Brief information about the project

Name of the project	AR14872061 "Classification of types of modulation of a noise mixture of MIMO signals"
Relevance	MIMO antenna technologies are often used in wireless radio communications, as this system can increase the throughput of the wireless channel and improve the quality of communication. The main method of increasing throughput in MIMO systems is multiplexing, that is, the parallel transmission of several streams of information from different antennas. Previous modulation classification (CM) algorithms were designed for SISO (Single-Input Single-Output, SISO) technologies and cannot provide efficient operation in transmitting data over multiple antennas. So far, many methods have been considered to solve the problem of signal identification for MIMO systems. It was revealed that due to the multiple number of antennas, crosstalk and noise arise, and the search for a new algorithm solves the problems associated with mutual interference in MIMO channels. The proposed detection system based on information-entropy method can effectively improve the reliability of MIMO systems in practical scenarios considering noise without any initial parameters by using conditional information from the same signal. In work related to classification based on one-dimensional information entropy, 9 types of modulated signals were studied and it was found that with different SNR (signal-to-noise ratio) it is difficult to identify BPSK (Binary phase-shift keying), QPSK (Quadrature Phase Shift Keying), and also QAM (Quadrature Amplitude Modulation) signals. The idea of the program is to develop and create effective digital information-entropy methods for determining the types of modulations of MIMO systems signals.
Purpose	The goal of this project is to develop and create, based on our own scientific results, algorithms for determining the types of modulation of noise signals in MIMO systems (with many inputs and outputs). Comparison of the results of the theory with known and own experimental facts.
Objectives	1. Theoretical and numerical modeling of modulation types (amplitude, frequency, phase, pulse) of MIMO systems signals with different noise levels. 2. Development of an algorithm for recognition (detection) of modulated signals using a new criterion - the difference in conditional information. 3. Creation of a transceiver module with control and measuring instruments for generating and receiving radio signals with various types of modulation in different frequency ranges. 4. Development of an algorithm for extracting detected modulated signals from a noise mixture by filtering using conditional information. 5. Creation of a system of MIMO antennas with emitting and receiving elements of an anisotropic - fractal shape. 6. Physical experiment on the transmission and reception of modulated signals of a MIMO system, modulated in amplitude, frequency, pulse. 7. Development of an algorithm for classifying types of phase modulation of a noise mixture by the difference in conditional

	information using characteristic phase functions determined from the received signal as a condition. 8. Experiment with MIMO signals with phase modulations at different polarizations and frequencies. 9. Determination of correlation, spectral, fractal, chaotic, statistical characteristics of established types of modulated signals for the purpose of their identification. 10. Comparison of theories with experiments, analysis and conclusions on all characteristics of MIMO signals.
Expected and achieved results	Expected results: 1. Receiving model signals: MPSK (Multiple Phase Shift Keying), QAM (Quadrature amplitude modulation), MFSK (Multiple frequency-shift keying) for MIMO systems. 2. Conclusion about the presence of various modulations in the noise mixture of signals. 3. Transmitting and receiving blocks will be created: generator, fractal antennas, modulators. 4. The modulation time series from the noise telecommunication signal will be obtained. 5. A MIMO antenna will be developed based on emitters with an anisotropic fractal shape. 6. Using MIMO antennas, the technology of adaptive shaping of characteristics will be implemented: radiation pattern, signal polarization. 7. Algorithms for identifying phase modulation, which is the most unstable to noise. 8. MIMO signal parameters defining the detected signals will be obtained. The data will be recorded in a format suitable for further analysis and processing. 9. Characteristics (spectrum, fractal dimensions, correlations, information entropy) of the reconstructed signals. Results achieved: The new entropy-conditional information algorithms we have developed can have effective applications in the creation of MIMO communication systems. An important task in this direction - knowledge of the information connection of signals at different frequencies and polarization of the fluctuation signal between two users requires the use of conditional information, which is non-zero even in the absence of signal correlations according to known methods.
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List of publications with links to them	1. Жанабаев З. Ж., Усипов Н. М. INFORMATION-ENTROPY METHOD FOR DETECTING GRAVITATIONAL WAVE SIGNALS //Eurasian Physical Technical Journal. – 2023. – Т. 20. – №. 2 (44). – С. 79-86. 2. Турлыкожаева Д. А. Усипов Н. М. Ахтанов С. Н. и др. ROUTING METRIC AND PROTOCOL FOR WIRELESS MESH NETWORK BASED ON INFORMATION ENTROPY THEORY //Eurasian Physical Technical Journal. – 2023. – Т. 20. – №. 4 (46). – С. 90-98.
Patents	-