

FUTURE GENERATIONS OF MOBILE COMMUNICATIONS: HISTORY AND INNOVATION OF AI

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Анотація

У цій роботі розглядаються інтелектуальні антени для мобільних мереж 5G та перспективних технологій наступних поколінь зв'язку. Досліджуються принципи роботи адаптивних антенних систем, фазованих антенних решіток та технології MIMO (Multiple Input Multiple Output). Особлива увага приділяється використанню штучного інтелекту для оптимізації роботи антен, покращення ефективності використання спектра та підвищення продуктивності мережі. Аналізуються методи формування діаграми спрямованості та адаптивного управління пучками сигналу, що дозволяють зменшити рівень перешкод і покращити якість зв'язку. Результати досліджень підтверджують перспективність інтелектуальних антен для забезпечення високошвидкісного та надійного зв'язку у майбутніх бездротових мережах.

Ключові слова: інтелектуальні антени, 5G, 6G, фазовані антени, адаптивні антени, MIMO, beamforming, спектральна ефективність, штучний інтелект, бездротовий зв'язок, мобільні мережі, оптимізація сигналу, зниження перешкод, високошвидкісний зв'язок.

Abstract

This paper examines intelligent antennas for 5G mobile networks and next-generation communication technologies. The study explores the principles of adaptive antenna systems, phased antenna arrays, and Multiple Input Multiple Output (MIMO) technology. Special attention is given to the use of artificial intelligence for optimizing antenna performance, improving spectral efficiency, and enhancing network productivity. The paper analyses beamforming techniques and adaptive beam management methods that help reduce interference and improve connection quality. The research findings confirm the potential of intelligent antennas in providing high-speed and reliable communication in future wireless networks.

Keywords: intelligent antennas, 5G, 6G, phased array antennas, adaptive antennas, MIMO, beamforming, spectral efficiency, artificial intelligence, wireless communication, mobile networks, signal optimization, interference reduction, high-speed communication.

Introduction

At the beginning of the 20th century, the development of mobile communications began with the first experiments in the field of radio communications. Initially, the technology was used mainly for the needs of law enforcement agencies, which allowed police officers to maintain communication during patrols. Later, in the 1930s, the first two-way radio systems appeared, which significantly improved the quality of communication. And in 1946, the first public mobile telephone service was created, which became a step towards the development of mobile technologies for the general public. These first achievements laid the foundation for the evolution of mobile communications, which later led to the emergence of modern wireless networks.

First generations of mobile communications (1G-3G)

The development of mobile communications has come a long way from the first analogue systems to modern high-speed digital technologies. The first generation (1G) provided only voice communication, but had significant drawbacks, such as poor signal quality and the possibility of eavesdropping. With the advent of 2G, communication became digital, which allowed for improved security and the addition of new features, including SMS. The third generation (3G) was a real breakthrough, opening up access to the mobile Internet, video communication and multimedia services. Each stage of the development of mobile technologies laid the foundation for subsequent innovations that led us to modern high-speed networks [1].

Modern generations (4G-5G)

Modern mobile communication technologies have taken a significant leap forward with the advent of 4G and 5G. While 4G provided users with stable high-speed Internet, allowing them to watch videos and use online services without interruption, 5G has opened up new horizons thanks to even higher data transfer speeds, minimal latency and the ability to connect millions of devices simultaneously. Thanks to these technologies, smart cities, autonomous cars and telemedicine have become a reality. It was 4G and 5G that created the foundation for the future development of wireless communications, which continue to change the world around us [1],[2].

Adaptive Antenna Systems: Dynamic Signal Management

Adaptive antennas operate on the basis of phased array antennas, which allow changing the directivity pattern depending on the location of the subscriber and the level of interference. They can dynamically focus the signal in the desired direction, which significantly improves communication quality and reduces losses. The main advantages of such systems include interference suppression, improved signal-to-noise ratio and increased network throughput [3].

MIMO technology: increasing communication speed and reliability

MIMO technology uses multiple antennas on the transmitter and receiver, allowing multiple data streams to be transmitted simultaneously. This allows for significantly higher data transfer rates without increasing the required frequency spectrum [3].

Using artificial intelligence in antenna optimization

One of the key areas of AI application is adaptive beamforming. Artificial intelligence algorithms analyse user locations and interference levels to automatically adjust antenna radiation and ensure maximum signal quality [3],[4].

Efficient spectrum use: dynamic management and forecasting

AI optimizes the allocation of frequency spectrum between subscribers and services, reducing network congestion and increasing the speed and stability of communication. With interference prediction, machine learning algorithms analyse the environment, detecting potential obstacles before they appear. Combined with automatic correction of antenna parameters, these technologies make mobile networks more reliable, flexible and faster, which is critical for the development of 5G and future communication standards [4].

Prospects for future generations of mobile communications 5G and its development

The fifth generation of mobile communications has already changed the way we interact with the Internet. It provides speeds of up to 10 Gbps and low latency, which is key for the Internet of Things (IoT), autonomous vehicles and online services. In addition, 5G opens up new opportunities for education, medicine and industrial technologies, expanding the use of mobile communications in everyday life. The number of 5G subscribers is expected to exceed 6 billion by 2030, which will contribute to even greater innovation [5].

6G and its prospects

The next generation, 6G, is expected to offer speeds of over 1000 Gbps and latency of less than 100 μ s, opening up new possibilities for quantum computing, holographic communication, and intelligent networks. 6G is expected to integrate with advanced artificial intelligence technologies, enabling even more efficient communications and expanding the horizons of automated systems and virtual reality.

The role of artificial intelligence

Artificial intelligence will play a key role in future mobile networks. Its application will allow optimizing frequency spectrum allocation, predicting interference, and automatically adjusting antenna systems. This will improve communication quality and make the networks themselves more flexible and efficient [6].

Conclusion

Mobile communications have undergone significant evolution, with each generation demonstrating increased speed, reliability, and intelligence. Adaptive antennas, MIMO technology, and artificial intelligence are already changing the way we communicate wirelessly, making it more efficient. In the future, 6G will open up even more possibilities, providing minimal latency and ultra-high data rates. The integration of the latest technologies will make mobile networks even smarter and more adaptive, which will significantly affect the development of the digital world [1-6].

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