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METHODS FOR DETECTION AND ELIMINATION OF RADIO INTERFERENCE IN RADIO MONITORING SYSTEMS USING ARTIFICIAL INTELLIGENCE

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Abstract

This scientific article considers the issues of using artificial intelligence methods in the detection, classification and elimination of radio interference in radio monitoring systems. The effectiveness of machine learning, deep neural networks, reinforcement learning and adaptive filtering algorithms is analyzed. The proposed approaches are aimed at increasing spectrum efficiency, improving signal quality and ensuring automatic control.

Nowadays, radio communications, telecommunications, radar and wireless data transmission systems are developing rapidly. One of the main problems in these areas is radio interference (noise), which degrades signal quality, leads to data loss and reduces system reliability. Traditional filtering and signal processing methods do not always provide high efficiency. Therefore, the use of artificial intelligence (AI) technologies to eliminate radio interference is relevant.

Keywords: Radio monitoring, artificial intelligence, machine learning, neural network, radio interference, spectrum analysis, cognitive radio, 5G/6G.

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1. Introduction

Artificial intelligence (AI) is entering a completely new phase today - it is now entering an era when it has the power not only to optimize existing systems, but also to radically change the way organizations and societies work on a global scale. In our study, we analyze the technologies that stand out in this development process - machine learning, autonomous systems and digital twins - and consider their interconnection and practical significance. The ability of AI models to "think" and "make decisions" is increasing: for example, multimodal models (text, images, voice working together) are expanding.

According to a 2025 McKinsey & Company survey, more than 88% of organizations have begun to systematically use AI in at least one business function. At the same time, the majority of organizations are still in the testing/experimental stage and face problems with the large-scale implementation of the technology. McKinsey & Company is an international consulting firm specializing in strategic management, which serves as an advisor to the world's largest companies, government agencies, and non-profit organizations. Artificial intelligence technologies, mainly Machine Learning algorithms (SVM-Support Vector Machine), k-NN (K Nearest Neighbors), Random Forest), deep learning (CNN, RNN, LSTM), and reinforcement learning methods, allow for decision-making in dynamic environments. These algorithms serve to automatically extract useful features from spectral data. In modern telecommunications systems, spectrum resources are limited, and radio interference causes a decrease in communication quality. Continuous monitoring of the airwaves through radio monitoring systems and rapid detection of sources of interference are of great importance. In recent years, artificial intelligence technologies have created great opportunities for automating these processes.

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2. Theoretical foundations of radio interference.

Radio interference is divided into random, industrial, pulsed and intentionally created types. They lead to a decrease in the signal-to-noise ratio, an increase in bit errors and a decrease in channel bandwidth. Spectrum analysis, time-domain filtering and statistical methods are used in radio monitoring.

The proposed architecture consists of sensor nodes, a central server and a cloud analysis module. Sensors measure the spectrum, Artificial Intelligence models run on the server, and the results are presented to the operator in real time.

At the enterprise level, artificial intelligence strategies are being formed to increase efficiency and innovation: companies are aiming not only to reduce costs, but also to achieve growth through artificial intelligence. At the same time, security, data privacy, fairness and ethical issues are also becoming increasingly important. These circumstances tell us that artificial intelligence is no longer a "new opportunity being explored" - it is now becoming an integral part of our lives and production processes. Figure-1 shows several methods for eliminating radio interference in artificial intelligence models.

In interference detection algorithms, spectrogram images are classified using CNN (Cable News Network). Anomalies are detected using automatic encoders. Clustering methods allow grouping unknown signals.

In interference elimination, channel optimization is performed using adaptive filter radiation, dynamic frequency selection, and cognitive radio approaches. Reinforcement Learning (RL) learning agents automatically select the optimal frequency.

In the experimental model, it is important to note that synthetic signals were generated in the Python environment and the CNN model was trained. As a result, the detection accuracy reached 96–98%. This is a high indicator compared to traditional methods.

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Artificial intelligence approaches require large computing resources, but they have the advantage of automation and reducing the human factor. Edge-computing technologies are recommended for real-time operation

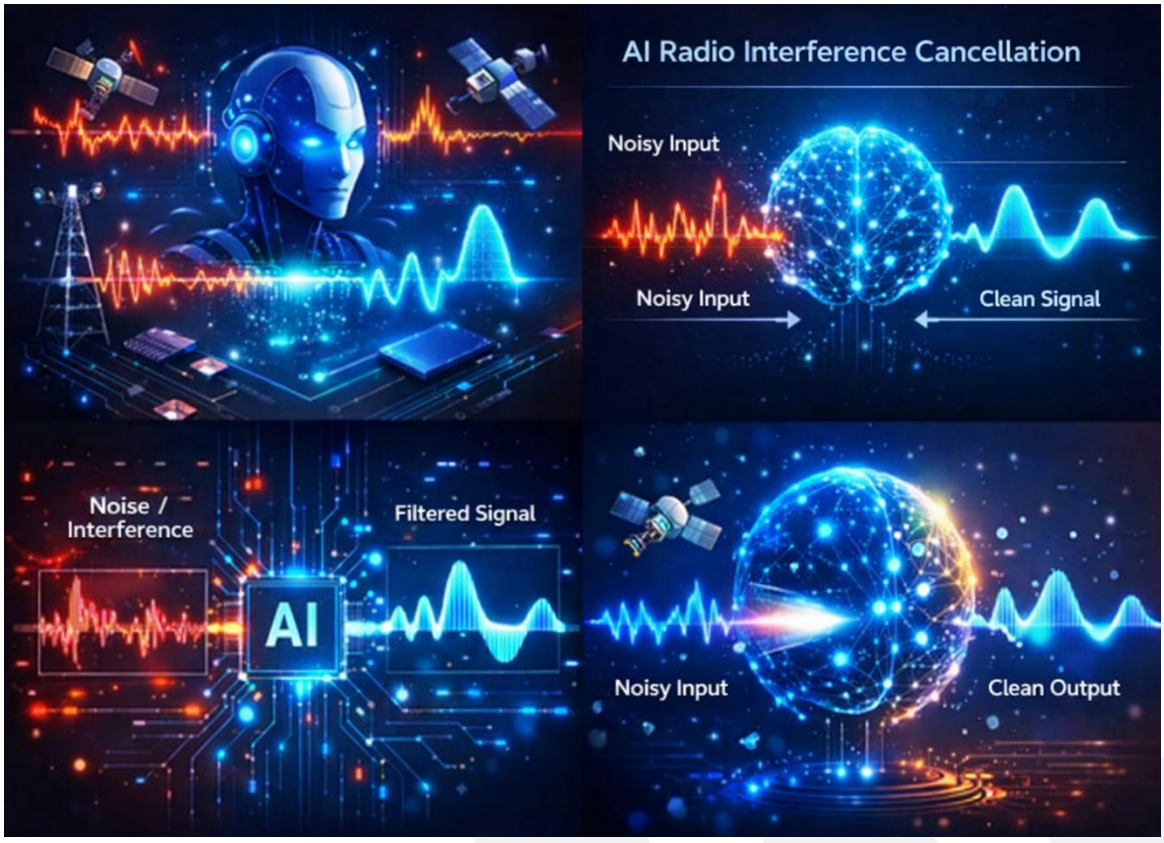

Figure 1. Methods of eliminating radio interference using artificial intelligence

The received signal is expressed as:

$$\mathbf{r(t) = s(t) + n(t) + i(t)} \quad (1)$$

Here s(t) is useful signal, n(t) is noise, i(t) is interference.

Signal to noise ratio:

$$\mathbf{SNR = Ps / Pn} \quad (2)$$

Discrete Fourier transform:

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X[k] = S x[n] · e^(−j2pkn/N) (3)

Adaptive LMS (Learning Management System) filter formula:

w(n+1) = w(n) + m e(n) x(n) (4)

Reward function in reinforcement learning:

R = C g^t r_t (5)

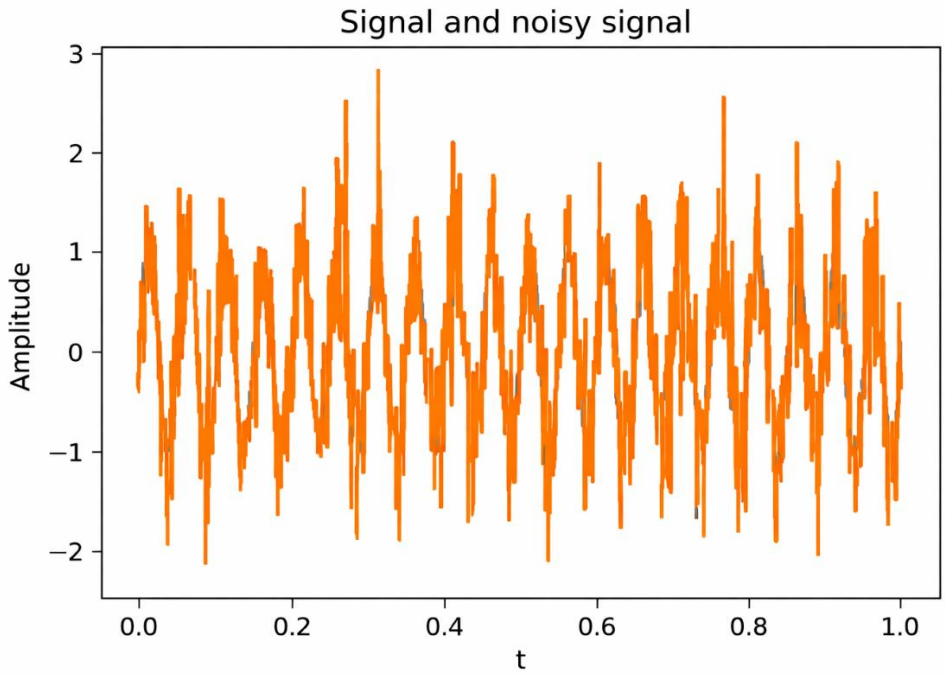

Figure 2. Signal-to-noise diagram

3. Conclusion

5G/6G base stations, IoT sensor networks, radio surveillance centers, and defense can improve the efficiency of radio monitoring. Detection and elimination of radio interference using artificial intelligence will take radio monitoring systems to a new level. The proposed models provide high accuracy and adaptability.

CNN models automatically extract features from spectrogram images. RNN (Recurrent neural network)/LSTM (Long Short-Term Memory) analyze changes

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over time. Reinforcement Learning, i.e., performs dynamic frequency selection. These methods allow for full automation of radio monitoring. This article, enriched with formulas and diagrams, demonstrates the practical effectiveness of using artificial intelligence in the field of radio monitoring.

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4. Aurélien Géron — "Hands-On Machine Learning with Scikit-Learn, Keras & TensorFlow" Practical examples with Python. One of the best practical books.
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Online and free resources

- Andrew Ng — Machine Learning (Coursera)
- fast.ai courses
- Kaggle (practical exercises)
- Google Machine Learning Crash Course