

## An Overview of Artificial Intelligence (AI) in 6G: Types, Advantages, Challenges and Recent Applications

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### ABSTRACT



The world is on the cusp of a new communications revolution. The next generation of communication networks, known as 6G, will enable a wide range of new applications and services that are not possible with current 4G or 5G networks. In overview, we will review Artificial Intelligence (AI) Types, Advantages, challenges and some of the most promising applications of 6G technology. Some of the key applications that are being developed for 6G communication networks include Digital Twin (DT), Holograms, Robot Avatar, High Density (IoT), and AR & VR. The use of these applications in 6G communication networks is not a new concept, but integration to 6G will need more improvements. These applications have been around for some time now and have seen various improvements over the years. However, with the advent of 6G communication networks, the use of AR and VR is expected to see a drastic change. This paper contributes to the existing literature about the nature of 6G and applications to give more understanding and further discussion in potential and new trends.

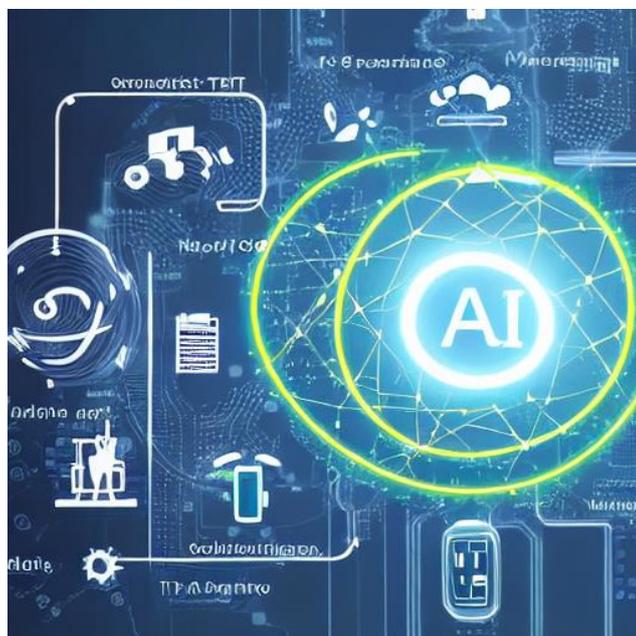
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## 1. INTRODUCTION

Artificial Intelligence (AI) is the development of intelligent machines capable of performing tasks that would otherwise require human intelligence [1]. AI promises to revolutionize many aspects of our lives, from creating smarter robots to providing more efficient ways to solve complex problems [2]. AI has been around for decades now and its capabilities have grown significantly over time. The concept of Artificial General Intelligence (AGI) suggests that machines should be able to think like humans and solve problems like humans [3]. This idea was first proposed by Alan Turing in the 1950s and has since become an important part of AI research.

On the other hand, 6G networks are the next step in the evolution of wireless networks. 6G networks will provide faster speeds, greater capacity, and more reliable connections than ever before. 6G networks will also be able to support a variety of new applications, such as augmented reality and virtual reality [4]. 6G networks will also be able to support the Internet of Things (IoT), which will allow for the connection of billions of devices to the internet. Furthermore, Artificial intelligence (AI) is an area of research that seeks to create machines that have the same or similar capabilities as humans. AI uses artificial neural networks, which are composed of artificial neurons and computational nodes, to analyze data and make decisions [5]. Feedforward neural networks are one type of network model used in AI. These networks consist of perceptron's which act as decision-making nodes. Training models are used to teach these networks how to interpret incoming data and make decisions based on it. An illustration depicting the related network of AI is shown in Figure 1.



**Figure 1.** 6G Network drawn by AI

AI and 6G networks are two of the most exciting and rapidly evolving technologies of our time [6]. AI can be used to automate mundane tasks, improve customer service, and optimize network performance. 6G networks will provide faster speeds, greater capacity, and more reliable connections than ever before. The combination of AI and 6G networks will be a powerful one, as they will be able to work together to create new applications and services. The combination of AI and 6G networks could be used to analyze data from 6G networks and make decisions based on that data [7]. For example, AI can be used to optimize network performance and ensure that the network is running at its peak efficiency. AI can also be used to detect and prevent security threats, as well as to provide personalized services to customers.

In addition, AI is a very broad term, encompassing everything from simple machine learning algorithms that can be used to identify patterns and make predictions, to more complex “deep learning” systems that can be used to develop a wide range of sophisticated applications. In recent years, AI has been used to create powerful “learned” AI systems [8] that can learn from data and develop increasingly accurate models of the world. Present AI tools are being used in a wide range of fields such as finance, healthcare, marketing, and robotics. AI is also being applied to quantum computing for its ability to reinforce AI systems with new functionality and greater efficiency. Quantum computing is the use of quantum-mechanical phenomena such as superposition and entanglement to perform calculations on data.

### 1.1. State of Art

The state of the art in 6G Communications Networks is advancing rapidly. 6G networks promise to provide a range of advanced communication and data services that go beyond what 5G provides, such as the integration of smart devices in sensors and actuators, millimeter wave technology for high speed and high accuracy positioning, Cognitive Radio (CR) capabilities for effective management of spectrum resources, network virtualization, latency reduction to meet requirements for mission-critical applications, formation of distributed antennas systems via multi-hop device-to-device communications among other features. In addition, there are several potential applications such as Autonomous Transportation Systems (ATS), Internet of Things (IoT), Augmented Reality (AR), Advanced Manufacturing Solutions that can benefit from 6G networks. An important challenge moving forward is to accurately assess all the potential benefits against tradeoffs associated with the deployment and operations of these complex networks.

### 1.2. Paper Contribution

This review contributes an introduction different types of AI and possible advantages, challenges and application developments in both AI and 6G networks. The main contributions are as follows:

- This paper gives an overview of the AI in 6G communication network and changes that possible to occur in these technologies.
- This paper discusses the types of AI in 6G networks, advantages and challenges that face continuous developing of technology.
- Recent applications and trends related to AI and 6G networks are described based on their characteristics, benefits and possible challenges.

## 2. METHODS

As a review research, we have collected the latest trends and applications based on the prior researches further directions. In addition, Scopus data based was used to determine the last studies in AI and 6G especially IEEE journals. This review doesn't further investigate outcomes or methodological approaches, instead concentrated in further direction to determine latest trends and applications.

Furthermore, after determining recent applications, researchers used both google scholar and Scopus database to determine the benefits and challenges of AI in 6G and applications. This review is a descriptive case which means describing the application, their usage, benefits and challenges without giving deeper explanation of their effect, architecture modal, simulation and so on.

## 3. RESULTS AND DISCUSSION

In this part, we review the different types of AI in 6G networks in addition to the advantages and challenges of integration of AI in 6G communication networks.

### 3.1. Types of AI in 6G Networks

AI is an ever-evolving field, and new types of AI are being developed all the time. As AI continues to advance. Artificial Intelligence (AI) is a broad term that encompasses a wide range of technologies and applications. AI can be used to automate tasks, improve decision-making, and provide insights into complex problems. Types of AI includes [9] [10] [11]:

- Machine Learning: Machine learning is a type of AI that uses algorithms to learn from data and make predictions. It is used in a variety of applications, such as facial recognition, natural language processing, and autonomous vehicles.
- Deep Learning: Deep learning is a type of machine learning that uses neural networks to learn from data. It is used in applications such as image recognition, natural language processing, and autonomous vehicles.
- Natural Language Processing (NLP): NLP is a type of AI that enables computers to understand and process human language. It is used in applications such as chat-bots, voice recognition, and text analysis.
- Computer Vision: Computer vision is a type of AI that enables computers to recognize and interpret images. It is used in applications such as facial recognition, object recognition, and autonomous vehicles.
- Robotics: Robotics is a type of AI that enables robots to perform tasks autonomously. It is used in applications such as manufacturing, healthcare, and autonomous vehicles.
- Expert Systems: Expert systems are a type of AI that enables computers to make decisions based on a set of rules. It is used in applications such as medical diagnosis, financial analysis, and legal advice.
- Neural Networks: Neural networks are a type of AI that enables computers to learn from data. It is used in applications such as image recognition, natural language processing, and autonomous vehicles.

### 3.2. Advantages of AI in 6G Networks

The advent of 6G technology is expected to bring about a revolution in the way we communicate and interact with the world around us. Artificial Intelligence (AI) is expected to play a major role in this revolution, as it has done in previous generations of wireless technology. AI has the potential to revolutionize the way we use 6G technology, and the advantages of AI in 6G are numerous. Some of these advantages are:

- AI can help to improve the speed and efficiency of 6G networks [12]. AI can be used to analyse data from the network and identify areas where improvements can be made. This can help to reduce latency and improve the overall performance of the network. AI can also be used to optimize the network for specific applications, such as streaming video or gaming. This can help to ensure that users get the best possible experience when using 6G technology.
- AI can help to improve the security of 6G networks [13]. AI can be used to detect and prevent malicious activity on the network, as well as to identify and block potential threats. This can help to ensure that users are safe when using 6G technology. AI can also be used to detect and prevent data breaches, which can help to protect user data and ensure that it is not misused.
- AI can help to improve the user experience of 6G networks [14]. AI can be used to analyse user behaviour and identify areas where improvements can be made. This can help to ensure that users get the best possible experience when using 6G technology. AI can also be used to provide personalized services to users, such as tailored content or recommendations.
- AI can help to reduce the cost of 6G networks [15]. AI can be used to automate certain tasks, such as network maintenance and optimization. This can help to reduce the cost of running a 6G network, as well as the cost of providing services to users.

In conclusion, the advantages of AI in 6G are numerous. AI can help to improve the speed and efficiency of 6G networks, improve the security of 6G networks, improve the user experience of 6G networks, and reduce the cost of 6G networks. As 6G technology continues to develop, AI will become an increasingly important part of the technology, and its advantages will become even more apparent.

### 3.3. Challenges of AI in 6G Networks

On the other hand, the development of 6G networks is expected to bring a number of new challenges for artificial intelligence (AI). AI is expected to play a major role in 6G networks, as it will be used to enable new services and applications, as well as to improve the performance of the network. However, there are a number of challenges that need to be addressed in order for AI to be successful in 6G networks. Some of these challenges are:

- Need for high-speed data processing [16]: 6G networks will require AI algorithms to process large amounts of data in real-time, which is a challenge that current AI algorithms are not yet able to meet. Additionally, 6G networks will require AI algorithms to be able to process data from multiple sources, such as sensors, cameras, and other devices, which is another challenge that current AI algorithms are not yet able to meet.
- Need for AI algorithms to be able to adapt to changing conditions [17]: 6G networks will require AI algorithms to be able to quickly adapt to changing conditions, such as changes in network traffic or changes in user behaviour. This is a challenge that current AI algorithms are not yet able to meet.
- 6G networks will require AI algorithms to be able to make decisions in real-time [18]. 6G networks will require AI algorithms to be able to make decisions quickly and accurately, which is a challenge that current AI algorithms are not yet able to meet.

Overall, the development of 6G networks will bring a number of new challenges for AI. In order for AI to be successful in 6G networks, these challenges need to be addressed. This will require the development of new AI algorithms that are able to process large amounts of data in real-time, adapt to changing conditions, and make decisions quickly and accurately.

## 4. 6G RECENT APPLICATIONS

In this part, we discuss the recent applications in 6G networks communication and possible usage of these applications in the future. Furthermore, main characteristics, benefits and implementation challenges related to these technologies were included.

### 4.1. Digital Twin (DT)

Digital Twin is a virtual representation of a physical object or system used to monitor, analyze, and optimize performance [19]. It is becoming increasingly popular in a variety of industries and is expected to continue to grow. It can be used to reduce the cost of service migration, make 6G networks more secure, and

create a secure, immutable, and transparent digital representation of physical objects. Challenges include the cost of implementation, complexity of data, and accuracy and reliability [20].

6G networks use DT technology to create a virtual replica of physical objects or systems, allowing them to detect any unauthorized access or changes and take appropriate action to protect them from malicious activity [21]. This technology also makes the network more secure. For example, if a sensor detects a temperature change in a machine, the digital twin can be used to adjust the temperature to ensure optimal operation. Digital Twin in 6G is a complex system that combines the physical and digital worlds. It is composed of hardware, software, and data that creates a digital representation of a physical object or system [22]. This representation is created using data from sensors, cameras, and other sources, and is used to monitor, analyze, and control the physical object or system. The data is then stored and analyzed on a cloud-based platform, which can be used to create predictive models to anticipate future events and take proactive action.

Digital twins and blockchain technology can be used together to create a secure, immutable, and transparent digital representation of physical objects [23]. This digital representation can be used to track the performance of the physical object, store and share data related to the object, and create smart contracts that are stored on a blockchain and automatically executed when certain conditions are met [24]. This can help to reduce costs and increase efficiency.

Digital Twin technology is a powerful tool, but it comes with a few challenges [25]. These include the cost of implementation and maintenance, the complexity of data collection and analysis, and accuracy and reliability issues [24]. All of these require significant resources and expertise to address. Furthermore, Digital twin technology is a complex process that requires a lot of expertise and resources to collect and analyze data accurately [26]. Despite its potential, there are still issues with accuracy and reliability, and it can be difficult to keep the digital twin up to date. Additionally, the digital twin must be kept up to date in order to remain useful, which can be a challenge.

#### 4.2. Holograms

Holograms are a 3D imaging technology used to create realistic images of objects and people [27]. It is now being used to create a more immersive experience for customers, such as allowing them to interact with a customer service representative in a virtual environment [28]. This could be especially useful for customers in remote areas or who have difficulty traveling to a physical location.

Furthermore, Holographic Nondestructive Testing (HNNDT) is a type of non-destructive testing (NDT) that uses holography to detect flaws in materials [29]. It is used to inspect a wide variety of materials, including metals, plastics, composites, and ceramics, and is used in industries such as aerospace, automotive, and medical. HNNDT is a powerful tool for detecting flaws that could lead to failure or malfunction, as well as corrosion, fatigue, and other types of damage [30]. It is an important tool for ensuring the safety and reliability of components and materials.

Additionally, Hologauze is a revolutionary new technology that allows for the projection of large scale 3D holograms [31]. It is a lightweight, transparent fabric made up of tiny, reflective particles that create a 3D image when light is shone through it. It is versatile, cost effective, and easy to set up and use, making it a great choice for those on a budget or with limited technical knowledge [32]. Holograms are a new technology with a number of challenges that must be overcome before they can become mainstream. These include the cost of specialized equipment and materials, lack of standardization and compatibility, complexity of the technology, low resolution, and difficulty of interaction [33].

#### 4.3. Robot Avatar

Robot avatars are computer-generated characters that can be used to represent a person in a virtual world [34]. They can be used for a variety of purposes, from providing a virtual presence to providing a more realistic representation of a person. They can be programmed to perform tasks such as navigating a virtual world, playing games, or providing assistance to other avatars, allowing for a more realistic interaction between people in the virtual world [35].

The use of robot avatars in 6G for service migration presents numerous challenges, such as creating a realistic avatar that can interact with humans, integrating the avatar into existing services, ensuring security and reliability, and providing a high-quality user experience [36]. These challenges require extensive research and development, technical expertise, security measures, and user testing and feedback [37].

Robot avatars and blockchain technology are two of the most promising advancements in 6G technology, with the potential to revolutionize how we interact with the world. AI-powered robot avatars can understand and respond to human commands, while blockchain technology can securely store and transfer data [38]. This combination could lead to more efficient and cost-effective services, as well as more secure and transparent transactions.

#### 4.4. High Density (IoT)

The Internet of Things (IoT) is a rapidly expanding network of connected devices that can communicate with each other and other networks. High-density IoT solutions are designed to provide a secure, energy efficient mesh network architecture for efficient data transmission between multiple devices [39]. These solutions are ideal for applications that require a large number of connected devices in a limited space, such as smart cities, industrial automation, and healthcare. 6G promises to bring immense potential benefits, such as faster data transmission speeds, more secure data transmission, and more efficient use of spectrum [40]. It will also enable new applications and services, such as smart cities, autonomous vehicles, and the Internet of Things (IoT), to connect millions of devices in a single area for more efficient data collection and analysis [41].

IoT devices are becoming increasingly popular and are being used to provide a variety of services [42]. By integrating these devices with blockchain technology, service providers can create a secure, distributed, and automated system for delivering services, which can provide a number of benefits such as increased security and reliability [43]. The integration of IoT and blockchain in service migration can provide a more efficient, cost-effective, and transparent system for delivering services [44]. Blockchain technology can automate the process of delivering services, reducing time and cost, and ensure that all data related to the service is visible and accessible.

Integrating IoT and blockchain technology presents a number of challenges, such as scalability, security, and interoperability [45]. Scalability is a major challenge due to the large amount of data generated by IoT devices, and security is a concern as IoT devices are vulnerable to attack [46]. Interoperability is also a challenge, as IoT devices must be able to communicate with each other and with the blockchain network [47]. To address these challenges, a secure and resilient blockchain network is needed that is able to support multiple protocols and standards.

#### 4.5. AR & VR

6G promises to be a faster, more reliable, and more secure wireless technology than ever before, allowing AR and VR applications to take advantage of its increased speed and reliability to provide users with an even more immersive experience. AR and VR have already been used in a variety of applications, from gaming to education to healthcare [48]. 6G networks provide users with a more immersive experience due to increased speed and reliability. This allows for more realistic graphics and smoother gameplay in gaming, virtual classrooms and teachers in real-time in education, and more accurate diagnosis and treatment of patients in healthcare [49].

6G networks offer increased speed, reliability, and security compared to previous generations, making them ideal for AR/VR applications [50]. The combination of 6G and blockchain technology can enable secure, distributed applications with real-time, immersive experiences [51]. This could be used in a variety of contexts, such as gaming, education, and healthcare, to protect user data and privacy.

The potential of 6G and blockchain technology when combined in the AR/VR space is immense. This combination can create a powerful platform for applications, as well as new business models and secure, distributed networks for data sharing and collaboration [46]. This could enable developers to monetize their applications and create new revenue streams, as well as leverage the collective intelligence of the network.

### 5. CONCLUSIONS

In this overview, we discussed the AI types, advantages and challenges. We also reviewed the existing under-developed applications in 6G communication network that have a huge advantages in next years in different area including education, healthcare, technology, economic and businesses. These applications are digital twins, holograms, and robot avatar, high density IoT and AR & VR in 6G networks. Furthermore, the characteristics, advantages and possible challenges were included as part of this essay.

### 6. FUTURE WORK

AI and 6G communication Networks are under-development at the current time. It is predictable that this technology will grow quickly in next years and will be implemented in 2030. There will be high potential for researchers and scholars to develop new applications, platforms, modals and software in next years. This review is a descriptive case and analysis of current types, advantages and challenges of this development.

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