An Overview of the Implications of Artificial Intelligence (AI) in Sixth Generation (6G) Communication Network

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Abstract

The 6G communication network is anticipated to be a cutting-edge next-generation communication network that will enhance the value of the intelligent Internet of Things (IoT). The emergence of many domains within artificial intelligence (AI) has paved the way for significant opportunities in the development of 6G technology. These opportunities include the enhancement of human intelligence, the integration of various devices and systems through the Internet of Everything (IoE), improvements in the quality of experiences, and enhancements in the overall quality of life. The integration of AI and 6G networking technology is anticipated to bring about a transformative shift, transitioning from a focus on interconnected devices to a paradigm centered around interconnected intelligent systems. This article provides an overview of the extent to which AI is poised to revolutionize 6G networking technologies. This study is primarily concerned with the implementation of appropriate applications that address human needs and challenges. Furthermore, this research highlights the significance of technology that has the potential to provide value for emerging technologies.

Keywords: 6G; Communication technology; Artificial intelligence; Machine learning; Deep learning; UAV; Data; Robot.

1 Introduction

The convergence of 6G networks and AI has the potential to profoundly reshape our technology paradigm and usher in a transformative era in modern living (Serôdio et al., 2023). Hence, it can be anticipated that the market for 6G networking technology will have significant growth throughout the period spanning from 2030 to 2040 (Meena et al., 2022). Similar to most innovations, it is anticipated that the realization of commercial viability will need several decades. Numerous scholars have already elucidated the favorable and unfavorable effects of the novel network technology (Raihan, 2023a). The integration of full AI is expected to occur in 6G networking technology (Banafaa et al., 2023). According to Meena et al. (2022), AI will play a crucial role in the communication systems of the 6G network. Furthermore, it is anticipated that the system would provide compatibility with Extended Reality (XR) and Augmented Reality (AR) technologies (Viswanathan & Mogensen, 2020). These technologies possess the capability to enhance the network system to a higher standard. In summary, the entirety of the architecture will be built on cloud computing, exemplified by the implementation of Edge Computing (Raihan, 2023b). The client does not necessitate the installation of servers, software, or hardware, but does require a high-speed internet connection. Cloud technology has the potential to encompass comprehensive network connectivity and adaptability (Waqar et al., 2023), thereby establishing a dynamic ecosystem powered by real-time data. According to Banafaa et al. (2023), 6G technology is expected to possess significant capacity and minimal latency, enabling it to effectively support highly extended network systems while maintaining low power consumption.

The telecoms business on a global scale is currently experiencing a significant and remarkable period of change (Duan & Xia, 2022). The utilization of a decentralized network system enhances its overall potency (Asaithambi et al., 2022). The continuous development of network systems aims to achieve uninterrupted performance in the areas of mobile broadband, highly dependable and low-latency communications, and the interconnection of large-scale machine-type devices (Kasgari et al., 2020; Banafaa et al., 2023). A significant number of contemporary hardware systems possess the capability to effectively manage and integrate substantial volumes of data. According to Kafetzis et al. (2022), cellular wireless networks employ several advanced techniques, including software-defined networking, heterogeneous networks, and virtualization, in order to enhance connection. The implementation of AI technology in network management enables the efficient control and oversight of a high-speed monitoring system (Song, 2023). The implementation of various cloud services, network virtualization, and other discrete components has the potential to streamline some tasks (Adoga & Pezaros, 2022). However, over time, this phenomenon results in further division and a heightened necessity for the regulation of these technologies. The implementation of 6G technology will facilitate the development and customization of an advanced toolkit (Dao, 2023). According to Firouzi et al. (2022), the utilization of edge AI in a management system enables the handling of intricate integration in a hierarchical manner.

The development of 6G network is intelligently advancing the existing communication networking infrastructure (Meena et al., 2022). Despite the fact that the global deployment and practical implementation of 5G technology is still ongoing, scholars have already shifted their focus towards the development of the 6G networking framework (Chavhan, 2022). Furthermore, the researchers have initiated efforts to integrate the 6G networks with the capabilities of AI in order to establish pervasive and dependable communication (Banafaa et al., 2023). Therefore, it is increasingly seen as the fundamental pillar supporting the societal shift towards digital transformation (Asghar et al., 2022). The integration of diverse technologies and applications enables 6G networking technology to establish connections with a wide range of devices and systems (Banafaa et al., 2023). Additionally, it provides compatibility for holographic, haptic, and submersible technologies. The implementation of this technology has the potential to enhance the connectivity and functionality of various domains within the IoE, including the Internet of Industrial Things, Internet of Medical Things, Internet of Nano-Things, and others (Kasgari et al., 2020; Sun et al., 2020). Hence, the potential of 6G networking technology to deliver on its commitments can be realized with the integration of sophisticated AI.

The primary objective of this research study is to conduct an intricate investigation of the 6G communication network. This article presents a review of many advanced methodologies, including quantum machine learning (ML), deep learning (DL), and black box techniques, with the aim of enhancing the capabilities of high configuration networking systems. This study explores the complete life cycle of the AI process. Additionally, it delineates the various applications in the construction and surveillance of intelligent data products. This article hinges on the security, confidentiality, and privacy limitations of networking systems, emphasizing the effective utilization of modern AI methods.

2 Core Technologies of 6G

The concept of 6G networking revolves around the notion of sixth-sense communication. The technology in question will encompass three dimensions, specifically those of time, space, and frequency (Miya et al., 2023). The forthcoming 6G technology is expected to be characterized by a communication system that is primarily driven by AI. The essential requirements for 6G communication technology encompass several key factors, including a high data rate, a high operating frequency, a low end-to-end delay, a reliable high quality of service, a high level of mobility, and a wide frequency range. Furthermore, the integration of holographic communication and augmented simulation is expected to enhance the capabilities of intelligent network communication systems (Banafaa et al., 2023). The emerging technology of 6G is expected to provide 3D sorts of support through many means such as edge technology, AI, cloud computing, and blockchain (Khan et al., 2022). The 6G networking system is expected to have a ubiquitous presence and be fully integrated. According to Zappone et al. (2019), the implementation of 6G technology is expected to enhance and expand connectivity by enabling seamless communication between devices, as well as through low-earth orbit (LEO) and satellite communication (Dicandia et al., 2022). The objective of 6G is to integrate computation, routing, and detection into communication networks. Within the realm of safety, the 6G technology will encompass the domains of security, confidentiality, and safeguarding the vast amount of data generated by billions of intelligent devices (Chavhan, 2022). A transition is anticipated from smart electronics to intelligent gadgets. Intelligent devices necessitate high-speed connectivity that is characterized by ultra-reliable low-latency communication (URLLC). The essential requirements for 6G networking encompass an operating frequency of 1 THz, a data throughput of 1 Tbps, a frequency range of 300 µm, and a range of versatility spanning 1000 km (Serôdio et al., 2023). The design of 6G incorporates three-dimensional aspects encompassing time, space, and frequency. According to Luong et al. (2019), the latency components of 6G communication, namely the end-to-end delay, radio-only delay, and processor delays, are all within the range of 1 ms, 10 ns, and 10 ns, respectively. The communication technology known as 6G is characterized by its reliance on AI. As a result, it requires a wide mobile bandwidth and low latency. Additionally, it encompasses two key aspects: enormous broad bandwidth machine type (mBBMT) and massive low latency machine type (mLLMT) (Gui et al., 2020). In their study, Bi (2019) examines ten emerging themes in the field of 6G communication. In their publication, Letaief et al. (2019) offer insights into the role of AI within the context of 6G communication. The study conducted by Zhang et al. (2019) centers around the topics of 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 very low-power communication. Figure 1 illustrates the fundamental technologies of 6G, accompanied by their respective components.

Figure 1. Core technologies of 6G (Qadir et al., 2023).

2.1 Quality of services (QoS)

The QoS in a designated network region pertains to the comprehensive evaluation of performance delivered by 6G communication technology. The provision of QoS in 6G communication is facilitated by the utilization of AI techniques. AI plays a crucial role in enhancing the QoS in 6G communication. This advanced communication system encompasses various features such as high data rates, ultra-reliable low-latency communication (URLLC), improved portable broadband, extensive machine-type interchanges, long-distance and high-mobility communications, and highly efficient low-power interchanges. Furthermore, the concept of QoS encompasses the integration of flexible and extensive transmission capacity along with low latency, as discussed by Luong et al. (2019) and Chen et al. (2020). The QoS of 6G networks is largely reliant on AI, particularly in the context of AI-driven physical layer security. The significance of QoS increases as organizational performance requirements adapt to the growing number of persons employing their services. Modern online apps and services necessitate substantial amounts of bandwidth and network performance, with users expecting them to provide high-performance reliability. The persistence of this matter can be attributed to the substantial level of similarity potency exhibited by the 6G network. Hence, it is imperative for organizations to devise strategies and implement innovative approaches that guarantee optimal support. The significance of QoS is growing as the IoT continues to advance. Within the assembly area, machines already play a significant role in enabling businesses to provide real-time notifications regarding any potential issues (Nawaz et al., 2019). Consequently, any delay in acknowledging the matter could result in significantly costly errors. The concept of QoS enables the efficient management of information flow inside an organization, ensuring that data is transmitted at optimal speeds to meet the business's requirements. Urban communities are equipped with a multitude of sophisticated sensors that play a crucial role in facilitating the extensive range of IoT projects and infrastructures (Raihan & Tuspekova, 2022a; Raihan et al., 2022a; Raihan et al., 2023a).

2.2 Quality of experiences (QoE)

The concept of QoE encompasses the provision of QoS and client-centric communication facilitated by AI-assisted services. The achievement of QoE can be facilitated through the utilization of holographic communications, AR, virtual reality, and material internet. These technologies necessitate a high rate of information transmission coupled with very low latency (Kasgari et al., 2020; Viswanathan & Mogensen, 2020). Therefore, the integration of AI with 6G connectivity is necessary in order to enhance the QoE for consumers. Furthermore, the advancement of QoE is deemed necessary in the context of cutting-edge automobiles, smart devices, sophisticated healthcare systems, intelligent automation, and various other domains. According to Nawaz et al. (2019), the achievement of a high QoE is contingent upon the successful fulfillment of all the promises made by 6G technology. The implementation of 6G technology is expected to enhance the overall quality of user experience, particularly in the educational sector. This improvement in quality is anticipated to contribute to the provision of high-quality services within the educational business. The type of Involvement refers to the extent to which a client is satisfied with the assistance received, as seen by the customer. The aim is to acknowledge the conceptual experiences of the service recipient, encompassing all their complexities and factors influenced by human dependence, such as the physical, temporary, user-oriented, and financial aspects. The determination of QoE in a particular scenario is influenced more by the magnitude and scope of the subject matter that is being assessed and quantified (Alsharif et al., 2020). Understanding the essential elements of customer satisfaction and accurately assessing them from the customer's perspective are crucial aspects to consider. Therefore, it is imperative for specialized businesses to consistently monitor and assess the QoE of their clients in order to make real-time improvements to their services.

2.3 Quality of lives (QoL)

The enhancement of individuals' well-being can be achieved through the utilization of QoS and QoE measures. The advancement of 6G technology is expected to enhance the overall quality of life by leveraging advanced communication innovations. The achievement of a high QoE can be realized through the implementation of optimal boundaries facilitated by the advancements in 6G technology. Holographic communications have the potential to attain a superior QoE, enhanced reality, AR, and material web, necessitating a substantial information transmission rate coupled with little latency. The advent of 6G innovation is expected to bring about significant advancements in the field of communication technology, driven by the integration of AI. As a result, we anticipate witnessing several transformative changes in our daily lives, societies, and business operations. The provision of high QoS, QoE, and QoL in 6G technology for communication is deemed unattainable without the integration of AI. Furthermore, the 6G is expected to provide a comprehensive sensory experience by enabling communication that engages all five human senses, hence enhancing the overall quality of user experience. According to McMahan et al. (2017), the transition from analog devices to intelligent devices is expected to occur during the era of 6G. The emergence of AI and its integration with diverse communication technologies has led to significant advancements in various domains, ranging from innovative creations to intelligent systems (Raihan and Tuspekova, 2022b; Raihan et al., 2022b; Raihan, 2023c). Starting from the year 2030 and onwards, it is anticipated that the IoT would become increasingly perceptive and eventually be replaced by the concept of the IoE. The prevalence of smartphones is expected to surpass that of traditional cell phones. Intelligent gadgets refer to technologically advanced devices that are powered by AI and have the capability to connect with the internet. Accordingly, the intelligent device will seek to predict, make a decision, and provide its interaction with other intelligent devices (Simeone, 2018). This support is essential for enhancing the contemporary style of living and overall quality of life.

3 Internet of Everything (IoE)

In the contemporary digital age, the Internet has become an integral and inseparable aspect of our daily existence. The major objective of high-level sensing is capture. According to Chen et al. (2020), the acquired data undergoes a process of conversion into digital format, subsequent storage in a local memory cache; and subsequent transmission to remote sites in real-time. In certain instances, digital data undergo conversion into signals and subsequent transmission to other devices for the purpose of processing (Wang et al., 2020). The introduction of 6G network technology has the potential to revolutionize the sector of communication, enabling the consolidation of critical services into a single platform. The concept of the IoE aims to enhance the capabilities of IoT solutions. This text provides an objective depiction of decentralized frameworks and their capacity to facilitate digital transformation. The concept of IoE innovation has been considered as a means to enhance the outcomes of the IoT industry. Currently, the innovation of the IoT is being approached from multiple perspectives, including efficiency detection, device connectivity, communication interfaces, and device-generated data. The aforementioned restrictions are thoroughly examined and addressed in order to effectively utilize the inherent processes and address the anticipated challenges in the IoT. The concept of IoT innovation anticipates providing a broader understanding of the same. The IoE represents the subsequent stage of technological advancement following the IoT, with both concepts exhibiting a significant degree of interconnectedness. The ongoing utilization of the hyper-associated suitable framework, as identified by Rakesh (2019), represents a pivotal advancement in the field of measure stack advanced. The primary objective of IoE innovation is to facilitate the transformation of collected data into meaningful information-based capabilities that can be easily utilized by companies engaged in the development of IoT applications. The applications of the IoE encompass a wide range of technologies, including computerized sensor devices/interfaces used for remote apparatuses, as well as intelligent and interconnected smartphones, advanced AI systems, and various types of distributed hardware that have recently demonstrated increased levels of intelligence and automation (Piran & Suh, 2019). Machines often acquire astuteness through access to information and expanded networking opportunities. Figure 2 presents the four key features of IoE which are people, things, data, and process.

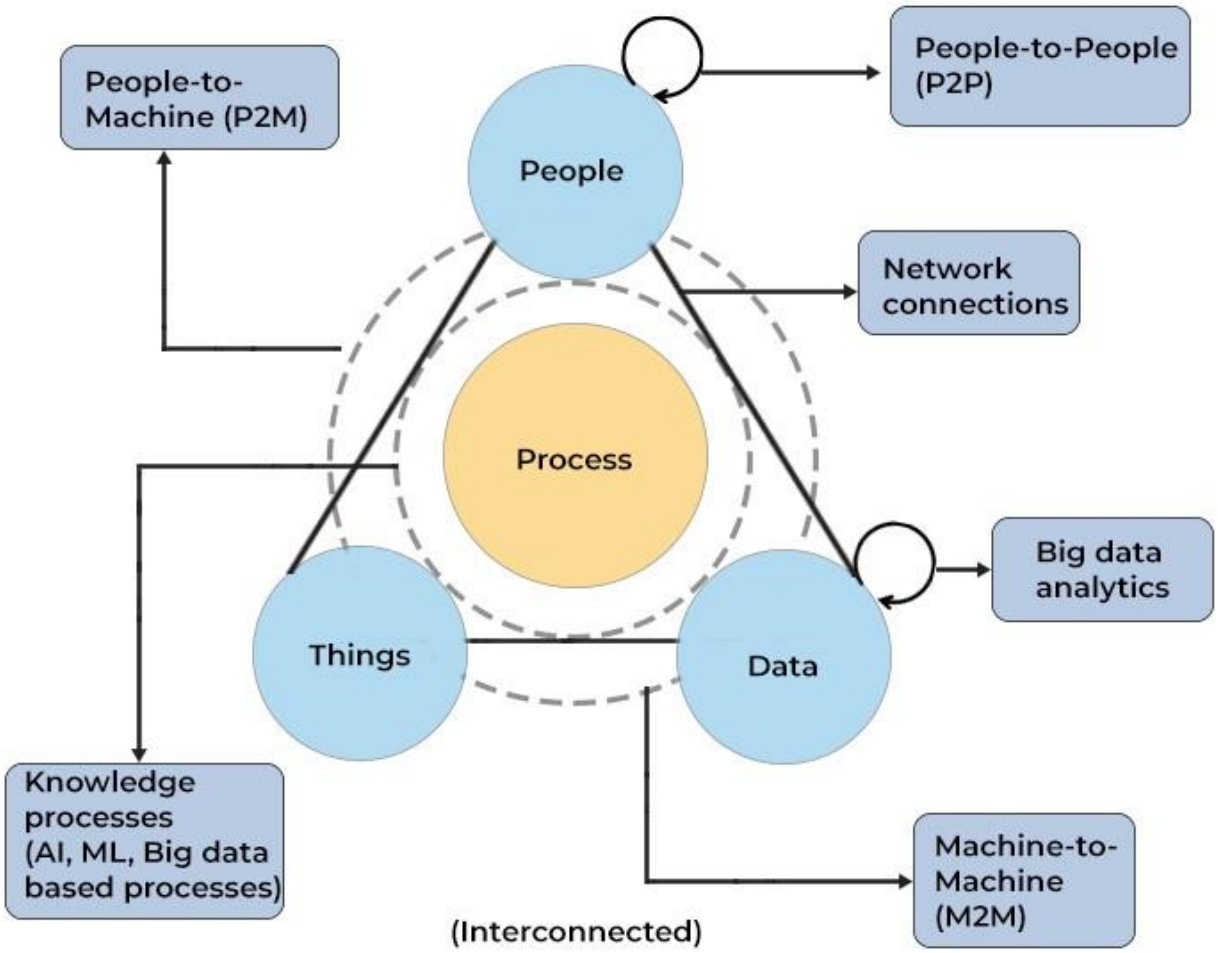

Figure 2. The key elements of IoE.

4 Going Smart to Intelligent

The IoE will have a strong inclination towards intelligence, hence indicating that 6G will also possess advanced cognitive capabilities. Hence, it is anticipated that smart devices will undergo a transformation into intelligent gadgets, characterized by their integration of AI capabilities (Kasgari et al., 2020; Sun et al., 2020). According to Zappone et al. (2019), the intelligent device will possess the capability to anticipate, make decisions, and exchange information with other intelligent devices. In this regard, there has been a shift in viewpoint from brilliance to astute utilization of 6G communication technology and AI. The application of multidimensional plan innovation is employed to generate a highly valuable product inside the sector. The system utilizes technological and advanced scientific methods in order to provide optimal solutions for its clients. The holographic user interface is employed within the context of the 6G remote systems management paradigm to effectively monitor the product. The utilization of remote multi-street accessibility is employed in the communication between various components and their corresponding actions. The 6G technology is expected to provide a seamless interface for human users by leveraging simulated intelligence. The study conducted by McMahan et al. (2017) highlights the significance of Human-Driven Administrations (HDA) that rely on target-based approaches rather than crude rate-dependability dormancy measures. The integration of dynamic structural components with the foundational IoT enables the deployment of distributed characters through the utilization of 6G connection technology. The utilization of astute detection and the incorporation of relevant knowledge are essential strategies for effectively engaging the model. The stem inquiry would be directed towards the calculated trajectory. The utilization of multi-object IoT and edge logic is also employed for the purpose of facilitating proper context-aware architecture. A standardized information analysis tool has the capability to forecast the future outcome of a firm. The vast amount of data may be effectively managed with the wide adoption of the 6G networking network, which enables holographic communication and virtual interaction between users, including both humans and robots. According to Letaief et al. (2019), the efficient transmission of content via the web necessitates rapid communication and the utilization of URLLC to ensure a continuous flow of data. The aforementioned advancement will be employed for the purpose of conducting remote operations utilizing the cutting-edge 6G connection technology. This technology will also assist professionals in conducting remote examinations through contactless means. Haptic Human-PC communication (HCI) can be classified into three distinct categories, namely work region, surface, and wearable, as outlined by Simeone (2018). Within the professional domain, the proficient individual will possess the option to utilize a virtual apparatus for the purposes of operation or discovery. The device used for making requests features a flat display, such as a mobile phone or tablet. By manipulating the hand on the display, the robot can receive a command to establish a connection with the patient. In the context of wearable technology, remote subject matter experts utilize a haptic glove, for example. Saad et al. (2020) suggest that material progress can also contribute to the provision of healthcare during times of disaster. AR facilitates the integration of virtual elements into the physical world. Similarly, it is associated with many sensory capabilities, such as auditory, visual, tactile, etc. Furthermore, AR provides continuous connectivity and offers three-dimensional representations of both virtual and physical objects (Zappone et al., 2019). AR facilitates the provision of a simulated or virtual existence in situations when tangible evidence is absent. The organization's extraordinary nature necessitates the utilization of huge data speeds.

5 AI-powered 6G

According to Liu et al. (2020), the implementation of 6G networks will involve the utilization of edge computing in conjunction with AI. This approach aims to bring the server in closer proximity to the end-users, hence reducing reliance on cloud-based infrastructure. The forthcoming era of technology is expected to encompass significant variations in technology for operation as well as communication and information technology (Raihan et al., 2022c; Raihan & Tuspekova, 2023a; Raihan, 2023d).

5.1 Hyper specification

A network platform that is tailored specifically for users with extremely specialized needs. Clients have the capability to retain their Internet Protocol (IP) addresses and networking classifications without necessitating any alterations to the network infrastructure of the client data center. The Windows Network Virtualization (WNV) policy enables the Hyper-V host to accommodate virtual machines using the same IP scheme, owing to the isolation it provides (Nawaz et al., 2019). The implementation of highly specialized network technology is expected to result in significant expansion within the realm of online services. The expansion of web services presents a significant difficulty. The rapid expansion of data interchange has significantly altered our interactions with the internet, our commercial activities, and interpersonal relationships. The incorporation of internet services and the corresponding business and technology frameworks underpin the majority of notable advancements in the past decade (Raihan et al., 2022d; Raihan and Tuspekova, 2023b; Raihan, 2023e). However, the pace at which these technologies are being adopted does not follow a linear trajectory. Although the initial emergence of web services occurred during the late 1990s, it was not until approximately ten years later that they achieved widespread adoption and became a prevalent phenomenon. The proliferation of online services and applications that are web-based is gaining momentum, driven by enhanced connectivity, improved website content, and the rapid proliferation of mobile devices. Web services now play a substantial role in facilitating various aspects of the digital economy, and it is anticipated that their prevalence will continue to grow as innovative and robust applications are developed (Raihan et al., 2022e; Raihan and Tuspekova, 2022c; Raihan et al., 2023b). This confers a significant advantage to hosting firms. Policy rules can be established to enforce the segregation of virtual machines from clients, while also guaranteeing that clients connect to their workloads using the identical IP address set as they are on their local network. The provision of a fully developed and verified system offers clear advantages, including short deployment timeframes and reasonably high reliability (Wang et al., 2020). This is due to the implementation of comprehensive testing protocols for each component, which guarantees compatibility with other components and ultimately results in the development of enterprise-level appliances (Wang et al., 2020). The concept can be likened to a compact data center encapsulated within a confined space. Consequently, the implementation of the 6G network of communication is expected to have a significant influence on hyper specification.

5.2 Hyper capable

The initial designation employed to characterize this methodology was 'hyper-channel' technology. The inception of this initiative can be traced back to the need for upgrading copper-based infrastructure with advanced technology capable of facilitating faster data transmission. The term "emerged" in the 1990s while the speed of the network became the predominant factor, and it was defined to indicate that the system was not only swift but also capable of transmitting larger amounts of data compared to previous capabilities. The evolution of highly competent network technologies has led to significant modifications in network protocols and provisioning methods. The aforementioned advancements are propelled by the imperative demands of the telecoms and Internet sector, aimed at effectively resolving the predicament of congestion in networks in the current era. According to Simeone (2018), the implementation of 6G technology necessitates a substantial increase in various dimensions, utilizing the Terahertz band. The relocation of the address results in the disruption of existing communication and the interruption of services operating on the virtual computer. According to Wang et al. (2020), the utilization of Hyper Network Virtualization (HNV) enables the dynamic migration of virtual machines across different sub-networks. HNV ensures that the precise position of a live migrating virtual machine is consistently updated and synced between hosts that maintain continuous communication with the migrating virtual machine. According to Liu et al. (2020), there have been no advancements in the technology employed for continuous virtual machine migration. Virtual computers can be relocated to different virtual subnets or premises without requiring any alterations to the network structure (Liu et al., 2020). Hosting providers have the capability to seamlessly transfer client virtual machines to alternative data centers in the event of maintenance operations at one of their hosting sites. This allows customers to continue using their virtual machines without experiencing any service disruptions. The capacity of 6G communication technology is expected to undergo a significant enhancement.

5.3 Hyper sensing

Hyper sensing is an emerging conceptual framework in the field of wireless networks, wherein the network nodes are endowed with multiple high-gain radio antennas. The radio has been specifically engineered to function exclusively with the present sensing technology. Therefore, the power consumption of the subject in question is significantly more when compared to that of human beings. Conversely, wireless sensors employed for the purpose of detecting human motion or health indicators are typically engineered with extended life cycles in mind. Wireless sensors find widespread utilization in healthcare, making it the foremost application in which they are commonly employed. Healthcare apps encompass many functionalities such as the monitoring of health conditions for both patients and staff, as well as the retrieval of patients' information. Sensors are commonly positioned within the human body to monitor essential physiological parameters of patients, such as heart rate, body temperature, and blood pressure. In the context of these particular applications, it is imperative that the sensors exhibit prolonged operational functionality over an extended period of time. The utilization of a powerful antenna results in a significant reduction in power consumption compared to a traditional antenna, while yet maintaining the same level of gain. Therefore, by maintaining a constant transmitter power, the detector is capable of receiving a greater number of signals. The advent of 6G networks has facilitated the seamless integration of both human and machine augmentation. According to Simeone (2018), the deployment of a traditional solution for ordering parts can be a time-consuming process, often taking several months. In contrast, a hyper-converged framework offers a more efficient alternative, with deployment periods ranging from weeks to even just a few days. Considerable effort is dedicated to the interoperation of components. The management processes pertaining to the solutions are specifically tailored to them, resulting in the mitigation of many of the challenges often associated with handling and ensuring a datacenter (Letaief et al., 2019). Hyperspectral line-scanning cameras, as described by Kasgari et al. (2020), are devices utilized for capturing reflected light across an image slice. Each frame captures a single row of spatial pixels, with each pixel providing comprehensive spectral data, while motion is taking place. There are two potential methods for achieving motion: by aerial deployment or by exerting realistic force (Nawaz et al., 2019). An additional option exists wherein a hyperspectral sensor, positioned at a fixed location, utilizes pan-and-tilt or rotational phases to conduct stationary detection of objects (Nawaz et al., 2019). Therefore, the efficacy of hyper sensing is heavily contingent upon the rapidity and adaptability of the network. The implementation of 6G network technology is expected to have a significant influence on the largescale industrial revolution, as highlighted by Wang et al. (2020). The exponential advancement of technology is anticipated to usher in a paradigm shift in future technological developments (Raihan, 2023f), particularly in the realm of networking systems.

6 Machine Learning (ML) with 6G

The field of ML is experiencing a surge in popularity as a result of its wide-ranging applications and versatile capabilities. ML models refer to computer programs employed for the purpose of acquiring knowledge about the distinct attributes or patterns exhibited by a system, which is represented by a detailed mathematical model (Kumar et al., 2022). These models are commonly employed in various tasks, including classification, regression, and the analysis of interactions between an intelligent agent and its environment. According to Wang et al. (2020), when a model possesses the ability to identify and comprehend the characteristics of a system, referred to as a qualified model, it becomes capable of acquiring knowledge about the properties of that system. Execute the work proficiently by employing elementary arithmetic computations. The potential for such progress is plausible as a result of the availability of advanced machine learning models, extensive datasets, and significant computational capabilities (Liu et al., 2020; Viswanathan & Mogensen, 2020). ML has the capability to be implemented within a meticulously designed infrastructure that offers extensive network adaptability and the ability to handle data in real-time (Alattas & Mardani, 2022). The integration of ML variants, including supervised, unsupervised, and reinforcement learning, holds equal potential for incorporation into the 6G framework (Puspitasari et al., 2023).

ML is employed to yield societal and social advantages. The implementation of 6G technology is anticipated to facilitate the efficient processing of large volumes of metadata, while requiring reduced resources and computer capacity (Alraih et al., 2022). ML has the capability to efficiently analyze vast quantities of data and make predictions based on certain limitations (Sharifani & Amini, 2023). The potential of ML is incalculable. The potential impact of ML in conjunction with 6G communication technologies is significant across various domains, promising to revolutionize numerous tasks in the foreseeable future (Asghar et al., 2022). Various methodologies are being employed in the fields of AI and ML, which have a significant impact on our everyday existence. The establishment of a well-integrated ecosystem may be facilitated by the judicious application of cutting-edge technologies (Raihan et al., 2022f; Raihan & Tuspekova, 2022d; Raihan, 2023g) such as ML. Organizations are actively seeking sophisticated software solutions to facilitate data analysis and enhance decision-making processes. The utilization of business intelligence tools is leading the way in these endeavors. The objective of business intelligence is to effectively deliver accurate and relevant information to the appropriate individuals within an organization in a timely manner. According to Wang et al. (2020), the utilization of 6G technology enables the integration of software intelligence, hence facilitating autonomous operations and the continuous improvement of market outcomes.

6.1 Supervised learning

In the context of supervised learning, the model acquires knowledge from a set of pre-labeled data. The determination of the coefficient for half of the route stage is achieved through the use of the pre-existing data source arrangement, in conjunction with its corresponding anticipated performance (Viswanathan & Mogensen, 2020). The optimal utilization of supervised ML occurs in situations where there exists access to the accurate joint distributions of the input and output variables. This distribution can be derived from the understanding of the relevant domain (Viswanathan & Mogensen, 2020).

The coefficients associated with precipitation approaches are acquired by supervised learning, wherein the existing dataset of inputs and their corresponding desired outputs is utilized. Supervised ML is most effectively applied when the actual joint distribution of the parameters for input and output is known, allowing for an ideal scenario. According to Zappone et al. (2019), in the context of transceiver communications, the utilization of supervised learning techniques at the physical layer can yield optimal power management and temporary cessation of interference. The applications of supervised learning extend beyond the physical layer and encompass several networks, including common applications at the application, transport, and various other layers. Hence, the implementation of 6G technology has the potential to impact the process of supervised learning.

6.2 Unsupervised and semi-supervised learning

Unsupervised learning involves the absence of feature names, with the model autonomously identifying patterns and grouping related data points (Liu et al., 2020). In the context of the 6G networking network, the unsupervised learning technique utilizes a collection of input data samples to train the system, despite the absence of any prior knowledge regarding the expected system response. Unsupervised learning is believed to have the potential to be utilized for a wide array of activities encompassing points clustering, feature extraction, feature categorization, distribution estimation, and production of samples specific to a certain distribution. In scenarios involving intricate vehicular communication, the limited coherence time imposes constraints on the available time within the physical layer (Sun et al., 2020). The widespread implementation of 6G technology will be undertaken to facilitate intricate decision-making processes. At higher layers of the networking system, several potential applications of unsupervised and semi-supervised learning can be observed, which aim to group, pair, cluster nodes, or allocate network resources optimally.

Semi-supervised learning involves the utilization of a limited quantity of labeled training data.

Simultaneously, a significant portion of the data lacks labels, whereas unsupervised learning does not have access to annotated training material (Viswanathan & Mogensen, 2020). The real-time data relies on a high-frequency network such as 6G. In the context of semi-supervised learning, there exists a restricted amount of annotated training data, while a significant portion of the available information remains unlabeled. Model-based learning often aims to optimize performance metrics while maintaining a high level of computational effectiveness across a range of available target functions. According to Sun et al. (2020), the utilization of semi-supervised learning is expected to contribute to the enhancement of channel equalization as well as monitoring tasks. Therefore, the implementation of 6G technology is expected to enhance the capabilities of unsupervised learning algorithms, leading to increased levels of intelligence.

6.3 Reinforcement learning

Unsupervised learning is characterized by the absence of feature names, allowing the model to autonomously identify patterns and group similar information (Liu et al., 2020). In the context of the 6G networking network, the unsupervised learning technique utilizes a collection of input data samples to train the system, despite the absence of any prior knowledge regarding the expected system response. Unsupervised learning is believed to have the potential to be utilized in a wide array of tasks encompassing points clustering, feature extraction, feature classification, distribution estimation, and creation of distribution-specific samples. In scenarios involving intricate vehicular communication, the limited coherence time imposes constraints on the available time within the physical layer (Sun et al., 2020). The widespread implementation of 6G technology is anticipated to facilitate intricate decision-making processes. At the higher layers of the networking system, various possible applications of unsupervised and semi-supervised learning can be observed, which aim to group, pair, cluster nodes, or allocate network resources optimally.

Semi-supervised learning involves the utilization of a limited quantity of labeled training data. Simultaneously, a significant portion of the data lacks annotations, whereas unsupervised learning does not have access to any annotated training data (Viswanathan & Mogensen, 2020). The real-time data relies on a high-frequency network such as 6G. Semi-supervised learning involves the utilization of a restricted amount of annotated training data, while a significant portion of the available information remains unlabeled. In the field of ML, model-based learning is commonly employed to maximize performance metrics while maintaining computational efficiency over a range of target functions that are readily available. According to Sun et al. (2020), the utilization of semi-supervised learning is expected to play a significant role in facilitating channel equalization as well as monitoring tasks. Therefore, the implementation of 6G technology is expected to enhance the capabilities of unsupervised learning algorithms, resulting in increased intelligence.

7 Deep Learning (DL) with 6G

The implementation of the 6G intelligence networks would have a significant impact on all components of the DL system. DL is a specific branch of AI known as ML, which primarily focuses on the analysis and processing of unsupervised data (Raihan, 2023b). DL is a computational approach that integrates both supervised and unsupervised learning techniques. The utilization of automatic learning features enables a system to acquire knowledge of intricate functions that facilitate the direct transformation of input to output through the analysis of data at multiple levels of abstraction. This approach reduces reliance on features that are manually designed by humans (Chen et al., 2020). The application of DL techniques has been investigated in various areas such as network anomaly detection, fault identification, detection of intrusions and prevention, network design, and optimizations (Liu et al., 2020). The utilization of 6G technology for communication facilitates the acquisition and analysis of data in a real-time context.

7.1 Artificial Neural Network (ANN)

An ANN is a computational model inspired by the structure and function of biological neural networks. It is specifically designed to acquire knowledge and perform various computational tasks based on observed data (Viswanathan & Mogensen, 2020). The ANN is often regarded as a highly effective DL technique. ANNs employ a structure like that of neurons, allowing for the utilization of various methodologies to effectively process large volumes of data. The computational capabilities of the network and its interconnectivity have the potential to impose limitations on neural-level operations (Gui et al., 2020). The formation of the neural network occurs through the integration of multiple layers (Letaief et al., 2019). The term "multi-layer perception" is commonly used to refer to the numerous underlying layers. The neurons in a single layer are regarded as inconsequential. The aforementioned nodes possess a module designed for the purpose of activation function, as outlined in the work of Chen et al. (2020). The artificial neural network's neuron employs cognitive intelligence in order to do complex computations. The significance of the interconnections inside an ANN's design has been emphasized by Sun et al. (2020). The training process of an ANN involves the application of its operations to a substantial dataset, enabling it to effectively handle novel input data samples (Letaief et al., 2019).

7.2 Deep Neural Network (DNN)

The DNN is a specialized artificial neuron system that possesses the ability to perform classification and generalization tasks. DL can be conceptualized as an abstraction of human cognitive processes, wherein multiple layers of artificial neurons mimic the hierarchical structure of human neural networks (Sun et al., 2020). Similar to the human brain's ability to perceive and differentiate between unique images, a DNN possesses the capacity to acquire a model that can recognize and categorize similar images. Similar to the human brain, a DNN employs an artificial sensory input, which is represented as a vector. The input layer, alternatively referred to as the hidden layer, is represented as a matrix in the model. This characteristic is what distinguishes DL as a DNN. DL is capable of acquiring intricate knowledge, such as images, characters, or voice, because to its inherent nature. In contrast, a linear classifier is limited to learning just linear classifications. The implementation of deep networking is expected to significantly enhance the efficiency and speed of the next 6G advanced network. The utilization of modern networking techniques enables the reconstruction of neural networks, hence enhancing the speed at which decision-making occurs.

7.3 Federated Learning (FL) in 6G

FL is an innovative ML methodology that facilitates the distribution of models across participating entities in a learning assignment, even in the absence of mutual awareness. This platform facilitates the simultaneous training of ML models without the need for direct sharing or communication of model parameters. In contrast, each individual entity undertakes the training of a localized model using data specific to its domain. The resulting model parameters are subsequently transmitted to the federated server to facilitate the ultimate updates of the collective model. This collective model is then employed to train the united ensembles. The approach of FL exhibits conceptual similarities to FL, since it involves the division and distribution of both data and the parameters of the model among multiple entities. However, the primary distinction lies in the fact that training is exclusively conducted at a local level, rather than being conducted both locally and centrally. Numerous endeavors have been made in the realm of FL in previous instances. Nevertheless, these endeavors encountered obstacles in terms of limited adoption and scalability, primarily stemming from apprehensions regarding data privacy and the substantial computational burden associated with training. The 6G will be primarily focused on autonomous learning capabilities and the ability to make intelligent judgments, hence enhancing convenience and efficiency in daily life.

The FL technique offers advantages in terms of expediting the learning process by reducing the necessary time and autonomously stabilizing the state of the training data. The use of FL and inferential learning techniques aims to enhance the cognitive capabilities of the network. FL is a ML methodology wherein an algorithm is taught using a distributed network of edge devices or servers that possess local data samples, without the need for data exchange between them. The utilization of a decentralized system enables AI algorithms to acquire information from a wide range of data sources that are distributed across various locations.

Today's wireless communication networks are expected to undergo a significant paradigm shift towards intelligence, departing from the conventional notions of smartness and intelligence radio settings (Nawaz et al., 2019). The crucial aspect of the integration of DL functions inside communication networks does not revolve around its inevitability as a fundamental component of future networks, but rather focuses on the timing and methodology for its implementation. Adeogun et al. (2020) propose the use of DL as a supplementary approach to enhance the estimation and decoding of intricate information on sequential blocks, hence offering an end-to-end solution. The ability to recognize symptoms in critical cases, determine the appropriate course of action, and select the most suitable intervention is contingent upon one's level of expertise. FL facilitates the acquisition of expertise by AI algorithms through the utilization of diverse data sources distributed across multiple locations. According to Sun et al. (2020), the utilization of this technique enables numerous companies to engage in collaborative efforts for the expansion of models, while avoiding the need to directly share sensitive clinical data among themselves. FL is a technique that achieves decentralization in DL by reducing the requirement of centralizing data in a singular location. The model, on the other hand, undergoes training at several locations through multiple iterations. In order to maintain the security of patient data, the meticulous implementation of FL is important (Chen et al., 2020). However, it has the potential to address certain challenges encountered in the integration of sensitive epidemiological data. Each of the platforms inside the learning network possesses a duplicate of the model stored on their respective computers within a FL system. The separate devices utilize the data available on the client's local system to train their own instances of the model. Subsequently, the parameters or weights derived from the different models are transmitted to a central computer or server, where they are consolidated and used to modify the global model. According to Sergiou et al. (2020), it is feasible to repeat the training phase until the desired level of consistency is achieved.

7.4 Black box

The black box algorithm, alternatively referred to as the DL black box, is an advanced ML technique that restricts researchers' access to the training data, commonly known as the "black box" (Viswanathan & Mogensen, 2020). The concealed limitation of the black box is contingent upon the heightened specificity of the network in which 6G networks can establish a presence. The focus lies solely on the observed effect of the training process, rather than attempting to discern the internal operations of the learning algorithm. In a practical illustration, a proficient opaque system is commonly implemented on computing devices and/or mobile phones to facilitate decision-making or forecasting without possessing the capacity to comprehend its underlying mechanisms (Gui et al., 2020). These prognostications are commonly employed within a practical setting, rendering the procedure intrinsically capricious due to its lack of awareness regarding the surrounding milieu. Black box ML algorithms have proven to be advantageous in a multitude of applications, including but not limited to forecasting an investor's future financial behavior, detecting fraudulent activity on the Internet, and developing data mining systems. The black box algorithm is frequently utilized in the context of a classifier whose internal mechanism is not understood. A classifier utilizing a black box approach is trained using a specific dataset, and subsequently exposed to novel training data. The dataset utilized for model creation is commonly referred to as the training set. The utilization of an advanced AI-enabled 6G networking system would enhance the sophistication of the procedure.

8 Unmanned Aerial Vehicle (UAV) with 6G

UAVs encompass a range of aerial devices, including diminutive drones, balloons, intelligent drones, and airplanes, which possess the capability to be pre-programmed for designated missions and operated remotely. Cognitive intelligence networks are essential for the successful execution of various crucial tasks such as military operations, surveillance, rescue and search operations, among others. It is anticipated that the advent of 6G technology will serve as a catalyst for the advancement and widespread use of these technologies. This particular intelligent UAV possesses the capability to detect and classify fires, accidents, traffic congestion, and other relevant events, with the primary objective of providing continuous educational support to law enforcement agencies. Law enforcement agencies have the potential to employ intelligent UAVs, also known as smart drones, for the purpose of dispersing chemical agents and managing large gatherings of individuals. It is anticipated that UAVs would supplant numerous traditional systems, such as fire control, through the use of AI. The utilization of this technology is anticipated for the forthcoming 6G wireless communication standard, facilitating non-cellular forms of communication (Ali et al., 2020). According to Sharma et al. (2017), when the user equipment transitions from one cell to another, the call by the client must also transition to the next cell. By leveraging the integration of AI and 6G technology for communication, the enhancement of intelligence in drones may be readily achieved. According to Zappone et al. (2019), intelligent robots will possess Drone-to-Drone and Drone-to-Infrastructures capabilities for communication, enabling them to exchange information and facilitate expedited online data transfer.

One illustrative instance involves the utilization of swarm drones in targeted military operations. Furthermore, the utilization of drones can be employed for the purpose of real-time monitoring of border operations through the utilization of ultra-high definition video streams, facilitated by 6G connections. This can be exemplified by the implementation of initiatives such as Drone as Cop or Drone Surveillance along the border between two nations. The integration of cutting-edge networking technologies will facilitate the seamless connection of all available devices inside a server environment, hence fostering enhanced collaboration capabilities. The integration of an intelligent cloud is crucial for the comprehensive functioning of the 6G network, as it facilitates the autonomous decision-making capabilities of artificial intelligence. The primary categorization of UAVs is based on their altitude and purpose, with particular emphasis on the significant impact that 6G technology's advanced communication capabilities will have. It also anticipates the provision of exceptional service and the attainment of a superior quality of life. There exists potential for the integration of 6G technology in closed-circuit video cameras (CCTV). Presently, CCTV systems are employed for the purposes of enhancing security and facilitating surveillance, hence contributing to the overall safety of individuals. Additionally, CCTV technology finds application as a means of observation within courtrooms across numerous nations. The efficacy of CCTV in accurately assessing various factors and differentiating potential hazards is limited. The proliferation of lightweight shopping drones, which have become more affordable due to technological advancements in aircraft design, has led to a substantial rise in the use of aerial photography and camera applications. Consequently, the utilization of automatically lifted frames has become commonplace. It is advisable to refrain from engaging in reviews and observations for business purposes. Figure 3 illustrates the utilization of UAVs in many domains.

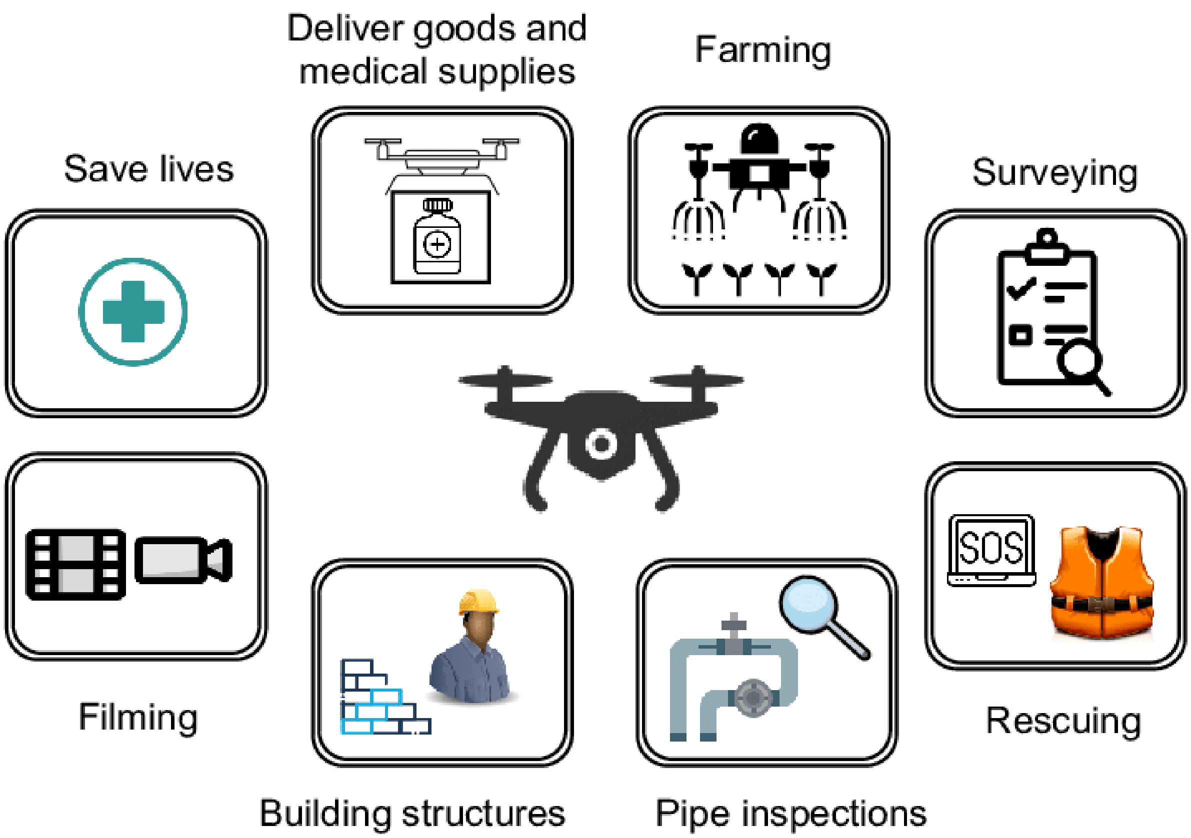

Figure 3. Various usage of UAVs (Alladi et al., 2020).

The UAV refers to an aircraft that operates without a human pilot. The UAV can function as a remotely operated aircraft, with a pilot controlling it from a ground control station. Alternatively, it has the capability to fly autonomously by following a predetermined flight plan or a sophisticated dynamic automation system (Elmeadawy & Shubair, 2019). Drones are presently employed for a range of roles, encompassing both reconnaissance and offensive operations (Alsharif et al., 2020). This observation highlights the necessity of incorporating ground stations and supplementary equipment alongside the aircraft itself, acknowledging the inherent complexity of these systems. The nomenclature of UAV was formally revised to Unmanned Aircraft System (UAS) in order to acknowledge the comprehensive nature of these intricate systems, which encompass not only the aerial vehicle itself, but also encompass ground stations and several other components (Alsharif et al., 2020). Drones have emerged as a swiftly deployable airborne wireless communication platform for encrypted communication in various contexts, including transitory social events, military operations, and catastrophe scenarios. It is anticipated that drones will continue to be considered as potential candidates for fulfilling such roles in the future. According to Sharma and Kim (2020), recent advancements in drone technology have facilitated the development of wireless applications that offer cost-effective, resilient, and compact drones. The categorization of unmanned aerial systems often involves their classification as either high altitude platforms or low altitude platforms (LAP), which is determined by their dimensions and operational capabilities. The LAP has the capability to operate within a vertical range of several hundred meters. It is probable that the drone will maintain a position of moderate magnitude for the duration of the process, rather than adopting a position of significant magnitude. Nevertheless, it is probable that the spatial phase of the drone's motion exhibits uniformity.

6G is anticipated to integrate drone technology, hence achieving complete functionality, due to its enhanced network flexibility.

9 Automated Vehicle with 6G

In contemporary times, the presence of automated vehicles, such as self-driving cars, can be observed as a result of technological advancements. According to Letaief et al. (2019), the implementation of 6G communication technology in intelligent vehicles has the potential to enhance fuel efficiency, navigation capabilities, and overall operational efficiency. This is due to the continuous services provided by 6G communication, which enables intelligent vehicles to anticipate future events and address them in a more cost-effective manner. The computer vision method can be employed to ensure the maintenance of connectivity among all the components. The 6G network will explore the concept of dynamic range access, utilizing AI to handle the complex computational tasks required for providing advanced services. According to Piran and Suh (2019), the implementation of a more interactive neural network connection will enable automobiles to operate in an intelligent manner. This enhanced connectivity will facilitate communication between vehicles, allowing for the sharing of data through 6G communication technology. There exist two distinct classifications of automated cars, namely autonomous car and connected automated vehicles.

9.1 Autonomous vehicles

An autonomous vehicle refers to a mechanized system that exclusively depends on its internal sensors to execute vehicle control operations and uphold situational awareness. The autonomous motor is a technology that exhibits a high degree of self-sufficiency, necessitating minimal human intervention. It possesses the ability to sense its environment and execute movements in a manner that ensures safety. Autonomous cars employ a range of sensors, including radar, sonar, GPS, and inertial measurement units, to perceive and comprehend their surroundings. According to Letaief et al. (2019), advanced control systems possess the ability to analyze sensory data in order to differentiate between suitable navigation paths and relevant impediments and signals. The primary focus of functional enhancement or growth in the realm of autonomous cars is the pursuit of safety, as highlighted by Wang et al. (2020). There is an undeniable consensus that autonomous vehicles exhibit a higher level of safety in comparison to vehicles operated by human drivers. Mechanical failures account for the remaining 10% of accidents, alongside harmful road conditions, both of which are presently beyond our control (Wang et al., 2020). The overwhelming majority of automobile collisions can be attributed to deliberate wrongdoing. The implementation of these safety elements is expected to enhance the safety of human-operated vehicles prior to the surpassing of their numbers by autonomous vehicles.

9.2 Connected automated vehicles

A networked autonomous vehicle refers to a type of automobile that possesses the capability to identify and acknowledge the presence of other similarly equipped vehicles in its vicinity. The system also possessed knowledge regarding the distinct characteristics of the adjacent infrastructure, including intersections and curves. One area of automotive research that has received significant attention is the development of connected car technology (Nawaz et al., 2019). Only a small portion of the technological advancements being developed for the future encompasses the currently accessible automotive technologies (Raihan & Tuspekova, 2022e; Raihan et al., 2022g; Raihan, 2023h). The technologies pertaining to autonomous vehicles, connected cars, and advanced driver assistance systems exhibit areas of overlap and provide a basis for comparison in terms of their respective technologies, ideas, benefits, and challenges within the emerging field. This field envisions the development of fully autonomous vehicles that operate without the need for a human driver and have the capacity to transport passengers. Furthermore, it is noteworthy that a significant number of connected vehicles are already present on our roadways (Alsharif et al., 2020). Connected car technologies enable automobiles to establish connections with the underlying infrastructure. Connected vehicle technology is a concept that is likely to be well-known among a significant number of individuals. Autonomous cars are subject to the coordination of multiple interdependent systems in order to ensure their proper control and operation. According to Liu et al. (2020), radar sensors distributed throughout the vehicle are responsible for monitoring the positions of neighboring cars. The camera is capable of detecting traffic signals, interpreting traffic signs, and monitoring the movement of other vehicles, all while remaining attentive to people and other impediments. The Light Range and Detection Sensor (LDRS) is a device utilized for the purpose of detecting the precise location of automobiles and other types of vehicles during the process of parking. The primary computational system examines data obtained from a range of sensors in order to control the functions of steering, acceleration, and braking. Additionally, a connected automated vehicle system encompasses the integration of Vehicle-to-Vehicle, Vehicle-to-Infrastructure, and a central cloud network. This technology is employed to enhance vehicle safety as well as optimize vehicle efficiency and travel duration. The primary objective of 6G communication technology is to establish comprehensive network connectivity by means of a high-speed internet connection based on cloud computing. According to Elmeadawy and Shubair (2019), the network will possess the capability to acquire knowledge from previous encounters. By leveraging ANNs, ML algorithms, and DL techniques, it is possible to enhance the efficiency and utility of machines. According to Nawaz et al. (2019), the enhancement of analog intelligence is expected to be fully realized in the context of 6G computerization. The automotive sector is currently poised for advancement, with manufacturers actively seeking to enhance the driving experience for its clientele. The advent of 6G communication networks is expected to have a transformative impact on the development and implementation of connected automobile technology. From the instant the automobile door is opened until it arrives at its ultimate destination, the integrated functionalities of the vehicle would enable the driver and passenger to undergo a significantly altered encounter, thereby rendering numerous existing inconveniences obsolete.

10 Data Science and 6G

Data Science plays a crucial role within the realm of AI. The dataset can be analyzed to extract useful internal information, which can then be used to make predictions about future concerns. The utilization of AI technology presents the potential for comprehensive optimization of the entire data science lifestyle by leveraging the robust networking capabilities offered by 6G (Elmeadawy & Shubair, 2019).

10.1 Descriptive data analysis

Descriptive data analysis is a method used to ascertain the "What" condition or characteristics of a given dataset. This process encompasses the tasks of data cleansing, data integration, data summarization, and data visualization. The aforementioned constraints can be efficiently resolved by prioritizing connectivity and minimizing time complexity. Descriptive analysis refers to the utilization of analytical tools in order to elucidate or provide a concise overview of a dataset. Descriptive analysis is widely acknowledged as a prominent method of data analysis that facilitates the generation of comprehensible insights from raw, uninterpreted data. The descriptive analysis methodology refrains from making estimations, in contrast to alternative approaches in data analysis. Instead of employing manipulative techniques to enhance its relevance, the study exclusively derives insights from previous findings (Saad et al., 2020).

10.2 Diagnostic data analysis

Diagnostic data analysis is a comprehensive approach that uncovers significant insights, including the breakdown, finding, mining, gathering, and causation of data. The integration of smart grid technology has the potential to significantly impact the growth of the market (Raihan et al., 2022h; Raihan & Tuspekova, 2022f; Raihan, 2023i). Diagnostic analytics is commonly conducted through the utilization of techniques such as data exploration, drilldown analysis, data mining, as well as correlation analysis. Analysts engage in the categorization of data sources throughout the discovery phase, a practice that aids in the comprehension and interpretation of the resultant findings. The term "drilling down" refers to the process of focusing one's attention on a specific component of the information or a particular widget.

10.3 Prospective data analysis

Prospective data analysis refers to the systematic procedure of forecasting the forthcoming value of data. The integration of AI into 6G technology is expected to facilitate the connection between real-time and historical data, enabling the prediction of very significant insights in real-time. AI can be utilized to construct a supplementary model and precise business intelligence tools within a deep network setting. Diagnostic analytics is a method utilized to extract knowledge from available information and effectively apply it to practical contexts. There exist multiple methodologies for addressing inquiries pertaining to data, thus necessitating a thoughtful consideration of the most crucial concerns for any given firm.

10.4 Predictive data analysis

The advent of AI has significantly transformed the accessibility of the world through the compact medium of a mobile phone. The appropriate application of AI inside a robust framework has the potential to enhance data prediction accuracy. The process of model optimization and refinement is expected to be significantly facilitated within the context of 6G networking technology. Predictive analytics is a methodology that employs statistical techniques and modeling to evaluate forthcoming outcomes by leveraging existing and past data (Elmeadawy & Shubair, 2019). Predictive analytic technology has the capability to generate possible insights with a significant level of accuracy. With the use of powerful predictive analytic tools and models, companies today possess the capability to utilize historical and present data in order to predict patterns and behaviors precisely, spanning timeframes ranging from milliseconds to days or even years into the future. Predictive analytics is a data analysis methodology that primarily utilizes past data and employs various analytical approaches, including ML, to generate forecasts for forthcoming outcomes (Alsharif et al., 2020). The forthcoming 6G technology for communication will prioritize connectivity and data availability, employing a network architecture that is driven by data (Piran & Suh, 2019). The potential impact of 6G and AI on marketing can be analyzed in terms of their ability to enhance economic models through intelligent capabilities.

11 Artificial Robots with 6G

In the near future, there will be a significant revolution triggered by the emergence of sophisticated AI systems. The ability for humans to engage in direct interaction with machines facilitates the accurate completion of activities. The increasing prevalence of AI and technology for communication is expected to enhance the intelligence of industrial robots (Piran & Suh, 2019). In order to assure accuracy, robots and sensors require highly robust and efficient matching capabilities, while the implementation of switching mechanisms facilitates enhanced speed. The utilization of 6G edge nodes will facilitate the management of computationally intensive tasks, hence enabling the provision of real-time and immediate responses. According to Strinati et al. (2019), the 6G technology possesses the capacity for high-density communication and has the potential to effectively handle a substantial quantity of robots and sensors. It might be argued that the forthcoming 6G networking technology will incorporate AI-driven wireless communication networks, edge AI, and quantum ML within embedded systems (McMahan et al., 2017). Despite the existing restrictions within the current research landscape, it is evident that 6G networking technology will gain significant prominence in the foreseeable future. There are additional factors that warrant consideration within the domain of robot automation when incorporating 6G technologies.

11.1 Robots with emotional intelligence

The primary challenge in the development of AI lies in comprehending and replicating the intricate framework of the human brain. Sharma and Kim (2020) assert that DNNs are employed for the purpose of decomposing substantial volumes of data, resembling the functioning of neurons, and then generating predictions for future outcomes. Robotic systems endeavor to acquire increasingly sophisticated responsibilities. One of the several occupations, and undeniably one of the most challenging, is the attainment of significant human interaction. The development of socially proficient robots capable of fulfilling roles as caregivers, instructors, assistants, and companions necessitates the integration of numerous interrelated and carefully coordinated technologies. The utilization of lightweight, robust, and tailored apps can significantly impact the robot's ability to establish a human-robot connection in relation to the user experience. The lack of user-friendliness contributed to the failure of numerous intricate and advanced equipment available in the market. In order to facilitate realistic and intuitive engagement, it is imperative that any robot engaged in close interaction with individuals be equipped with appropriate programming.

11.2 Industrial robots

The integration of an interconnected intelligent network has the potential to facilitate the automation of the whole sector through the utilization of AI. In recent years, the utilization of intelligent systems and smart gadgets has become increasingly feasible. Furthermore, the robots have the capability to autonomously exchange their data without requiring any form of human intervention. According to Piran and Suh (2019), there is a need for a communication channel that facilitates uninterrupted contact for continuous inspection and activity planning. The integration of novel robotics techniques is important for the advancement of AI. The primary focus lies in the development of solutions that integrate both hardware and software components, enabling operations to be executed with exceptional levels of pace, reliability, security, and safety. This integration facilitates the effective utilization of ML and AI-guided functionalities. The implementation of AI is necessary to provide optimal levels of dependability and precision in robotic systems. Manufacturers employ AI in the field of robotics to evaluate the requisite timeframe for providing comprehensive maintenance for robots. This enables clients to effectively mitigate unnecessary equipment failures and the associated substantial costs of maintenance. Enhancing the efficacy of robots entails doing a comprehensive analysis of the data acquired by their sensory apparatus. These considerations encompass elements such as the utilization and transmission of energy. The real-time modification of the robot's software can be achieved by utilizing the output generated by the AI algorithm. The presence of artificial robots is expected to persist, as the future manufacturing industry is on the verge of a forthcoming industrial revolution. The exponential progression of automated technology is expected to further expedite advancements in automation and AI technologies. Consequently, this will facilitate the emergence of novel and captivating types of robotic technology, including autonomous and dynamic machines in the future. It is projected that the healthcare industry will account for around 30 percent of the overall worldwide market share of robots by the year 2020. The exponential expansion observed in the healthcare industry will have a substantial impact on the need for a diverse range of devices, such as surgical-robotic structures, diagnostic robots, and mobility robots. It is projected that the worldwide healthcare industry would attain a value of 1.7 trillion dollars by the year 2025. It is anticipated that the logistics sector will have a substantial expansion, surpassing a value of US$ 1.2 trillion by the year 2025. The expansion observed in logistical services can be predominantly attributed to the notable surge in e-commerce enterprises and the concurrent growth witnessed in the retail sector.

11.3 Robots in healthcare

The utilization of the Internet of Intelligent Medical Things (IIoMT) has the potential to mitigate the constraints imposed by the physical world. For instance, remote professionals have the ability to utilize remote surgical procedures that necessitate rapid communication in order to execute cautious duties. Additionally, experts can oversee remote surgeries through oral consultations, amicable appointments, or remote support. The Hospital to Home (H2H) program is set to undergo enhancements in the form of a portable medical clinic integrated onto an intelligent vehicle platform. This updated system will depend on emergency clinics staffed by medical specialists and assistants. The implementation of a multi-functional medical clinic can effectively supplant the benefits offered by rescue vehicles, particularly in terms of expediting the identification of emergency cases within clinics and promptly reaching the accident site. Intelligent wearable devices (IWD) are interconnected with the Internet and have the capability to transmit both mental and physical data for the purpose of testing and validating methodologies (Letaief et al., 2019). Healthcare AI pertains primarily to the utilization of advanced technology by physicians and hospitals to access and analyze extensive datasets containing potentially life-saving information. This encompasses various treatment modalities and their corresponding outcomes, including survival rates and the timeliness of therapy, which have been derived from extensive data sets comprising millions of patients across diverse geographical regions and encompassing a wide range of interconnected health disorders. Recent advancements in computational capacity have facilitated the detection and analysis of both extensive and intricate data patterns. Moreover, with the utilization of ML techniques, these computational systems are capable of making predictions and identifying potential outcomes. Robotic systems are employed for the provision of customer care in resorts and shopping establishments on a global scale. AI's ability to process natural language enables its utilization in the humanistic communication with clients. It is noteworthy that extended interaction with both individuals and customer service robots enhances their capacities. Various robots within the field of robotics are made available as open-source systems, equipped with AI capabilities.

11.4 Robots in smart cities

AI has the potential to generate services and meticulously monitor critical activities. According to Jamil et al. (2020), the city's Internet connection would be closely monitored to ensure efficient management of logistics scans by automated systems. The establishment of smart cities is subject to many obstacles, including security and comfort. Furthermore, cognitive intelligence will have a profound impact on various businesses. Empirical evidence suggests that the advent of Industry 4.0 has facilitated the transformation of traditional physical industries into digital industries (Raihan & Tuspekova, 2022g; Raihan et al., 2023c). Furthermore, the integration of industrial automation within the infrastructure of 6G technology is expected to establish seamless connectivity across various entities, including mobile phones, machines, and robots. The assumption is made that artificial humans or robots have the ability to maintain balance and move ahead inside urban environments. Scholars specializing in robotics express optimism amidst the prevailing apprehension among individuals regarding the potential displacement of occupations by robots, as well as concerns regarding the hypothetical scenario of robots assuming control over the globe. The utilization of robots holds the potential to aid in the resolution of humanity's most formidable global issues. By employing algorithms, a more comprehensive comprehension of climate change can be attained, enabling the analysis of data derived from many sources such as the oceans, tropical forests, and atmosphere (Raihan & Said, 2022; Raihan & Tuspekova, 2022h; Raihan, 2023i; Raihan et al., 2023d). In instances where communities are in need, it is possible to establish provisions for surplus food distribution, provide assistance after natural catastrophes, and undertake various other initiatives. Several years ago, certain job positions such as social networking researchers, data analysts, software engineers, and mobile marketers were not well recognized. However, these roles have emerged and gained prominence in the present day. The implementation of a highly interconnected robotic system centered on the latest iteration of Automated Guided Vehicles (AGV) is carried out by Smart City Robotics in order to realize this vision. Over the course of an extended period, AI robots demonstrate greater cost-effectiveness; nevertheless, their intricate nature necessitates substantial initial investment in terms of technology. Over the course of time, as the demand for proprietary solutions diminishes, the cost of this technology will decrease for organizations. The integration of advanced AI systems into robots would result in a reduction of error margins, facilitating the execution of difficult tasks with enhanced precision and autonomy. Hence, it is imperative to underscore that the implementation of a highly adaptable 6G network will propel our economy towards the realization of a completely automated sector. Robotic systems possess the potential to effectively address and resolve the full spectrum of jobs currently undertaken by human beings. Robotic systems possess the capability to execute vital jobs with enhanced accuracy, hence mitigating the occurrence of human errors.

12 Security, Secrecy and Privacy

In general, 6G networks have the capability to opt for the transmission of the utmost level of security. The inclusion of the IoE in the context of 6G, along with the implementation of novel management systems including domains like smart houses, emergency healthcare facilities, transport, and energy systems, among others, will give rise to the security concerns already highlighted (Saad et al., 2020). Moreover, the implementation of quantum communications will underscore the crucial security requirements of the 6G technology. The integration of AI systems will serve as a safeguard against hostile assaults in the context of 6G technology. It is noteworthy that 6G technology will offer physical layer security. In general, the 6G technology has the capability to determine the optimal security level for data transmission. This is achieved through the utilization of terahertz (THz) frequencies (Attanasio et al., 2021). The level of secrecy and safeguarding is contingent upon the security measures provided by the 6G system, as outlined by Alsharif et al. (2020). In each scenario, the safeguarding of sensitive information necessitates a fundamental element of enigma, exemplified by the utilization of a confidential passphrase to access financial accounts. Quantum cryptography has the potential to elucidate the enigma. Furthermore, safeguarding is a primary focal point for individuals responsible for managing the intricacies of 6G (Yeh et al., 2023). According to Strinati et al. (2019), it is emphasized that human services necessitate the utmost level of security assurance. The advent of 6G technology is expected to bring up novel opportunities for the integration of comfort and safety measures. These opportunities encompass various aspects such as central administration, use cases, performance metrics, facilitation of innovation, designs, factory operations, existing challenges, prospective remedies, openness, and avenues for further investigation (Gui et al., 2020).

The primary objective of 6G is to generate value through the fulfillment of human needs. Smart grids necessitate network connections with low latency in order to facilitate expedited data transfer rates. The 6G technology will operate on a dedicated platform that offers enhanced network flexibility. The use of 6G technology is expected to enhance the optimization of cellular networks in various aspects, including interfaces, hardware capabilities, and the efficient transmission and processing of significant amounts of data. Rapid forays into ML can enable every device to own a vantage point that can be leveraged in both advantageous and detrimental ways. If malicious devices possess this capability, they must deliberately induce resistance. Currently, it can be employed in analogous circumstances. The presence of various underlying devices introduces a potential security vulnerability (Zappone et al., 2019).

13 Conclusion

This study provides a comprehensive review of the implications of AI in 6G communication network. The study's findings suggest that 6G communications will likely become a necessary prerequisite for the general population. Furthermore, it is anticipated that in the near future, the integration of AI will be employed to develop an intelligent system for communication. Intelligent networking will exhibit a cognitive framework of network architecture as AI is extensively integrated into its operations. This paradigm is expected to exert a significant influence on multiple aspects, encompassing artificial general intelligence, narrow artificial intelligence, and artificial superintelligence. The wide range of possible supporting technologies has the capacity to provide a higher quality of service and experience, hence enabling the societal shift towards an AI-driven smart city. It is foreseeable that in the next period, AI integrated with 6G technology will demonstrate improved efficacy and dependability for end-users. The integration of AI with 6G networking technologies is expected to initiate a paradigm shift in the field of communication using digital technology.

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