IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Artificial Intelligence Integrated With 5 G For Future Wireless Network

Rajendrakumar
Asst Professor,
Department of Computer Science,
Government First Grade College, Sedam.

Abstract

The advent of the wireless communications systems augurs new cutting-edge technologies, including self-driving vehicles, unmanned aerial systems, autonomous robots, the Internet of Things, and virtual reality. These technologies require high data rates, ultra-low latency, and high reliability, all of which are promised by the fifth generation of wireless communication systems (5G). Many research groups state that 5G cannot meet its demands without artificial intelligence (AI) integration as 5G wireless networks are expected to generate unprecedented traffic giving wireless research designers access to big data that can help in predicting the demands and adjust cell designs to meet the users' requirements. Subsequently, many researchers applied AI in many aspects of 5G wireless communication design including radio resource allocation, network management, and cyber-security. In this paper, we provide an in-depth review of AI for 5G wireless communication systems. In this respect, the aim of this paper is to survey AI in 5G wireless communication systems by discussing many case studies and the associated challenges, and shedding new light on future research directions for leveraging AI in 5G wireless communications.

Artificial intelligence and fifth-generation mobile networks (5G) are two of the few technologies that work together so effectively. The complexity of a 5G ecosystem necessitates a level of service assurance that can't be met by human effort alone. Fifth-generation network operators will leverage AI for network diagnostics, cyber security, and personalized applications, all of which will radically alter the relationship between businesses and their consumers. The facts that even more nearly half of internet services have already integrated another aspect of AI into its 5G networks demonstrates that the industry has already invested much in the coupling. At the core of the complementary connection between AI and 5G is the significance of data; 5G opens a floodgate for data, something AI could then analyses as well as learn from more swiftly to create unique consumer experiences that were already suited to the numerous needs of consumers. As AI runs simulations for analysis, reasoning, data fitting, clustering, including optimization, the 5G network provides support in the background, increasing the reliability and significance of the findings.

Keywords: Network slicing, Edge computing, AI driven network management.

I. INTRODUCTION

The eventual expansion of 5G-powered Internet of Things (IoT) devices in settings as diverse as manufacturing floors and driverless cars will cause the volume of data to grow not linearly but exponentially. Reason being, 5G will provide for much quicker data transfers. All of these gadgets and their integrated sensors provide new data that can be used to train smarter computer systems. Networks are now guaranteed with timely delivery of critical traffic as they are built with AI-enabled smart switching. The inception of COVID-19 drastically changed the network service demands and operational processes due to movement restrictions and work from home policies. AI will enable network with proactive and dynamic resource allocation to allocate resources in desired locations based on real-time demand unlike static

resource allocation method used in existing networks till now. This can resolve the issue of sudden shift in traffic demands from major cities to small towns and rural areas straining RAN and backhaul network.

Discussion

Furthermore, Artificial Intelligence to manage network traffic of 5G wireless networks are used to forecast traffic and identify cell outages enabling network to amend new configurations. It can be done by switching off inoperative base stations or turn on self-healing functionalities of self-organizing networks (SON). AI will also optimize proactive handover required to manage critical emergency situations where in patients are attended via video conferencing/voice communications and avoid network disruption or in case switching connections from one cell tower to another while care professionals are in the ambulance on their way to hospitals.

- CSPs are under pressure to curb operational and capital costs as they accelerate 5G wireless network rollouts. Technologies like Artificial Intelligence and Machine Learning are gaining traction in the network management field and assisting operators to manage 5G networks. Initially, reluctant to place their data on public clouds, operators have started optimizing network through AI algorithms on public cloud due to its multiple key benefits. Due to the increase in complexity of 5G architecture, use of AI is certainly becoming a prerequisite to manage and optimize such network.

The authors focused on some types of neural networks, such as recurrent, spiking, and deep neural etworks,and how it can empower some wireless communication problems. Nevertheless, most of these survey papers focus on artificial intelligence theory, which is well-established, more than they focus on how this technology can solve practical problems in wireless communications. In this paper, we review wireless artificial intelligence with a particular focus on how AI methodologies can solve complex problems in 5G wireless networks considering many aspects of wireless communication and networking. For each aspect, we illustrate how machine learning can be applied using well-selected examples; and we pinpoint the advantages and disadvantages of using such machine learning/deep learning to solve each particular problem. We also provide some future research directions to overcome the challenges facing AI driven wireless communication and networking. It is not only about the complexity of the architecture but also, addition of 5G on top of the layer stack comprising previous cellular technologies 2G, 3G, and 4G. Moreover, modern use cases and abilities such as network slicing ads on to its intricacy.

Innovative AI solutions are being leveraged to enhance the network performance and provide best connectivity. Here are some examples of operators utilizing AI to enhance 5G wireless networks:

- China Mobile is utilizing AI technology to isolate network anomalies and bandwidth demand where the data capture is originated from the RIC (RAN Intelligent Controller).
- Mobile network operators are using VMware's Uhana to detect RAN anomalies. Signal strength is determined, and radio sessions are managed in real-time applying eNodeB trace data. In addition, AI can analyze impact on customer due to cell site after detecting RAN anomalies.
- Ciena, a telecom company is implementing AI to resolve signal impairments in layer zero, one and two i.e., optical and Ethernet. AI-engine has the capability to drive decision input and automate manual tasks executed by skilled engineers.

5G and Artificial Intelligence (AI) are two transformative technologies. Together they have the potential to revolutionize wireless networks in telecommunications, offering unprecedented connectivity and intelligence. As 5G networks roll out globally, offering high data speeds, ultra-low latency, and the ability to connect many devices simultaneously, they provide the necessary infrastructure for AI applications to operate in real-time. AI can optimize the performance of 5G networks by managing traffic, predicting maintenance needs, and improving security. This symbiotic relationship between 5G and AI is not just about enhancing current capabilities but is set to transform how we connect, communicate, and consume data. These technologies can help create a future where telecommunications are smarter, faster, and more reliable than ever before.

Future work

5G technology, a technological paradigm shift akin to the shift from typewriter to computer, is essential to using AI features in telecommunications. 5G facilitates rapid information transmission and exceptionally low latency. This capability is essential for AI applications designed for real-time operations, where even milliseconds can significantly impact performance and outcomes. AI advancements can help improve 5G system performance and efficiency, while the proliferation of 5G connected devices can drive distributed intelligence with continued enhancements in AI learning and inference. A crucial aspect of 5G is its ability to support a vast network of connected devices. This connectivity is vital for distributing AI's computational power and intelligence across a wide area. It not only multiplies the points of data collection and interaction but also enriches AI learning and inference processes by leveraging insights from a broader array of sources.

The synergy between AI and 5G technologies promises to significantly elevate customer experiences in telecommunications. AI's potential to personalize services, anticipate customer needs, and streamline support is markedly amplified by 5G's speed and responsiveness. AI plays a critical role in the rollout of 5G networks, promoting more efficient network planning and design, improving network performance, and enhancing the customer experience. For example, AI can help identify the best locations for 5G cell sites based on population density, network coverage, and terrain. AI-driven CX intelligence can help identify customers who are up to five times more likely to churn in response to a poor network experience; it can identify opportunities to reduce capital expenditure by 5 percent to 10 percent; and it can also help generate a 10 percent to 15 percent increase in sales conversion, all of which can further drive up customer experience.

AI revolutionizes the telecommunications industry by offering innovative solutions that enhance efficiency, security, and customer satisfaction. From optimizing network operations to personalizing customer interactions, AI's versatile applications are setting new standards for service quality and reliability in telecom. Network Optimization and Management (Wireless Network Planning) AI can help optimize network performance by analyzing network traffic patterns and optimizing resource allocation. For instance, in wireless network planning, AI can model complex urban environments and predict how different building materials affect signal propagation. This modeling can help in determining the optimal locations for small cells in cities to ensure wide coverage with minimal interference.

AI algorithms can monitor network traffic 24x7, scrutinizing every data packet and user interaction while also detecting anomalous patterns or behaviors that human analysts might overlook. This capability helps detect and prevent fraudulent activities like unauthorized network access, fake profiles, and so on. AI can analyze data from network sensors to identify potential problems before they occur. This feature allows telecom providers to take proactive steps to fix problems and prevent outages. AI-driven automation system constantly checks your network for problems and automatically updates software to keep it safe. AI assists Communication Service Providers (CSPs) in developing self-optimizing networks that maximize network quality based on traffic and service KPI data by area and time zone. These AI apps employ powerful algorithms to identify data trends to detect and anticipate network anomalies and proactively resolve issues before affecting customers. AI can continuously monitor network performance metrics, such as latency, packet loss, and throughput. By analyzing this data, AI algorithms can identify bottlenecks, prioritize critical traffic, and optimize network parameters to deliver a consistent and reliable quality of service to end-users.

By analyzing customer behavior and preferences, AI enables telecom companies to tailor personalized offers, boosting sales and enhancing the customer experience. Additionally, AI's capability to scrutinize network traffic patterns aids in identifying potential issues early on, ensuring network performance and

reliability are maintained at optimal levels. The automation of routine tasks in call centers through AI not only streamlines operations but also allows human agents to concentrate on addressing more complex customer issues, further elevating the standard of customer service. Implementing AI features within telecommunications networks introduces a range of technical challenges that necessitate a strategic and informed approach. One significant hurdle is dealing with unstructured or incomplete data, which can render AI systems ineffective.

Furthermore, the adoption of AI technologies requires additional technical expertise—a resource that can be in short supply. This expertise is crucial not only for the initial implementation but also for the ongoing management of AI systems. The integration of AI into existing telecommunications infrastructure presents another layer of complexity. Legacy systems, often deeply entrenched within organizations, pose significant challenges to seamless AI integration, requiring time-consuming and complex solutions.

Another obstacle is the critical need for specialized training and education in this field. The absence of clear objectives for AI implementation can lead to difficulties in measuring success and demonstrating value, further complicating adoption efforts.

Data analysis capabilities are essential for AI's success, yet many organizations lack the necessary tools and skills to analyze large volumes of data effectively. Security concerns add another layer of complexity, as AI systems frequently process sensitive information, raising significant data protection and privacy issues. Navigating the maze of regulatory compliance presents its own set of challenges, with telecommunications companies needing to ensure that their use of AI aligns with current laws and industry regulations. Despite these challenges, with the strategic allocation of resources, investment in training, and a clear focus on integrating AI in telecommunications, organizations can overcome these hurdles. 5G networks' capacity to support AI-driven innovations in telecommunications will become increasingly critical, offering solutions that enhance network performance, improve customer service, and ensure more efficient operations.

In order to ease the integration of deep learning, research efforts are needed in several directions. For instance, the acceleration of deep neural network alongside advanced parallel computing, faster algorithm, and cloud computing, distributed deep learning systems present an opportunity for 5G to build the intelligence in its systems to deliver high throughput and ultra-low latency.

CONCLUSION

In the world of new technologies, 5G and AI everywhere, are two technologies expected to change the entire ecosystem. The deadly combination of 5G and AI on one platform will lead to incredible new opportunities with a totally new point of view. The cutting-edge AI and 5G technologies will help creating an environment where data-driven algorithms control cloud-enabled processes, devices to give an enthralling experience to its consumers. And, AI will play a critical role in enhancing 5G wireless networks to give excellent Quality of Experience 24X7. Building and managing network is a constant process for mobile network operators. Multiple components and several new-age technologies added into the networks like 5G increases its complexity and puts several challenges on operators. To address such operators' concerns, operators are partnering with AI solution providers to solve and reduce their network management costs. The power of combining 5G and AI will interpret complex datasets faster with more accuracy than humans; recommend engines to customize offerings based on user preferences. Clubbing 5G and AI technologies can give new 5G and AI use cases used in different industry verticals to improve efficiency. We studied several case studies including modulation classification, channel coding, massive MIMO, caching, energy efficiency, and cyber security. As a conclusion of this in-depth study, AI enabled 5G wireless communication and networking is a promising solution that can provide wireless networks with the intelligence, efficiency, and flexibility required to manage the scare radio resource well and deliver high

quality of service to the users. However, some efforts are still needed to reduce the complexity of deep learning so it can be implemented in time-sensitive networks and low power devices and test the models in more realistic scenarios.

Reference

[1]. A. Dash, D. Pradhan, H. M. Tun and Z. M. Naing, "Integration of AI to enhance 5Gcapabilities in Smart Cities", *Journal of Image Processing and Artificial Intelligence*,

[2]. M. Essayed and M. Erol-Kantarci, "AI-Enabled Radio Resource Allocation in 5G FOR URLLC and Ebb Users", *2019 IEEE 2nd 5G World Forum (5GWF)*,

[3]. N. Gupta and U. Ghosh, *Artificial Intelligence and blockchain driven beyond 5G networks: A Review*, 2022.

[4]. A. Hunter, "Information hiding: Ethics and safeguards for Beneficial Intelligence", *Proceedings of the 8th International Conference on Agents and Artificial Intelligence*, 2016.

[5]. C. Zhang, P. Patras, and H. Haddadi, "Deep learning in mobile and wireless networking: A survey," IEEE Communications Surveys & Tutorials, 2019.

[7] M. Soltani, V. Pourahmadi, A. Mirzaei, and H. Sheikhzadeh, "Deep learning-based channel estimation," IEEE Communications Letters, vol. 23, no. 4, pp. 652–655, 2019.

[8] S. Gao, P. Dong, Z. Pan, and G. Y. Li, "Deep learning based channel estimation for massive mimo with mixed-resolution adcs," IEEE Communications Letters, vol. 23, no. 11, pp. 1989–1993, 2019.

[9] H. Ye, G. Y. Li, and B.-H. Juang, "Power of deep learning for channel estimation and signal detection in ofdm systems," IEEE Wireless Communications Letters, vol. 7, no. 1, pp. 114–117, 2017.

[10] Y. Wang, M. Narasimha, and R. W. Heath, "Mmwave beam prediction with situational awareness: A machine learning approach," in 2018 IEEE 19th [11] E. Balevi and J. G. Andrews, "Deep learning-based channel estimation for high-dimensional signals," arXiv preprint arXiv:1904.09346, 2019.

[12] H. He, C.-K. Wen, S. Jin, and G. Y. Li, "Deep learning-based channel estimation for beamspace mmwave massive mimo systems," IEEE Wireless Communications Letters, vol. 7, no. 5, pp. 852–855, 2018.

[13] M. S. Safari and V. Pourahmadi, "Deep ul2dl: Channel knowledge transfer from uplink to downlink," arXiv preprint arXiv:1812.07518, 2018.

[14]. International Workshop on Signal Processing Advances in Wireless Communications (SPAWC). IEEE, 2018, pp. 1–5.