Multithreshold Decoder's Concatenation for Satellite Communication Channels

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The necessity of maintenance of a high noise immunity at small complexity of coding demands development of simple methods of fast and effective correcting code decoding. The concatenation methods are offered at the basis of multithreshold decoders (MTD) with simple implementation, close in number of operations to the elementary majority decoders.

Application of multithreshold decoders (MTD) [1-3] (literature is shown in Russian topic) allows to ensure decoding almost conterminous to optimum decoding (OD). The complexity of implementation as a calculation number corresponds to Massey's decoder [4]. The main property of MTD is the convergence to the solution OD, if decoder changes processing symbols. In this connection the maintenance of an effective utilization MTD is directly connected to a capability of long-lived process of correction of characters. This problem was solved by construction special codes with a very small potential level of grouping of errors at majority decoding.

There are no many really different effective methods of decoding. The relevant advantage of turbo codes is the rather high decoding characteristics. And the high enough characteristics are possible on the basis of algorithms MTD, which one can actually optimally decode special lengthy codes with very small computing costs.
At fig.1 the capabilities of the concatenated methods are shown as E_b/N_o versus P_b (e). The vertical **C_M** corresponds to channel capacity C=1/2 for binary modulation and soft modem with 16 quantizing levels. The chart ***turbo*** (***турбо***)- best outcome for turbo codes obtained by the authors of the method [6], with rather high complexity of implementation (up to 10 000 operations, hereinafter - per a data bit) for a code length K=65 thousands bits and code rate R=1/2. The chart ***VA-RS (AB-PC)*** corresponds to capabilities of VA with K=7 concatenated with code RS 255 bytes length [7]. The lower estimations for capabilities of two ***woven*** codes (***ПЛЕТ-К1,2***) with length K=10000 and K=1000 [8]. At last, we shall address to capabilities MTD. This method is effective enough in the base non cascade version in Gaussian a channel, providing at small delay and R=1/2 optimum decoding of lengthy codes with probability of an error per bit P_b (e) ~10^{-5} for a level of power engineering $E_b/N_o \geq 3$ дБ. Simple and nevertheless very effective MTD with code concatenating are submitted by the schedules ***MTD-C1,2 (МПД-К1,2)***. Delay in convolution version for the maiden code no more than 40 thousand bit, and for second - less than 5000. The delay factors can be reduced.
The most essential factor by selection of preferential decoders for an actual apparatus is that at $E_b/N_o \geq 3$ dB it is always possible to apply customary MTD to decoding practically optimally with the help of the decoder, which one almost coincides the elementary threshold decoder (TD) [4]. At Eb/No ≤3 and R≈ 1/2 in a satellite channel the matching of complexity of different decoders as number of operations, that MTD in all cases of application of cascading it appears approximately 100 times simpler. At implementation of summation is quick, the difference in complexity with all other known decoding algorithms will exceed 3 decimal order in equal conditions. The formal MTD complexity is $M_1=2 * (J+2) * (d+1)$, where d - the minimum code distance. They found better estimation $M_2=4*(d+3)+J*3$.Thus, MTD's complexity almost does not increase with **J** growth. MTD is implemented in different ways. It have got official support too.

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