

Review on the Integration of Artificial Intelligence and 6G Communications

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Abstract – With the deployment of the fifth generation in communication technology (5G) the interest of researchers is swiftly shifted towards the next generation or 6G. This generation is expected to replace 5G by 2030. In order to meet the growing demands in the field of communication technology, it is essential to envision 6G with various aspects to unleash its true potential. The purpose of this paper is to review the computational capabilities of 6G and also understand how artificial intelligence and 6G communications will complement each other to achieve breakthrough in future communication technology. With the fast-growing advancement in AI, it has the potential for 6G networks to utilize its capabilities to achieve superior performance. Emergence of 6G will encourage the networks to employ AI to automate and optimize their operations. AI playing a critical role in 6G optimizations will help 6G to enable integration with AI to implement various futuristic technologies.

Key Words: 6G mobile communication technology, Artificial intelligence, automated systems, intelligent communications, self-driving vehicles, holographic communications.

1. INTRODUCTION

The communication technology has changed rapidly in recent years and has made a profound impact on the way humans understand and interact with each other and the surrounding environment. The latest communication technology i.e 5G or fifth generation of the mobile communication technology is already deployed in various locations around the world and will soon enough connect the entire globe. Now that the 5G is deployed it raises an obvious question of what next. Researchers have already started their work on the next generation in communication i.e 6G. It has been observed that the generations in mobile communication technology were deployed and saw the commercial daylight after every 10 years. With the 5G deployment in the year 2020 with full swing, the focus is now shifting slowly to completely on the sixth generation. The 6G is expected to replace 5G partially or completely by the year 2030. The sixth generation(6G) will be in contrast will the previous generations and would have capabilities way beyond 5G [10]. Unlike the previous generations, 6G will turn out to be much more transformative and will bring a paradigm shift in communication technology by evolving from “connecting devices” to “connecting network

intelligence” and will come with much stringent requirements in order to full fill rising future needs [6].

In this paper, we understand what exactly are the powers that will come along with the 6G communication technology and how strong influence will the artificial intelligence and 6G communications have on each other, which will indeed revolutionize the industry.

2. WHAT IS 6G?

Before we talk about the capabilities, needs and envision 6G with reference to various concepts, we need to understand what exactly 6G means. 6G is the sixth generation in the mobile communication technology. There have been previous generations such as 2G, 3G, 4G and now 5G which have their own computational capabilities and limitations and were deployed in various periods of time to meet the current needs. Each generation has evolved roughly over every 10 years and 6G is expected to be deployed by 2030.

A particular definition of 6G at the moment cannot be determined as it is a technology still under research. 6G can be explained as the successor of 5G in the communication technology. 6G will substantially overcome the limitations of 5G and would have many more advantages to sustain the growing needs to futurize communication [4].

6G communication system will have a global coverage which will be an integration of 5G network and satellite network systems [18]. It is proposed that 6G will have ultra-fast internet with very high data rates and minimal latency along with a massive network coverage which will much reliable and energy efficient.

3. WHY DO WE NEED 6G?

Even before the 5G being deployed around the world completely, the research on 6G has started vigorously. We need to understand why do we need 6G even when 5G deployments are underway. It is foreseen that the IP traffic globally by 2022 will become three times of that in 2017 and may reach about 400 exabytes per month. About 71 percent of the total IP traffic is observed to be generated from mobile and wireless devices [17]. This is because of the growing need and extensive use of smartphones and the enormous amount of data generated by applications such as YouTube or any other streaming platform. To cope up with this huge IP traffic and to hold a control of it, it has become essential to invent a technology that will feature the capability to meet this need. Though 5G will be a promising evolution in the

communication technology, it may soon fail to solve the network problems with rapidly increasing data generation per day that will eventually go out of the scope of the computational capabilities possessed by 5G [17].

There will be novelty of new applications and inventions in the future of communications such as holography which will require huge data rate to make it work effectively. Data rate up to Terabits per second is essential for these upcoming applications and 5G even with some improvements in coming years might fall short to deliver such speed. This is where 6G comes into consideration. It is believed to deliver data rate of 1 Terabyte per second and assure the smooth functioning of these applications in the near future. Moreover, with the expansion and exponential increase in smart devices or IoT devices, both the network coverage and capability of 5G will be in need of enhancement to keep the devices connected and to efficiently communicate [9]. Also, for the wireless networks in the future, manual network configurations and optimizations, may not be suitable. Automation will be highly essential to meet the network demands. Hence, the need for the sixth generation in communication technology can be determined.

4. 6G EXPECTATIONS

Now that the need of a 6G mobile communication is understood we can have a look at the features of 6G [4] which are expected to be a part of this future generation in communication technology.

Table - 1: Expectations and 6G Vision

6G Communication Technology	100 Gbps to 1 Tbsp peak data rate.
	0.1 ms radio latency.
	100 devices per meter cube density.
	10 cm indoor and 1 m outdoor positioning.
	10000x traffic increase.
	10x more energy efficient.
	10ns radio-only and processing delay.
	Extreme ultra reliability.
	Complete global network coverage.

5. INTEGRATING ARTIFICIAL INTELLIGENCE AND 6G

The whole world is soon to be connected with the rapid growth in communication technology. Artificial intelligence has an important influence on 6G communications [16]. All the latest technologies nowadays support AI. We can expect the world to be a AI driven pretty soon in coming years. The 6G will enhance artificial intelligence in many ways. AI agents are surely destined to play a vital role in the future. Artificial intelligence will be the main driving force in the mobile communication technology and will become a source to create an entirely new generation of applications for machine learning [16]. The recent researches and breakthrough findings in deep learning along with the increase in the no of devices especially smart devices and generation of big data, the wireless community has shown a keen interest towards artificial intelligence. The 6G communications are expected to bring a completely wireless and automated experience and would hence require artificial intelligence to be an essential component of the technology. The 6G communication will transform from connected things to connected intelligence where the latter can only be realized with an involvement of artificial intelligence along with its subsets, machine learning and deep learning [1].

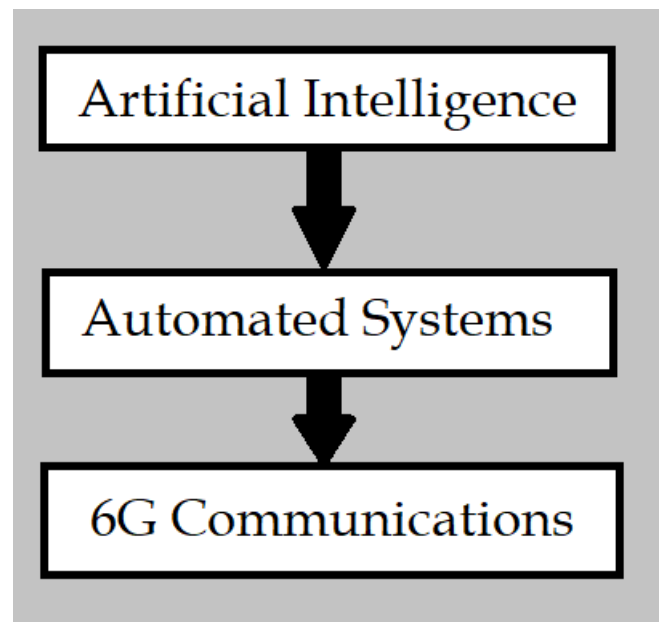


fig - 1: Relating AI and 6G

We can say that artificial intelligence, automated systems and 6G mobile communications are all connected to each other [fig-1]. The artificial intelligence in the pivot enabling technology for automated systems. Various machine learning algorithms and deep learning concepts are the main force behind automation. The concept of real-time learning makes an automated system function efficiently. The automated systems are of importance when talking about 6G communication technology. When connected the globe it is necessary for many systems to be automated to make the most out of the capabilities of 6G communications. Many

applications today that run on smartphones or any smart devices are powered by artificial intelligence and particularly machine learning and hence AI will play a key role in 6G in various aspects such as semantic communications; machine learning and deep neural networks; and holistic management of communication, computation, caching, and control resources.

When we try to integrate artificial intelligence, automated systems and 6G communication technology it can be deduced that 6G will be a transformative and revolutionized generation of the wireless communication technology in multiple aspects. The future networks that will be developed will be too complex to be able to operate manually or with human interference. Human operators can even turn out to be threat to these wireless and complex networks. To achieve such exceptional capabilities, an AI empowered and learning based network technology is needed to manage the communications with zero-touch. AI turns out to be a big trend towards 6G communications for network planning, optimization, analysis, failure detection and resource management. The combination of 6G enabled internet of everything (IoE) and AI will make a strong connection and become a very productive interaction of two technologies where the 6G will help supply data and AI will analyze and determine knowledge from it [8].

6. SELF-DRIVING VEHICLES: A USE CASE

The self-driving vehicles have a perfect blend of the three terminologies discussed before. The integration of artificial intelligence, automated systems and 6G communications can be observed in the implementation of self-driving vehicles. The self-driving vehicles are completely automated and without any human operation. These vehicles are an application of the 6G mobile communication technology. They use real time data to complete its journey from source to destination. This requires tremendous amount of data. They are AI enabled and use real-time prediction and self-organizational approach to complete its journey. This use-case is called as an ultra-high-speed low-latency communication [12]. This is only possible with 6G communications, now knowing its capabilities. The concept of autonomous vehicles uses all three aspects discussed viz AI, automation and 6G. The autonomous vehicle is itself an automated system which is only functional when powered with artificial intelligence. These vehicles require real time data to predict the next move while driving and constantly update the information in its systems. The vehicle is in motion while driving and totally relies upon the data it receives at real time which is utilized by the AI models in its system to guide it on its path [3]. Now, the vehicle needs latest and updated information continuously, this generates huge amount of data every second which may include traffic updates, high resolution maps, live system working updates, warnings etc. Data is received via satellite communication and the network must have high enough data rates that match with the autonomous vehicle requirements. If in case the data does not reach the vehicle requesting it or there in

an interference in communication, these self-driving cars would become unfunctional and even a threat to society when getting out of control and can even turn out to be fatal. The quantum machine learning communications compliment with autonomous vehicles that completely depend upon self-organizations which includes self-configuration, self-optimization and self-healing [5]. The real time network decisions to encourage self-organizational capability can only be taken when the communication technology is strong enough to provide very high data rate and minimal latency. The traffic on roads is increasing enormously along with rapid growth of vehicles in motion at real time. This makes it even more difficult for communication technology to implement the concept of these vehicles and meet the strict requirements of ultralow latency, high data rate, high security and reliability. The machine learning has come up as promising AI technique to make wireless communication adaptable and therefore pave a way for the future intelligentization in the 6G vehicular networks [11]. 6G is envisioned to successfully meet the stringent requirements of such concepts and open up a plethora of opportunities for many such technologies to see the commercial daylight in the coming future [8].

7. HOLOGRAPHIC COMMUNICATIONS: A 6G VISION

The holographic communications have been in buzz in these recent years and there are extensive researches going on to take this concept from vision to reality. We need to understand how 6G communication technology will be a major supporting element for these holographic communications. Holographic communications are nothing but a virtual replication of a real-time entity at two different places at the same time. These communications can bring out a revolution in the human interactions. In the upcoming years the current methods of remote human interaction will become obsolete and holographic communication will be on the verge of deployment. The holographic communications and the services in 5D that is expected to integrate all kinds of human sense information will evolve together hand in hand and will provide a surreal yet immersive experience. The multi-view cameras and sensors that will come along with holographic communications are expected to demand high data rates of terabits per second which is which difficult for a communication generation of 5G to full fill. This demands the need of 6G which will support and help function these types of communications effortlessly [2],[7].

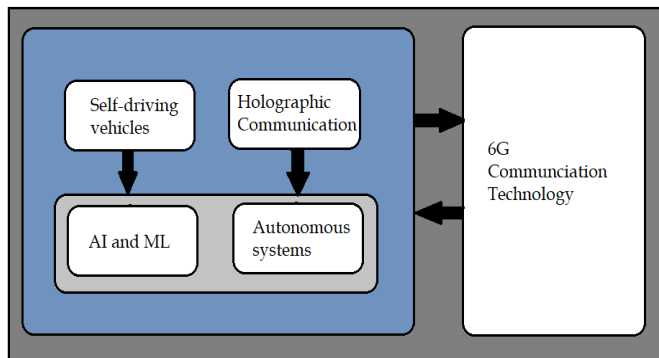


Fig -2: Relation between 6G and its applications with reference to AI

8. CONCLUSION

As the 5G communications are under deployment, it is the right time to think beyond 5G and build a roadmap to take a quantum leap in terms of development for the next generation which is expected to see the industrial daylight by 2030. In this paper we provided the need for 6G communication technology and envisioned the capabilities it is expected to possess. Moreover, we integrated artificial intelligence with 6G communication to analyze various applications that will transform the way humans interact with each other and communication devices. We also discussed two possible technologies that would be one of the important applications derived from the emergence of 6G smart networks, namely self-driving vehicles and holographic communications. This new generation of communication technology will bring out a surge in technological development in terms of networks and communications. 6G is expected to go parallel with the fourth industrial revolution or industry 4.0 which for sure will change the way of living.

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