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A Study of the Applications of Artificial Intelligence in Telecommunication

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ABSTRACT

Telecommunication is defined as the electronic transmission of information, such as voice telephone calls, texts, images, or video, over a distance. Today, telecommunication has taken a new and higher technological dimension, especially with the introduction of 5G, or the 5th generation network system. Taking this as well as the capability of artificial intelligence (AI), which involves its ability to function like humans, into consideration, it became imperative to investigate the role of artificial intelligence (AI) in telecommunication. The research adopted review and descriptive research methods, which provided the authors the opportunity to study a wider scope of research works carried out in this research area in addition to the telecommunication case study. From the study, it was discovered that some applications of AI in telecommunication are traffic management, fault detection, network security, and quality of service management or regulation. It was concluded from the results that AI has many applications in telecommunication. It was recommended that the challenges to the effective application of AI in telecommunication be studied in future work.

KEYWORDS: *Artificial Intelligence, fault detection, Security, Traffic management*

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1. INTRODUCTION

Telecommunication is defined as the electronic transmission of information, such as voice telephone calls, texts, images, or video, over a distance. Today, telecommunication has taken a new and higher technological dimension, especially with the introduction of 5G, or the 5th generation network system. Network performance is one of the important aspects of telecommunication. Network performance is the capability of a telecommunications system to provide effective and efficient communication services, which is characterised by metrics such as latency, bandwidth, jitter, and packet loss (Bari *et al.,* 2013).

The telecommunications network is responsible for carrying all internet data and is made up of various technologies like satellites, microwaves, and mobile networks (Kennedy et al., 2024). At a never-before-seen pace, artificial intelligence is revolutionising the telecommunication sector, as new and cutting-edge

telecommunications technologies like 5G networks, autonomous vehicles, and the Internet of Things are being created with machine learning, which is an AI technique (Raman and Vinat, 2024).

Furthermore, AI-driven network management provides several key advantages over traditional approaches. Thus, AI algorithms can analyze vast amounts of network data in real time, then identify the patterns and anomalies that might indicate potential issues or faults. This predictive capability allows for preemptive maintenance and optimization, reducing downtime and improving overall network reliability. Another importance of AI is that AI can automate routine network management tasks, such as traffic routing and resource allocation, and in the process, free up human operators to focus on more strategic activities (*Cath* et al., 2018). According to Tsiatsis *et al.* (2018), the convergence of AI with Internet of Things (IoT) devices in telecommunications networks is another area that holds great promise, as AI can enhance the intelligence of IoT devices, enabling more sophisticated data analysis at the device level, thereby resulting in more informed decisions and actions without human intervention.

In the areas of security, especially from the cyber area, artificial intelligence is emerging as a transformative force in cybersecurity, offering innovative solutions to address the challenges of network security. AI technologies, such as machine learning, natural language processing, and deep learning, provide advanced capabilities for detecting, predicting, and responding to cyber threats or attacks (Anita, 2024). And so, it is safe to say that the future of telecommunications lies in harnessing the power of AI to drive innovation and improve services in telecommunications. As these technologies evolve, they will play a pivotal role in shaping next-generation networks that are more efficient, secure, and responsive to the needs of users (Samuel et al., 2024). As a result of this, there is a need to study the importance of AI in telecommunications.

2. Materials and methods

2.1. Materials: The materials used for the work are mostly from secondary sources, such as library materials, online-published research papers, and YouTube videos, with others gotten through case studies of telecommunication systems, in which the operation of telecommunication companies and service providers was studied.

2.2. Methods: The research work made use of mixed methods approaches, combining review methods and descriptive methods. It carried out the review of different previous or existing works in the research area, especially the recent ones.

3. Results and Analysis

Research question: What are the applications of artificial intelligence in telecommunication?

This section provides some applications of artificial intelligence in telecommunications and their brief explanations.

3.1. Predictive Maintenance

Predictive maintenance is defined as the proactive approach to maintaining equipment and systems by using data analytics, machine learning, and sensors to predict when maintenance is required. This approach helps in preventing unexpected failures, reduces downtime, and optimizes maintenance schedules. Artificial Intelligence (AI) plays a crucial role in predictive maintenance in telecommunications, enabling proactive identification and prevention of network equipment failures. IT helps in detecting network anomalies very early and predicting potential failures before they affect the quality of service negatively. Predictive maintenance in telecommunications using AI can be in the form of condition-based maintenance, which deals with maintenance performed based on the actual condition of telecommunication equipment or the maintenance performed based on predictions of the failure of telecommunication equipment. This can be done through the use of AI techniques such as machine learning algorithms to analyse sensor data from network equipment for prediction of failures, as well as the use of deep learning techniques like neural networks to analyse complex sensor data for prediction of failures. In simple terms, the AI predictive maintenance process involves the use of real-time data and algorithms to predict failures, minimizing downtime, reduce the frequency of unexpected outages, monitor network infrastructure, and reduce repair time by preparing solutions before the problems occur (Alabi, 2023).

3.2. Network Optimisation

Network optimisation is defined as the process of analysing and improving network performance, reliability, and efficiency. This involves using various techniques, such as traffic engineering, resource allocation, and topology optimization, to ensure that network resources are utilized effectively and efficiently. Artificial Intelligence (AI) plays a crucial role in network optimization in telecommunications, enabling real-time monitoring, analysis, and optimizing the network performance. Network optimisation in telecommunications using AI can be in the form of traffic Optimisation which is used for

improving the network traffic flow, which reduces congestion and latency; resource optimization, which is used for improving the network resource allocation to ensure efficient use of bandwidth, storage, and computing resources; and topology Optimisation which is used for improving the network topology to reduce latency, increase reliability, and increase scalability. This can also be achieved through AI techniques like Natural Language Processing used for analysing network logs; Machine Learning used for analysing traffic patterns, and Deep Learning used for analysing network performance. According to Samuel, (2024), AI-driven solutions enable dynamic and adaptive network configurations, ensuring optimal performance even under varying traffic conditions and unexpected disruptions. Furthermore, it was also stated that the predictive capabilities of AI help in preemptively addressing network issues before they impact users, thus maintaining high QoS standards.

3.3. Quality of Service (QoS) Management or Regulation

Quality of Service (QoS) management or regulation is defined as the process of monitoring, controlling, and optimizing network performance to ensure that it meets specified standards and requirements. QoS management involves regulating network parameters, such as bandwidth, latency, jitter, and packet loss, to enable high-quality network services. Artificial Intelligence (AI) plays a crucial role in quality of service (QoS) management or regulation in telecommunications by enabling real-time monitoring and analysis, as well as improving the performance of the network. AI techniques for QoS management in telecommunications are machine learning, which analyses the network traffic patterns to predict QoS parameters and detect faults; Deep Learning which analyses the complex network traffic patterns to improve the QoS. AI-driven solutions are very vital in telecommunications as they offer substantial enhancements in network performance and quality of service (QoS) using robust AI models, continuous monitoring, and ethical considerations in order to mitigate potential risks. (Samuel, 2024).

3.4. Network Security

Network security is defined as the practices and technologies used to protect network infrastructure, devices, and data from unauthorised access, use, modification, or destruction. Artificial Intelligence (AI) plays a crucial role in network security in telecommunications, enabling real-time threat detection, analysis, and mitigation. Some common types of network security threats in telecommunication are malware (malicious software), which is software designed to harm computer systems; phishing, which involves tricking an individual to reveal sensitive information like passwords or credit card numbers or to steal sensitive information; and DDoS (Distributed Denial of Service) attack, which is an attack that causes overwhelming network traffic from multiple sources on a computer or its network, which disrupts services. In the view of Kartheek (2024), telecommunication networks may defend themselves against intrusions and breaches continuously by using real-time data analytics and automated decision-making to respond quickly to new threats. In addition, the AI-powered enhancement of proactive threat information gathering and analysis is so vital that telecommunication operators may anticipate possible weaknesses, detect unusual trends, and adjust defensive measures in advance using machine learning techniques.

3.5. Fault Detection

Fault detection is defined as the process of identifying and detecting faults or anomalies in network equipment, systems, or services. It involves using various techniques, such as machine learning, data analytics, and sensor data, to identify potential faults before they occur or to detect faults in real time. Artificial Intelligence (AI) plays a crucial role in fault detection in telecommunications, enabling real-time monitoring, analysis, and identification of network faults. Some common types of faults in telecommunications are Hardware faults, which are faults in network equipment, like servers, routers, and switches; software faults, which are faults in network software such as configuration issues; and network faults, which are faults with network connectivity, and this can be in the form of link failures or congestion. From the work of Kennedy *et al.* (2024), research that develops a machine-learning fault detection model for received signal levels in telecommunication infrastructure, it was inferred that unitilising these machine learning-based fault detection models enables telecom service providers to reduce downtime, optimise network performance, and increase customer satisfaction. According to Philip *et al.* (2024), by leveraging real-time data analytics and automated decision-making, telecommunication networks can swiftly adapt to evolving threats and ensure continuous protection against intrusions or breaches.

3.6. Traffic Management

Traffic management is defined as the process of monitoring, controlling, and optimizing network traffic to ensure efficient and reliable network performance. It involves regulating network traffic

flow, as well as prioritizing traffic and optimizing traffic routing in order to reduce congestion, latency, and packet loss. In telecommunications, traffic management refers to the process of controlling and optimising the flow of network traffic to ensure efficient and reliable communication services. Artificial Intelligence (AI) plays a crucial role in traffic management by enabling real-time monitoring, analysis, and optimization of network traffic. Real-time traffic monitoring with AI-powered tools collects and analyze network traffic data in real-time, providing insights into traffic patterns, volumes, and anomalies; traffic prediction and forecasting with AI-powered machine learning algorithms analyse historical traffic data to estimate or predict future traffic patterns and volumes. Broadly speaking, tasks in the field of traffic analysis and management can be conditionally divided into three groups: traffic analysis tasks, traffic management tasks, and traffic generation tasks. Traffic analysis tasks include various statistical data collection and analysis tasks, while traffic management tasks include traffic restriction tasks to prevent network elements from being overloaded (Zufarova, 2022).

4. Conclusion

This work was conducted on the applications of artificial intelligence (AI) in telecommunications, considering the capability of artificial intelligence (AI), which involves its ability to function like humans and even do more beyond human expertise in some cases. The research adopted mixed research approaches—descriptive research and review research methods. The methods provided the authors the opportunities to study a wider scope of research works carried out in this research area. From the study, it was discovered that some applications of AI in telecommunication are traffic management, fault detection, network security, and quality of service management or regulation. It was concluded from the results that AI has many applications in telecommunication. This result will be useful to the stakeholders in telecommunication sectors as well as policymakers.

5. Recommendation

It is recommended that the research on the challenges to the effective application of AI in telecommunication be studied in future work.

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