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EFFICIENCY OF THE CONCATENATED SCHEME OF CODING BASED ON THE MULTITHRESHOLD DECODER AND HAMMING CODES

The concatenated scheme of coding consisting of a self-orthogonal code, decoding with the help of the multithreshold decoder, and Hamming code is considered. Results of computer modeling of the given schemes are submitted.

At designing modern systems of telecommunications one of the major problem is maintenance of high reliability of data transfer. It is necessary to attribute application of error correcting codes in which development the coding theory last decades makes very significant successes to the most effective methods of the decision of the given problem. Application of error correcting coding in digital communication also allows to receive a coding gain which each decibel according to the experts more 20 years ago was estimated in millions dollars as it can be used for reduction of power of the transmitter, increases of communication speed, reduction of the sizes of very expensive aerials, increases of range of communication, economy of a passband and improvement of many other important properties of communication systems.

For today the coding theory knows some methods of coding/decoding [1..4] allowing to work near to capacity of the channel. Among them it is possible to allocate multithreshold decoders (MTD) [3, 4] as they allow to decode almost optimum even very long self-orthogonal codes (SOC) with linear complexity of practical realization from length of a code.

On fig. 1 dependences of bit error rate (BER) for MTD with SOC with code rate 1/2 and code distance 7, 9, 11, 13 and 15, chosen according to criterion of minimization of error propagation (EP), are submitted. At data acquisition of dependences it was used about 15 decoding iterations. For comparison in the figure dashed lines submit dependences of BER at optimum decoding the given codes. As follows from the given figure, application MTD for decoding codes with small EP provides almost optimum decoding that allows to receive coding gain more than 7 dB at $P_b=10^{-5}$. We shall notice, that such results are unattainable at use of practically sold optimum Viterbi algorithm because of its complexity growing exponential at increase constructive length of a code.

From the further analysis of the submitted dependences it is visible, that at increase in code distance used SOC in a limit it is possible to receive the big efficiency, but thus the area in which MTD starts optimum them to decode is shifted aside smaller noise. The given property essentially complicates reduction of decoding BER at the big noise in a liaison channel.

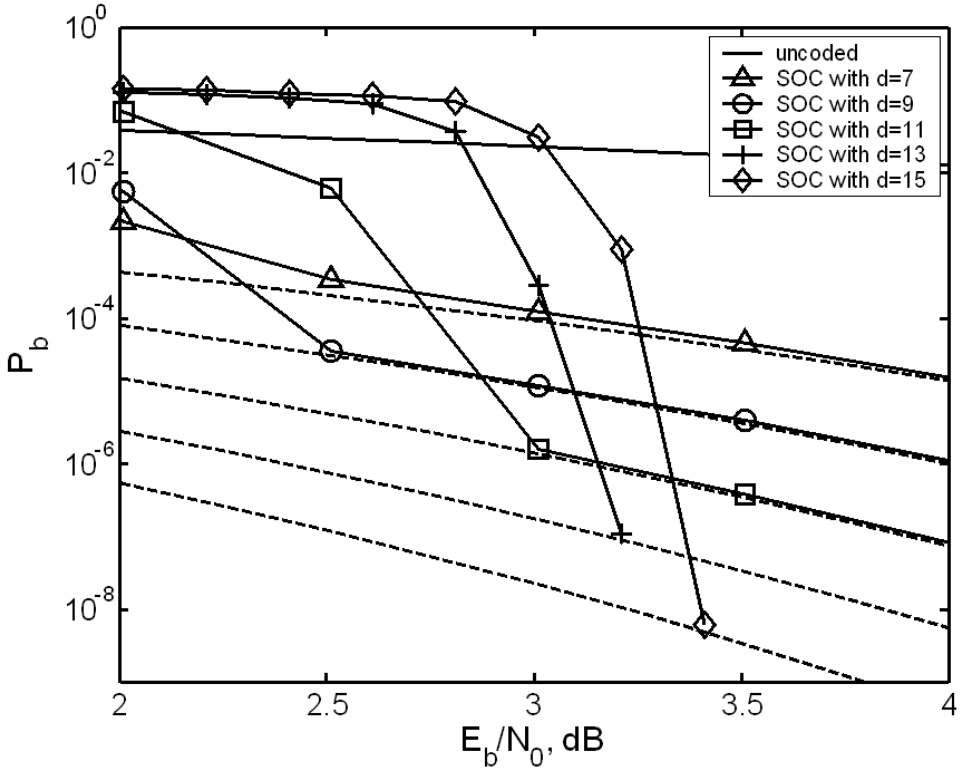

Fig. 1. Performance MTD over AWGN channel

It is possible to apply some approaches to the decision of the considered problem, based on use MTD in structure of various concatenated coding schemes. As shown in [5] addition to SOC decoding with help of MTD, an external parity check code allows to reduce BER in 10-100 times. Also it is possible to use MTD in schemes with parallel coding [6] which allow to approach area of its effective work to channel capacity approximately on 0,5 dB.

In given article we shall present results of research of one more concatenated coding scheme allowing essentially to reduce decoding BER. The suggested scheme will consist of external Hamming code (use of expanded Hamming code) enough the big length (64, 128 or 256) and internal convolutional or block SOC. Thus Hamming code is decoded with the help of Chaise decoder which is taking into account the information on reliability of code symbols, and SOC - with help of MTD. We shall note, that at decoding the given scheme the iterative principle at which decoding making codes is repeatedly carried out is used.

On fig. 2 characteristics of the given concatenated code are shown at use of the same SOC with code distance 7 and 9, as on fig. 1 and Hamming codes of length 64, 128 and 256. From the submitted dependences follows, that use together SOC and Hamming code allows on two or even three order to reduce decoding BER in comparison with base not concatenated MTD. Comparing concatenated schemes with Hamming codes of various length it is possible to

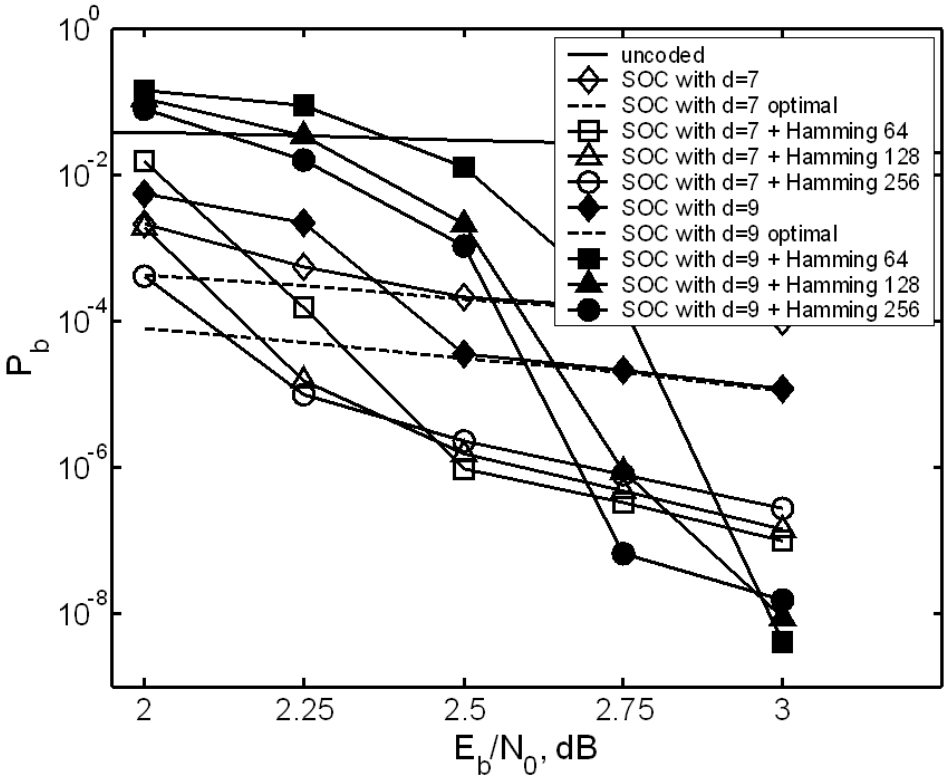

Fig. 2. Performance of the concatenated coding scheme, consisting of SOC with code rate 1/2 and Hamming code, over AWGN channel

notice, that at the big signal to noise ratio by the best noise stability codes with Hamming codes of small length possess. It speaks that, that correcting ability of Hamming codes with growth of its length decreases [4], and correcting ability of all concatenated scheme accordingly decreases. At the small signal to noise ratio efficiency of Hamming codes with various length is approximately identical. And as code speed of Hamming codes with growth of length of a code increases, at such signal to noise ratio as a result of smaller losses in power codes with the greater length appear better.

More detailed information on the multithreshold decoding algorithm can be found on a website [7].

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