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## **New Technologies for High-Quality Communication Through Radio Channels with a Large Noise Level on the Basis of Multithreshold Algorithms**

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The achievements of the theory and technique of the noiseproof coding of the last ten years are presented. Efficiency and complexity of decoder realization are analyzed. A high economic value of new coding methods applications in digital communications is underlined.

### **1. High efficiency - is the basis of digital systems development.**

Dynamic movement of our technological civilization to the digital system of processing and information transmission causes many problems in creating of modern systems of telecommunications and informatics. One of the main problem, that must be solved in all similar systems, is the providing of high data transmission trustworthiness. It is obvious that only at absolutely right digital data, received for further processing, there is a sense to develop a rather expensive in use technologies of informatization of the society.

### **2. Criteria of the coding efficiency .**

In projecting of communication systems it is more convenient to estimate an efficiency of coding application as a value of lowering of bit energy to spectral noise power ratio in communication channel  $E_b/N_o$  in case of applying of noiseproof coding, comparing with the case when the transmission is done without such a coding. This criterion is called a code gain (CG). In fact CG corresponds to an effect of transmitter power increase re-counted to equal transmission speeds of informational flow. For example, an efficiency of standard Viterbi Algorithm (VA) is close to  $G=5$  dB. But Shannon's bound for channel capacity  $C$  shows that CG for code speed  $R=1/2$  can be more than 9 dB. So this decoder is quite far from the CG level, that is guaranteed by the information theory. Note that foreign specialists evaluated every 1dB of CG in millions dollars more than 20 years ago [1]. Now the value of CG has grown up even more, because in this case it is possible to diminish sizes of very expensive antennae or to increase communication distance, enlarge transmission speed or to lower indispensable power of transmitter, and also to improve other important properties of communication systems. That is why through all over the world the great attention is paid to the problem of CG growth, and the importance of creating of very simple and effective algorithms of decoding could not be overrated at all.

### **3. New principles of decoding algorithm realization.**

The progress of the noiseproof codes decoding during many decades surprisingly was not connected anyway with methods of functional with many variable optimization solution .

This problem now is solved by methods of multithreshold decoding (MTD). Research of this algorithm, that has been continued for more than 30 years, now are successfully finished [1,3-5]. Decoders of this type strictly become closer to the optimal decoder solution at all changes of decoded symbols. There is no such a property now for any of known errors correcting methods at high levels of channel noise. Certainly, for providing a high efficiency of MTD at large channel noises it is necessary always to choose only specially created for it codes with minimum possible level of error propagation [2,6].

#### 4. The complexity of algorithm realization.

One of the main advantage of MTD is an extremely low complexity of decoding. Evaluating expenditures of MTD for one bit decoding of the formally defined complexity as a number of operations at MTD is approximately in 100 times less than at turbo codes with comparable energetic efficiency [1,4,6]. Results of direct comparison MTD and algorithms for turbo codes [9] have really shown the difference in the speed of program realization of these decoders for equal noise levels up to 70 times [7-9].

In its the most natural variant the hard decoder is characterized with throughput that defines only by maximum approvable speed of data movement through shift registers of decoder  $W_{max}$ . Certainly, shift registers as the simplest elements of digital technique can be very fast. At typical for MTD algorithms meanings of code speed  $R=k_0/n_0 < 1$ , where  $k_0=3 \div 20$ , we get that productivity  $W$  MTD will be limited only by summary speed of data movement through all decoder registers, i. e.  $W=W_{max} * k_0$ . So it follows that the real advantage of MTD in terms of working speeds in some cases is really about 1000 times, comparing with others methods. So applying of MTD algorithms in communication apparatus completely solves the problem of fast acting of decoders in high speed communication systems. Submitted results are principally important. Achievement of such small complexity levels with the same energetic efficiency, as at MTD, for all other methods now is actually impossible.

#### 5. Efficiency of MTD algorithms.

Characteristics of MTD as at usage itself, as in complex code construction are considerably better than VA and different concatenated schemes. In all cases of achievement of considerable CG levels of the order 8 dB, MTD occurs in soft and in hard variants of realization in 40-220 times easier than other coding systems with standard parameters. Additional information about the efficiency and throughput of this algorithm is in [1-6,9].

#### 6. Changing of an appearance of new communication systems

Lowering of channel energy in 3 dB, rather easy providing with a help of MTD, additional to the current efficiency level of standard coding properties, increases satellite channels throughput in 2 times. Taking into account, that for contemporary technology level the realization of MTD decoders has no any difficulties at all, so we can consider that application of MTD is actually equivalent to the doubling of absolute number of such channels and networks without any serious financial expenses. It corresponds with economy of the budget, that can be compared with the volume of production in the communication branch.

The ability to achieve such a big level of CG allows on the actually new basis to project systems of mobile satellite communication, because just here it is possible to get decreasing of used frequency band and even much more high levels of code gain. At the same time it would improve characteristics of VSAT stations.

Applying of MTD at suitable choice of its parameters allows to increase the distance of retransmission for different lines, that also could help to save building expenses for them in millions dollars. Especially wide opportunities are opened for MTD algorithms in

modernization systems of broadcasting with technology of International Consortium DRM. Wide opportunities of MTD in achievement of high CG levels are also attractive because of the economic reasons.

Using MTD in systems of satellite multiprogram TV broadcasting with speed up to 45 Mbits/c can considerably diminish sizes of antennae or practically without any serious expenses increase number of satellite channels. So this algorithm could be applied effectively for high resolution TV.

There is one more direction of applying of coding on the basis of MTD, thanks to the simplicity of it's realization - immediate processing of signals on the satellite board.

Besides, MTD would be very useful in solving the problems of the Earth distant zonding, because in this case it would be easy to reach a very high throughput of this algorithm. In this situation it would be possible to provide transmission speed up to hundreds Mbits/s.

Finally note that with current constantly increasing requirements to the transmission reliability of digital flows, necessary for this CG levels also considerably increase. In such conditions there is no actually any alternative to MTD methods, that could already now provide high CG levels with such a small complexity of realization, that is not available in the nearest future for other algorithms.

## 7. Conclusion

All extraordinary high MTD parameters are provided by using of simple, but effective and very powerful procedure of functional optimization with a very big number of variable on the basis of majority decoding, so practically optimal decoding of long code construction is achieved. So absolutely new principles of the very long codes decoding have allowed to create MTD – a very effective and at the same time rather simple at any realization of received data processing scheme with maximum high throughput. Nowadays MTD in fact is the only candidate to be used in all high-speed data transmission networks, where it is necessary to combine requirements for maximum possible level of a code gain and minimum processing complexity.

## LITERATURE

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