

A SURVEY ON SMART CITY APPLICATIONS USING AI

Abstract

The world's population residing in cities is expected to rise to 80% by 2050, from 55% in 2022(World Economic Forum). According to (United Nations World Population Prospects 2022) world's population is projected to reach 8 billion on 15 November 2022 and latest projections suggest that the population could grow to 8.5 billion by 2030, 9.5 billion in 2050 and 10.4 billion in 2100. Cities are going to be overcrowded, to tackle this problem and make them more comfortable and to adjust the projected population in the city and giving them a better lifestyle requires proper planning for infrastructure and its implementation. Modern problems like traffic congestion, sewage problems, noise pollution and many more. To overcome these modern problems, we can use modern technologies such as enabling Artificial Intelligence (AI), Machine learning (ML) and Internet of Things (IOT) to bring smart solutions. Smart cities are the solution to all these problems. Smart transportation, education, healthcare, and energy sectors in the smart cities have more significant influence

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I. INTRODUCTION

A City is defined as a large human settlement where the majority of the population residing in that area are basically not indulged in agriculture as their main occupation [1]. City is a permanent and heavily populated region with modern amenities like airports, roads, bridges, multiplexes, malls, trains, metro, public transportation, public parks, water supply and electricity. The world's population residing in cities is expected to rise to 80% by 2050, from 55% in 2022(World Economic Forum). The rate at which urbanization is taking place will surely influence the environment, management, healthcare, education, energy and security. In order to prevent overcrowding and high pressure on the existing infrastructure, we need to build new infrastructure/add existing infrastructure with the modern technologies such as Artificial Intelligence (AI), Machine Learning (ML) and Internet of Things (IOT). The modern technologies can be implemented in each and every sector like healthcare, education, transportation, security and energy. Various technologies used in modern smart cities help in achieving long-term socio-economic goals and prospects. Scientometric analysis shows that AI has been used in smart cities [2]. Furthermore, it has been used by underdeveloped countries to achieve United Nations Sustainable Development Goals [3]. AI will surely help in giving modern solutions to overcome the problems. AI will cater the purpose to reduce road congestion, more adequate water, reducing noise and pollution. By 2025, AI will allow over 30% of smart city applications including transportation solutions considerably adding sustainability, social welfare, resilience and vitality to urban life [4].

II. LITRATURE

1. Emerging smart cities: Smart city is basically defined as a modern urban area that uses information and communication technologies (ICT) to increase operational efficiency, share information with the public [5]. Smart literally implies nothing in ICT but due to its popularity Smart word is used as a synonym for everything nearly intelligent. Basically, people's definition for the word smart is something which performs its function just on a few commands by an individual [6]. Smart cities help its citizens to do things quickly and more efficiently, it helps to reduce time and makes it easier and faster for ordinary citizens. In transportation, an intelligent monitoring (IMS) system built through sensors can monitor vehicles and can generate penalties on vehicles for violating rules, can calculate traffic volume and regulate traffic signal durations to clear traffic jams. In security IMS is used in intelligent alarm devices which are placed at corresponding positions of the streets, if anyone feels threatened then they can go to the nearest alarm. This system is also used in cabs and other public transports. Coming to architectural aspects, we can use AI for face recognition and voice recognition and to collect data in smart buildings. The comfort level of buildings is improved by combining architecture with 5G and 3D modelling to form an intelligent building. In healthcare it is used in diagnosing and storing data of the patient and keeping track of the patient's previous encounter with diseases so as to make it convenient for doctors to diagnose better and treat the patient. Governments can keep track of the citizens who have paid tax or not and it helps in smoother administration and governance. Smart garbage trucks which can pick the garbage without the help of humans and segregate the waste in dry, wet and plastic, thereby reducing a lot of man-work.

2. Artificial Intelligence (AI): “The science and engineering of making intelligent machines” [7]. Artificial intelligence [8] was coined by a computer scientist named John McCarthy in 1979. Artificial intelligence (AI) basically is defined as the capability of machines/systems to mimic human intelligence to perform tasks and iteratively improve themselves based on data collected. Total of 37% of organizations have implemented AI in some form and the percentage of Enterprises implementing AI has grown to 270% in the past four years (As per Garton). It is roughly estimated that by 2025 customer interactions will be powered by AI (Servion’s Global Solutions). Recently, it has been estimated that the market value of AI will expand at a compound annual growth rate (CAGR) of 39.4% reaching USD 422.37 Billion by 2028, currently the AI market is valued at USD 59.67 Billion (2022). North America had a share of 41% in the global AI market during 2021. Markets of AI in Asia–pacific are expected to grow at a higher CAGR in the projected period of 2022 to 2028, the use of AI services in healthcare, manufacturing, and automotive sectors by nations like Japan, China, and Australia will fuel this expansion. Smart city initiatives are proposed in many countries. The Smart cities are majorly backed by AI based

Smart applications to help in user friendly interaction and ease the process. China owns the largest number of smart cities in the world, approximately 800 smart cities, which is more than half of smart cities worldwide [9]. China manages its smart cities and public space by using metering devices, embedded sensors, cameras, other monitoring technologies, data mining, processing and AI based techniques. AI technologies implemented in smart cities will improve the quality of life and efficiency.

III. ADOPTION OF ARTIFICIAL INTELLIGENCE IN SMART CITIES

To Achieve sustainable development goals [10] as well as new urban agenda smart city should blend with AI assuring incorporation of essential aspects such as culture metabolism and governance use of block chain in smart city will signify significantly improved the urban administration when combined with AI, ml, IoT collecting of data and storing [11] using device setup devices and sensors is necessary for better analysis in urban administration a will be used to conduct advance investigations on the data collected with the advancement of AI government are able to predict the air quality and also help to monitor environmental hazards [12]. An overview of adoption of artificial intelligence in smart cities is shown in Figure 1.

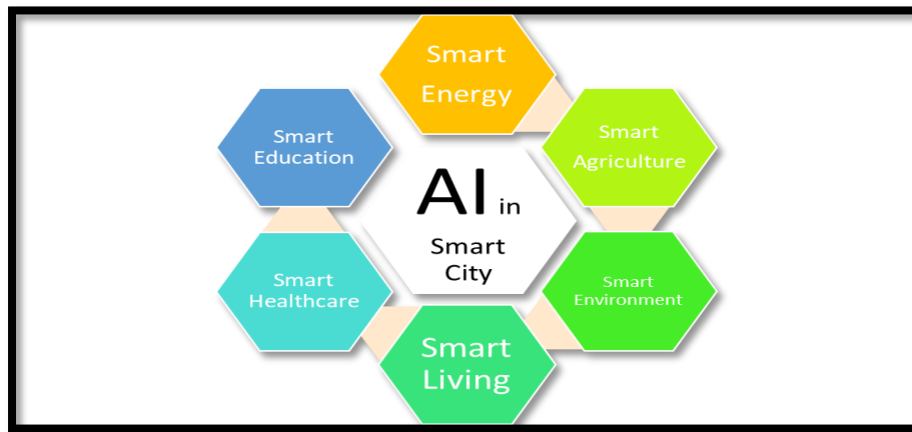


Figure 1: Adoption of AI in Smart City

- 1. AI in smart energy:** The use of electronic gadgets and other smart appliances by almost everyone has increased the demand for energy requirements. Energy has become crucial for the world in this era, energy is so important for development and progress as most of the gadgets used are powered by energy. The shifting of hydrocarbons-based fuel vehicles to electric vehicles has increased at a very rapid rate. To cater the energy needs for the ever-increasing population in cities, we need to develop smart energy models by inclusion of AI into traditional energy. Accurate electric load predicting helps in development of fully automated smart energy grids [13]. The assessing of uncertainty in short term electrical demand estimates is done using DL and gradient tree boosting approaches. Algorithms like ANN, SVM, Decision tree and other statistical algorithms are used to train energy consumption prediction models as its AI-Based energy forecasting are very crucial as they help in forecasting the energy requirements in a smart city [14].

- 2. AI in smart agriculture:** As the world's population continues to grow, the amount of food produced each year has also increased significantly, Agriculture is one of the most important sectors in our society and economy. It produces food, fibers and chemicals that are essential for our survival. The traditional farming practices that have been used for centuries are no longer able to meet the increasing population's needs for high-quality food and economic growth. As a result, the use of modern technologies such as artificial intelligence (AI) has become essential for the advancement of agriculture. The purpose of this essay is to discuss the importance of AI in agriculture and how it can be used to develop smarter farming methods. The application of AI to agricultural challenges will lead to more efficient production methods and improved food security around the world. Researchers have already developed a wide range of innovative algorithms that can improve the performance of modern farm machinery. For example, machine learning algorithms can be used to control vehicle speed and automate the harvesting process. The use of AI in agriculture has the potential to solve a number of important problems faced by farmers today. Intelligent machines can monitor crop growth patterns and measure soil conditions in real time. These data-driven insights can then be used to make better-informed decisions about agricultural development. A shortage of water is one of the most common problems in agricultural regions around the world. In response, researchers have used data analytics and machine learning to predict rainfall patterns and optimize irrigation strategies. Similarly, digital sensors are becoming increasingly popular on farms across the world. These devices can track plant growth and development and create in-depth analytics that can be used to improve crop yields. AI can also be used to monitor livestock conditions and make recommendations about breeding stock. This is particularly beneficial in developing countries where it can be hard to obtain reliable information about the animal's health. Overall, AI represents a new and exciting approach to sustainable agriculture that can help address many of the challenges facing the industry today.
- 3. AI in smart healthcare:** With the rapid development of artificial intelligence (AI), it is no surprise that smart healthcare is one sector where AI can be applied in many ways. AI has the potential to improve diagnosis, treatment planning and even patient care. For example, by applying machine learning algorithms to a patient's data, healthcare providers can better identify which patients are at risk of developing certain diseases and monitor patients' progress during treatment.

In addition, AI can be used to automate administrative and clinical processes, such as medication reconciliation and scheduling appointments. This can reduce errors in care and ensure that health care providers spend more time providing medical care to patients. How can AI be applied to smart healthcare? There are several ways that AI can be incorporated in a smart healthcare system. It can be used to automate administrative tasks, such as patient registration or appointment scheduling. It can also help with data analysis and enable doctors to make more accurate diagnoses and make better treatment decisions [18]. Another way in which AI can be used is to augment human intelligence. A doctor could review a large amount of patient data, examine it manually and compare it with other relevant data, and then use AI to highlight potential correlations that could be overlooked at first glance. AI can also help with disease management and prevention. By analysing a patient's medical data and historical records, AI tools can predict when the patient is likely to develop a disease and alert the doctor in advance so that they can be prepared to treat the patient accordingly. In recent years, AI technology has become more advanced and less expensive, making it more attractive for the healthcare industry. The CSO LSTM model was used to detect illness. Healthcare data was used to assess the performance of the CSO-LSTM model. The CSO-LSTM model was tested to detect heart disease and diabetes, achieving accuracies of 96.16% and 97.26%, respectively. The authors of [33], have devised a comprehensive ML technique to read shapes of segmented cells using KNN and SVM and then compares with unknown cervix cell samples through training and testing, an accuracy rate of 86% for SVM and 70% for GLCM was achieved.

- 4. AI for security:** As the population of the smart city grows and more devices are connected to one another through a networked infrastructure, security concerns may become more prevalent. In order to protect the citizens of a smart city, AI-based systems may be used to predict or detect crime, violence, and other security incidents. For example, researchers at the Department of Computer Science at the University of Malta have presented an AI-based safety precaution procedure for the early detection of hazards, disasters, and environmental causes. In their paper, titled "Automated disaster risk assessment by learning semantic similarity", they describe a system based on deep learning that can "automatically generate alerts" when potential hazards are identified in sensor data in real time. Using data from sensors that monitor environmental changes within a building, the AI system is able to learn the patterns that could indicate a fire or other hazardous condition and then predict when the conditions might become dangerous. Based on its findings, the system can then warn the occupants of the building so that they can evacuate if necessary. The researchers hope their system will eventually be able to identify different types of hazard more quickly and accurately than humans can and provide a better level of protection for the people who live and work in these buildings. In addition to monitoring indoor environmental conditions, AI can also be used to detect and prevent criminal activity. At Carnegie Mellon University in Pittsburgh, Pennsylvania, researchers are developing software that uses artificial neural networks (ANNs) to analyze video footage from surveillance cameras and identify people carrying weapons or suspicious objects that could be used to commit crimes. By comparing the video feeds with a database of known criminals and terrorists, the software can identify individuals that it believes are engaged in unlawful activities and alert human investigators to their systems. [20] Although AI is still in its early stages, its ability to

identify patterns and perform complex calculations at very fast speeds could make it a valuable tool for improving public safety in the smart cities of the future.

5. AI for waste management and environment: The rapid development of artificial intelligence (AI) has led to increased expectations that AI can play a significant role in various domains, including environment and waste management. In particular, numerous studies have investigated the application of AI to the management and analysis of large datasets of environmental monitoring data. A number of studies have demonstrated the potential of AI for the analysis and prediction of patterns of resource use and waste generation from specific household or industrial sources. Nevertheless, researchers in this field have acknowledged that there are significant challenges associated with applying AI to real world environmental and waste management problems. These include difficulties in obtaining accurate representations of environmental conditions, lack of comprehensive datasets with information about both the environment and the humans responsible for its production and use, limited understanding of the behaviour of human populations in terms of resource use and waste generation, and the lack of a scalable approach that can incorporate information from multiple sources in order to generate real-time predictions about future environmental conditions. These challenges are particularly acute in the context of solid waste management, which is characterized by complex interactions between humans and the environment that are difficult to predict using conventional methods. Given this context, a research group at the Massachusetts Institute of Technology recently carried out a study aimed at evaluating the use of AI for the prediction and management of municipal solid waste collection patterns. The aim of the study was to evaluate the performance of existing data-driven models for simulating patterns in residential garbage collection with the goal of identifying areas where improvements can be made in the future. The researchers carried out a detailed analysis of the data collected from households in the city of Providence, Rhode Island over a period of two years. The dataset consisted of various households and was used to identify a variety of patterns in residential waste generation and disposal.

6. AI for smart education: Education plays a vital role in the development of any country. Smart education based on AI applications will also play a big role in the development of the education field in smart cities. History of smart education initiatives taken in different countries like Malaysia (1997), Singapore(2006), Finland(2011), Australia with the help of IBM(2012), South Korea(2012) and North America(2014). According to the World Economic Forum report, experts project that by 2025 two-thirds of all jobs will require education and training beyond high school. This clearly shows the importance of education and the need to improve the existing system to cater to the needs of the new generations. To meet these needs, new technologies such as Artificial Intelligence are being integrated in the classrooms to enhance teaching and learning experience of the students and teachers.

By integrating AI technologies in education, we can reduce the burden of the educators and help them focus more on improving the quality of education. The teachers can also use AI technology to provide personalized learning experience to the students. Personalized learning helps the students focus on their areas of interest and excel in that domain. It also helps them develop other skills as well. Some of the applications of AI in Education include tutoring of students using chatbot, automated grading of student assignments, personalized recommendations for books based on a student's interests etc.

With the help of these technologies, students can learn at their own pace and get support from the teachers when needed.

7. **AI in smart homes:** The developments were a bit more complicated; the machine learning and AI technologies made it easier for simple home technological advancements like air conditioning controlling and saving energy, using Alexa devices which have made good internet access and can do many works at just a command [32]. This has been eliminating humans from their job and replacing them with new automation technology even at home and industrial level to cause the end of labour. This would lead us to the new industrial revolution.
8. **AI in logistics and mobility:** The number of automobiles on the road and the growing population causes transportation, traffic, and logistical problems in most big cities. To design and manage a sustainable transportation system, technology could be enormously beneficial. For instance, the Personal Rapid Transit system developed by [34] uses AI.

“Intelligent transportation systems” or “ITSs” are systems that incorporate control systems, sensors, actuators, and ICTs that generate a lot of data and influence the evolution of the IoT (Internet of Things). They are also used for public mass transit systems. One such system is “Smart Corridors” that uses active vehicle management to control the speed of vehicles and pedestrians on a stretch of road. [35] This system uses adaptive cruise control with wireless vehicle-to-vehicle communication to reduce congestion and improve safety. Furthermore, a system called “car2go” is used in cities around the world to enable convenient transportation for its users. It is a network of electric cars that can be rented for short periods of time using a smartphone app. All vehicles are equipped with satellite-based GPS navigation systems and wireless communication devices.

The use of artificial intelligence has significantly changed the logistics industry in recent years. According to McKinsey & Company, artificial intelligence could boost the productivity of logistics companies by 40 percent by the year 2030.[36] In addition, the use of AI in the logistics sector has led to the development of new solutions such as autonomous vehicles that can transport goods without a human driver. These systems can be used to reduce transportation costs and help increase the efficiency of delivery networks.

Other ways AI is revolutionizing the logistics industry include the development of warehouse management systems and inventory management systems. AI can be used to optimize storage and warehousing processes and reduce the amount of physical space needed for storing inventory. As a result, companies can use space more efficiently and reduce operating costs. The use of AI can also improve supply chain operations and increase the availability of goods and services for consumers.

IV. CONCLUSION

We discussed the adoption of AI and its benefits from the use in smart cities by automating operations, reducing human errors in decision making, improving the environment through the implementation of new business opportunities, and improving the

efficiency of urban management. This paper discusses the benefits of using AI in major domains within smart cities including healthcare, education, environment, waste management, mobility, smart transportation, agriculture, risk management, and security. One of the most significant benefits of using AI in smart cities is increased efficiency. AI helps automate a wide range of processes to increase efficiency and reduce errors. For example, an AI-powered system can analyze traffic flows in real time to reduce congestion and provide information to drivers about alternative routes to avoid delays. This helps provide a better user experience and boosts traffic volumes resulting in increased revenue for the city. Another example is the use of AI-enabled systems in healthcare to help analyze and interpret patient data to improve diagnosis and treatment outcomes. This reduces the amount of time patients spend in hospitals and improves the overall efficiency of healthcare systems. In the education sector, AI enables teachers and professors to provide better instruction to their students by delivering customized course content based on their learning ability and interests. This helps improve learning outcomes and builds a stronger relationship between students and teachers. The use of AI in smart cities can also have a significant impact on the environment by reducing resource consumption and pollution levels. For example, AI can help improve the energy efficiency of buildings by using intelligent sensors to detect occupancy and adjust heating and air conditioning settings accordingly. It can also reduce CO2 emissions by cutting down on the number of vehicles on the road through the use of autonomous vehicles.

V. FUTURE DIRECTION

Cities increasingly use AI to improve their overall efficiency and performance in a number of critical areas including health, education, the environment, and urban development. There are several benefits to using AI in these fields including increased efficiency, reduced waste and increased revenue through automation, and improved decision-making capabilities based on data-driven insights. However, before implementing AI in any domain it is important to be aware of the various challenges that must be addressed. This will enable cities to reap maximum benefit from the use of AI while minimizing potential downsides.

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