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Smart City Aided by AIoT

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***Abstract*—With growing development and advancement in the field of technology, smart cities are equipped with several electronic devices like cameras and other sensors. In many places Internet of Things (IoT), is being used to take advantage of available devices but still lacks efficiency. In this paper, we will discuss, how integration of AI and IoT will make smart cities even smarter, the paper also lists some practical applicationsof AIoT in smart city and the challenges that may arise while implementing artificial intelligence and internet of things in smart cities.**

***Index Terms*—Artificial Intelligence (AI), Internet of Things (IoT), Smart City, Big Data Processing, Smart Parking System, Environment Monitoring.**

I. INTRODUCTION

In times of escalating urbanization, local decision makers must be prepared to maintain and increase the quality of life of a growing urban population. For instance, there are major challenges related to minimizing pollution, managing traffic as well as making efficient use of scarce energy resources. To adduce, according to a report by Times of India, the traffic congestion cost 1.47 lakhs crore rupees per year in four major Indian cities, it also accounts for wastage of time and natural resources. Moreover, non-availability of the parking space only makes problems worse. In addition to challenges related to the efficient use of natural and manmade resources ensuring the health and safety of urban citizens, e.g., in the context of large events or supporting law enforcement are key concerns of a modern smart city. With the advent of deployed sensor systems such as mobile phone networks, camera networks, sensors to find weather and citizens themselves create a constant stream of data in and about cities by using their smartphones, by using apps like Twitter, Facebook and Google Maps [5]. Sufficient amount of data is available with urban planners and witharrival of Internet of Things and with it, the extension ofthe internet to virtually every artifact of daily life by the use of identification and sensing technologies, provides all the necessary tools for implementation of AIoT in smart city. AIoT can have vast application when all its components are functioning properly, with IoT providing all the data and AI using that data for mining knowledge. The information can be used by policy makers to take correct decision and increase quality of life. Some application could be managing traffic, keeping a check on environment, managing natural resources and providing smart energy solution for ever growing demand. The paper provides an insight to some applications. Despite all the necessary conditions for a Smart City are met, thereis still a lack of an analytical framework that pulls all these components together such that services for urban decision makers can easily be developed [1]. The biggest challenge could be handling big data, this includes making reliable,efficient and secure system that can ensure data privacy for every citizen of the city.

II. LITERATURE SURVEY

A. Analysis of Artificial Intelligence of Things

AIoT gives better human machine communication with organized data. IoT systems are integrated with AI using chipsets. AI is a tool that uses the data gathered from IoT to make decisions by learning from the present information [4]. AI in IoT helps scalability as it will filter the data fromone device to the other as and when required connecting multiple devices smoothly. AIoT adds a layer of alertness and surety as it can systematically determine where a hardwarewill need maintenance in the future, or it can foresee dangers. It also will help reduce cost for large data handling companies.Smart Cities have AIoT altering traffic lights during ambulanceemergencies and it also can understand accidents, wrong parking etc.

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B. The Relation of Artificial Intelligence with Internet of Things

IoT is a network of multiple devices including cars, watches, mobiles etc. IoT collects large chunks of data that is analyzed using AI techniques. AI algorithms used in IoT are Depth-First, Breadth-First, Depth-Limited, Genetic, directional etc. and also edge processing [9]. Challenges in AIoT: - Security of data, Compatibility and Complexity, AI stupidity etc. AIoT sensors are used in oil fields, home appliances and smart home devices

C. IoT in smart city

The Internet of Things (IoT) with its new applications are enabling Smart City. It provides the ability to remotely monitor, manage and control devices, and to create new insights and actionable information from massive streams of real-time data. The main features of a smart city include a high degree of information technology integration and a comprehensive application of information resources. The essential components of urban development for a smart city should include smart technology, smart industry, smart services, smart management and smart life. The Internet of Things is about installing sensors (RFID, IR, GPS, laser scanners, etc.) for everything, and connecting them to the internet through specific protocols for information exchange and communications, in order to achieve intelligent recognition, location, tracking, monitoring and management. With the technical support from IoT, smart city needs to have three features of being instrumented, interconnected and intelligent. Only then a Smart City can be formed by integrating all these intelligent features at its advanced stage of IOT development. The explosive growth of Smart City and Internet of Things applications creates many scientific and engineering challenges that call for ingenious research efforts from both academia and industry, especially for the development of efficient, scalable, and reliable Smart City based on IoT. New protocols, architectures, and services are important to respond for these challenges. The goal ofthe special issue is to bring together scholars, professors, researchers, engineers and administrators resorting to the state-of-the-art technologies and ideas to significantly improve the field of Smart City based on IoT.

Fig. 1. The images shows use of IoT in a smart city

D. Artificial Intelligence Enabled IoT: Traffic Congestion Reduction

The world has now entered in a new era of Computing, blessed with many prominent technologies including Artificial Intelligence (AI) and Internet of Things (IoT). In an IoT world, sensor enabled objects (things) are connected together via the Internet to participate in performing a particular task mainly by sending and receiving data from one to other. Artificial intelligence empowers agents (machines or devices) to perceive the surrounding environments leading to take calculative decisions, followed by performing efficient actions in order to maximizing the chances of successfully accomplishing a desired task or goal. In this research, we combine both IoT and AI to reduce traffic congestions in a smart city environment[3]. A detailed literature review has been conducted and a simple solution based on AI Algorithm has been proposed. Future directions of the research have also been identified and advocated. The Relation of Artificial Intelligence with Internet of Things.

E. AIoT-Based Smart Bin for Real-Time Monitoring and Management of Solid Waste

In the current time, the immense growth in population creates unhygienic environment for the citizen of a society with respect to waste generation. +is rapid generation of waste leads

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to various infectious diseases in the environment. As followed by the traditional municipal system, in our surroundings, we can see over flooding of solid waste in the garbage bins. Solid waste management is a pivotal aspect in traditional systems and it is becoming dangerous in most populated areas[7]. Arduous labor works and costs are required to manage and monitor garbage bins in real time. To maintain the cleanliness of a city and for real-time monitoring of trash bins, a smart bin mechanism (SBM) for smart cities is proposed in this paper, which is based on Artificial Intelligent of things (AIoT). Thee SBM works on the 3R concept, that is, Reduce, Recycle, and Reuse. The SBM has the access to get real-time information about each bin and avoid overloading of these bins.

F. Artificial intelligence in Internet of things

The true smartness of an IoT service is determined by the level of processing or acting that it can perform. A non-smart IoT system will have limited capability and will be unable to evolve with the data. Voice Assistance is a daily used example of AIoT as it reads the voice, processes it, analyses the request and then performs the required task. AIoT is robotics can be seen in Pepper, robot used by Softbank that can understand human expression like joy, sadness, anger and surprise. It is used to interact with customers and attend to them. Home appliances like smart ovens have cameras that can understand if the food is cooked and controls its temperate regulation accordingly[2]. Smart Security cameras alert the home owner on their smart phones when someone is at the front door and the home owner can access the speakers in the security system even from a remote location (SkyBell).

III. PROPOSED METHODOLOGY

Research gap and Problem statement AIoT in smart city can be beneficial with good use of appropriate algorithms and infrastructure, but there has not been much work done in proposed field. It is known that AI algorithms can be used to with IoT and its application can be huge and can change the way we live our life. In this paper, we will provide solution to problems faced in smart city such as traffic management and environment monitoring using AIoT.

Fig. 2. Graphical Representation of applications of AIoT in smart city

A. Smart Transportation

The transportation system in large cities has a huge impact on daily life of the citizens. Due to economical and physical constraints, in many cases it is no longer possible to improve transportation by improving the infrastructure. Instead, weneed to make the transportation network more efficient using advanced planning and control tools with the integration of smart sensing and communication infrastructure. The first step towards making a transportation system more efficient, environmentally friendly, comfortable, and safe is to estimate its state at any given moment and predict its trends and future behavior. Accurate estimation and prediction from a large number of sensors enables proactive traffic management,which has the potential to increase efficiency and reduce congestion substantially. The sensor data play a crucial role inmanaging the transport system, thus a sensing infrastructure that enables robust, timely and secure communication andprocessing of this data while maintaining privacy of users in the system is of major importance [4]. For state estimationand prediction of the transport network, sensors are deployed and typically combined with models that can predict the trafficevolution in space and time. Sensors can be fixed or placedon vehicles traversing the city. Fixed sensors, such as radars, Bluetooth detectors and license plate cameras can be used to measure speed, flow and travel times. With use of fast R-CNN object detection algorithm which is best suited for the task because training is single-stage, using a multi-task loss, training can update all network layer and no disk storage is required for feature caching.

B. Environmental Monitoring

There is a plethora of studies and reports regarding the negative health effects of living in urban environments due to pollution. One report shows that more than 90 /begin of

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people living in cities breathe dangerous air. A study from MIT [3] shows a very disturbing result that the air pollution could be blamed for more than 200.000 early deaths each yearin the US, while another report shows that more than 1 billion people are exposed to outdoor air pollution annually. Weather:for getting real-time or average data for the weather conditionsin the city areas the following measurements are gathered:
(i) temperature, (ii) humidity, (iii) barometric pressure, (iv)

Fig. 3. Various components of smart transportation are illustrated in the figure.

rain levels, (v) wind speed, and (vi) wind direction. Air pollution: for getting average values (over a time period) for parameters that indicate pollution of the air quality within cities. These parameters are: (i)Carbon dioxide (CO2), which is emitted by vehicles, factories and electricity generation. High concentrations of CO2 in the atmosphere can cause headaches, dizziness, confusion and loss of consciousness and should be monitored especially for warning the elderly and the vulnerable groups of people. (ii)Carbon monoxide (CO), which is a gas emitted by vehicle exhaustions and is formed when carbon fuels are not burned completely. CO can be toxic in high concentrations. (iii)Nitrogen dioxide (NO2), which is emitted from motor vehicle exhaustions, can irritate lungs and have devastating effects of respiratory illnesses to children when they are exposed to high concentrations of NO2. Noise measurements: for getting average values of sound levels in streets to ensure that no excessive noise that could damage the citizens' health is encountered. On collection of data from all the sensors AI will give authorities the notification of the problem like, when there are predictions of low rainfall then it can start water-management cycle, when pollution level start to rise then it can notify nearby factories to check their emission and when noise levels exceed health thresholds an alarm will be raised and forwarded to the relative authorities to act for resolving the issue.

C. Smart power Management

Population is increasing with alarming rate and so are energy need of our society. As electricity requirement areincreasing and to cope up with it the production of electricity needs to be increased, but burning fossil fuel is not an option. We need to use renewable energy sources; due to technologicallimitations we cannot solely use renewable energy sources.A hybrid system must be deployed in smart cities to solve problem. During day time household do not require muchenergy so their power output can be decreased and that power can be channelized to commercial areas so that power loss during transmission can be reduced, AIoT can be used for this purpose as the system can learn where the more people are andthereby distributing energy. Solar and wind are an important source of electricity. When sunlight is plenty AIoT can use batteries to store electricity from solar panel and smartly store wind energy at night. AI can calculate energy that can be produced with renewable energy sources and then can direct power plants to meet the rest of requirement.

D. Problems arising due to system

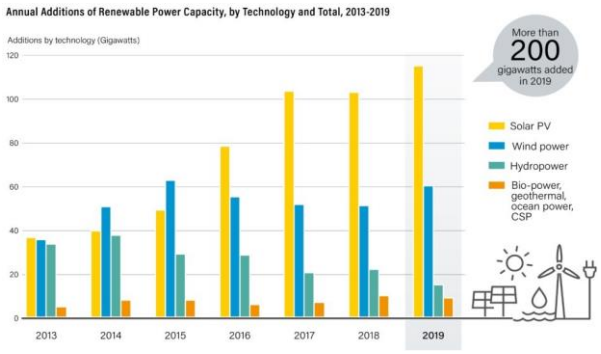

Fig. 4. An example of localization using distance measurements of various landmarks

Reliability, scalability and security are three main challenges that can be faced by the AIoT in smart city. Assigning multiple AI in a hierarchical pattern can solve reliability issue or designing specific AI for different propose can also be a solution. Using hierarchical pattern can help in scaling the system. Now more advance security solution is being used which uses an AI to secure the system.

IV. CONCLUSION

Increasing urbanization has presented our society with many problems and finding the smart solution is the need of hour. Technological advancement and sophisticated method are now available making use of these resources optimally is important.

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Internet of Things has many components and collection of data using all those components is done in many cities around the world but making appropriate decision with that data is something that is required and this can be achieved with the help of artificial intelligence. AI can handle big data efficiently and mine for meaningful information. There are vast applications of AIoT in smart city such as: healthcare, traffic management, natural resource management and waste management. The paper provides an insight to how these applications can be made possible with use of AIoT in smart city. The paper also addresses the issues that AIoT can face such as: reliability, scalability and privacy, a feasible solution can be "divide and conquer" approach which can be used by AI.

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