensors include ambient sensors, motion trackers, and power/energy consumption monitors.

- *Smart Industry*

Businesses all across the world aim to be more cost-effective and productive while increasing efficiency. Cyber-physical systems that integrate workers and machines in manufacturing and production processes have provided the industry with numerous benefits, including faster and better innovation, improved manufacturing schemes (resources and processes), and improved quality and safety for factory workers.

- *Smart Infrastructure*

Sensors for assessing the structural condition of buildings and bridges for structural health monitoring with accelerometers [13] and smart materials [14] help cities ensure that their infrastructure is in excellent working order.

- Smart Transport

It's no longer uncommon to see vehicles, infrastructure, and pedestrians all communicating with each other in real-time. It's possible to construct smart transportation systems thanks to technologies like Pedestrian to Infrastructure (P2I), Vehicle to Pedestrian (V2P), Vehicle to Infrastructure (V2I), and. Vehicle to Vehicle (V2V)

B. *Internet of Things for Smart Cities*

The concept of smart cities was born as a result of extensive digitization enabled by technology. Sensors connected to the Internet of Things can collect and transmit data on the state of a city, which can then be analyzed and utilized to make choices.

- *IoT Architectures for Smart cities*

Fig. 2 depicts a generic five-layer IoT architecture in which each layer builds on top of the information provided by the layer before it. Fig. 2 demonstrates the architecture of IoT.

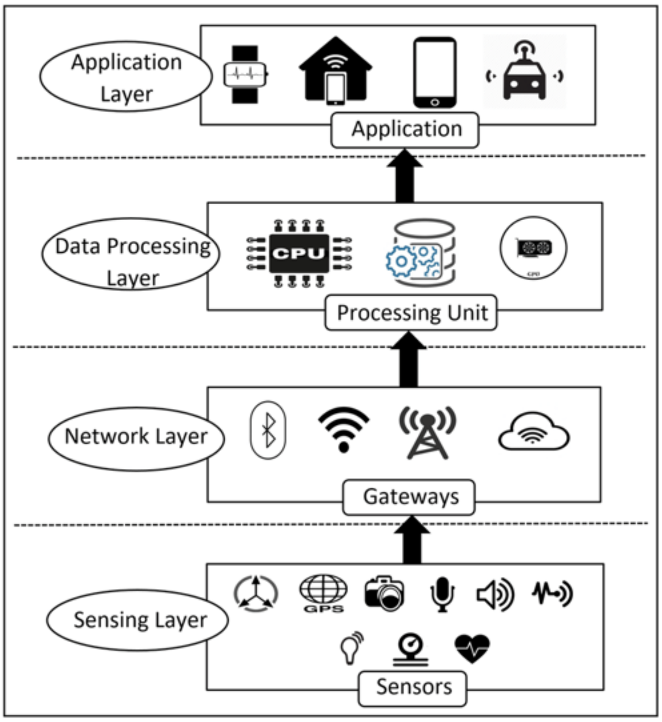

Fig. 2. IoT Architecture.

Sensors and actuators, such as RFID readers for reading RFID tags and other devices, are used to collect data on physical quantities that are relevant to any application. Sensor data is transmitted to the Middleware layer using technologies such as Wi-Fi, cellular internet, Zigbee, and Bluetooth. The APIs and database management tools of the Application layer are given by the Middleware layer, which in turn serves as a generic interface to the sensing hardware to provide services to users. The Business layer sits on top of the Application layer and is in charge of developing strategies and policies that govern the overall operation of the system.

III. IoT Challenges for Smart Cities

The Internet of Things will someday connect everything in our life. Smart cities will experience an increase in the number of sensors in all sectors of city operations as a result of this digitization process. The creation and subsequent implementation of IoT systems in smart cities present significant challenges that must be considered. Our goal in this section is to give IoT system designers a better knowledge of the challenges they face when deploying their systems in smart city applications. Some of the difficulties that smart city IoT system implementations confront include privacy, smart sensors, security, big data analytics, and networking. The challenges of IoT in smart cities are illustrated in Fig. 3.

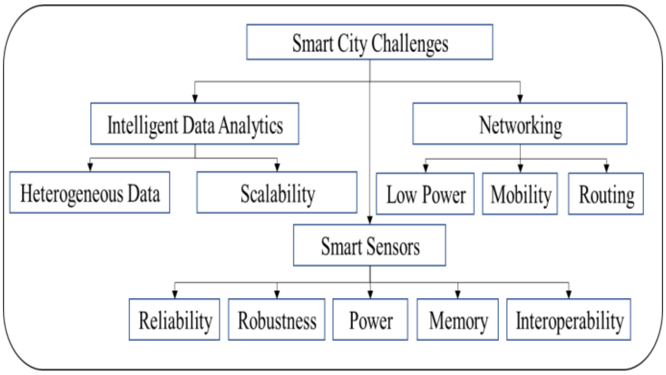

Fig. 3: Challenges for IoT in Smart Cities

A. Smart Sensors

Smart sensors collect data in smart cities. These devices are made with a variety of sensors, measurements, data formats, and networking protocols. To establish a smart city, all of these devices must be able to communicate, coordinate actions, and collect data. Manufacturers can leverage open data formats and protocols to develop interconnected equipment, speeding up IoT device rollout. Another option is to establish a "standard" access point node for IoT systems that can connect to devices and understand data. According to [16], only a few manufacturers have made their equipment truly protocol-neutral.

Besides reliability and durability, smart sensors have other challenges. The IoT system's dependability and accuracy are described as "reliable" and "robust." Because the Internet of Things is the foundation of future smart cities, a great user experience is important. This necessitates fast and precise service requests from app users. Everyone in a smart city must be treated equally. Decentralized systems should offer transportation and power. As a result, the system will be more reliable. Smart Grids can self-heal, for example.

Many modern networking protocols, on the other hand, are designed for devices that require continual power, such as smart cities' battery-powered sensors. They'll need to collect, measure, share, and save data. New memory and storage technologies, as well as low-power devices, must be developed to maximize battery life. Compression and database technologies will be required in the future as smart cities and IoT store massive volumes of data. New battery technologies and maybe energy harvesting techniques in these gadgets are necessary for long-term usage.

B. Networking

Sensors and other devices must be able to communicate with each other and the cloud. It will be difficult to connect new smart city apps to existing networking infrastructure. Current networking solutions aren't optimized to deliver network services for smart city components. Many technologies in smart cities require mobility and data throughput to function properly. Various solutions for identifying access points, local networks, etc. have been proposed to overcome this issue. The IoT necessitates efficient and dynamic routing algorithms for both stationary and mobile devices. Many contemporary protocols do not match these standards. [17].

C. Intelligent Data Analytics

From 13.6 Zetta Bytes in 2018 to 79.4 Zetta Bytes in 2025 [15-17], IoT-connected devices will generate data at an exponential rate. New data analytics approaches are necessary to harness this data and improve smart city services. To extract conclusions and discover patterns, these algorithms must be able to interact with a variety of data sources (structured and unstructured). Deep learning has received a lot of attention in this industry since it can use huge amounts of data to improve various applications. Another important issue to consider is the produced algorithms' scalability, or its generality and ability to be applied across the entire application. For example, in [18-21], the authors found that a CNN trained for activity detection on one dataset did not perform well on other datasets, and in [19], [22-23], the deep learning network performed poorly when the tomato color was changed. Another problem is that data quality may alter over time due to continuous collection. Techniques like progressive learning may help here. The capacity to adequately explain the benefits of Smart city analytics is also required, especially in smart health. [24-27] shows a hybrid deep learning classifier and semantic web technologies-based flood monitoring method.

IV. Discussion

To better understand the many properties and traits of IoT systems as well as the compelling reasons for employing them, the most recent literature was examined. Since implementing IoT infrastructures may open up a lot of options, the highest scientific motives are initially mentioned, followed by a list of practical applications. It is shown how utilizing them might develop and improve daily tasks. The difficulties that can emerge when putting the IoT system in place were also fully outlined. One of the most intriguing future trends in this regard is the integration of the IoT platform with other autonomous and intelligent systems to create smart and widespread applications. Furthermore, there is still interest in developing a means of addressing some of the most pressing issues, such as the citizens' right to privacy. The IoT should make use of intelligent systems and sensors with its functionality and capabilities to protect the rights of inhabitants in smart cities. In response to the challenges posed by increasing urbanization, the concept of "smart cities" has arisen as a necessary prerequisite. The recommendations in this chapter demonstrate that cities are confronting these issues head-on to enhance the lives of their citizens and inhabitants. Worldwide, there has been a significant increase in the number of cities attempting to transform themselves into smart cities. There are significant political, economic, and technological challenges to overcome, despite these positive developments. The following obstacles and problems must be taken into consideration before moving forward. Smart city efforts typically entail a significant amount of planning, financial resources, and ongoing assistance. The fact that investments must be lucrative is another element to consider. To be successful in the long run, all smart city initiatives must be able to sustain an ever-increasing amount of resources and infrastructure.

V. Conclusion

The IoT connects physical objects and technology without human intervention. As a result, smarter cities can be constructed globally. The internet of things has enabled smart city systems that promote sustainable living, improved comfort, and enhanced productivity. Smart Cities' Internet of Things includes a wide range of themes and technologies. Smart city projects and programs are now possible all around the world because of the increasing use of IoT. This study looks at the IoTs in smart Cities. This paper has covered different of architectures smart cities, the challenges that faced the applications of the smart city in numerous domains, also, cover the current state of use and deployment of the numerous key components and technologies used in smart city deployments.

References

[1] Sharma, H., Haque, A., & Blaabjerg, F. (2021). Machine learning in wireless sensor networks for smart cities: a survey. Electronics, 10(9), 1012.

[2] Ahvenniemi, H.; Huovila, A.; Pinto-Seppä, I.; Airaksinen, M. What are the differences between sustainable and smart cities? Cities 2017, 60, 234–245.

[3] Cardullo, P.; Kitchin, R. Being a ‘citizen’ in the smart city: Up and down the scaffold of smart citizen participation in Dublin, Ireland. GeoJournal 2019, 84, 1–13.

[4] Wu, S.M.; Chen, T.C.; Wu, Y.J.; Lytras, M. Smart cities in Taiwan: A perspective on big data applications. Sustainability 2018, 10, 106.

[5] Ejaz, W.; Anpalagan, A. Internet of things for smart cities: Overview and key challenges. Internet Things Smart Cities 2019, 1–15.

[6] Janssen, M.; Luthra, S.; Mangla, S.; Rana, N.P.; Dwivedi, Y.K. Challenges for adopting and implementing IoT in smart cities: An integrated MICMAC-ISM approach. Internet Res. 2019, 29, 1589–1616.

[7] Sánchez-Corcuera, R.; Nuñez-Marcos, A.; Sesma-Solance, J.; Bilbao-Jayo, A.; Mulero, R.; Zulaika, U.; Azkune, G.; Almeida, A. Smart cities survey: Technologies, application domains and challenges for the cities of the future. Int. J. Distrib. Sens. Netw. 2019, 15.

[8] Silva, B.N.; Khan, M.; Han, K. Towards sustainable smart cities: A review of trends, architectures, components, and open challenges in smart cities. Sustain. Cities Soc. 2018, 38, 697–713.

[9] Atat, R.; Liu, L.; Wu, J.; Li, G.; Ye, C.; Yang, Y. Big data meet cyber-physical systems: A panoramic survey. IEEE Access 2018, 6, 73603–73636.

[10] Alkhayyat, A., & Habeeb, N. A. (2019, March). A cooperative MAC aware network coding toward improving throughput wireless body area network. In 2019 2nd Scientific Conference of Computer Sciences (SCCS) (pp. 182-187). IEEE

[11] Koubaa, A.; Aldawood, A.; Saeed, B.; Hadid, A.; Ahmed, M.; Saad, A.; Alkhouja, H.; Ammar, A.; Alkanhal, M. Smart palm: An IoT framework for red palm weevil early detection. Agronomy 2020, 10, 987.

[12] Shirazi, E.; Jadid, S. Autonomous Self-healing in Smart Distribution Grids Using Multi Agent Systems. IEEE Trans. Ind. Informatics 2018, 3203, 1–11.

[13] Alkhayyat, A., & Mahmoud, M. S. (2019, August). Hybrid network coding and cooperative communication in WBAN. In 2019 2nd International Conference on Engineering Technology and its Applications (IICETA) (pp. 79-82). IEEE.

[14] Trencher, G.; Karvonen, A. Stretching “smart”: Advancing health and well-being through the smart city agenda. Local Environ. 2019, 24, 610–627.

[15] Huang, Y.; Dang, Z.; Choi, Y.; Andrade, J.; Bar-ilan, A. High-precision smart system on accelerometers and inclinometers for Structural Health Monitoring: Development and applications. In Proceedings of the 2018 12th France-Japan and 10th Europe-Asia Congress on Mechatronics, Tsu, Japan, 10–12 September 2018; pp. 52–57.

[16] Farag, S.G. Application of Smart Structural System for Smart Sustainable Cities. In Proceedings of the 2019 4th MEC International Conference on Big Data and Smart City (ICBDSC), Muscat, Oman, 15–16 January 2019; pp. 1–5.

[17] Abbas, S. T., Mohammed, H. J., Ahmed, J. S., Rashid, A. S., Alhayani, B., & Alkhayyat, A. (2021). The optimization efficient energy cooperative communication image transmission over WSN. Applied Nanoscience, 1-13.

[18] Lele, A. Internet of things (IoT). Smart Innov. Syst. Technol. 2019, 132, 187–195.

[19] Abbas, A. H., Ahmed, A. J., & Rashid, S. A. (2022). A Cross-Layer Approach MAC/NET with Updated-GA (MNUG-CLA)-Based Routing Protocol for VANET Network. World Electric Vehicle Journal, 13(5), 87.

[20] Risteska Stojkoska, B.L.; Trivodaliev, K.V. A review of Internet of Things for smart home: Challenges and solutions. J. Clean. Prod. 2017, 140, 1454–1464.

[21] Saini, A.; Malik, A. Routing in internet of things: A survey. Commun. Comput. Syst. 2017, I, 855–860.

[22] Casilari, E.; Lora-rivera, R.; García-lagos, F. A study on the application of convolutional neural networks to fall detection evaluated with multiple public datasets. Sensors 2020, 20, 1466.

[23] Rahnemoonfar, M.; Sheppard, C. Deep count: Fruit counting based on deep simulated learning. Sensors 2017, 17, 905.

[24] Thakker, D.; Mishra, B.K.; Abdullatif, A.; Mazumdar, S. Explainable Artificial Intelligence for Developing Smart Cities Solutions. Smart Cities 2020, 3, 1353–1382.

[25] Syed, A.S.; Sierra-Sosa, D.; Kumar, A.; Elmaghraby, A. IoT in Smart Cities: A Survey of Technologies, Practices and Challenges. Smart Cities 2021, 4, 429–475. https://doi.org/ 10.3390/smartcities4020024.

[26] AL-Obaidi, A. S., Jubair, M. A., Aziz, I. A., Ahmad, M. R., Mostafa, S. A., Mahdin, H., ... & Hassan, M. H. (2022). Cauchy Density-based Algorithm for VANETs Clustering in 3D Road Environments. IEEE Access.

[27] Najim, A. H., Mansour, H. S., & Abbas, A. H. (2022). Characteristic Analysis of Queue Theory in Wi-Fi Applications Using OPNET 14.5 Modeler. Eastern-European Journal of Enterprise Technologies, 2(9), 116.