Зайцев Сергій Васильович,
доктор технічних наук, професор, професор кафедри інформаційних та комп'ютерних систем Національного університету «Чернігівська політехніка»

Риндич Євген Володимирович,
кандидат технічних наук, доцент, доцент кафедри інформаційних та комп'ютерних систем Національного університету «Чернігівська політехніка»

Приступа Володимир Віталійович,
кандидат технічних наук, науковий співробітник Інституту телекомунікацій і глобального простору Національної академії наук України

Зайцева Лілія Ігорівна,
аспірант Інституту телекомунікацій і глобального простору Національної академії наук України

Курбет Павло Миколайович,
аспірант Інституту телекомунікацій і глобального простору Національної академії наук України

METHOD FOR ASSESSING THE RELIABILITY OF INFORMATION UNDER CONDITIONS OF UNCERTAINTY

Currently, there is a trend of rapid development of wireless technologies.

Last years the next generations of networks are developed and implemented including security aspects [1] and new approaches in coding. The main advantages of the fifth generation of wireless communication technology are [2, 3]:

- low signal delay;
- increased bandwidth;
- increased user mobility;
- higher data transfer speed (peak speed of 20 Gbit/s);
- increased transmission speed.

These advantages allow using such wireless networks in systems which have special requests for quality. Implementing such technologies in systems of critical infrastructure will provide a higher quality of the system in common. Especially in energy systems and other 24/7 systems which transfer control signals. To transfer correctly and fast these signals are very important in extraordinary situations like emergencies, natural disasters, and damage to infrastructural objects during hostilities. Also, it is important to telemedicine and other real-time systems. Because modern distributed infrastructure, like Smart Grid, are always include wireless channels which are often functioning in difficult conditions. In such systems, wireless networks take a central part of

LITERATURE

1. Ryndych Y. Research of tunneling technologies in modern computer networks / Y. Ryndych, A. Borovyk, O. Borovyk // Technical sciences and technologies. 2021. Vol. 4(26). P. 67-74.
2. Shafi M. 5G: A Tutorial Overview of Standards, Trials, Challenges, Deployment and Practice / Mansoor Shafi, Andreas F. Molisch, Peter J Smith, Thomas Haustein, Peiying Zhu, Prasan De Silva, Fredrik Tufvesson, Anass Benjebbour, Gerhard Wunder // IEEE Journal on Selected Areas in Communications. – 2017. Vol. 35, no.6. P. 1201-1221. DOI: 10.1109/JSAC.2017. 2692307.
3. Adebusola J.A. An Overview of 5G Technology / J. A. Adebusola, A. A. Ariyo, O. A. Elisha, A. M. Olubunmi, O. O. Julius // 2020 International Conference in Mathematics, Computer Engineering and Computer Science (ICMCECS). 2020. P. 1-4. DOI: 10.1109/ICMCE CS47690.2020.240853.
4. MacKay D. J. C. Near Shannon limit performance of low density parity check codes / D. J. C. MacKay, R. M. Neal // Electron. Lett. 1996. Vol. 32, no. 18. P. 457–458.
5. Arora K. A survey on channel coding techniques for 5G wireless networks / Arora K., Singh J., Randhawa Y.S. // Telecommun. Syst. 2020. Vol. 73. P. 637–663.
6. Kazymyr V. Technology for improve cyber security using turbo codes / Kazymyr, V., Zaitsev, S., Ryndych, Y., Zarovskyi, R. // 2015 Information Technologies in Innovation Business Conference, ITIB 2015 - Proceedings, 2015, pp. 85–88, 7355060
7. Berrou C. Codes and Turbo Codes / Berrou C. – Springer, 2010. – 415 p.
8. Arvinte M. EQ-Net: Joint Deep Learning-Based Log-Likelihood Ratio Estimation and Quantization / Arvinte M., Tewfik A.H., Vishwanath S. // ArXiv,abs/2012.12843v2.
9. Bian X. Joint Activity Detection and Data Decoding in Massive Random Access via a Turbo Receiver / X. Bian, Y. Mao, J. Zhang // 2021 IEEE 22nd International Workshop on Signal Processing Advances in Wireless Communications (SPAWC). 2021. P. 361-365.

the data transmission mechanism: information and control at the same time.

In this regard, one of the main tasks is to evaluate the channel, increase the reliability of information transmission and use parametric adaptation [3].

Using interference-resistant codes allows to increase reliability and quality. This effect can be achieved by using such codes like LDPC codes [4,5] and turbo codes (TC) [5-7]

TC and LDPC codes are adopted by the fifth-generation mobile communication standards 4G LTE and 5G, respectively.

4G and 5G systems use adaptive modulation, power, and coding techniques. The main point of our research is the adaptation of coding. In modern standards oding rate R is adjusted in the range from 1/5 to 2/3. At the same time, the use of TC is more expedient at low coding rates, and LDPC codes - at high ones.

The high efficiency of turbo codes is due to the iterative decoding algorithms developed for them. Decoding algorithms developed for turbo codes use «soft» solutions at the input and output of the decoder. In this connection, they received the name of algorithms with «soft» input – «soft» output SISO (soft input - soft output). These algorithms include the Viterbi algorithm with a «soft» output SOVA (soft output Viterbi algorithm), the decoding algorithm based on the maximum a posteriori probability MAP (maximum a posteriori probabilities) or, as mentioned in some sources, the BCJR algorithm (Bahl-Cocke-Jelinek-Raviv), as well as less complex Max Log MAP and Log MAP algorithms [7,8].

According to the 3rd Generation Partnership Project (3GPP) TS 38.212, LDPC is recommended for the fifth-generation due to its high throughput, low latency, low decoding complexity and rate compatibility.

According to [8], a method presented there solves two problems, namely, estimates of the logarithmic ratio of the likelihood function and quantization. This method is focused on high-performance computing units with low latency, achieved using deep neural networks.

The paper [9] presents the development of a turbo receiver based on the Bilinear Generalized Approximate Message Transfer (BiG-AMP) algorithm. In this turbo receiver, all received symbols are used to estimate the channel state, user activity, and program data symbols, which effectively exploit the common sparsity pattern. The extrinsic information from the channel decoder is used for joint channel estimation and data discovery.

In [10] proposes the use of a compression sounding (CS) channel estimator in a system using orthogonal frequency division multiplexing (OFDM) and software defined radio (SDR) devices. The application of compression sounding theory is enabled by using sparse reconstruction algorithms such as orthogonal match search (OMP) and compression sample match search (CoSaMP) to take advantage of the sparse nature of the pilot subcarriers used in OFDM, optimizing system throughput.

Paper [11] proposes a new method for iterative channel estimation and data decoding. In the proposed

DOI: 10.1109/SPAWC51858.2021.9593149.
10. Yanza-Verdugo A. Compressive Sensing Based Channel Estimator and LDPC Theory for OFDM using SDR / A. Yanza-Verdugo, C. Pucha-Cabrera, J. I. Ortega // Ingenius [online]. 2020. N.23. P.74-85. https://doi.org/10.17163/ings.n23.2020.07.
11. Takeuchi K. A Construction of Turbo-Like Codes for Iterative Channel Estimation Based on Probabilistic Bias / K. Takeuchi, R. R. Muller, M. Vehkapera // 2011 IEEE Global Telecommunications Conference – GLOBECOM 2011. – 2011. P. 1-5. DOI: 10.1109/GLOCOM.2011.6133738.
12. Jin X. Analysis of Joint Channel Estimation and LDPC Decoding on Block Fading Channels / Jin X., Eckford A. W., Fuja T. E. // International Symposium on Information Theory and its Applications, ISITA2004 Parma, Italy, October 10–13. 2004. P. 679 – 684.

method, the probability of occurrence of transmitted symbols is shifted. The a priori information about the offset is used for the initial channel estimation. The proposed scheme is based on the parallel concatenation of two shifted convolutional codes, which are constructed as systematic recursive convolutional codes with state-dependent puncturing.

Paper [12] presents an iterative receiver for a channel with phase-coherent block fading. The receiver jointly estimates the channel and decodes a low density parity check (LDPC) code using a sum product algorithm.

The result of the research includes adaptive method for assessing the reliability of information under conditions of uncertainty through the use of a priori and a posteriori information of the decoder, which allows adapting to changing the parameters of the encoder and decoder of the turbo code (LDPC code) through the use of LRR and the calculated values of the noise dispersion. The using of the sign change of a priori and a posteriori LRR during iterative decoding and taking into account the noise dispersion values in the channel reliability parameter, the method allows obtaining information reliability values (error coefficient) without using an additional service channel. Simulations let to understand that the accuracy of the information approaches the reliability estimate when using an additional service channel. This method can be used in conjunction with other methods of parametric and structural adaptation under conditions of a priori uncertainty.