V.V.Zolotarev (В.В. Золотарев)

Multithreshold Decoding Usage Instead Viterbi Algorithm

(Published paper)

The replacement a decoder realizing Viterbi algorithm (VA) for standard short non-systematic convolutional codes by a simple multithreshold scheme with closed characteristics is offered. As the calculus of the check sums with the subsequent comparison with a threshold appears much easier and faster, considerable decrease of complexity of final decoding hardware is possible.

The successful application of Viterbi algorithm (VA) in systems of noiseproof coding is determined by high performance and homogeneity of this procedure at its hardware implementation. However it is well known, that the complexity an VA grows is exponential with a code length, that does not enable usage in actual systems of enough lengthy codes.

Essential at VA implementation is also that for increase of power efficiency of coding the application of the best non-systematic codes is expedient, that allows is fullest to realize capabilities of this algorithm.

On the other hand, it is known, that multithreshold decoders (MTD) [1-5] allow by simple means to organize decoding of lengthy codes with a degree of quality, in many cases practically coinciding with optimum. But usually MTD effectively works with systematic codes.

Let us consider features of MTD application to decoding standard for VA non-systematic code (133,171) with length К=7. At conventional MTD construction, which one usually sequentially improves its own hypotheses and as a result it in many cases comes to the optimum solution, this decoder always has a reasonable initial hypothesis about the received massage. In case of application of non-systematic codes for MTD most difficult problem appears just creation of an initial hypothesis about transmitted information sequence conforming received and, probably, distorted in a channel code word.

At the solution of a problem of construction of an initial preliminary hypothesis on information sequence has appeared indispensable to consider as customary versions of creation of syndrome vector, which one would serve the basis for construction of different hypotheses about errors in an received code flow, and a little more composite ways of definition of a channel errors on the basis of the different registers with feedback.

At the second phase of formation of a hypothesis about information vector it is necessary to create procedures similar to methods of syndrome calculation, which one, however, at this stage created already series of hypotheses about a true information flow. At this hypothesis construction also can be used the customary schemes of multiplying of received code flows at some specially chosen polynomials. But the special chains of the registers with feedback are in this case effective enough also. The final selection between different versions of the schemes of hypotheses formation about information flows should be made with allowance for number of yardsticks, main of which is the minimization of an error propagation effect. It is the rather natural approach to selection of the best schemes of information flows creation, as at MTD usage for customary systematic codes the yardstick of a minimum of an error propagation effect also is one of major by selection both codes, and threshold schemes, on the basis of which decoding may be implemented.

The final part of a non-systematic code pretreatment in conventional calculus consists of a syndrome vector on the basis of a preliminary hypothesis about an information flow and received code vector.

Main for MTD last part of a decoding procedure completely coincides with the basic step of improvement solution decision series of the customary MTD. The starting hypothesis about an information flow considers that information sequence, which one was constructed on a preliminary step. Such MTD for a considered non-systematic code allows by the improvement of solution in some step in addition to minimize error probabilities for an initial hypothesis about information vector. The improvement of the solution at transit of an initial hypothesis through MTD makes some decimal powers, as it allows to achieve the levels of a noise immunity, close to those, which ones correspond to optimal VA decoding.

Let emphasize, that MTD appears to be more simple, than VA decoder. As the AB is an optimum algorithm, the energetic MTD characteristics can not be better, than for VA. In the most simple version MTD provides approximately at 0,5 dB more low level of a code gain, than VA, for conventional at matching algorithms of an error probability per bit $P_b(e) = 10^{-5}$. However its throughput can be much more high. At increase of decoding iterations number a probably even greater approaching of MTD capabilities to the characteristics of initial VA.

The reviewed approach to construction MTD for a code (133,171) can be applied and at MTD creation for many other codes used with VA. Corresponding MTD-schemes are successfully built for K=9 and K=11. Moreover, it is possible to create other special short non-systematic codes with the specially high characteristics achievable at usage special MTD for these codes, specially regardless to a capability of their decoding on the basis of those or that VA modifications. In this case it is possible to select much more long codes, than codes used at VA implementation, since VA will be always too complex, if the selected code is long enough. Thus the considerable reduction of decision delay, appropriate to customary MTD will be reached specially, but the rather high levels of a code gain will be ensured, which one is a final effectiveness criterion of application of hardware decoder in communications systems.

Literature.

1. V.V.Zolotarev (Золотарев В.В.) An actual code gain for satellite channels // In book.: 4-th International conference " Satellite communications -2000 ". V.2, Moscow, 2000, pp.20-25.
2. V.V.Zolotarev (Золотарев В.В.) Usage of noiseproof coding in a communication engineering. Electric communication. 1990. №7, pp. 7-10.
3. V.V.Zolotarev (Золотарев В.В.) Simple methods of error correction in channels with a large noise level. Radio techniques, №10, 1991, pp.79-82.
4. V.V.Zolotarev, G.V.Ovechkin. (Золотарёв В.В., Овечкин Г.В.) Noiseproof coding. Methods and algorithms. The Reference Book, "The Hot Line - Telecom", Moscow, 2004, 126 p.
5. V.V.Zolotarev, G.V.Ovechkin. (Золотарёв В.В., Овечкин Г.В.) Multithreshold Decoding. A Specialized Web-site SRI RAS: www.mtdbest.iki.rssi.ru .