AI FOR SUSTAINABLE SMART CITY HEALTHCARE

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Abstract

The combination of the Internet of Things (IoT) and Artificial Intelligence (AI) has emerged as a promising solution for tackling the challenges of real-time IoT applications. By leveraging AI, big data can be analysed with unprecedented accuracy and speed. However, the development of big data analysis through AI poses significant challenges, including security of the data, its privacy, training data, and centralized architecture. Smart cities consist of urban areas that use various converging technologies, sensors, and actuators to collected data and process it, providing valuable insights and services to residents. Information technology plays a vital role in managing the physical, social, and business infrastructures of smart cities, ensuring optimal resource utilization. The IoT devices within smart cities, including smart homes, intelligent vehicles, industries, and transportation, are capable of communicating with each other, optimizing various fields effectively and efficiently through smart solutions. AI for sustainable smart city healthcare involves utilizing artificial intelligence technologies to enhance healthcare services within smart cities while promoting sustainability. This integration aims to provide efficient and effective healthcare solutions that contribute to the well-being of residents while minimizing environmental impact. Despite numerous advantages, the IoT faces significant challenges, such as data security, centralization, data analytics, connectivity, and hardware constraints.

Keywords: Artificial Intelligence, Internet of Things, Data Analysis, sustainable development

1. INTRODUCTION

AI helps in creating intelligence for machines making them intelligent machines. In other terms, it can be said that the intelligence displayed by the machines and or software programs is termed as AI. AI has an influence on almost everything now a days, be it the social life or the economic activities of the citizens. Smart cities comprise of smart sensors, actuators, other smart devices to generate and capture big data on a daily basis and use wireless communication for data transfer. AI is implemented and used to handle this big data generated by the smart cities. It can process this big data with great accuracy and efficiency and learn from the data at the same time which helps in deriving inferences which further helps in making smart cities sustainable and resourceful. AI can help in reducing and eventually eliminating unsustainable growth and help us achieve sustainable growth. The world is aiming for sustainability in terms of economic growth, education, health, health care infrastructure, climate control etc.

2. OBJECTIVE OF THE STUDY

The primary aim of the study is aiming for sustainable development and achieving sustainable goals in healthcare. AI has the capability to predict infrastructure failures, usage patterns, resource demand ratios, and other relevant factors. Deployment of AI in smart cities will be a daunting task. The challenge is that most of the AI's resources and power are limited to a few companies. They all have their own AI ecosystems. We need to make AI as a service and a utility. Our objective is sustainable development for the entire world. The world is looking at us for solutions and it will be a challenge to fulfill the expectations. The world is collectively working on sustainability and our study will be quite beneficial for Smart Sustainable cities using AI.

3. RESEARCH METHODOLOGY

Systematic use of artificial intelligence and various other converging technologies to achieve Sustainable Development Goals (SDGs). We can make AI as a paid service on the basis of the volume of data processed or on per hour basis or on per project basis, in the future. Universities and educational institutions should fast track AI courses and put in efforts in the field to get a better workforce and AI systems. In the future, AI should transform into a utility, available to all. It will become as normal as cloud computing within the next 8–10 years.

AI, when implemented correctly will have a significant impact/influence on smart city development and up gradation. AI will start to learn how people use their cities. It will start analyzing the data and give predictions on the basis of previous experiences.

The use of IoT and Blockchain will further boost the concept of Smart cities. Converging technologies will help attain Sustainable goals.

4. ARTIFICIAL INTELLIGENCE

AI refers to the simulation of the human understanding and intelligence into the machines. They are programmed in such a way that they think like humans and try to mimic their actions. Machines which are capable of learning from experience and problem solving can also be called AI machines [1].

The ideal characteristic of AI is their ability to learn from past experiences and take actions, as per the input received, which has the best chance of attaining a desired goal. Machine Learning (ML) is a subset of AI. In ML computer programs can automatically learn from and adapt with the new data provided without any human intervention. A subset of ML is Deep learning technique helps in automatic learning with the help of huge amount of structured as well as unstructured data such as audio, video, images, text etc. [2].

5. Understanding Artificial Intelligence

When we hear the term AI, we automatically start to think about robots.. This is because many novels and movies tell us stories about robots and other human like machines wreaking havoc on humans and the planet earth. But that is not the truth at this moment.

The basic principle of AI is that the intelligence of humans can be recreated and be used by the machines to execute a set of tasks or even mimic the human behavior, be it the very complex tasks or even the simplest ones. The goal of AI includes mimicking the human cognitive activities. Humans have reached the levels where machines are mimicking human activities such as learning, reasoning, and perception, with a very high success rate [1]. Researchers and scientists believe that sooner or later they will be developing a system that will surpass the human capacity to learn or reason out any subject. But it is still an achievement to achieve since all cognitive activities are linked with the value judgments that are unique to experiences of the humans.

Benchmarks defined previously regarding AI are being surpassed everyday due to the advancement in technology. For instance, text recognition systems or machines calculating basic functions are no longer considered to be an AI system, they are now days thought of as an inherent computer function.AI is evolving continuously and is being used in almost every industry.

6. Applications of Artificial Intelligence

AI has endless applications today. The technology is being applied to all sectors of life and industries. AI is also being extensively used in healthcare industry for various different tasks such as calculating drug dosages, giving personalized treatments to patients, and aiding in surgeries and operation theaters. AI is being used in gaming; they play games such as chess which require the use of mind and skills. Self-driving cars also use AI. In the above two examples, the next steps are changed and altered due to the current as well as previous state. Each action has an impact on the end result. Winning the game is the end result in chess, while in self-driving cars; the AI must take into considerations all the external data and factors and make progress likewise to prevent a collision and other miss happenings [3].

AI is also being used in financial industries. It is helping the banks in detecting and flagging unusual card usage as well as deposits of huge amounts at a time. AI is being used in smart cities and making the life easier for the citizens. It will be discussed in great detail in upcoming sections.

7. Types of Artificial Intelligence on the basis of complexity

AI can broadly be categorized into two main types: weak AI and strong AI [4].

Weak AI is designed in such a way that it carries out a single work. For example, video games like chess, shooter games etc., personal assistants such as Amazon Alexa, Apple siri, Google assistant etc. We ask these assistants our questions and they provide us with the answers. Youtube's and Netflix's recommendation engine tell us what movie we should watch, Chatbots and search engine are other examples.

Strong AI are the systems that perform tasks that are considered to be human-like. These systems are more completed and complex. They are capable of handling tasks on their own in which human intervention is needed otherwise. Self-driving cars and puzzle solving and exhibition of common sense are a few examples.

8. Types of AI on the basis of development

Artificial intelligence can be categorized into four types.

- Reactive AI: This category of AI utilizes algorithms to optimize the output based on a specific set of inputs. For instance, AI used in chess playing is a prime example [5].
- Limited memory: AI systems of this type have the capability to adapt to their past experiences and update themselves based on new observations or data.The memory is often limited hence called limited memory. Autonomous vehicle system is an example [6].
- Theory-of-mind: Theory-of-mind AI refers to the development of artificial intelligence systems that possess the ability to understand and model the mental states of humans and potentially other AI agents. This concept involves creating AI systems that can attribute beliefs, intentions, emotions, and desires to themselves and others, allowing them to comprehend and predict human behavior based on inferred mental states [7].
- Self-aware AI: Self-aware AI refers to the concept of artificial intelligence systems that possess a level of consciousness and self-awareness similar to human beings. Self-aware AI is still largely theoretical; contemplating its implications highlights the intersection of technology, philosophy, and ethics. While the journey toward self-aware AI is complex and uncertain, its exploration pushes the boundaries of our understanding of both AI and human consciousness [8].
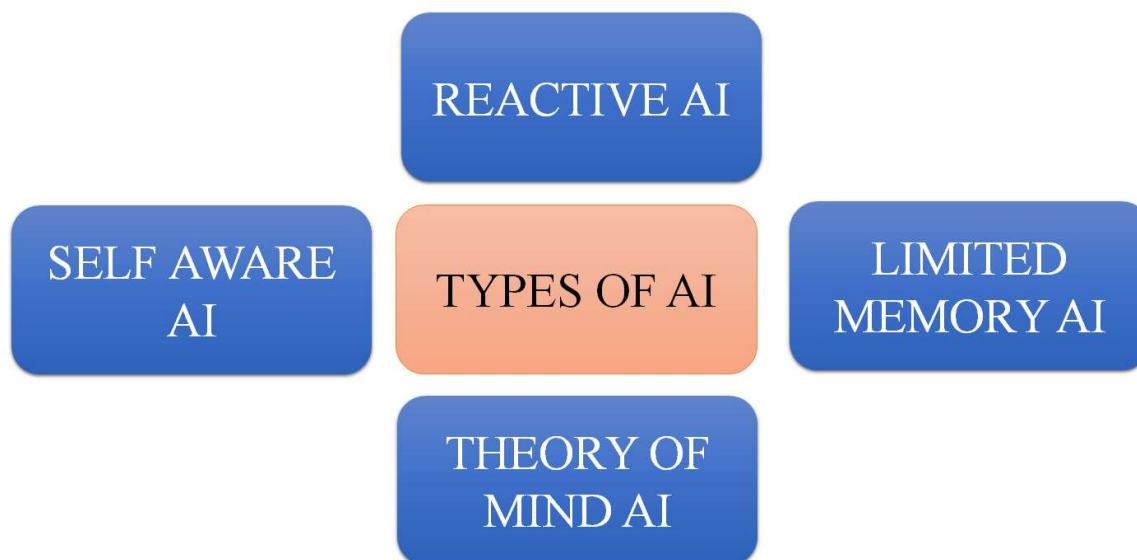
Figure 1: Types of AI

9. Why Is Artificial Intelligence Important?

AI offers a range of critical benefits and services to the users that make it a very useful tool for almost every organization or industry. It is being used from developing vaccine to automating processes like fraud and money laundering.

As per report by CB insights, the private market of AI saw a record-breaking increase in 2021. The global funding were up by 108% compared to that of 2020.In which 18% was in the healthcare industry alone [9]. Figure 2 depicts the same. Due to the speedy adoption in various industries, AI is making waves all around the world.

According to the Business Insider Intelligence's 2022 report more than 50% of banking and related companies have already started to use AI for risk management, revenue generation and customer service. AI can lead up to $400 billions in savings if employed properly [10].

In 2021, World Health Organization (WHO) reported that integration of AI in healthcare is a difficult task but not impossible. It comes with its challenges as well as benefits and the technology "holds great promise". AI could help in providing personalized healthcare to the patients and accurate and perfect diagnosis [11].

AI has also touched and benefited the entertainment industry. according to an estimate done by Grand View research, the global media and entertainment industry using AI was $10.87 in 2021 is estimated to touch $99.48 by 2030 [12]. AI is being used in detecting plagiarism in the media content and developing high-end graphics using AI and computers.
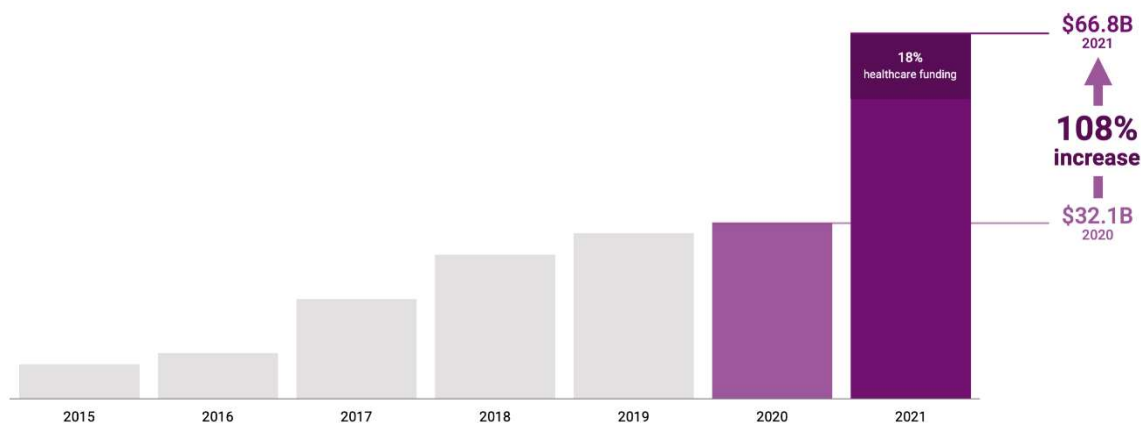
Figure 2: AI funding up by 108% in 2021.

10. How is AI Used Today?

Today, AI is being used in almost every industry across a wide range of services and applications, with different intensity of sophistication. Recommendation systems are the most used and implemented AI systems. Chatbots flashing on various websites are the next most used AI system. AI is also utilized in smart speakers such as Amazon Alexa, Google Assistant, and Apple Siri. Predictive systems are also being implemented to make predictions on weather and financial forecasting. This section has highlighted some of the primary applications of AI [13][14][15][16].Figure 3 illustrates the various uses of AI.

11. Personalized Shopping

When a user visits a shopping website and searches for an item, the recommendation engines help in better engaging with the users and improving their shopping experiences. The recommendations are made on the basis of previous searches, interests and preferences. This helps in improving and maintaining good terms with the customers.

12. AI-powered Assistants

Chat bots are also included in AI powered assistants. These assistants, currently, solve 40% of customer queries without any intervention of humans. The percentage is likely to increase in the near future.

13. Fraud Prevention

Financial fraud and fake ratings and reviews are the most serious issues which can be tracked and solved by the use of AI. Fraud can be prevented by checking and studying the usage patterns of the card and the card holder. AI can help in the same. A large number of new as well as the old users prefer to go through the reviews and ratings of a product or services before purchasing them. Fake reviews and ratings can have great impacts on the users. AI can help identify and eliminate fake reviews.

14. Administrative Tasks Automation

AI is all about doing things without human need or intervention, industries have started to automate regular, recurrent and daily tasks which is helping in reducing the need of man power. Tasks dangerous to human life are being done with the help of automation. Students and workers are getting automated personalized messages about their whereabouts and other personal data.
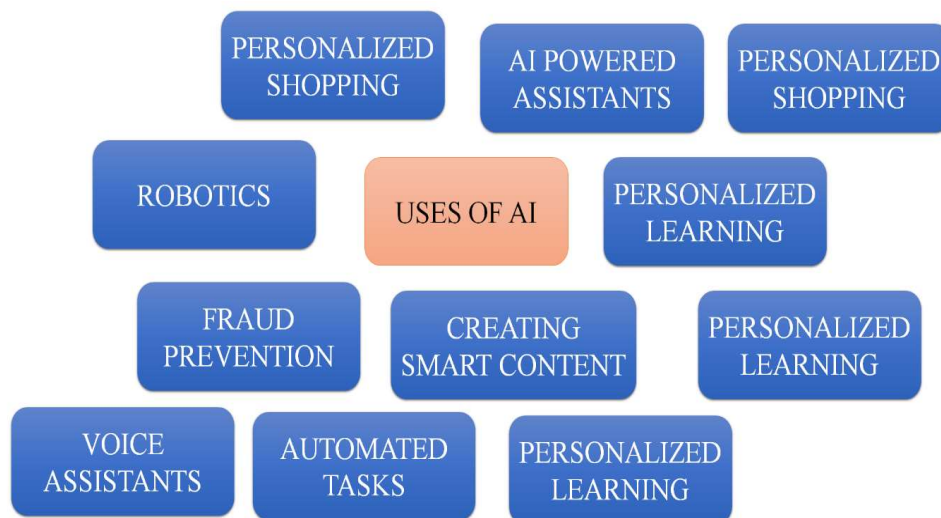
Figure 3: Uses of AI

15. Creating Smart Content

AI is being used in creating smart contents like videos and sound effect. They are being used in digitizing contents of meetings, conferences, lectures, speeches etc. Animations and cartoons are being created for entertainment purposes as well as for studying complex structures and concepts of biology and other sciences. It is also helping in making the content more interactive and interesting and a rich learning experience.

16. Voice Assistants

AI powered virtual assistants use natural language processing to make conversation with humans as normal as possible. Virtual assistants like Amazon Alexa and apple siri are an example. They can help in takings notes setting up reminders and answering questions of the users.

17. Personalized Learning

AI is helping in creating personalized content for each and every user or individual. The recommendations a user gets on Netflix are personalized to his likes and dislikes; other users have no influence on the same. AI is helping create personalized routines for athletes and patients to maintain their health and well-being.

18. Autonomous Vehicles

Companies like Tesla, Audi, BMW, Jaguar are using ML to train machines to think and work like humans. They are implementing this into their vehicles and cars and making driverless cars. These cars can be driven in any type of environment with the help of cameras and sensors.

19. Spam Filters

Emails are the most basic and widely used form of communication being used by almost 60% of the world population living in urban areas. Spam emails are one of the most annoying things when using emails. These emails can be very dangerous and leak personal and private data to unknown users. AI is being deployed to block these emails from going into the main mailbox of the users. Email by google, Gmail, has succeeded in blocking 99.9% of spam emails.

20. Facial Recognition

The smart device market has grown at an unprecedented rate in the past few years. The features which were never thought of to be possible have aroused and are being used in almost every smart device available. These devices use facial recognition to confirm the identity of the user and unlock the device. This feature protects the device from unauthorized access and at the same time make the user experience like a breeze and quick.

21. In Robotics

AI has also driven the robotics industry to unprecedented levels. AI powered robots are able to use the real-time data and updates to sense objects in their path and plan their journeys accurately, efficiently and instantly.

AI powered robots can be used for -

• Transporting medicines and other medical devices in hospitals and to the patients, moving goods and items in factories, and warehouses

• Cleaning large areas in offices and homes without any human intervention

22. Applications of Artificial Intelligence in Healthcare

One of the most recent influences of AI is found in the healthcare industry. AI finds itself to be immensely popular and is being used in diverse application. It is helping in making sophisticated and accurate machines. ML is currently being employed to detect, identify, and predict various diseases such as cancer and tuberculosis at an early stage, thus aiding in early diagnosis. Moreover, AI has the potential to detect and prevent diseases like COVID-19 [17]. We have discussed it in the upcoming sections.

23. Artificial Intelligence Pros and Cons

While AI is considered to be a life changing technology, it comes with its shares of downsides [18].

Few of the advantages of AI are

- Reduction in errors caused by humans
- Takes risk instead of humans
- Available 24X7
- Helping in repetitive jobs
- Virtual assistants
- Faster decision
- New inventions

Some of the disadvantages of AI are

- High cost of creation
- Making humans lazy
- Unemployment
- No emotions
- Lacking out of the box thinking

24. AI IN SMART CITIES HEALTHCARE

Smart cities are now a reality with smart healthcare as one of its important pillar. We have a number of smart cities around the world. Butthese cities still need development in one or the other sectors. Currently smart citiesdeploy Internet of things (IoT)[19], Internet of Drones (IoD)[20], Cloud computing[21], Edge computing [22], smart healthcare and other technologies.AI, if implemented correctlyplays a crucial role in the development and upgrading of smart cities and its healthcare.

AI will start to learn how people use their cities. It will start analyzing the dataand give predictions on the basis of previous experiences.

25. How can AI be used in smart cities healthcare

The massive amount of big data being generated in cities every day is making AI very different to the AI of the past. Huge amount of data is the main driver for AI. When this big data is paired with efficient and robust algorithms, the capabilities of AI increase exponentially. The use of AI in healthcare is becoming interesting as the developers are integrating and creating systems that are capable of learning from the past experiences [23]. For example, in a smart healthcare system where demand of energy tends to spike under certain circumstances, AI can learn where the spike is usually occurring and under what conditions and circumstances. Engineers and scientists can then make better use of the power grid. Other examples could be, by learning, AI can provide services to disabled and elderly people who might not be able to go for grocery shopping.

26. Transformative Applications of AI In Smart Cities Healthcare

AI can be used in smart cities healthcare in various ways, including:

27. Predictive Analytics:

AI has the capability to analyze patient data, medical records, and public health data to predict disease outbreaks, identify patients at high risk of developing a particular disease, and forecast future healthcare needs. This can help healthcare providers to take preventive measures, allocate resources efficiently, and provide timely care to patients.

28. Clinical Decision Support Systems (CDSS):

AI-powered CDSS can provide healthcare providers with evidence-based recommendations for diagnosis, treatment, and medication. CDSS can integrate patient data, medical knowledge, and clinical guidelines to provide personalized treatment plans and reduce the risk of medication errors.

29. Robotics:

Robotic systems empowered by AI have the potential to support healthcare professionals by handling everyday tasks, including the administration of medication, tracking essential health indicators, and contributing to rehabilitation efforts. This integration of robotics can result in time savings, decreased chances of errors, and enhanced patient care within the healthcare sector.

30. Remote Patient Monitoring:

Utilizing AI-driven remote patient monitoring solutions facilitates the tracking of patient information, encompassing vital signs, medication compliance, and activity metrics. This empowers healthcare practitioners to remotely oversee patients and deliver timely interventions when required. Additionally, remote patient monitoring holds the potential to decrease hospital readmissions and enhance patient results.

31. Virtual Health Assistants:

Virtual health assistants powered by AI can offer patients personalized health advice, monitor their symptoms, and provide support for self-management of chronic diseases. Virtual health assistants can also help patients to schedule appointments, refill medications, and access healthcare resources.

32. Medical Imaging:

Algorithms based on AI can be used to analyze medical images, including X-rays, CT scans, and MRI scans, to detect abnormalities and assist in diagnosis. AI can also help reduce the number of false-positive results, leading to more accurate diagnoses and reduced costs.

33. Electronic Health Records (EHRs):

AI-powered EHRs can help healthcare providers to manage patient data efficiently, identify trends and patterns in patient data, and provide personalized treatment plans. AI can also help reduce documentation errors and improve patient safety.

34. Personalized Treatment Plans:

By analyzing patient data such as medical history, lab results, and vital signs, AI algorithms can pinpoint individual characteristics that might impact treatment outcomes. This, in turn, can aid healthcare providers in designing tailored treatment plans for their patients, leading to better outcomes and reduced costs.

35. Drug Discovery:

AI plays a pivotal role in identifying novel drug candidates and refining current medications. Furthermore, AI assists in expediting drug development by pinpointing potential safety concerns and forecasting drug effectiveness, ultimately leading to reductions in time and cost.

36. Chatbots and Virtual Health Assistants:

Chatbots and virtual health assistants powered by AI can deliver personalized health advice to patients, monitor their symptoms, and provide support for self-management of chronic diseases. Chatbots and virtual health assistants can also help patients to schedule appointments, refill medications, and access healthcare resources.

These are just a few examples of how AI is being used in healthcare to improve patient care, reduce costs, and enhance overall efficiency. As AI technology continues to evolve, it is likely that we will see even more innovative applications in the future.

37. AI in healthcare use case

In this section we have discussed various use case in AI.

38. Natural language processing

Another use case of AI in healthcare is natural language processing (NLP), which involves teaching machines to understand and interpret human language. NLP can be used in healthcare to improve communication between patients and healthcare providers, as well as to analyze large volumes of medical text data.

One example of NLP in healthcare is the use of virtual assistants or chatbots that can converse with patients in natural language to collect and analyze their symptoms and medical history. These virtual assistants can help patients to identify potential health issues and provide advice on appropriate next steps, such as scheduling an appointment with a healthcare professional.

In addition, NLP can be used to analyze electronic health records (EHRs) and medical literature to identify patterns and trends in patient outcomes, drug effectiveness, and disease prevalence. This can help healthcare professionals to make more informed decisions about patient care and develop better treatment plans.

Another application of NLP in healthcare is in clinical decision support systems (CDSS), which are designed to assist healthcare professionals in making clinical decisions by analyzing patient

data and providing recommendations based on the latest medical research. NLP can be used to analyze patient records and provide CDSS with additional information to improve their accuracy and relevance.

Overall, NLP has the potential to improve communication and data analysis in healthcare, leading to better patient outcomes and more efficient healthcare delivery. With continued development and integration into healthcare systems, NLP will likely play an increasingly important role in the future of healthcare.

39. Big data

Another use case of AI in healthcare is the analysis of big data. With the growth of electronic health records (EHRs), wearables, and other digital health technologies, healthcare providers have access to massive amounts of data that can be used to improve patient outcomes and healthcare delivery.

AI can be used to analyze big data in healthcare, identify patterns, and generate insights that can be used to improve patient care. For example, machine learning algorithms can analyze patient data to identify patterns that may indicate the onset of a particular disease, allowing healthcare providers to intervene before the condition becomes more serious.

Moreover, big data analytics can be used to optimize healthcare operations, reducing costs and improving the efficiency of healthcare delivery. For instance, predictive analytics can be used to anticipate demand for certain procedures or services, allowing healthcare providers to allocate resources more effectively.

Another example of big data analytics in healthcare is in drug discovery. AI can be used to analyze vast amounts of data on molecular structure and function to identify potential drug candidates and predict their efficacy.

Overall, the analysis of big data in healthcare has the potential to transform the way we approach patient care and healthcare delivery. With AI-powered analytics, healthcare providers can better understand patient needs, improve outcomes, and optimize healthcare operations for greater efficiency and effectiveness.

CONCLUSION

In this paper we have discuss the various implications of AI in smart city environment and healthcare, its challenges and drawbacks and the ways the challenges can be controlled and eliminated. The study will help carter new ideas which will help researchers in reaching new heights and potentially sustainable development goals. The research has focused on smart healthcare also.

It will help us make an eco-friendly environment which will lead to sustainable development. Implementation of AI in smart city healthcare will come with various types of advantages for the society. Smart cities and AI with energy efficient, eco-friendly, better traffic and waste management and smart lights and appliances will help us reduce pollution which will help in making the environment less polluted and will conserve energy.

The future of healthcare is highly promising due to the rapid advancements in sensor technology, AI, and machine learning. These developments present new opportunities for patients, hospitals, physicians, and medical device manufacturers, as well as the potential to leverage the Internet of Things. Of course, there are challenges and significant changes that must be overcome. Throughout the literature, there is a consistent emphasis on the use of smart technologies in smart cities, especially in healthcare, and AI and blockchain are key drivers of improvement for the overall user experience of smart cities. Despite potential drawbacks associated with AI and machine learning in smart cities, they also have the potential to significantly impact the way we approach smart healthcare and smart cities.

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