Research on Application of Artificial Intelligence in Communication Network

Zijun Bai
High school attached to Northeast Normal University, Changchun, 130000, China
robbbertbai@163.com

Abstract—Artificial intelligence has been widely utilized in people’s lives, especially in communication. The article provides a review of the recent research status of the application of artificial intelligence in communication, the usefulness of big data, machine learning, and cloud computation in this field. Several examples of how artificial intelligence is used to communicate are illustrated to discuss better and form a framework of modern artificial intelligence applications. The aspects of concern in ethics of using artificial intelligence are also mentioned, as ethics are the principles judging whether the technologies are suitable for humans to use or not. In order to predict the future development of communication, an introduction of previous progress in the field of communication is provided and sorted into categories of wireless communication, ethical concerns, and network monitor and control. This study confirms that the future development of artificial intelligence is mainly in two aspects: SDN (Software-defined network) and NFV (Network function visualization). AI will thus be used in enhancing communication efficiency.

1. Introduction
In recent years, the development of big data, cloud computation, and machine learning inevitably incite the utilization of artificial intelligence. AI has been increasingly used in individuals’ everyday lives. After making several signs of progress, such as driverless cars, artificial intelligence is also being increasingly brought into focus by the public. People are interested in how this advanced technology can be utilized to benefit society.

People nowadays are increasingly paying attention to the safety of their private information when using the internet, as they are terrified by the abuse of private information. To solve the intriguing problem, network security should be improved. Additionally, the moral principles that should be concerned during the designing of communication networks with the help of artificial intelligence are also important. The authority should ensure that individuals’ rights and interests are inviolable while benefiting from the technology, so it is crucial to investigate which aspects of ethical concerns should be applied.

The purpose of the study will firstly focus on reviewing the history of development in artificial intelligence and communication, which summarizes the previous efforts made by the masters in the field. Communications is a sector with heavy ICT use, dealing with various consumer demands on individualization requirements, multimedia services, and precision management, which has made network security more and more critical.[1] Thus, the article will subsequently summarize the modern research of how artificial intelligence is applied in communication networks. To enable the required technological developments and responses, AI researchers and practitioners will need to take moral, societal, and legal value into account in the design of AI systems.[2] Therefore, the third part of the
article mentions ethical concerns in the present-day development of communication. In the fourth sector, there will be a prediction of the future application of AI in communication networks and future developments.

2. Artificial intelligence and communication network

2.1. Concept of artificial intelligence

AI, known as artificial intelligence, has been defined differently during various periods. However, the modern definition of AI can be understood as intelligence demonstrated by machines instead of the natural intelligence displayed by humans or animals. According to what is defined in the book A Collection of Definitions of Intelligence (Technical report), AI is the field as the study of "intelligent agents": any system that perceives its environment and takes actions that maximize its chance of achieving its goals.[3]

The main advantage of utilizing artificial intelligence in the modern world is that AI can simulate or implement human learning behaviors, which is realized by the technique called machine learning. The technologies in machine learning of artificial intelligence significantly contribute to AI's advanced application in modern industry.

Using the technologies in artificial intelligence, the communication network can benefit from the strengths of AI, especially in two aspects—learning and reasoning. With the strengths of learning and reasoning, AI is suitable for enhancing communication efficiency due to advanced learning and reasoning strategies.

2.2. Concept of communication network

The communication network is not a tangible network that enables communications between people. As communication generally refers to the conversations between individuals through a specific medium, the communication network's definition can be considered the link connecting people through remote communicating devices, which ensures the share of information between people, people, computers, and computers. The communication field at present is mainly telecommunication, consisting of various nodes connected by telecommunication links, enabling the transmission of information and messages.

2.3. Communication

Communication is directly linked with people's living conditions, as it is essential for individuals to connect and chat with others to send and receive messages. The main characteristic of modern communication is mobile, and mobile communication technology is also constantly updated. The communication technology when the first cell phone came out was 1G, which adopted an analog cellular network. The second version of mobile communication technology was 2G, using digital voice transmission technology as the core. The 2G technology is only valuable for enabling calls and messages but is too outdated to serve mobile phones' advanced functions in recent years. The emergence of 3G ensured the delivery of images, though the data transmission rate was relatively slow. 4G was the more effective version of 3G, allowing better quality of the images conveyed and the rate of delivering information. 5G is the recent development in telecommunication with the advantages of high speed, large capacity, low delay.

3. Analysis of the application status of artificial intelligence in communication networks

The recent study of communication mainly converges in improving communication networks. There are three core sectors which are the application of AI in wireless communication, the ethical concerns of using AI in communication and network monitor and control.

3.1. Wireless communication

Communication, which used to be constrained by geographical factors, would take much time to transfer. However, the efficiency of communication has been significantly prompted after the invention of
wireless communication. The recent research of wireless communication is increasingly paying attention to the detection of abnormal communication flow.

![Diagram](image)

**Fig. 1. Favorable conditions for the adoption of machine intelligence techniques in the next generation wireless networks [4]**

Due to the advantages demonstrated in the graph, the usage of AI significantly contributes to wireless communication. As people utilize wireless communication systems, asking for network services, certain network flow will be generated,[5] The management and inspection for communication flow is undoubtedly an essential part of the telecommunication field—the most common way to monitor and manage networks in detection technology. People can detect abnormal flow through established and matched rules and models. As the attacking technologies are growing more and more advanced simultaneously, the old way to detect the flow seemed outdated. The computation for a high-speed network is massive nowadays, so the key to enhancing flow detection methods is to utilize big data and machine learning strengths. Based on the previous attack experience, the database for vulnerability can be improved, thus protecting the network from more attacks.

As a result, the modern method for detecting abnormal communication flow takes advantage of big data, though learning from the previous attacks to enhance the database record to prevent attacks.

### 3.2. Ethical concerns

The author of [6] maintains that people must meet the moral requirements that enhance human well-being when developing AI. As the extent of autonomy in the systems based on AI has been improved, more responsibility should be taken into account. For example, the decision-making process of AI should be more transparent, and the resource of the data should be proposed.

The artificial intelligence system designed for communication networks should consider responsibility, accountability, and transparency. Responsibility, in this case, means the AI systems’ role of making decisions and take part in recognizing errors. Accountability refers to explaining and showing the exact process of individuals’ actions to other network users to consider the decisions. Transparency means the ability to analyze, reproduce, and inspect the mechanisms for making decisions from AI during communication.

In a word, the ethical concerns of applying artificial intelligence in communication networks are recently focused on accountability, responsibility, and transparency.

### 3.3. Network monitor and control

Monitoring and controlling the network, which significantly enhances the network security, is in charge of network supervision, regulation, and inspection. Routing has a significant impact on the network’s performance, and it is a wild-studied topic in communication.[7] Machine learning techniques have been applied to deal with routing problems such as shortest past routing, adaptive routing, and multicasting
routing. Researchers utilized several algorithms with core knowledge in machine learning, such as the genetic algorithm applied to solve multicasting problems.

Research in monitoring the network, primarily focusing on traffic, using AI to analyze and predict traffic demand. According to the author of [8]'s opinion: basically, traffic tendencies can be divided into two types: short-term tendencies, such as temporary traffic increases during the events, and long-term tendencies, from which anomalous tendencies such as temporary traffic increase during the events have been removed. AI is applied to learn the characteristic of the two trends in order to make appropriate predictions. AI can analyze the network information to distinguish whether the network quality is at any normal state.

AI is generally significant in improving network security with an advanced machine learning basis. The security of the Internet is also the key for individuals to use the network for communicating safely.

4. Future application of AI in communication

With the rapid development of communication technologies and the increasing demand for high communication efficiency, the IP network seems outdated with huge network flow problems highly enhance the amount of work required. Therefore, the performance of the network should be enhanced.

4.1. SDN

SDN (software-defined network) is a network architecture approach that enables the network to be intelligently and centrally controlled, or ‘programmed,’ using software applications.[9] There are three aspects that SDN benefits communication. Firstly, SDN allows network operators to adjust the network behavior and avoid being constrained by the proprietary platforms. Furthermore, SDN is of centralized intelligence to control logically, enabling the better control and management of resources on the internet. The openness of SDN is also advantageous, as the network supports are compatible with applications in the same software environment.

4.2. NFV

The increase in communication efficiency can be realized by NFV (Network Function visualization) as well. The article [10] mentions that NFV is a way to reduce cost and accelerate service deployment for network operators by decoupling functions like a firewall or encryption from dedicated hardware and moving them to virtual servers. The advantages of NFV are mainly to the operators that it brings a new way for network maintenance so that the cost and time for maintaining the network can be reduced. Additionally, NFV decreases network power consumption, as NFV techniques make networks' functions, especially in hardware to the software, thus reducing network power consumption.

5. Conclusion

The article reviews the characteristics of artificial intelligence and the development of communication technology, explaining what artificial intelligence is and how applying AI technology benefits communication. The study emphasizes how AI is utilized in the field of communication. The modern study of applying AI to a communication network mainly concerns three aspects: wireless communication, ethical concerns, and the monitor and control of the network. Wireless communication promotes the importance of detecting abnormal traffic flow, while ethical concerns emphasize communications accountability, responsibility, and transparency. The monitor and control of the network increase the security of individuals’ privacy during communication.

The future research focus of applying AI in communication networks should pay attention to SDN and NFV technologies. Although SDN and NFV are applied in modern society in some instances, the spread of the technologies has to be reinforced to provide a more effective way of communicating. However, the new systems for communicating face problems such as lack of experience and being replaced by updated methods. As people are generally less familiar with the rationales of SDN and NFV, the potential problems are not clearly shown unless more time for application. It is also uncertain
whether SDN and NFV will soon be replaced, as the developing rate in AI is amazingly rapid. The future is virtually unpredictable—accountability, responsibility, and transparency.

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