International Journal of Advance Research in Science and Engineering
Volume No. 12, Issue No. 03, March 2023
www.ijarse.com
IJARSE
ISSN 2319 - 8354

Review on Application of IoT in Smart Cities of India

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Abstract

The idea of a 'smart city' aims to use digital innovation to improve the lives of citizens and make urban living sustainably by excelling in governance, economy, transport, environment, resources, and people's services, such as healthcare, education, housing, and living. Smart cities stand for an 'ecosystem' concept where every sub-system is linked to each other to make the complete package an attractive summation. IoT has become one of those things that have slowly made its way into almost all aspects of all sectors and made more suited for the changing world. Almost anything can be made better with the wonders of IoT and many times at relatively lower prices. The use of IoT products will be of great advantage to boost the mission of setting up Smart Cities in India.

The paper focuses on the aspects of applying IoT applications for various smart solutions for setting up Smart Cities in India. Some of the domains have been discussed in the paper.

Keywords— *IoT, Smart City, Applications*

I. INTRODUCTION

Smart cities introduce a variety of new services that impact urban policy-making and planning as they co-exist with urban facilities. And there are various ways that the smart city framework can help city planners meet the above-mentioned standards and contribute to urban life. Out of 100 cities, seven have taken a lead with the most projects completed. The mission period will end in June 2023. Bhopal has completed approximately 92% of projects, Surat 82.44%, Udaipur 78%, Bhubaneswar 76%, and Indore, Varanasi & Ahmedabad 70%.

Recently, the Ministry of Housing and Urban Affairs (MoHUA) organized a series of events and conferences to explore ideas, innovations, and partnerships toward the future trajectory of smart urban development in India. The conference focused on five sub-themes namely reimagining public spaces, digital governance, climate-smart cities, innovation, and smart finance and the conference will advertise the learnings from smart cities to other cities and towns in India. The Operation emphatically, conditions that there is no standard definition of a 'smart city' and indicates immeasurable freedom for cities to self-define their thoughtful of 'smart-ness'. It is also an innovative footstep by the Indian Government to construct smart cities in India to permit monetary development and eminence people's life by permitting confined expansion and using smart technologies to make it's resident's life healthier. For this purpose, the government of India first covered five years plan for hundreds of cities in India. After five years the evaluation process takes care of by the MoUD and fascinating theexistence of smart cities criteria and also will apply outside of the cities. This paper presented the challenges of the operation,implementation strategy, and achieving objectives of smart citiesin India.

Due to the Invention of the internet now devices can communicate with each other at a rapid rate. Simultaneously the demand for IoT-enabled devices have beenincreased the main attraction of these devices is that they do not require human interaction at all which makes them suitable to be deployed for smart cities. The framework of IoT consists of sensors actuators, servos, hardware and software, architecture, and protocols, etc. Today in India every city wants to be 'smart', since there is no established definition of the smart city in terms of observation – be it in scientific, developmental, or managerial terms. A Smart City is more than a technically equipped city. Now India is also planning to build more than a hundred smart cities in several parts of India [1]. Since the population of India is raising continuously and at the end of 2020, India's population will overtake china's population. So to cope, with the various challenges such as infrastructure, land, resources, etc. one strategy is the deployment of the smart city [1].

There are many areas of development such aspower generation, security, transportation, water, etc. all theseareas must be covered by smart cities [2]. For gaining the best result IoT and its related technology must be used in a smartcity.

The use of technology in upscaling a city requires connected and intelligent networks that can seamlessly process data. The Internet of Things (IoT) is a "smart" solution that supports these technological developments. IoT use and development have increased over the past few years, and a study by IoT Analytics predicts that there will be about 27 billion linked IoT devices by 2025. India will be the largest economy at the end of 2025 according to the UN reports and with the increased population, India will overtake the china innext five years so according to that proper utilization and distribution of resources such as land, fuel, etc. is a must. Foreffective utilization of resources, we must have some provision and that provision or measure is provided by IoT. IoT by using the state of art method provides solution to such a problem.

I. CHARACTERISTICS OF IOT NETWORKS

In the following, we discuss some unique characteristics of IoT networks.

A. Heterogeneity

The devices in the IoT are heterogeneous and based on different hardware platforms and networks. They can interact with other devices or service platforms through different networks.

Enormous scale positioning: The smart devices connected via the internet have limited storage capacity and the design framework of data communication is very crucial and challenging. This includesdevice protection and vulnerability to attacks, knowledgeable data, etc.

B. Inter-connectivity

With regard to the IoT, anything can be interconnected with the global information and communication infrastructure.

C. Communication in close proximity

IoT devices can communicate without concerning the essential authorities for example root systems. Communication between devices influences P2P communication and analogous technology. the prevalent network is concentrated toward network-centric communication while nowadays the heterogeneity of networks

and services makes easy content and device-centric communication thereby enhancing the devise performance.

D. Reliability

Reliability and rapid communication are a must for IoT devices since in case of disaster, real traffic management, and the medical field this kind of delay is not permissible

Self-organizations

In case of urgent situations such as earthquakes, tsunamis, etc. these IoT devices must perform their work uninterrupted therefore in such cases auto arranged network must be placedfor IoT devices.

E. Safety

Safety is needed while devices transmit data when they communicate with each other. For example in the case of pacemakers which isvery essential for the heart patient can be hacked by hackers which put in danger the life of the person.

F. Intelligence

The main fascinating feature of smart devices is theirdecision-making capabilities the data produced by devices are processed and provide useful information. and this information is needed for taking the action.

G. Things-related services

The IoT is capable of providing thing-related services within the constraints of things, such as privacy protection and semantic consistency between physical things and their associated virtual things. In order to provide thing-related services within the constraints of things, both the technologies in the physical world and the information world will change.

H. Dynamic changes:

The state of devices changes dynamically, e.g., sleeping and waking up, connected and/or disconnected as well as the context of devices including location and speed. Moreover, the number of devices can change dynamically

II. FEATURES OF SMART CITY WITH IOT TECHNOLOGY

Combining automation, machine learning, and the IoT is allowing for the adoption of smart city technologies for a variety of applications. For example, smart parking can help drivers find a parking space and also allow for digital payment

Smart traffic management monitors traffic flows and optimizes traffic lights to reduce congestion, while ride-sharing services can also be managed by smart city infrastructure.

Smart city features can also include energy conservation and environmental efficiencies, such as streetlights that dim when the roads are empty. Such smart grid technologies can improve everything from operations to maintenance and planning to power supplies. In smart cities existing living spaces will be ready to house the increasing human population and also elevate the living standard.

Smart cities will have services available 24x7 for emergency situations and disasters. This makes the city safe and less prone to disaster. By using CCTV cameras, Drone illegal movement will be tracked, and extreme safety measures will be taken to keep women safe.

Smart city initiatives can also be used to combat climate change and air pollution as well as waste management

and sanitation via internet-enabled rubbish collection, bins, and fleet management systems.

Smart cities will be more eco-friendly by reducing garbage and there will be less consumption of naturally available recourses. Smart buildings can also offer real-time space management or structural health monitoring and feedback to determine when repairs are necessary.

In smart cities, people will have access to each service online and these services will provide precision and participation of the public. The creation of an online group will permit people to exchange their thought and obtain a public reaction.

III. KEY APPLICATIONS OF IOT IN SMART CITIES

The Internet of Things has developed one of the most important types of groundwork in smart cities. A primary objective of the Internet of Things in smart cities is to deliver simple and exceptional entrees to public possessions so that better consumption and utilization of Vehicle investigation, water, power, and maintenance of public areas can be attained. The concept of smart cities is being used to upswing clear and achievement been taken by native physiques in respect of civic requirements. There is the Internet of Things-based applications that are present in various smart cities as illustrated in figure 1.

A. Solid Waste Management

Solid-Waste-Management is the largest issue in developing countries It has serious threats in terms of atmospheric harm, health hazards, and economic growth. so to cope with this situation there is a need for proper solid waste management. The author suggested GIS and alternative technologies like RFID, GPS, etc. are useful for solid waste management [4]. The author analyzed the 40 years of data and suggested 08 major classes of solid waste management, which are reducing and set-down animal feeding, recapitulation, nourishing, simmering, landfills, cauterization, and land application [5].

B. Smart transport

The author proposed Smart Parking together with the AI Embedded signboard system. This system worked on solar energy with sensors, and this system illustrates the location, distance to that location, atmosphere condition, temperature, and different paths to those locations [6]. T. M. Bojan et.al proposed IoT based smart transportation system with ingredient sensors, monitor and display different types of sensors likewise Global-Positioning-System (GPS), Near-Field-Communication (NFC), Temperature, and Moistness sensors are used for tracing the position of the moving vehicle monitor system monitors the prevalent conditions and filter the data from the DB, when condition and event meet it gives the specific information to the driver in a meaningful manner[7].

C. Health care

This paper studied various techniques for smart healthcare systems such as U/E-healthcare, Age-friendly healthcare approaches. The author described and proposed a smart healthcare system that is capable of monitoring patient conditions [10].

This paper studied the pros and cons related to wearable devices and their security issues and privacy challenges of the smart healthcare system [11].

D. Smart governance

This paper analyzed e-governance and its related strategy for future direction and it also discussed the architectural plan for smart cities and the methodology of smart governance [12]. In this paper, the author suggested 02 categories of smart government with IoT. Firstly, new era-based, and secondly completely smart government based. The author also studied major challenges and implementation issues, and investment plans discussed with respect to the USA and ASIAN Countries[13].

E. Smart energy

Smart energy built on IOT the author suggested the home automation system. That can be managed and monitored from any place on the earth but the internet plays a vital role in this purpose[14]. This paper discussed, the design protocol of the smart grid system for a smart home built on IoT.

F. Smart water

This paper addressed the smart water management system built on IoT. For this purpose, the author used microcontroller ZR16S08 for optimization of water supply and its losses. This system monitor, control, distribute and provide a quality supply of water [15]. The author developed a smart water management system based on IoT. This system which is based on the sensor can monitor the water level and inform the user via an android app installed on a Smartphone. This system was developed for smart residential colonies [16].

G. Smart agriculture

This paper focuses on the automation of smart agriculture built on IoT technology. The major attraction of the proposed techniques is raising crop production in an efficient manner. The automation system contains sensors for controlling the humidity and temperature factor of crops [16,17]. For this purpose, the author used the CC3200 single chip [16]. The proposed technique is based on sensors using the Arduino board for smart agriculture. Whenever the activity of an animal that is harmful to the crops is caught by the camera then automatically sensors are activated and the message is sent to the farmer via smartphone [17].

H. Smart Security

This paper suggested the IOT-based home surveillance system. The objective of the author is to capture the image of an intruder in front of the door. The suggested system works on motion-based detection and sends the image of an intruder and sends it via SMS and e-mail to the house owner [18]. In this paper, the author developed a home surveillance system using Raspberry pi. The main focus of the author is based on appliances automation, here the security is obtained through

AES encryption. This system sends information to the owner regarding intruder and the alarm get activated automatically, for this purpose sensor is laid down around theperiphery of the house [19].

I. *Smart emergency*

The paper, "IoT-based smart emergency response system for fire hazards,"[19] presents an automatic fire hazards systembuilt on IOT. The proposed system can be achieved by a low-cost Espressifwi-fi module ESP-32, Blaze detection sensor, Fume detection sensor (MQ-5), vivid gas detection sensor, and one GPS .in any discrepancy the sensors are activated and warning the local authorities i.e. police, fire department, and rescue department via sending messages [19]. The author presents state–of–the–art method for fire emergency systemsin industries with IoT-enabled services. In this paper, the current trends of the research and its challenges are given [21].

J. *Smart traffic*

The author developed the immediate response traffic management built on IoT and data analytics. For this purpose, ultrasonic sensors are used for analyzing the traffic data and signal via the algorithm. This system is capable to send the data to the server through the internet. If a rescue vehicle is identified by the system then the route is cleared for this vehicle as on a priority basis [22]. This paper developed a smart traffic management system with IoT. In this paper, the author demonstrates the new approach toward traffic management by filling the gap between the previous prevalent methods. by using an innovative algorithm to tackle traffic density. The developed system captures traffic density as input via a camera and produces the output for traffic management [23].

K. *Smart Logistics*

This paper demonstrates the smart logistics system with IoT, which is used for managing the goods, tracking, and itshandling through the route [24,25].

L. *Cultural Heritage of Smart Regions*

This Paper Presents the Use of IoT in culture conservationand the recovery of smart towns. This Paper Focuses on IoT-based technologies, design, services and It's protocols [25]. The paper presented IoT-enabled smart museum design. Theauthor gave the real scenario study of the museum, situated ina momentary art exhibition of sculptures in the Maschioangioino Bastile, Located in the town of Naples, Italy [25].

M. *Smart Lighting Systems*

The proposed system is based on IoT enabled smart lighting System. The author studied distinct kinds of communication standards which can be useful for smart cities. The author evaluated IoT-enabled smart lighting systems for smart citiesand achieved a 33.33% reduction in power consumption [28].The main objective of the authors is to decrease power consumption, and manpower, provide better visibility at night, security on-road, and disclosure to communal areas with minimum cost [29].

N. *Smart Vehicles*

The paper smart vehicles with everything [30], presentssmart vehicles based on WSN protocol and IoT. In this paper, the author developed a system to avoid possible accidents at a low cost and communicate constantly through cloud during the traveling [30]. Communication via the internet is a must during traveling in a smart vehicle. The author served up to 2015, different types ofrouting protocols and advancement of the IoT-enabled

technology in the smart vehicle. The author also gave design strategy and challenging issues of prevalent technology [31].

O. *Smart Environment*

This paper deals with the environmental condition, monitoring, and controlling for IoT-enabled smart environments using Arduino, Raspberry Pi 3, Zigbee, and AdafruitIO. This system was a low-cost system with less power consumption [32,33].

P. *Smart Animal Farm*

In this paper, the author developed the IOT-based smart animal husbandry system which is constructed of microcontrollers, watermeasuring sensor, ultrasonic-sensor, gas-sensor, temperature, and humidity sensor, and an IP Camera along with an Internet connection with the devices i.e. smartphones or computer/laptop.by using this system, farmers can get the information regarding cattle feed, water level condition, and animal extract through surveillance system[36]. In the Paper "Smart farm computing systems for animal welfare monitoring,"[35] developed a low-cost system for smart animal farming using edge computing. For this purpose, the author used Raspberry Pi as an edge device to surveillance the animals and the farm environment, and we let the edge devices communicate with a local farm owner [35].

Q. *Smart Home*

This paper provides the solution for IoT-enabled smart homes; this smart home can be accessed at any place anywheretime via an internet connection. The different appliances in this smart home can be controlled by a single app [38,39]. The author demonstrates the Frugal-Labs IoT Platform (FLIP) for the construction of IoT-based Smart-Home. The author also described its architecture, functionality, and applications using FLIP. It also discusses monitoring and controlling for the developing smart home structure [37].

IV. CONCLUSION

The Internet of things is not only associated with advanced technology but it is more related to the universal socialscenario as well. The Internet of Things allows greater efficiency for running the cities. Extensive use of the internet permits the Internet of Things to work in an effective and efficient manner. This paper not only covers IoT networks, IoT technology, and its application but also describes its impact on human life. The Internet of Things makes cities smarter and it allows various services to be integrated however for its success.

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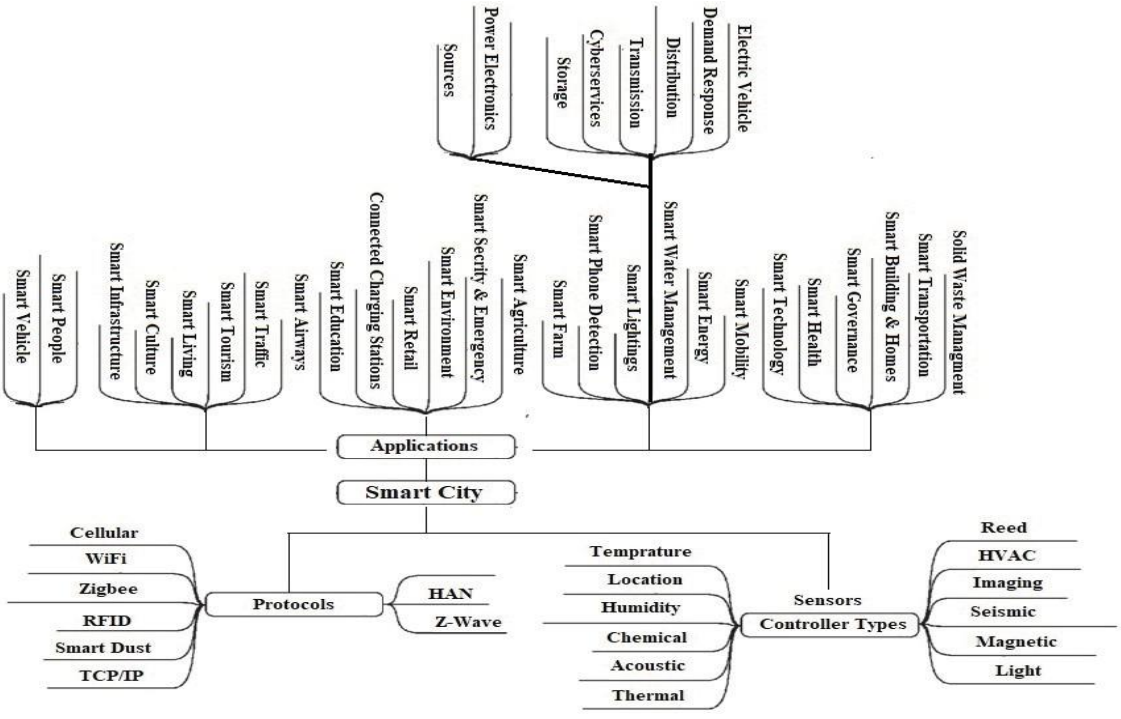

Figure 1: Smart-Cities Scenario in India [2]