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A vision on the artificial intelligence for 6G communication

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Abstract

The 6G communication network will be a sixth-sense next-generation communication network, which will increase the worthiness of the intelligent Internet of Things. With the advent of various fields of artificial intelligence, 6G will create enormous possibilities, that is, Augmentation of Human Intelligence, Internet of Everything, Quality of Experiences, Quality of Life, etc. Artificial intelligence and 6G communication technology will completely change from connected things to connected intelligence. This article summarizes the scope of artificial intelligence in making a revolutionized 6G communication technology. We directly focus on implementing suitable applications that solve human needs and problems. Moreover, we emphasize such technology that can create value for new technologies.

Keywords: 6G communication; Artificial intelligence; Edge AI; Quality of Life; Quality of Experience; Cognitive intelligence; Federated AI; Black-box; Data Science; Big Data; Unmanned Aerial Vehicles

1. Introduction

Together, 6G communications and artificial intelligence can change the view of our technological thinking aspects and revolutionize the modern lifestyle. Therefore, 6G communication technology will flourish in the future market of the 2030–2040 era [1,2]. As with many inventions, it will take decades to see the commercial dawn [3]. Many researchers have already illustrated the positive and negative impacts of the new network technology. 6G communication Technology will integrate with full artificial intelligence. In the 6G communication network, artificial intelligence will be an integral part of the communication systems [4,5]. In addition, it is expected to support the Extended Reality (XR) and Augmented Reality (AR) [6]. These technologies are sufficient to elevate the network system to a new level. In short, everything will be cloud-based architecture, for instance, Edge Computing. The client does not need any server or software installation or hardware implementation but requires a fast internet connection. Cloud technology will acquire all network connectivity and flexibility to provide a real-time data-driven ecosystem. With tremendous capacity and extremely low latency, 6G will be able to handle extremely expanded network systems with extremely low latency, and power consumption [7].

The global telecommunications industry is undergoing an extraordinary transformation. With the help of a decentralized network system, it becomes more powerful. The evolving network system seeks seamless achievement for better mobile broadband, ultra-reliable, low-latency communications, and large-scale machine-type cross-connection [8]. Many of the recent hardware can also handle a large amount of data integration. Cellular wireless networks integrate innovative strategies to optimize connectivity such as software-defined networking, heterogeneous networks, and virtualization [9]. AI-powered network management to control the fast monitoring system. Implementing several cloud services, network virtualization, and other individual components could simplify some activities. Still, it leads to more fragmentation in the long run and an increased need to regulate tools. 6G will help us to build and modify that advanced toolkit. Edge AI over management system would handle the complex integration in a hierarchical order [5].

6G communication is evolving the current communication networking system smartly. Nayak & Patgiri [1,2] envision the diverse future possibilities of 6G application in various domains, where 5G is the foundation for building the next

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generation of communication technology; for example, intelligent vehicles, Internet of Things, and savvy urban areas [10]. Although 5G has yet to be deployed worldwide and get experience at this time, researchers have turned their attention to the 6G communication framework [11]. In addition, the researchers have started working on integrating the 6G communication networks with AI's capabilities to provide ubiquitous and reliable communication. Thus, it is becoming the backbone of the digital transformation of society [9,12]. 6G communication technology provisions the connection with everything by integrating various technologies and applications. It also supports holographic, haptic, and underwater technologies. It will strengthen the Internet of Everything such as the Internet of Industrial Things, Internet of Medical Things, Internet of Nano-Things, etc. [7,8,13]. Therefore, the 6G communication technology can fulfill its promises with the help of advanced AI.

Table 1 elucidates our papers with the existing literature. Nayak and Patgiri [1,2] focus on the obstacles, opportunities, optimizations of the 6G communication network. Our research article mainly focuses on the descriptive analysis of the 6G communication network. We have found similar scopes for the intelligent healthcare system implementing the AI constraints to every software system. Chen et al. [20] also illustrate the fundamental advancement of smart networking systems. Ali et al. [5] and Sun et al. [13] concentrate on the different layers of networking systems. In contrast, our research article discloses the advanced scopes such as quantum machine learning, deep learning, black box techniques to support the high configuration networking system. We have also found a valuable aspect comparing our article with [21,22] is that the 6G network will be mostly depended on the cloud, and the whole networking environment would be deployed and maintained by the server-less cloud system. Both the papers [9,23] emphasize the machine learning features integrating with the intelligent network. On the other hand, our research focuses on the whole life cycle of the artificial intelligence process. It also describes the use cases in building and monitoring intelligent data products. We have also done extensive security research and privacy constraints as compared to the articles [24,25]. Our research article focuses on networking systems' security, secrecy, and privacy constraints with the proper implementation of advanced artificial intelligence techniques. The intelligent network requires a low-latency network connection to make the data transfer rate faster.

The article is organized as follows—Section 2 explores the core technologies of 6G communications as preliminaries of the article. Moreover, Section 3 establishes a relationship between the Internet of Everything with 6G communication. Section 4 illustrates the transition from smart technology to intelligent technology. Thus, Section 5 envisions the AI-driven 6G communication. In addition, Section 6 and Section 7 envision the future impact of machine learning and Deep Learning in 6G communication. Also, Section 8 and Section 9 exhibit the future possibilities of UAV and Autonomous Vehicles in AI-driven 6G communication. Moreover, Section 10 and Section 11 explore the role of AI-driven 6G communication in Data Sciences and Artificial Robots. Section 12 discusses security, secrecy, and privacy in AI-driven 6G communication. Finally, Section 13 concludes the article.

2. 6G core technologies

6G communication is all about sixth-sense communication. It will be a three-dimensional technology, particularly time, space, and frequency. 6G will truly be an artificial intelligence-driven communication. The necessities of 6G communication innovation are high data rate ($\geq$1 Tbps), high working recurrence ($\geq$1 THz), low start to finish delay ($\leq$1 ms), unwavering high quality (10-9), high portability ($\geq$1000 km/h) and frequency of $\leq$300 μm [1,2]. Additionally, holographic communication and increased augmented simulation will help intelligent network communication systems. 6G will offer the 3D types of assistance with the help of arising innovation; for example, edge innovation, artificial intelligence, distributed computing, and blockchain [4]. The 6G communication organization will be omnipresent and incorporated. 6G will give further and more extensive inclusion through gadget to gadget, low-earth orbit (LEO), and satellite communication [26]. 6G plans to combine calculation, route, and detecting to the communication organization. In the space of safety, 6G will cover security, secrecy, and protection of the enormous information created by billions of intelligent gadgets. There will be a change from smart gadgets to intelligent gadgets. Intelligent gadgets need high-speed communication with URLLC. The critical necessities of 6G communication are 1 THz operating frequency, 1 Tbps data rate, 300 μm frequency, and 1000 km versatility range [1,10]. The 6G design is 3D with time, space, and frequency. The end-to-end delay, radio-only delay, and processing delays are $\leq$1 ms, $\leq$10 ns, and $\leq$10 ns for 6G communication, respectively [5]. 6G communication technology is an artificial intelligence-driven communication, and henceforth, it demands broad mobile bandwidth and low latency (MBBLL), massive broad bandwidth machine type (mBBMT), massive low latency machine type (mLLMT) [27]. Bi *et al.* focus on ten trends on 6G communication [28]. Letaief et al. provide vision on Artificial Intelligence in 6G communication [29]. Zhang et al. focus on further-enhanced mobile broadband (FeMBB), extremely reliable and low-latency communications (ERLLC), ultra-massive machine-type communications (umMTC), long-distance and high-mobility communications (LDHMC) and extremely low-power communication [30].

2.1. Quality of Services

In a specific network area, the quality of service measures the service's overall performance provided by 6G communication technology. Quality of Service (QoS) in 6G communication is AI-driven. AI assists 6G communication to provide high QoS, and the service incorporates high data rates, ultra-reliable low-latency communication (URLLC), further-improved portable broadband, ultra-enormous machine-type

Table 1
Comparison of existing review articles and our article on both 6G and AI communication technology.

Papers	Year	Features	Our article
[1]	2020	The main focus of this research is to demonstrate the obstacles and optimization of the 6G communication network in a broadway	The primary focus of this article is to illustrate the scopes and opportunities that will be envisioned to be implemented in the 6G communication era.
[2]	2020	In this paper, the application of 6G communication technology has been discussed, and also the potential uses of those applications are also mentioned elaborately	Our article describes the potential uses of descriptive analysis of 6g communication technology.
[10]	2020	The main pivot point of this research article is to exemplify the healthcare system by the advanced communication networking system	In this article, we focus on the potential healthcare system and extract the smart technological system product and the intelligent software ecosystem.
[7]	2020	The paper is the backbone of the 6g networking system, which implies the machine learning field. Also, the research indicates every possible solution which will be done by machine learning with a fast and efficient networking system	Our research article focuses on the whole artificial intelligence field where we have a wide deliberation such as Deep Learning, Reinforcement Learning, Data Science, and also Quantum Machine Learning.
[14]	2020	The paper featured the main use cases of deep reinforcement learning in the 6g communication era and also disclosed the networking constraints of 6g communication technology	In our article, we featured deep neural learning, advanced artificial neural network, federated learning, and black box techniques that enrich the potential application 6g communication network.
[15]	2020	The article decorates the wireless communication system and the advanced wireless communication networking system. Also, the article brought out that the wireless communication technology will be entirely dependent on the cloud infrastructure	Our research article also indicates almost the same point of view and discovered the wide potential range of 6g communication technology network.
[12]	2019	This research article encapsulates the power of quantum computing and the potential energy of the quantum sources, which will boost the machine learning algorithm efficiency	Our research article mainly discloses how to use quantum computing in the application of machine learning and artificial intelligence field. Also, we have found out that quantum computing also aids in automatically setup of networking system and use quantum power to generate the leads automatically.
[16]	2020	The research article shows an elaborate idea of how the AI will empower the 6g communication networking system	Our research article focuses on the same issues and discloses the whole processing life cycle of the artificial intelligence field.
[17]	2018	The research focuses on machine learning applications in every step of networking topology. The main focus is to enrich networking systems with the effectiveness of machine learning	We focus comprehensive research on the artificial intelligence product building and maintenance of those corresponding use cases.
[18]	2020	The article illustrates deep learning techniques, a subset of machine learning and networking flexibility. It also features the decentralized data science methods in-depth	The 6G and AI research article brings all the data science aspects into one platform. The main parts of the data science issues have been broadly discussed and compared with the advanced networking system.
[19]	2020	The paper focuses on the intelligent vehicles empowered by artificial intelligence and the security measures of the networking system	Our research article focuses on the security, scarcity, and privacy constraints of networking systems with the proper implementation of advanced artificial intelligence techniques and algorithms. The intelligent network requires a low latency network connection to make the data transfer rate faster.

interchanges, long-distance and high-mobility communications, and extremely low-power interchanges [2,10]. Additionally, Quality of Services incorporates versatile, expansive transmission capacity and low idleness [5,20]. Most of the QoS in 6G communication depends on the AI; for instance, AI-based physical layer security. Quality of Service is progressively significant as organization execution necessities adjust to the developing number of individuals utilizing them. The most recent online applications and administrations require tremendous measures of transmission capacity and organization execution, and clients request they offer superior consistency. This issue could be kept up by the immense measure of similarity force of the 6G communication technology. Therefore, associations need to send strategies and innovations

that ensure the ideal assistance. Quality of Service is likewise getting progressively significant as the IoT comes to development. In the assembling area, machines presently influence organizations to give continuous notices on any expected issues [12]. Subsequently, any postponement in recognizing the issue could cause profoundly expensive slip-ups. Quality of Service empowers the information stream to take the need in the organization and guarantees that the data streams as fast as could be expected. Urban communities are loaded with intelligent sensors that are imperative to running the enormous scope of the IoT undertakings structures.

2.2. Quality of Experiences

The Quality of Experiences (QoE) defines a high Quality of Services (QoS) and client-driven communications with AI-assisted services. QoE will be accomplished by holographic communications, augmented reality, virtual reality, and material internet, which requires a high information rate with amazingly low inertness [6,8]. Thus, it requires AI to integrate with 6G communication to provide higher QoE for users. Additionally, Quality of Experience is required to be progressive in keen vehicles, intelligent gadgets, canny human services, intelligent automation, and many more. A high QoE can be accomplished only if when 6G is able to deliver all its promises [12]. 6G will ensure high quality of experience, and thus, it will help the educational industry to support the high quality of service experience. Nature of Involvement is the proportion of a client's general degree of fulfillment with help from the client's viewpoint. It targets accepting the abstract encounters of the help client, with everyone of their intricacies and human-subordinate factors like the physical, fleeting, user-friendly, and financial components. The embodiment of deciding Quality of Experience in a specific case depends less on the volume or extent of what is to be estimated and changed into measurements [31]. It is fairly about knowing which help boundaries are fundamental components in client fulfillment and estimating them from the point of view as near the client's discernment as expected. Hence, specialist organizations need to know their client's Quality of Experience continuously to have the option to improve their administrations on the fly.

2.3. Quality of Lives

Quality of Lives (QOL) can be improved using Quality of Services (QoS) and Quality of Experience (QoE). 6G innovation will empower high Quality of Lives utilizing communication innovation [2]. A high QoE can be accomplished when all ideal boundaries are carried out by 6G innovation. Holographic communications will achieve a high Quality of Experience, increased reality, augmented reality, and material web, which requires a high information rate with very low idleness [1]. 6G innovation will be genuinely simulated intelligence-driven communication innovation, and hence, we will prove numerous adjustments in our ways of life, social orders, and organizations. It is impossible to provide high QoS, QoE, and QoL without AI in 6G communication technology. Additionally, 6G promises to give five senses communication to give rich Quality of Experience. All analog gadgets will be changed over to intellient gadgets in the period of 6G [4]. With the appearance of simulated intelligence alongside versatile communication, we will prove numerous advances from brilliant things to canny things. From 2030 and forward, the Internet of Things will be insightful and will be supplanted by the Internet of Everything. Smartphones (towards intelligent phones) will supersede the conventional cell phone. Intelligent gadgets will be artificial intelligence-driven gadgets that can interface with the web. Subsequently, the smart gadget will want to anticipate, settle on a choice, and offer their involvement in other smart gadgets [20]. This assistance is fundamental in Quality of Life to improve the cutting edge way of life.

3. Internet of Everything

Now, in this digital era, the Internet has become part and parcel of our lives. The main focus of high-level sensing is capturing. The captured data are converted to digital data, stored in a local cache, and transmitted to remote locations in real-time [4,20]. In some cases, digital data are further converted to signals and transmitted to other devices for processing [21]. The 6G network can create a revolution in the communication field that would allow us to range our all essentials in one place by the implementation of 6G communication technology. The Internet of Everything is a wide idea that objectives to provide an edge to the Internet of Things arrangements. It is an objective portraying of the decentralized frameworks and empowering computerized change. Internet of Everything (IoE) innovation has been thought of upgrading the IoT business results. At present, the Internet of Things innovation is drawn closer from various viewpoints like detecting effectiveness, associating gadgets, communication interfaces, and gadget-created information. These limitations are investigated and put away to use the sheer cycles and engage the expected issues in IoT. IoE innovation expects to give a more extensive idea to the equivalent. The Internet of Everything is the following phase of innovation of the Internet of things, and the two of them are a lot related. It follows the hyper-associated appropriated framework continuously, which is the central innovation in measure stack advanced [32]. The worthy goal of the IoE innovation is to help the change of gathered data into significant information-based capacities that can be handily consumed by the internet of things application improvement company. IoE applications range from computerized sensor devices/interfaces utilized for far-off apparatuses to more astute and all-around associated intelligent phones, modern AI frameworks, and different sorts of dispersed equipment that have as of late become more insightful and mechanized [11]. Machines will commonly get astute by admittance to information and extended systems administration openings.

4. Transition from smart to intelligent

The IoE will be keen; in this manner, 6G will likewise be insightful. Therefore, all smart gadgets will change into

intelligent gadgets, and these intelligent gadgets will be AI-driven gadgets [8,13]. In this manner, the intelligent gadget will have the option to foresee, settle on a choice, and offer their involvement in other intelligent gadgets [26]. Along these lines, there is a change in perspective from brilliant to savvy time utilizing 6G communication innovation and AI. Multi-dimensional plan innovation is utilized to create an overly valuable item for our industry. It uses electronic and edges scientific to give the best answer for the clients. Holographic user interface conveyed in the climate of the 6G remote systems administration framework to screen the item. Remote multi-street availability is utilized in communication among components and action. 6G will be the seamless communication for the human user interface through the simulated intelligence interface. Human-Driven Administrations (HDA) that require targets as opposed to crude rate-dependability dormancy measurements [4]. Dynamic structure components can be joined with the foundation Internet of Things, and circulated characters will deploy with the help of 6G communication technology. Brilliant detecting and inserted knowledge would use to engage the model. Stem investigation would be sent in the calculated direction. Multi-object Internet of Things and edge logic is likewise utilized for appropriate setting mindful structure. A uniform information examination device can anticipate the future result of a business. Enormous information can be controlled additionally through the high availability of the 6G communication network—holographic communication the virtual touch to another customer, maybe a human or a robot. Material web requires quick communication and URLLC to get the material constantly [24]. This development will be used for remote operations with the advanced 6G communication technology. It will similarly help experts for examination using contact without being present. Haptic Human-PC communication (HCI) is characterized into three categories; specifically, work region, surface, and wearable [22]. In the work region, the inaccessible expert will have the alternative to use a virtual contraption for operation or finding. The contraption to give request has a level screen, for instance, a compact or tablet. As moving the hand on the screen, the robot can be furnished a request to interface with the patient. For instance, in wearable devices, a haptic glove is used by distant subject matter experts. Material advancement will in like manner help in giving human administrations during cataclysm time [25]. Expanded Reality (AR) helps with including virtual to real things. Likewise, it is gotten together with various material limits, for instance, sound, visual, haptic, etc. Moreover, AR gives nonstop affiliation and presents 3D pictures of virtual and real things [26]. Augmented reality supports delivering a creative or virtual presence where nothing is certifiable. It will require high data rates to give the incredible nature of the organization.

5. AI empowered 6G

6G communication technology will use edge computing with artificial intelligence that brings the server closer to the users from the cloud [23]. Next-generation technology will witness a wide range of differences in both operational technology and information and communications technology.

5.1. Hyper specification

One network platform customized for the highly specialized user. Clients may carry their IP addresses and network typologies without needing any modifications to the customer data center network. The isolation offered by the Windows Network Virtualization (WNV) policy makes it possible for a Hyper-V host to host virtual machines with the same IP scheme [12]. Hyper-specific network technology will bring massive growth in web services. There is a challenge to the proliferation of web services. The accompanying explosion of growth in data exchange has transformed the way we interact with the web, our business, and each other. The adoption of web services and the associated business and technology models behind them is at the core of nearly all significant advances in the last decade. But the rate of adoption of these technologies is not linear. While the first web services came online in the late 1990s, it took nearly a decade before they became mainstream. The growth of web services and web-based applications is accelerating, fueled by increased connectivity, better quality web content, and the explosion of mobile devices. Web services already support significant parts of the digital economy, and the future will see more of them come to life as new and powerful applications are built. For hosting companies, this is a huge benefit. They can create policy rules to separate virtual machines from clients while ensuring that clients connect with their workloads using the same IP address set as they do on their local network. Short deployment times and relatively high reliability are the obvious advantages of providing a fully integrated and tested system [21]. This is because a massive series of tests are placed into each component to ensure that it works with any other component and, correctly, ends up with an appliance of the enterprise-level [21]. It is like a data center in a box. Therefore, the 6G communication network will profoundly impact hyper specification.

5.2. Hyper capable

The original term used to describe this approach was ‘hyper-channel’ technology. It began life as a response to replacing copper-based infrastructure with technology that could transfer data at higher speeds. The term emerged in the 1990s when the network’s speed was the primary driver, and the term was defined in part to signify that the network was both fast and capable of delivering more data than ever before. The development of Hyper capable network technologies has come to encompass some fundamental changes to network protocols and how networks are provisioned. These advances are driven by the needs of the telecommunications and Internet industry to address the issue of network congestion in the 21st Century. 6G requires a massive expansion across all dimensions using Terahertz spectrum [22]. The change of address breaks current contact and interrupts the services running on the virtual machine. With the support of Hyper Network Virtualization (HNV), it is now possible to migrate virtual machines to various sub-nets on a lively basis [21]. Hyper Network Virtualization guarantees that the location of a live

migrated virtual machine is updated and synchronized between hosts with ongoing contact with the migrated virtual machine. Concerning the technologies used for live virtual machine migration, there are no improvements [23]. Without needing a modification to the network topology, virtual machines may be transferred to various virtual sub-nets, or premises [23]. It is simple for hosting providers to move customer virtual machines to different data centers without downtime in case of any maintenance operation at one of the hosting sites and allow customers to access virtual machines without any service interruption. So the capability will be highly increased in 6G communication technology.

5.3. Hyper sensing

Hyper sensing is a new paradigm for wireless networks where the nodes are equipped with several high-gain radio antennas. The radio is designed for one use only with the current sensing technology. Thus, its power consumption is very high compared with that of the human body. On the other hand, the wireless sensors used to detect human movement or vital signs are usually designed for long life cycles. As a typical application, healthcare is the most popular application of wireless sensors. Healthcare applications include health monitoring for patients and staff and/or patients' information retrieval. The sensors are frequently placed in the body to measure a patient's vital signs, including heart rate, temperature, and blood pressure. For these applications, the sensors need to operate for many years. A high gain antenna means that the power consumption is reduced many times of a conventional antenna while the gain is maintained. So that, with the same transmitter power, the sensor can receive more signals. 6G communication makes it easier to augment humans and machines. Where it could take months to configure and deploy a conventional solution focused on purchasing parts, a hyper-converged framework can be deployed in weeks and sometimes even in days [22]. So much effort is put into the component interoperation. Because the management processes surrounding the solutions are specially built around them, much of the difficulty that usually allows a datacenter to be handled and ensured is removed [24]. Sensors are hyperspectral line-scanning cameras that capture reflected light through an image slice [8]. One row of spatial pixels is collected per frame as motion occurs, with every pixel containing complete spectral data. It is possible to achieve motion in two ways: either as an airborne deployment or by applying practical force [12]. A third choice is also available where pan-and-tilt or rotating phases allow a hyperspectral sensor at a fixed position to search for stationary object detection [12]. Thus the hyper sensing is very much dependent on the fast and flexibility of the network. The large-scale industrial revolution will have a great impact through 6G network technology [21]. The radical growth of technology will bring a whirl in the upcoming future technology with the foremost networking system.

6. Machine learning with 6G

Machine learning (ML) is becoming more popular due to its diverse applications and capabilities. Machine Learning models are computer programs used to learn the characteristics or patterns of a system that is an explicit mathematical model. These models are used in tasks such as classification, regression, and interactions of an intelligent agent with an environment. When a model recognizes the features of a system, known as a qualified model, then it can learn the features of a system [21]. Perform the task effectively using some simple arithmetic calculations. Such development is conceivable due to the accessibility of cutting-edge machine learning models, massive data sets, and high computing power [6,23]. ML can be deployed in a highly configured infrastructure with broad network flexibility and real-time processing data. The prominent variant of machine learning such as supervised, unsupervised, and reinforcement learning can be equally integrated with 6G.

Machine Learning (ML) is used for society and social benefit. 6G will help to process the last amount of metadata with fewer resources and less computational power. Machine Learning could process an enormous amount of data and predict certain constraints. The capacity of machine learning is immeasurable. The effects of machine learning compatible with the 6G communication technology are also huge in each area, which in the coming days would do a lot of tasks [4]. Diverse techniques are being applied in artificial intelligence and machine learning, and that affects our daily lives. So, ensuring that the proper usage of advanced technology like Machine Learning could be considered to build a centered ecosystem. Businesses are looking for advanced software to help them evaluate data and make better decisions. Business intelligence (BI) software is at the forefront of these efforts. The goal of BI is to get the right information to the right people at the right time. 6G provides software intelligence to allow autonomous operations and consistently enhance market results [21].

6.1. Supervised learning

In supervised learning, the model learns from known data. The coefficient for half of the route stage is determined by exploiting the previously accessible data source arrangement combined with its associated expected performance [6,9]. The ideal application of the supervised ML is a scenario in which the true joint distribution of the input and output parameters is available, which can be extracted from the knowledge of the available domain [6].

The coefficients of the precipitation methods are learned in supervised learning by exploiting the previously available set of inputs paired with their desired outputs. As a scenario in which the true joint distribution of input and output parameters is available, the ideal application of supervised machine learning can be pronounced. For transceiver communications, supervised learning at the physical layer can be optimal power allocation and temporary suspension of interference [26]. Supervised learning applications are not limited to the physical

layer, it has several common networks, application, transport, and other layer applications. Thus 6G could affect the supervised learning process.

6.2. Unsupervised and semi-supervised learning

In unsupervised learning, there are no feature names, and the model discovers how to cluster related information [22,23]. In the 6G communication network, the set of available input data samples is used in unsupervised learning to train the system, although no previous knowledge on the desired system response is available. Unsupervised learning can presumably be applied to perform the broad range of tasks related to points clustering, extraction of features, classification of features, distribution estimation, and generation of distribution-specific samples. In highly complex vehicular communications situations, where less coherence time restricts the time available in the physical layer [13]. 6G will be deployed on a large scale to ease the complex decision-making. Subsequently, different possible implementations of unsupervised and semi-supervised learning for grouping, pairing, node clustering, or points for the optimal allocation of network resources occur at the higher layers of the networking system.

In semi-supervised learning, a small amount of annotated training data is available. At the same time, most of the data is unlabeled, whereas, in unsupervised learning, no annotated training data is available [6]— the real-time data relay on a high-frequency network like 6G. A limited quantity of annotated training data in semi-supervised learning is open though much of the knowledge is unlabeled. Model-based learning usually optimizes performance indexes with high computational efficiency across accessible target functions. Semi-supervised learning will find its way to support the channel equalization and monitoring activities [13]. Thus 6G will help unsupervised learning to become more intelligent.

6.3. Reinforcement learning

In reinforcement learning, the operator connects with the situation and discovers how to plan for any contribution to the activity [24]. With the implication of 6G telecommunication technology, the network has become more intelligent and advanced. Reinforcement Learning uses several agents. The agent can partner with each service station on the cellular network to help in learning the best programming parameters to improve the quality of service on the network [9,10,33]. This technique of learning may be identified as a balance between supervised and unsupervised learning, where indirect control is provided by the previous knowledge of the optimal performance of the system [21]. The agent aims to enhance the accumulated reward in the long term. As a reinforcement learning problem, many wireless issues such as resource allocation can be formulated [21]. Various deep reinforcement learning architectures can be used to solve several problems on wireless networks, and in this process, 6G would fabricate the networking system.

It is possible to evaluate the machine learning algorithm based on the amount and quality of the data in progress. Networking constraints directly influence the decision-making paradigm. The batch-learning algorithms can be applied to applications with a large number of previous training data available [23]. These off-line methods, in which the data is manually collected, labeled, and then processed by batch, typically face the limitation of minimal data available. The advanced machine learning technology would use to empower the 6G network. Quantum Machine learning will also play a crucial role in the implementation of 6G communication [11,13]. Quantum ML uses cognitive learning intelligence and Edge AI. It is expected that quantum machine learning will provide high accuracy in real-time [10].

7. Deep learning with 6G

Every sector of the deep learning system would be affected by the 6G intelligent communication system. Deep Learning is a subset of Machine Learning in artificial intelligence that mainly deals with unsupervised data. Deep Learning is a combination of both supervised and/or unsupervised learning. Automatic learning features allow a system to learn complex functions that translate the input to the output directly from data at several levels of abstraction, without relying exclusively on human-crafted features [20]. Deep learning has been explored for network anomaly, and fault diagnosis, intrusion detection and prevention, network configuration, and optimization [23]. 6G communication technology aids the system to collect and process the data in a real-time scenario.

7.1. Artificial Neural Network (ANN)

An artificial Neural network is a biologically inspired data processing structure that is designed to learn different operations from the observed data [6]. Artificial Neural Network (ANN) is one of the most efficient deep learning algorithms. ANN follows neuron-like architecture to threat enables several techniques to use the vast amount of data. The high computation power of the network and the interconnected network can re-constrain the neural level operation [34]. From several layers, the neural network is formed [24]. The multiple underlying layers are also addressed as multi-layer perception. The neurons are considered insignificant in one layer. These nodes have a module for activation function [12,20]. The neuron of ANN would use cognitive intelligence to compute its complexity. The design of these interconnections in an ANN is important [13]. The generalization of the operations of an ANN implies its training over a large amount of data to successfully deal with any new unseen input data sample [24].

7.2. Deep neural network (DNN)

The deep neural network is a special artificial neuron system capable of classification and generalization. We can consider deep learning as a generalization of a human in the sense that there are several layers of human neurons [13]. And just

as a human brain is able to recognize a specific image and distinguish it from another image, a deep neural network can learn a model that can identify similar images and classify them. Like the human brain, a deep neural network uses an artificial sensory input, a vector. We provide this input as a matrix called the input layer or also the hidden layer; that is why deep learning is also called a deep neural network. This is why deep learning can learn very complex things like images or characters or speech, whereas a linear classifier can only learn linear classifications. The deep networking will fasten the 6G advanced communication system. With the help of advanced networking, we can also rebuild neural networks to accelerate the decision-making process.

7.3. Federated Learning in 6G

Federated Learning (FL) is a collaborative machine learning approach that allows models to be distributed amongst the entities involved in a learning task without necessarily knowing about each other. It provides machine learning models to be jointly trained in parallel without directly sharing or communicating the model parameters. Instead, each entity trains a local model based on local data and sends model parameters back to the federation server for the final model updates, which is then used to train the federated ensemble. The FL approach is conceptually similar to federated learning in that all data and model parameters are divided and distributed between the entities. Still, the main difference is that training is only performed locally instead of locally and centrally. There have been many attempts at federated learning in the past; however, these were either not adopted or could not scale up due to data privacy concerns and the sheer computational load of training. 6G will be devoted to self-learning and will make smart decisions to make life easier.

The federated learning technique has the benefit of facilitating the learning process by decreasing the required time and independently calming the state of the training data. Federated learning and Inferring learning would be deployed to make the network more cognitive. Federated learning is a machine learning technique in which an algorithm is trained through several decentralized edge devices or servers holding local data samples without them being exchanged. A decentralized system allows AI algorithms to obtain knowledge from diverse data stored across multiple sites.

A fundamental paradigm transition towards intelligence from smartness and intelligence radio environments is supposed to be encountered by today's wireless communication networks [12,35]. The important point about deep learning functions in such communication networks is not whether it will be an integral part of the future networks but rather when and how this inclusion can be activated. Deep Learning would be used to supplement the processing methods for estimating and decoding detailed information on sequential blocks as an end-to-end solution [36,37]. Knowing how to perceive symptoms in crucial cases, which decision to make next, and which intervention to have all comes down to the experience. Federated learning enables AI algorithms to gain experience from a wide range of data located at various positions. The strategy allows many organizations to collaborate on model growth, but without having to associate critical clinical data directly with each other [13]. Federated learning decentralizes deep learning by eliminating the need to pool data into a single location. The model instead is trained at various sites in multiple iterations. To ensure that patient data is kept secure, federated learning also needs careful implementation [20]. But it can solve some of the problems facing methods that enable sensitive epidemiological records to be combined. The various platforms that are part of the learning network each have a copy of the model on the computer in a federated learning system. The individual devices use the client's local data to train their copy of the model. Then the parameters/weights from the individual models are sent to a master computer or server, which aggregates the parameters and updates the global model. It is then possible to replicate this training phase until a desired degree of consistency is obtained [38].

7.4. Black-box

The black box algorithm, also known as the deep learning black box, is a type of advanced machine learning method in which access to the training data, or "black box," is prevented from researchers [39]. The hidden constrain of the black box totally depends on the high specificity of the network where 6G communication technology can put footprint. Exclusively, the outcome of the training process is observed instead of attempting to figure out the internal processes of the learning algorithm. In a practical example, a trained black box is usually deployed on computers and/or smartphones for making decisions or predictions without the ability to understand how it works [34]. These predictions are usually used in a real-world context, which makes the process inherently unpredictable as it has no knowledge of the environment in which it operates. Black box machine learning algorithms are beneficial for a variety of purposes, such as predicting the future financial behavior of an investor, identifying fraudulent activity on the Internet, or creating systems for data mining. The black box algorithm is most commonly applied to a classifier with an unknown internal mechanism. A black box classifier is trained on a set of data, and it is presented with new training data. The training data used to create the model is called a training set. The process would be more sophisticated with the help of the advanced artificial intelligence-enabled 6G communication network.

8. UAV with 6G

Unnamed UAVs (UAVs) can be interpreted as tiny drones, balloons, smart drones, or aircraft that can be pre-programmed for specific tasks and remotely controlled. Military, surveillance, search and rescue, and more critical tasks require cognitive intelligence networks to participate correctly, and 6G will become the driving force of these technologies. This kind of smart drone will identify fires, accidents, traffic, etc., with the purpose of constantly educating the police. The police can

also use smart drones to spray poison gas and control the crowd [1]. Unmanned aerial vehicles are expected to replace many conventional systems with the help of AI, for instance, fire control. This technology will be used for 6G, which enables non-cellular communications [7]. At this point, when the user equipment (UE) moves to start with a cell and then to the next, the call from the client must move to the next cell [9]. Through the combination of artificial intelligence and 6G communication, we can easily make our drones smarter. Smart robots will be equipped with Drone-to-Drone and Drone-to-Infrastructures for communication and will be able to share their knowledge and provide faster online data transfer [1,26].

For example, swarm drones are used for specific military operations. Additionally, drones can be deployed to monitor border activities in real-time via ultra-high definition (uHD) video streams to monitor border activities using 6G communications—for instance, Drone as Cop or Drone Surveillance on the border of two countries. The most advanced communication networks will connect all possible devices on a server for collaboration. The entire 6G network needs an intelligent cloud to help artificial intelligence make its own decisions. The main classification of drones is height and type, among which the high communication capabilities of 6G technology will play a vital role. We also envision high-quality service and high-quality life. Nayak and Patgiri also saw some potential for implementing 6G in closed-circuit video cameras (CCTV) [1]. Currently, CCTV is used for security and observation, which makes us very safe, and CCTV is also used as an observer in court in many countries. CCTV is ineffective in determining many things and distinguishing the mentioned dangers [2]. With the advancement of lightweight shopping drones reducing the cost of increasingly modern aircraft, and the potentially explosive growth of these drones has resulted in a significant increase in airborne photography and camera applications, automatically elevated frames have become the norm. Stay away from review and observation for commercial reasons.

UAV is an expression of an Unmanned Aerial Vehicle, an aircraft without a pilot. The UAV can be a remote-controlled aircraft that a pilot flies at a ground control station, or it can operate independently according to a pre-programmed flight plan or a more complex dynamic automation system [40]. Drones are currently used for various missions, including reconnaissance and attack missions. In some examples, the acronym UAV has been applied to the unmanned aerial vehicle system [31]. Reflects the fact that these complex systems require ground stations and other items in addition to the actual aircraft. The term Unmanned Aerial Vehicle was officially changed to Unmanned Aircraft System to reflect the fact that, in addition to the actual aircraft, these complex systems also contain ground stations and other component [31]. In a wide range of temporary social gatherings, military operations, and disaster situations, drones have recently become a rapidly deploying in-flight wireless access platform for secure communications and are expected to become future candidates. The latest advances in drone technology enable wireless applications to develop low-cost, durable, and miniaturized drones [41]. These unmanned aerial systems are generally classified as high altitude platforms and low altitude platforms (LAP) based on their size and operational range. LAP can work in a height range of up to several hundred meters. The drone is likely to stay in an intermediate position throughout the process rather than an extreme position. However, the spatial phase of the drone's motion is more likely to be uniform. With advanced network flexibility, 6G will combine drone technology to be fully functional.

9. Automated vehicle with 6G

Nowadays, we can evidence automatic vehicles with the help of technology, for instance, self-driving cars. The intelligent vehicles will upgrade fuel utilization, course, and work efficiency because 6G communication innovation can give continuous services and insightful vehicles are more conservative for the motivation to foresee future and improve the issue financially [24]. We can use the computer vision algorithm to maintain connectivity with all the components. 6G will investigate dynamic range access, and it will rely upon AI for carrying the overwhelming calculation duty to give cutting-edge administration. With the more interactive neural network connection, the cars will work intelligently, and they can communicate with each other for data sharing through 6G communication [11]. There are two categories of automated vehicles, particularly Autonomous Vehicles (AV) and Connected Automated Vehicles (CAV).

9.1. Autonomous vehicles

An autonomous car is a machine that relies entirely on its onboard sensors to perform vehicle control functions and maintain situational awareness. The autonomous motor is a device that requires almost no human interaction; it can perceive its surroundings and move safely. Autonomous vehicles integrate a series of sensors to explain their environments, such as radar, sonar, GPS, and inertial measurement units. Advanced control systems will interpret sensory information to distinguish between appropriate navigation routes and appropriate obstacles and signals [24]. In the case of autonomous vehicles, the search for the safety of autonomous vehicles is the main objective of functional improvement, or expansion [21]. There is no question that autonomous vehicles are safer than those driven by human drivers. Mechanical failures cause the remaining 10% of accidents and unsafe road conditions, which are currently beyond our control [24]. The vast majority of car accidents are the result of outright misconduct. These safety features will help make human-controlled cars safer before the number of self-driving cars on the road exceeds them.

9.2. Connected automated vehicles

A networked self-driving car is a vehicle that can recognize other equipped vehicles nearby. It was also aware of the specific features of the surrounding infrastructure, such

as intersections and curves. Among the most extensively researched automotive innovations are connected to vehicle technologies [12]. Just a fraction of what is being built for the future is the automotive technologies currently available. Technologies for autonomous vehicles connected vehicles, and advanced driver assistance systems overlap and compare the technologies, concepts, benefits, and challenges of this emerging field—a fully autonomous vehicle in which a driver is not needed and able to carry passengers, and there are many connected vehicles on our roads already [31]. Connected vehicle technologies allow vehicles to connect with the surrounding infrastructure. Many people would be familiar with connected vehicle technology already. Various systems cooperate with each other to control autonomous vehicles. Radar sensors scattered throughout the car monitor, the location of nearby vehicles, [23]. The camera detects traffic lights, reads traffic signs, and tracks other vehicles while paying attention to pedestrians and other obstacles. Light Range and Detection Sensor (LDRS) helps detect the position of cars and other vehicles when parking. The central computer analyzes all the data from various sensors to manipulate steering, acceleration, and braking. Moreover, a Connected automated vehicle system maintains Vehicle-to-Vehicle (V2V), Vehicle to Infrastructure (V2I), and a foremost cloud. This technology is used for vehicle safety and for improving vehicle efficiency and travel time. 6G communication technology aims to connect the entire network through a fast cloud-based internet connection to facilitate network connectivity. The network will be smart enough to learn from past experience [40]. With the help of artificial neural networks, machine learning algorithms, and deep learning, we can make machines more efficient and useful. Analog intelligence will be fully strengthened in 6G computerization [12]. The automotive industry is on the verge of progress, and manufacturers are looking to provide vehicles that will improve the driving experience for their customers. 6G communication network would eventually change the creation and introduction of the connected car. From the moment the car door is opened to the time it pulls up to the final destination, the connected features of the vehicle would allow the driver and passenger to have a radically different experience, making many of the current pain points of today a thing of the past.

10. Data Science and 6G

Data Science itself is an essential part of artificial intelligence. It can examine valuable inside information from the dataset and predict future issues. AI technology opens up the possibility of end-to-end optimization of a complete data science lifestyle through the powerful network facilities of 6G [40].

10.1. Descriptive data analysis

Descriptive data analysis finds out the "What" condition from data. It deals with the cleaning, relating, summarizing, and visualization of the data. These constraints can easily be solved with minimum time complexity with the foremost connectivity. The concept of using analytical techniques to explain or summarize a collection of data is descriptive analysis. Descriptive analysis is recognized as one of the major types of data analysis to produce accessible insights from otherwise uninterpreted data. The descriptive analysis does not try to make estimates, unlike other forms of data analysis. Instead of manipulating ways that make it more relevant, it draws insights solely from past results [25].

10.2. Diagnostic Data Analysis

Diagnostic Data Analysis reveals valuable information, such as data decomposition, data discovery, data mining, collection, and causality. Connecting to a smart grid system can drastically change the market's growth. Diagnostic analytics are typically carried out using data exploration, drill-down, data mining, and correlations. Analysts classify the data sources in the discovery process that will help them interpret the findings. Drilling down means concentrating on a particular aspect of the details or a specific widget.

10.3. Prospective data analysis

Prospective data analysis defines the process of predicting the future value of data. AI-enabled 6G technology will bridge real-time and historical data and predict the most crucial insights in real-time. With the help of artificial intelligence, we can build a complementary model and accurate business intelligence tools in a deep network environment. One of the ways we discover knowledge from our information and make it work for us is diagnostic analytics. There are numerous ways of addressing data questions, so reflect on which questions are the most important for any organization.

10.4. Predictive data analysis

It had been seen that AI had brought the world into our hands in the form of a tiny device, i.e., a mobile phone. Proper usage of artificial intelligence in a well-established environment can predict data that would be more accurate. Model optimization and refining the model would be much easier in 6G communication network technology. The use of statistics and modeling to assess future output based on current and historical information is represented in predictive analytic [40]. With a substantial degree of accuracy, predictive analytic technology will produce potential insights. Any company can now use past and current data to accurately forecast patterns and behaviors in milliseconds, days, or years into the future with the help of advanced predictive analytic software and models. Predictive analytics is a form of data analytic focused on historical data and analytic techniques such as machine learning to make predictions about future results [31]. The data-driven network architecture of the 6G communication technology will focus especially on the connectivity, and the availability of the data [11]. We can also derive how the 6G and AI will encourage every marketing more economical model with its intelligent power.

11. Artificial robots with 6G

Today, advanced artificial intelligence algorithms will spark a revolution in the short term. Humans can interact directly with machines to complete tasks accurately. Due to the emergence of artificial intelligence and communication technology, industrial robots will become more intelligent [11]. Robots and sensors need amazingly powerful, low-downtime matching to ensure accuracy, and swapping helps create faster. 6G edge nodes will control heavy calculations to provide spontaneous responses. 6G has high-density communication capabilities and will be able to manage a large number of robots, and sensors [42]. Agree, we can say that the 6G communication network will use AI-based wireless communication networks, edge AI [10] and quantum machine learning in embedded systems [4]. Although all these limitations are now in the research field, it is clear that 6G communication technology will become more prominent in the near future. More aspects can be considered in the field of robot automation with 6G communication technology.

11.1. Robots with emotional intelligence

The main obstacle to artificial intelligence is learning the human brain's infrastructure. Deep neural networks are used to decompose large amounts of data like neurons and continue to calculate future results [41]. Robots strive to receive more advanced duties. One of these jobs, and certainly one of the most difficult, is to achieve meaningful human interaction [10]. It takes a lot of interconnected, well-orchestrated technologies to create socially adept robots that can become our caregivers, tutors, assistants, and companions. Lightweight, powerful, and customized applications can make a big difference and allow the robot to achieve a human–robot interaction when it comes to the user interface. Since they were not user-friendly, many complex and sophisticated machines on the market failed. For realistic, intuitive interaction, any robot that is in direct contact with people should be programmed [10].

11.2. Industrial robots

With the help of the interconnected intelligent network, the whole industry can be automated with artificial intelligence [10]. The potential use of intelligent networks and smart devices have made it possible in recent years. Moreover, the robots can share their data without any human interaction. It demands a seamless communication channel for ongoing examination and activity arranging [11]. New robotics techniques are essential to artificial intelligence. The emphasis is on developing solutions that combine hardware and software, conducting operations with incredible speed, reliability, security, and safety to use machine learning and AI-guided functions effectively. AI is required to ensure maximum reliability and accuracy in robots. Manufacturers use AI intelligence in the robotics industry to assess the necessary timeline for delivering holistic robot maintenance. This allows clients to eliminate needless breakdowns and the related significant maintenance expenses [10]. The efficiency of robots is improved by carrying out a detailed review of the data collected from their sensors. These involve factors such as the consumption and movement of power. By using the AI algorithm's output, the robot's program can be modified in real-time. Artificial robots are here to stay as the future of manufacturing is poised on the cusp of a new industrial revolution. The rapid pace at which automated technology has advanced will continue to accelerate innovation in automation and AI technologies, paving the way for entirely new and fascinating forms of robotic technology, such as the autonomous, dynamic machines of tomorrow. The healthcare sector is expected to grow to approximately 30 percent of robots' total global market share by 2020. This rapid growth in the healthcare sector will significantly increase the demand for various devices, including surgical-robotic systems, diagnostic robots, and mobile robots. The global healthcare sector is expected to reach 1.7 trillion dollars in 2025. The logistics sector is also expected to grow to more than 1.2 trillion dollars by 2025. The growth in the logistics sector is primarily driven by the rapidly increasing e-commerce business and the growth in the retail industry.

11.3. Robots in healthcare

The Internet of Intelligent Medical Things (IIoMT) will help to stay away from the limitations of reality. For example, remote experts can use remote surgery that requires fast communication to perform prudent tasks, and experts can supervise remote surgery through oral appointments, pleasant appointments, or remote assistance [10]. Hospital to Home (H2H) will be upgraded to a portable medical clinic on an intelligent vehicle platform, which will rely on emergency clinics, including experts and assistants. This multi-functional medical clinic will replace the advantages of rescue vehicles, such as the gradual identification of emergency laptops in clinics accidents and arriving at the scene. Intelligent wearable devices (IWD) are associated with the Internet and can convey mental and physical information to test methods and verify methods [24]. Health care AI applies specifically to physicians and hospitals that access large data sets of potentially life-saving data. This involves methods of treatment and their outcomes, survival rates, and pace of care collected through millions of patients, geographical areas, and myriad health conditions that are often intertwined. New computational power can detect and analyze large and small data patterns and even make predictions through machine learning to identify possible possibilities [10]. Robots are used for customer service in hotels and shopping spaces worldwide. Thanks to artificial intelligence's natural language processing capacity, they use AI to communicate with clients humanely. Interestingly, their capabilities are improved by prolonged contact with individuals and customer service robots. Different robots in the robotics industry are provided as open-source robotics systems with AI capabilities.

11.4. Robots in smart cities

Artificial intelligence will create services and observe key operations very precisely. With the rapid management of the city's Internet connection, logistics scans will be monitored by human robots [10,43]. Security and comfort are also key constraints for the development of smart cities. In addition, the industries will be significantly affected by cognitive intelligence. Research shows that Industry 4.0 has led the physical industry to realize digital industry, and the industrial automation of 6G infrastructure will connect everything from mobile devices, machines, and robots [5]. It is assumed that artificial humans or robots balance and step forward in urban space. Experts in robotics are hopeful in the face of the daunting uncertainty in people's minds about robots taking away jobs or worries as great as robots taking over the world. Robots will help us combat the world's most challenging problems. Using algorithms, we will better understand climate change and analyze data from the oceans, rain forests, and atmosphere. For communities that need it, we can make arrangements for surplus food, respond to natural disasters, and so much more. Nobody thought of positions a few years ago, such as social media researchers, data scientists, software developers, or mobile marketers, but today they exist. Smart City Robotics implements a highly connected robotic system revolving around the new generation of Automated Guided Vehicles (AGV) to implement this vision. In the long run, AI robots are more cost-effective, but the technology needs massive initial investment because of their complexity. Over time, as the need to create proprietary solutions declines, this technology will become cheaper for businesses. If more sophisticated AI systems are implemented into robots, error margins will decrease, and complex tasks with more accuracy and autonomy will be easier to execute. Therefore, we can emphasize that a more flexible 6G network will push our economy towards a fully automated industry. Robots can be used to overcome all the tasks that humans now solve. Robots will perform critical tasks with greater precision and reduce human errors.

12. Security, secrecy and privacy

Generally, 6G can choose to transmit the highest level of security. Adding the Internet of Everything to 6G and providing new management, such as smart homes, emergency clinics, transportation, and smart grids, etc., will promote the aforementioned security challenges [25]. In addition, quantum communications will highlight the vital security needs of 6G. The combined AI will protect against adversarial attacks in 6G. Notably, 6G will provide physical layer security. Generally, 6G can select the most crucial security level for transmission, and because of the terahertz (THz) [44]. The mystery and protection depend entirely on the 6G security offer [31]. In any case, sensitive information requires the essential sense of mystery, such as the secret word for financial balances. Quantum cryptography can be used to unravel the mystery. In addition, protection is one of the main concerns of those who must take care of in 6G [45]. In particular, human services require the highest degree of security assurance [42]. 6G will open up new ideas for the coordination of comfort and safety 6G; including central management, use cases, key performance indicators, enabling innovation, models, factory operations, existing difficulties, potential repairs, openness, and exploration directions [34].

6G's top priority is creating value by meeting human needs. Smart grids require low latency network connections, which will allow faster data transfer speeds. 6G will run on a specific platform with more network flexibility. 6G will be better able to optimize cellular networks in terms of interfaces, hardware, and extensive data transmission and processing. Quick exploration in machine learning can allow each gadget to have a perspective that can be used positively or negatively. If vicious gadgets have this ability, they must intentionally cause resistance. At this point, it can be used in similar situations. The security of the different devices that are overlaid underneath poses a security risk [26].

13. Conclusion

With the agreement, we can conclude that 6G communications will be the daily needs of common people, and it will be integrated with artificial intelligence to make an intelligent communication system in the near future. The intelligent network will be fully AI-driven, and the cognitive model of the network architecture will affect every aspect, such as artificial general intelligence, narrow artificial intelligence, and artificial superintelligence. More importantly, the various potential enabling technologies will promise a high Quality of Services (QoS) and a high Quality of Experience (QoE) to transfer society into an AI-driven smart city. So we can predict that shortly AI and 6G will become more efficient and reliable to the end-user. Artificial intelligence and 6G communication networks will combine to create a new era in digital communication technology.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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