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Decoding of Convolutional Codes on a Sliding Window during Signal Propagation in a Multipath Communications Channel

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Abstract—An optimal recursive algorithm for joint interpolation of the Markov sequence of information symbols on a sliding window and for the interpolation with a fixed delay of the coder state has been synthesized under conditions of signal propagation in a multipath communications channel with known parameters. This algorithm makes it possible to perform the decoding of convolutional codes using the criterion of maximum of a posteriori probability. The analysis of the resultant algorithm was performed by using the computer statistical simulation.

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Data communications channels in real digital communications systems usually are band-limited. Moreover the frequency characteristic of the channel is nonideal that results in distortions in the form of intersymbol interference. The latter remains neglected and leads to errors in making a decision [1]. The channels introducing distortions in the form of intersymbol interference are often called channels with memory.

The convolutional codes are often used for enhancing the probability of correct reception under noise conditions. If the source of information is Markovian and messages are transmitted through a channel without memory, the decoding of convolutional codes can be performed by using the BCJR algorithm [2]. The latter calculates a posteriori probabilities for each symbol transmitted with due regard for all the symbols received on the interval under observation. An estimate of the symbol transmitted can be determined by using the criterion of a posteriori probability maximum making it possible to minimize the error probability in decision making. However, the BCJR algorithm obtained for a channel without memory cannot be used in the case of a multipath communications channel.

Under conditions of the multipath propagation of signal we can single out two statements of the problem of convolutional code decoding: 1) when the channel parameters are unknown and 2) when they are a priori known. In particular, the channel parameters can be found by using the methods described in paper [1].

The purpose of the present paper is to develop an algorithm for joint interpolation of the sequence of information symbols on a sliding window and for the interpolation with a fixed delay of the coder state. The specified algorithm ensures the decoding of convolutional codes in a multipath communications channel with known parameters using the criterion of a posteriori probability maximum.

The functional block diagram of the data transmission system is shown in Fig. 1. The sequence of information symbols b_k^j, $j=\overline{1,L}$, where L is the font size of information symbols, is fed to the coder input from a discrete Markov source of information. Since the source of information is discrete, the sequence of information symbols b_k^j can be described by the Markov chain with the matrix of transition probabilities Π_{ij} $i,j=\overline{1,L}$ and initial probabilities p_i, $i=\overline{1,L}$.

The operation of the convolutional coder is described by the variation of its states S_k^m, $m=\overline{1,M}$, where M is the number of possible states of the coder, under the impact of information symbols b_k^j, $j=\overline{1,L}$ and the formation of symbol vector $\vec{B}_k$. If at the instant of time $k-1$ information symbol b_{k-1}^i arrives at the coder input, this coder changes its state from S_{k-1}^n, $n=\overline{1,M}$ into a new state S_k^m in accordance with the state diagram of the coder. This process can be represented by conditional probability $P(S_k^m \mid S_{k-1}^n, b_{k-1}^i)$ that