AP19679505 Studying and developing multithreshold decoding algorithms for convolutional codes and their software and hardware implementation for high-speed radio channels with fading, p.m. Saylaukyzy Zh.

Relevance of the studies is related to the implementation of the tasks of the state program "Digital Kazakhstan", the Law of the Republic of Kazakhstan "On National Security" and the State Concept of Cybersecurity "Cyber Shield of Kazakhstan" to ensure information security of the information and communication infrastructure, maintaining and developing an effective system for protecting information resources and communication infrastructure. The development of a national radio communication system is an important component of national and information security, as it ensures the interconnection between the services of special government agencies, the Armed Forces, law enforcement agencies, emergency medical care, fire and search and rescue teams.

Currently, high-speed reliable radio communication systems are implemented using orthogonal frequency division multiplexing technology, which allows for the required spectral efficiency and high data capacity. But with broadband wireless communication over long distances, many errors occur, which leads to the need to also use forward error correction methods. The idea of the project is to develop and implement software and hardware for efficient error correction schemes for use in radio communication networks with fading, as well as in the presence of Doppler shift and intersymbol interference.

The project objective is studying and developing error correction methods and tools to ensure operation near the channel capacity when used in rapidly changing digital radio communication systems in conjunction with orthogonal frequency division multiplexing and multi-position modulation, space-time coding and precoding technologies.

Expected and achieved results

The methods of using MTD in the systems with several transmitting and several receiving antennas, methods and criteria of radio channel estimation using the MTD have been developed. The obtained results, confirming high loading on flying radio channels for singing the MTD in MIMO (Multiple Input Multiple Output) systems, ensured the reliability of the language even in a complex multichannel channel using OFDM during data transmission. In systems with several transmitting and several receiving antennas, the methods of application of the MTD allow conducting radio channel estimation and adjust decoding depending on the attenuation characteristics, while the computational complexity is maintained at a low level. These methods determine the advantages of the MTD in modern communication systems achieving high data transmission rates (decimal and hundredths of Gbit/s). While other codes lose their efficiency under conditions of multiple distribution, the MTD provides decoding of long codes with minimal computational complexity. The results showed that MTD provides stable and reliable data transmission in high-speed systems, suggesting it as a method that can be effectively used in challenging situations.

	Figure 1 – *Participation in the 8th International Symposium on Innovative Approaches in Smart Technologies, Bartin University, Istanbul, Turkey 2024* *Project Manager: Sailaukyzy Zh.* *Responsible researcher: Danenova G.T.*	

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List of publications

1. Saylaukyzy Zh. Development of an algorithm for optimizing multi-threshold decoding parameters of sequential codes. University Proceedings. 2023. No. 3(92). P. 474–480.
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7. Sailaukyzy Zh., Danenova G.T., Kuanysh A.K., Kutzhan S.D. 3. Software implementation for evaluating a radio channel using noise-resistant codes. Development of methods for increasing the energy efficiency of digital radio systems using a multi-threshold decoder//Certificate of state registration of rights to the copyrighted object. No. 46161 dated May 21, 2024 (computer program).

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10. D. Satybaldina, V. Zolotarev, G. Ovechkin, Z. Sailaukyzy, Z. Khassenova, E. Egamberdiyev "Specifics of Applying Multi-threshold Decoding Methods to Correct Errors in Fading Communication Channels. Journal of Electrical Systems (percentile 20) https://journal.esrgroups.org/jes/article/view/5966 .

11. D.Satybaldina, V. Zolotarev, G.Ovechkin, Z. Sailaukyzy, Z. Khassenova, E.Egamberdiyev «Specifics of Applying Multi- threshold Decoding Methods to Correct Errors in Fading Communication Channels» // Journal of Electrical Systems (percentile 20).

12. Published in the proceedings of the International Scientific and Practical Conference "XVI Saginov Readings. Integration of Education, Science and Industry"/ Sailaukyzy Zh., Ibragimov U.M., Methods and criteria for evaluating a radio channel using noise-tolerant codes https://www.kstu.kz/wp-content/uploads/2024/07/2-chast.pdf

13. 8th International Symposium on Innovative Approaches in Smart Technologies (December 6-7, 2024, Istanbul, Turkey) accepted for publication/ Gennady Ovechkin, Dina Satybaldina, Zhuldyz Sailaukyzy, Gulmira Danenova, Nurlan Tashatov. Methods of multi-threshold decoders use in MIMO systems and methods of assessing their performance.

14. Zh. Sailaukyzy, G.T. Danenova, M. M. Kokkoz. Development of methods for increasing the energy efficiency of digital radio systems using multi-threshold decoders.

Information for potential consumers

Implementation of this project on the development of error correction tools for radio channels supports the development of wireless networks of the new generation and the use of methods of building adaptive telecommunication systems that allow ensuring high reliability of message transmission in radio channels with variable parameters

Scope

Applicability and/or commercialization of received scientific results and expected scientific results can be used to modernize the equipment of radio communication systems of organizations providing national security and defense of the Republic of Kazakhstan, increase the reliability of information transmission.

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