International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 09 Issue: 07 | July 2022 www.irjet.net p-ISSN: 2395-0072

ROLE OF AI IN SMART CITIES

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Abstract - *Artificial intelligence is often regarded as the fourth industrial revolution owing to its unparalleled capability to change each and everything. Recent advances in artificial intelligence, including autonomous vehicles, robots, and city brains, have pushed the smart city toward becoming an autonomous city that collectively, is mostly unknown within this emerging strand of smart urbanism. Artificially intelligent entities are taking over the management of urban services and urban governance from humans and operating the city autonomously. Social scientists and engineers, as well as those who seek to integrate technology into their daily lives, have been fascinated by smart cities in recent years. A recent rise in smart cities urban locations that are leveraging community technologies and policies to advance productivity, innovation, sustainability, accessibility, good governance, and good planning has increased demand for AI-powered innovation. This paper sheds light on how artificial intelligence can contribute to the development of smarter cities.*

Key Words: **Artificial Intelligence, Smart cities, Smart urban technology, Urban planning.**

1. INTRODUCTION

Artificial Intelligence is a field of computer science dedicated for the creation of intelligent agents that are capable of performing tasks without human intervention. Today, AI is automating our modern world in every space, and naturally it is also potential use case in urban planning and also in urban design, which accelerates the development process of smart cities. Smart city solutions are based fundamentally on optimizing costs, enhancing living standards, preserving resources, integrating technology, and enabling faster transactions across a wide range of fields. The main aim of *urban planning* has been to improve the quality of lives of people by increasing the economic working of cities and by improving aspects like social equity [1]. The idea includes every aspect of technology in revolutionizing a complicated /complex infrastructure into a connected digital one that is advanced and easier to live. In this regard, artificial intelligence is developing and maintaining *smart cities* that not only improves the lifestyle of citizens but also strengthen society [1]. Over 30% of smart city applications are expected to include AI capabilities by 2025, including urban mobility solutions that contribute significantly to sustainability, vitality of urban life, social welfare and resilience.

2. ARTIFICIAL INTELLIGENCE FOR SMART CITIES

Smart cities are no longer the stuff of futuristic science fiction - they're a reality we can now see in our everyday lives.

2.1 FUTURE PROOF INFRASTRUCTURE

The devices are connected to vehicles in a city, like transit buses, garbage trucks etc. The perception devices mounted on vehicles utilize localization technology that has precision in order to detect and also map the objects like lane lines, signal pole, street signs, the fire hydrants and also trees. Data from this source is used to build a 3D virtual model of the city or digital twin of the city. By using AI to recognize objects using Images from satellites, in conjunction with ML for planning the paths, you can optimize planning of the infrastructure in the given space and align the work with labor and materials.

Fig 1. Future Proof Infrastructure

2.2 SMART GRIDS

Electricity control, distribution, and production are integral parts of a Smart Grid for the Smart Cities. Smart Grids will be improved with essential re-engineering of smart meters, electrical services, and appliances.

AI applications can assist in understanding energy grids and facilitating the optimal control of these grids. A major role for applied artificial intelligence in smart grids is to integrate the infrastructure systems which were isolated previously in terms of planning and operation, and to cover the gaps of inadequate monitoring and to effectively manage energy grids at the local levels. Smart grids that are enabled with AI can predict the generation of renewable energy from sources like sun and wind, and other decarbonized sources like

geothermal, aqua-thermal energy etc. as well to improve utilization capacity of the grid [3].

Incorporating micro grids helps reduce emissions by integrating renewable energy, reduces transmission line losses, reduces costs associated with long-distance transmission lines, and increases resilience of strategic loads against extreme weather and other incidents, all of which improve customer reliability [3].

The increasingly widespread use of smart meters at residences and other community buildings in the electricity grid, and increasingly powerful computing capabilities in the cloud, have also made AI more accessible. By utilizing new computing infrastructures and new data sets, AI implementations can develop and train AI models inside micro grids, while deploying them.

2.3 INNOVATIVE SMART SERVICES

The technology that supports and transforms conventional networks and services is what makes smart cities smart. Urban lighting and waste management are examples of smart services that could be improved with AI in this section. Several cities have considered smart urban lighting as the means to begin the smart city evolution. With the advent of enhanced and structured public lighting using Wireless monitoring and control using remotes, lampposts can be well suited for equipping with Internet of Things(IOT) devices that can gather, and analyze data on traffic and pedestrian flows locally, environmental factors like quality of air [1], temperature, humidity, and sound data for detection of weapons , noise pollution, etc.

Fig 2. Smart Urban Lighting

Smart waste management, a service that involves the collection of waste and its processing, is the second feature of a smart city. By implementing waste containers with sensors which would measure rate of filling and operational irregularities, gains in efficiency can be identified. To predict the patterns of how, when, and where waste is discarded, AI can be applied which opens up the possibilities for urban policy to stimulate more efficient waste production and discarding methods. Efficiency gains could be further increased when AI enabled vehicles (autonomous vehicles) are utilized for waste collection and it can be utilized to create sustainable urban waste processing [4]. Processing the waste by automated systems and recovering the recyclable things from waste is one of the most serious sector in development of the Smart Cities. Feasible programs could be made using Artificial Intelligence technologies which would help in formation of smart, self-thinking intelligent robots.

2.4 URBAN FARMING

A strong society would benefit from local, sustainable and dependable supply of food in addition to a reliable energy supply [2]. Urban communities are involved in activities like urban farming and vertical farming. These local farming and agriculture systems are unfathomably complex like the local energy system and sometimes be time intensive and also labor intensive in commercial spaces and their sub-spaces which are connected. To maximize urban farming's yield in a sustainable manner, e.g. by being efficient in usage of water and energy, and to keep citizens as hassle-free as possible, AI can play a major role. As leading examples, An AI-driven, robotics-controlled vertical farm has been developed by a California-based start-up, resulting in a 98.5% reduction in land-usage and 94.8% in water usage.

Fig 3. Urban Farming

2.5 URBAN MOBILITY

With the implementation of smart solutions, artificial intelligence has a huge role to play in maximizing transportation capacity. A coordinated device control framework could be provided by it, the dashboard would display all active traffic system-wide, providing a general overview of the network, drilling down to specific segments or intersections of a roadway could be accomplished using this information [4]. It would be very beneficial for identifying and resolving problems on the spot by using such an approach.

Fig 4. Urban Mobility

Intelligent solutions for mobility are also acknowledged as vital to further reduce carbon dioxide emission in the transportation sector and achieve the demanding EU emission reduction targets. One of the major dominant potential tool that possess the potential to drive a transition that is more sustainable and resource-efficient, livable and also human-centric mobility systems is AI, mainly in Densely populated urban areas . Urban infrastructures like Traffic controller detection, public transports produce huge amount of data which can be used by AI algorithms applied on urban mobility and also use third party data.

Vehicle data transmissions between smart vehicles and also from the smart vehicles to the central traffic management system, will make the traffic flow as an intelligent and also as a unified whole that would maintain ideal speeds and sets the vehicle distances. This leads to reduction in Number of Accidents and pollution decreases due to the increasing Throughput and fuel efficiency.

2.6 MOBILITY AS A SERVICE (MaaS)

Whenever you are travelling inside the city by using your own vehicle, carpooling or using public transportation you need proper planning and effort. Smart cities linked with connected intelligent transportation system and with open data platform infrastructure are reducing the effort and planning work and changing transportation from a tedious task into a service.

As cities develop, the number of intelligent, autonomous and connected vehicles increases, every transportation option would be transformed into a seamless, multimodal trip with the help of Mobility as a service (MaaS) application. Commuters would have a smoother travelling experience and saves time as the system efficiently optimizes the flow of traffic, energy efficiency and the vehicle movement inside the city.

AI based Smart parking management improves the car parking accessibility and allows free movement in spaces. Also this application has a very positive impact on ecology as it allows to check the parking space availability at the trip destination before travelling, which helps to avoid wastage of time and energy in search of parking space.

3. DEPLOYMENT CHALLENGES

It is evident that even the most positive of changes, such as smart cities and urban mobility, involves cost. When a change is implemented, it isn't typically distributed equally and fairly between those who benefit from it, thus resulting in contradictory interests that must be managed properly to attain the intended benefit for all. Smart urban solutions introduced by AI affect several pre-existing value chains in addition to the final level users. As far as tech challenges go, AI-based smart cities applications and urban mobility – both of them suffer from lacking computing power, knowledge, trust, biased data collection algorithms, and security concerns, especially at the local level. Involvement of citizens in local initiatives leads to a greater risk of errors due to a lack of skills or inaccurate information [3]. Oftentimes the algorithms that developers develop, the data that's collected , and the hardware and software they use are proprietary, which makes governance and transparency for the concerned governments and councils of smart city is challenging due to the lack of information about the third party. To assess the trustworthiness of locally or externally developed AI accurately, local governments must have digitalization and AI-related expertise.

There are several challenges cities face when implementing and scaling AI applications:

- Managing ethical challenges related to conflicts in the interests and the bias in decision-making along with economic pressure, inequity, privacy and ownership of data, as well as trust and transparency when utilizing AI for citizens, centralizing the public values would also require local governments support [3].

- In an increasingly automated world, it can be tough for local governments to maintain control over AI and IoT systems. A lack of computing chips, for example, can interfere with further rollouts and continuity of smart city systems.

- As AI applications become more prevalent in cities, their computing requirements would rise to a level that high-performance computing becomes indispensable [3]. Alternatively, edge AI reduces the need for supercomputers by removing computation from an asset level, while increasing the importance of IoT infrastructure.

- Another class of challenges pertains to the formation of a proper regulatory framework on top

of emerging technologies and related fields of application.

4. CONCLUSION

Unlike a static concept, smart cities are dynamic and evolve as they strive to foster a sustainable environment. With the introduction of modern technologies such as Machine Learning, Artificial Intelligence, and the Internet of Things, the world is moving increasingly towards total digitization. Several multinational IT companies and artificial intelligence firms provide smart city solutions. In this paper, we have discussed the role of AI technologies in smart cities. There is however a need for more research from the integrated socio-technical approach to analyze the various social challenges arising alongside the promotion of these technologies and practices in city contexts.

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