IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Impact Factor 7.39 ⁜ Vol. 11, Issue 4, April 2022

DOI: 10.17148/IJARCCE.2022.114105

IoT x ML : Smart Cities

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Abstract: The Internet of Things (IoT) is a typical internet framework with limitless possibilities. Today there is an unparalleled increase of global population. The density population of these metropolitan areas, places a tremendous burdens on the environment, which needs to be Strategically and Smartly controlled, with the ability to control the urban demand by developing new and intelligent experiences to make it more convenient everyday. IoT has unlimited prospects to improve the quality of life through its implementations in diverse devices, households, and even in cities, thanks to Artificial Intelligence (AI) and Machine Learning (ML). In today's world, IoT is implemented in nearly all of the products we use in our daily lives, ranging from a toaster to large electrical appliances such as air purifiers/conditioners, refrigerators, and so on. But this is just the tip of iceberg, as IoT can be used almost everywhere to ensure a more productive, effective, and safer atmosphere for the sustenance of our lives while still making it more convenient. In this short paper, the present and future developments in smart cities and IoT are discussed. We also go over how smart cities and IoT interact, as well as some of the driving forces behind IoT and smart city expansion and development. Finally, we go through some of the IoT's flaws and how they may be solved in the context of smart cities.

Keywords: Internet of Things, Machine Learning, Artificial Intelligence, Smart City, Smart Farming, Automation

I. INTRODUCTION

Smart and creative solutions are critical for enhancing productivity, increasing operational efficiency, and lowering management costs as cities grow and expand. Citizens are progressively installing IoT gadgets in their homes, such as televisions and Internet boxes. Thermostats, smart alarms, smart door locks, and other systems and appliances are examples of linked items in the real estate industry [4]. By developing and using low carbon emission technologies, smart cities projects can accurately deal with ensuring the green environment. Many countries (e.g., the United States, the European Union, Japan, and others) throughout the world have planned and implemented smart city programmes to address the emerging difficulties [5]. In terms of service revenue, smart home safety and security will be the second largest market. In 2020, services connected to health and well-being are expected to be worth $ 38 billion. The trade-offs between efficacy and privacy hazards must be found in a realistic solution. A clever attacker may, for example, take control of lighting, cameras, traffic signals, linked automobiles, and a variety of other intelligent equipment in cities. [6] The term "smart city" has no precise definition. However, it is merely defined in terms of the grouping of diverse resources, technology, and administrative operations for people's well-being and long-term development. The term "smart city" is defined as "Urban Intelligence" or "Intelligence in Urban Life," which helps people to feel safe and comfortable in all aspects of their lives. This definition or meaning of smart city may differ from one area to another, from one person to another, and from one government to another, depending on their plans and resources [3].

II. SMART CITY CHARACTERISTICS

Following are the fundamental characteristics of smart cities :

- Provide basic infrastructure.
- Quality of life.
- Clean & sustainable environment.
- Optimize city functions & promote economic growth.

III. OBJECTIVE

- Study about IoT & machine learning use in Smart cities.
- Study about wireless sensor networks (WSN)

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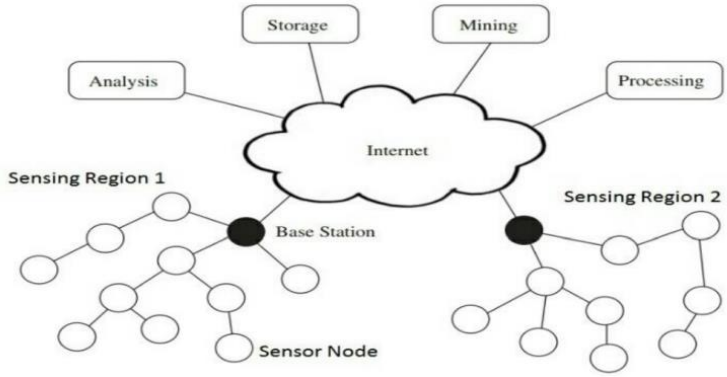
IV. WIRELESS SENSOR NETWORK FOR SMART CITIES

A wireless sensor network (WSN) is a computer network made up of sensor nodes that are connected together to monitor their surroundings. WSNs can be used to secure smart cities by providing remote monitoring and sensing for many critical scenarios, such as hostile environments, battlefields, or areas subject to natural disasters such as earthquakes, volcano eruptions, and floods, or large-scale accidents such as nuclear plant explosions, due to their cost efficiency and rapid deployment.

Large network architectures may be created by the interaction of individual or many sensor nodes that communicate through radio, allowing for comprehensive observation and monitoring of numerous events. All sensor data is sent to the base station, and network control is managed using wireless communication. From and to the control point, the gateway, both data kinds are cascaded or protocol-controlled, then transported across the network and routed to the control unit (query system/server). Wireless sensor networks operate invisibly, which means they provide a platform for the transfer of any measurement data without understanding what it means. Sensing modules for wireless sensor networks are built on a strict modular basis and have a variety of open interfaces for connecting digital and analogue sensors. As a result, a diverse range of sensors may be incorporated and addressed with moderate ease.



V. IOT AND ML AMONGST CITIES

The Internet of Things (IoT) refers to networks of physical items, or "things", that are equipped with sensors, software, and other technologies in order to connect and exchange data with other devices and systems over the internet. The primary goal of IoT deployment in smart cities is to improve sustainability in the face of urbanization issues by assisting with the development of smart transportation networks, smart health care, water management system optimization, smart buildings and public stations, and so on.

The working of IoT can briefly explained by 5 steps, these are-

- Data ingestion : IoT devices collect data from environment &the data is send to the loud for analysation.
- Data transmission: The data is transmitted to the cloud via gateways, the gateways use both cellular & satellite communication to transmit the data. To ensure the data security, protocols such as Bluetooth, SigFox, LoRa, NB-IoT, ZigBee, COAP etc. Are used.

ML Algorithm	Use Cases
Pattern recognition, Semantic reasoning	Smart health, public safety, Smart transportation
Multiagent learning	Convenient smart home, real-time traffic routing
Reinforcement learning	Convenient smart home
HMM	Smart pipeline
Rule-based	Smart healthcare
Semi –supervised deep reinforcement learning	Energy, water, agriculture, transportation, healthcare

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- Data processing: After the data send to the cloud, IoT platform process the data.
- Data visualization: The processed data is sent to the user through email, text, notification etc.
- Data analysis & prediction: To utilize the collected over the time, data analytics makes used of the historical data to provide actionable insight.

VI. SMART CITY PLATFORMS

Smart cities platforms include smart Healthcare, smart transportation system, smart agriculture, smart building, smart industries.

1. Smart Healthcare: -

IoT in healthcare

Remote Patient Monitoring (RPM) is a feature of advanced IoT technologies in the healthcare industry that allows healthcare providers to monitor vital signs and analyse bodily reactions to past treatments without having to be physically present with the patient. Digital Drugs is a new IoT breakthrough in healthcare (or Smart pills). Smart pills are taken like regular tablets, but they also include some form of monitoring technology in addition to the drug. They utilise it to send data to a sensor that is worn on the body. Based on a patient's perceived or diagnosed state, these sensors monitor medication levels in the body [1]. The data from the portable sensors is then sent to a mobile phone app, allowing patients to view information about their critical functions themselves. If the patient agrees, doctors can do so. This is how doctors judge if a medicine is working as it should or whether it is generating negative effects [1].

Machine learning in healthcare

AI algorithms are already being used in medical procedures for diagnostic imaging: these algorithms can be used by medical experts and support experts to make images from radiographs, nuclear medicine procedures, magnetic resonance topographies, or ultrasound of organ systems (brain, lungs, skin, fundus, and so on) even more precise, faster, and easier to analyse. Patients may benefit from AI-based technologies that give them more autonomy. Wearables enable users to create their own health goals, monitor them, and utilise the information to make their daily lives healthier. With direct access to personal information, the individual gets a larger data set from which to assess therapeutic alternatives or potentially make an initial self-diagnosis [1]. In the long run, AI has the potential to effectively analyse vast volumes of data and develop new ones, creating knowledge—for example, in epidemiology, which is the study of disease links and distributions in the population. There are also novel possibilities for early illness identification by studying an organism's genetic make-up (genome), outward appearance (phenotype), proteins (proteome), or microbes (microbiome) [1].

2. Smart Transportation system: -

IoT in transportation

The Internet of Things (IoT) for transportation refers to the networking of items using embedded sensors, actuators, and other devices to collect and send data on real-world activities. The transportation industry is evolving as a result of the adoption of IoT-enabled technologies. Within cities, data may be gathered through CCTV feeds that communicate vehicle-related data to traffic management centres using IoT technology. Applications using IoT technology include :

- Smart parking
- Traffic lights
- Smart accident assistance

ML in transportation

Congestion increases pollution while also causing major economic losses owing to delays and other transportation issues. The advancement of machine learning (ML) and deep learning (DL) has paved the way for the development of intelligent and adaptive traffic control systems that are both generic and flexible.

- Instance-based algorithm k-Nearest Neighbor (k-NN), use to make real-time autonomous accident detection.
- Support Vector Machine (SVM) use to identify road surface abnormalities.

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- A combination of an SVM and a Markov Random Field (MRF) algorithm use to implement a parking space detection system.
- A combination of k-Means and DBN use to optimize the traffic network configuration

3. Smart Agriculture: -

IoT in Smart agriculture

Growers and farmers may minimize waste and increase output by using IoT-based smart farming. IoT smart farming solutions are a system that uses sensors to monitor the agricultural field and automate the irrigation system (light, humidity, temperature, soil moisture, crop health, and so on). Farmers can keep an eye on their fields from anywhere. They can also choose between manual and automated solutions for taking appropriate data-driven actions. If the soil moisture level drops, for example, the farmer can use sensors to initiate irrigation. When compared to traditional farming, smart farming is significantly more efficient.

ML in Smart agriculture

Crop disease diagnosis, insect detection, plant species recognition, crop production prediction, precision fertilization, smart agricultural IoT, food material supply-chain security tracing, crop security, and other critical concerns in smart agriculture are all addressed using machine learning approaches. Crop and yield predictions employing clever machine learning algorithms help crop planners make better judgments. Accurate climatic parameter projections and better historical crop data would result in more accurate crop and yield forecasts in the future.

VII. CONCLUSION

This research provided an overview of smart cities in India, concentrating on their features, policies, status, and difficulties. Making cities smart is critical as they develop at an exponential rate. A basic understanding of AI, machine learning, and RPM approaches has been built. The effectiveness of the aforementioned protocols was investigated in order to develop near-optimal solutions for a variety of applications that are regarded critical to smart city efficiency. IoT may be used in a variety of scenarios, including building monitoring using passive WSNs, environmental monitoring (for example, gas concentrations, water levels in lakes, or soil humidity), waste management, smart parking, lowering CO2 emissions, and autonomous driving. Such objectives need a massive number of interconnected items. We briefly discussed the increasing importance of the aforementioned approaches in health care, including efficient diagnosis, health recovery, the security of health-oriented IoT devices, and their potential involvement in drug discovery. Finally, we discussed recent research issues and prospective research trends related to smart cities, in which previous approaches can play an important role.

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