APPLICATION OF THE MULTITHRESHOLD DECODER IN ERASURE CHANNELS

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One of the major problems at creation of high-speed digital communication is the correct choice of methods for error correction codes decoding. For today in the coding theory many classes of error-correction codes [1] are known. These codes distinguished from each other by structure, functional purpose, power efficiency, algorithms of decoding and many other parameters. The review [2] of most perspective decoding methods by criterion «efficiency-productivity» has shown, that the greatest preference in high-speed channels of a satellite communication multithreshold decoders (MTD) [3, 4] deserve. The given decoders, based on ordinary threshold decoder [5], allow decoding even very long codes with linear implementation complexity. In tens publications on multithreshold decoders efficiency of its application in binary symmetric or gaussian channels is considered. In this article the questions of usage MTD in erasure channels are discussed.

The erasure channel is characterized by that, that bits on it are transmitted correctly with probability $1–P_E$ and «erased» with probability P_E. Work of MTD in such channel [6] differs from work in the binary symmetric channel that, that at calculation of syndrome symbols (further named checks) the erased information and check bits on value of checks do not influence, but thus for each check the number of erased bits is remembered. Then during decoding erased information bit among checks concerning to it is searched the check containing only one erasure. It is obvious, that this erasure will be caused with decoding information bit which on value of the given check can be easily recovered. Thus also it is necessary to carry out correction of all checks for recovered information bit and to reduce by unit number of erasures for the same checks. After that pass to decoding of the next bit. If for erased bit is not present any check containing only one erasure this bit is passed and at once transition to decoding the next information bit is carried out.

On fig. 1 the bit unrecover performance are shown. Here P_E is probability of erasure bit in channel and P_U is probability of unrecover bit. In the given figure curves «MTD (R=5/10, d=11)», «MTD (R=4/10, d=14)», «MTD (R=4/10, d=16)», «MTD (R=3/9, d=19)» correspond to efficiency of multithreshold decoding of block self-orthogonal codes with code rate *R* and code distance *d*. The length of the given codes does not surpass 8000 bits. At reception of the submitted dependences about 10 decoding iterations were used. To a curve «MTD1 (R=5/10, d=13)» there corresponds efficiency of MTD for code with *R*=5/10, *d*=13, turning out at parallel concatenated of several self-orthogonal codes [7].

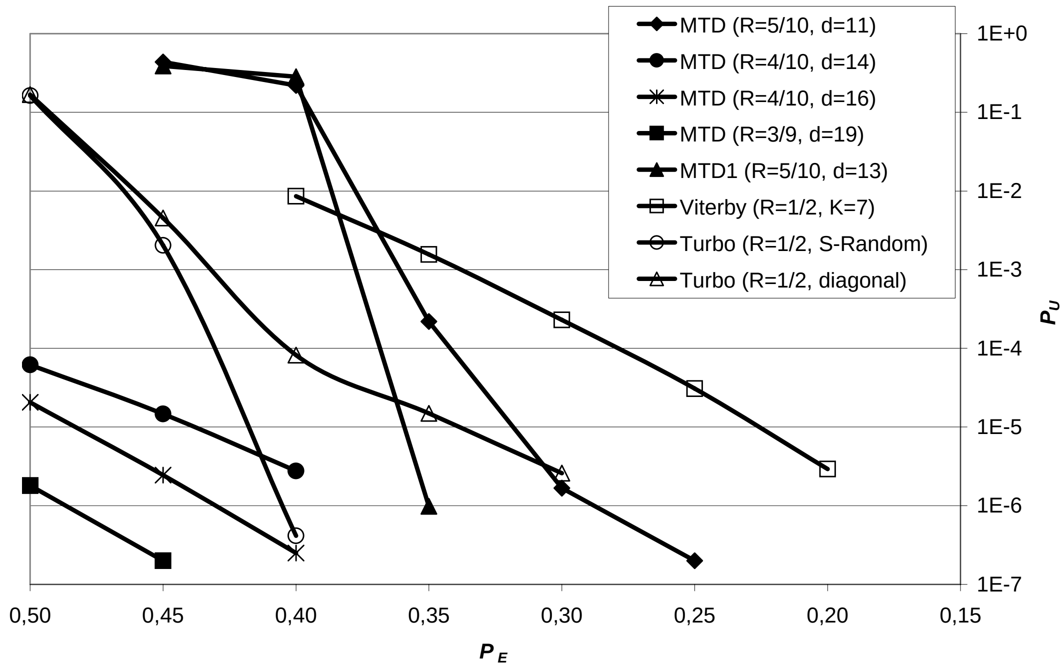

Fig. 1. Performance of MTD over the channel with erasures

For comparison on fig. 1 characteristics of classical Viterby decoder [8] for a code with R=1/2 and length of coding register K=7 (a curve «Viterby (R=1/2, K=7»), and also characteristics of turbo codes [9] with R=1/2 and length of 8000 bits also are submitted. The given turbo codes have consisted of two recursive systematic convolutional codes with the constructive length of 3, connected among themselves pseudo-random interleaver with length of 4000 bits (a curve «Turbo (R=1/2, S-Random)») and diagonal interleaver of the same lengths (a curve «Turbo (R=1/2, diagonal)»). At decoding of the turbo codes it was used Max-Log-MAP algorithm and 10 decoding iterations were carried out.

From the given figure it is visible, that efficiency of MTD surpasses efficiency of practically optimal Viterby decoder and it appears a little bit worse efficiency of the turbo code decoder. But thus implementation complexity of MTD (the number the operations required for decoding of one information bit) appears more than in ten times less than complexity of the turbo code decoder [10].

Further we shall consider efficiency of MTD in the channel with erasures and errors. The channel with erasures and errors is characterized by that, that bits on it are transmitted correctly with probability $1–P_E–P_I$, «erased» with probability P_E and inverted with probability P_I. At work in such channel MTD on each decoding iteration should be able to correct both erasures and errors.

On fig. 2 dependences of probability of unrecover or error bit P_U on an output of decoder from probability of erasure P_E in the channel are submitted. Here the probability of error in channel was equal P_I=10^{-3}. At this figure the characteristics for the same methods of error correction, as on fig. 1 are shown.

It is visible, as in the given conditions efficiency of MTD remains better than efficiency of Viterby decoder and concedes to the turbo codes decoder. The similar situation is kept and at other code rate.

The additional information about MTD can be found on a web-site [11].

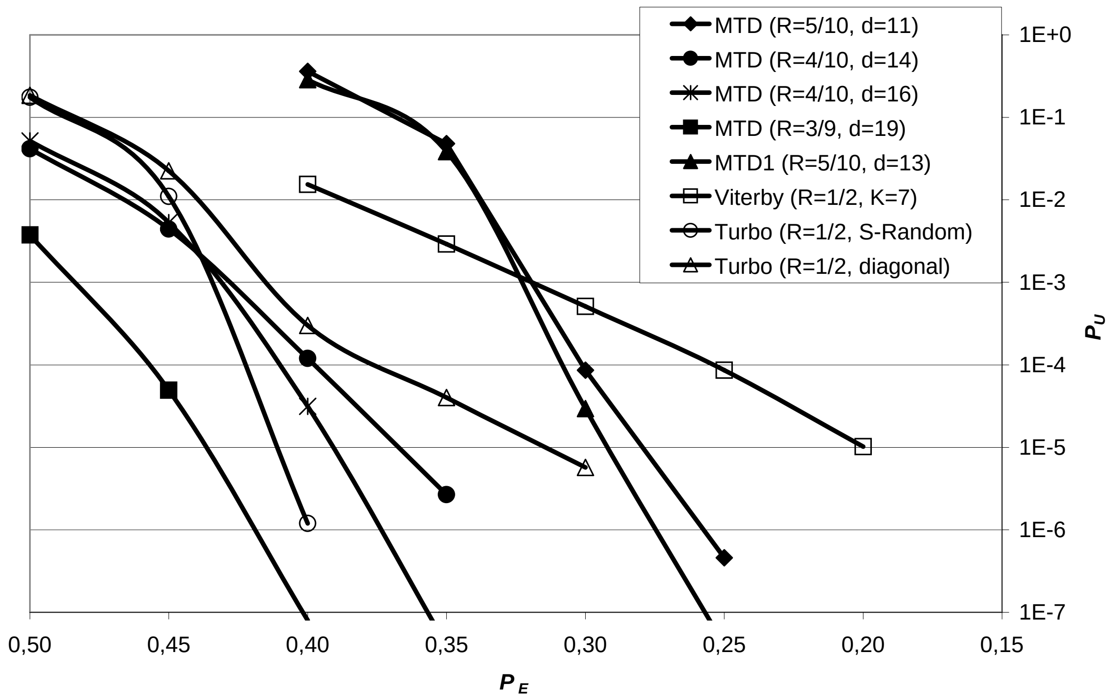

Fig. 2. Performance of MTD over the channel with erasures and errors

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