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Coding and Decoding Scheme Controlling Run Length

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Abstract

A coding and decoding scheme controlling run length is presented. The proposed scheme limits the run length of data 0 in digital communication systems. We present a transformation approach to reduce the implementation complexity. The new adaptive scheme is implemented by combining the tree structure model and the candidate space model.

Keywords: ***C****hannel coding, Error correcting codes*

1. Introduction

The aim of channel coding is to make the noisy channel behave like a noiseless channel. We will assume that the data to be transmitted has been through a good compressor, so the bit stream has no obvious redundancy. The channel code, which makes the transmission, will put back redundancy of a special sort, designed to decode the noisy received signal.

A coding and decoding scheme controlling run length is presented. The proposed scheme limits the run length of data 0 in digital communication systems. We present a transformation approach to reduce the implementation complexity. The new adaptive scheme is implemented by combining the tree structure model and the candidate space model.

Bayesian inference for general data model problems can be implemented by exact methods, by Monte Carlo sampling, or by deterministic approximate methods. The methods that make Gaussian approximations [1] using Laplace's method [2, 3] or variation methods [4]. For neural networks there are few exact methods. The two main approaches to implementing Bayesian inference for neural networks are the Monte Carlo methods [5, 6] and the Gaussian approximation methods [7].

A measure of the information transmitted is given by the mutual information between the source and the received signal, that is, the entropy of the source minus the conditional entropy of the source given the received signal.

In operational terms, we are interested in finding ways of using the channel such that all the bits that are communicated are recovered with negligible probability of error. In mathematical terms, assuming a particular input ensemble, we can measure how much information the output conveys about the input by the mutual information.

2. Combining the Tree Structure Model and the Candidate Space Model

The Langevin method [4, 5] is implemented by gradient descent with added noise. A noise vector is generated from a Gaussian with unit variance. The gradient is computed with one free parameter, which controls the typical step size. If the parameter is set to too large a value,

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moves may be rejected. If it is set to a very small value, progress around the state space will be slow.

Hopfeld networks [2, 8] have two applications. First, they can act as associative memories. Second, they can be used to solve optimization problems. The idea of associative memory is the content-addressable memory.

Imagine that the weights of code words whose activities are positively correlated are increased:

$$\frac{dw_{mn}}{dt} = Correlation(x_m, y_n) \ . \tag{1}$$

This means that when, on a later occasion, stimulus occurs in isolation, making the activity large, the positive weight will cause the code word also to be activated. We could call this pattern completion.

A Hopfeld network's activity rule is for each neuron to update its state as if it were a single neuron with a sigmoid activation function. The updates may be synchronous or asynchronous, and involve the equations

$$a_m = \sum_n w_{mn} x_n \tag{2}$$

and

$$x_n = \tanh(a_n) \ . \tag{3}$$

The learning rule is the same as in the binary Hopfeld network. It is useful to be able to prove the existence of Lyapunov functions. If a system has a Lyapunov function then its dynamics are bound to settle down to a fixed point, which is a local minimum of the Lyapunov function, or a limit cycle, along which the Lyapunov function is a constant. Chaotic behavior is not possible for a system with a Lyapunov function. If a system has a Lyapunov function then its state space can be divided into basins of attraction, one basin associated with each attractor.

A zero-mean Gaussian prior is clearly a poor assumption if it is known that all elements of the image f are positive, but let us proceed. We can now write down the posterior probability of an image given the data

$$Posterior = \frac{Likelihood \times \Pr[f]}{Evidence} \ . \tag{4}$$

The evidence is the normalizing constant for this posterior distribution. Since the posterior distribution is the product of two Gaussian functions, it is also a Gaussian, and can therefore be summarized by its mean, which is also the most probable image.

3. Experimental Result

We implemented the proposed scheme to test the performance of the methods. Figures 1 to 8 depict the error performances of the (63,30) BCH code, the (24,12,8) extended Golay code, the (64,42) RM code, the (128,99) extended BCH code and the (128,64) extended BCH code, respectively.

For each code, the techniques developed in this paper apply to single-carrier systems in which data are sent using linear modulation. An alternative technique for handling dispersive channels is the use of multicarrier modulation. The multicarrier modulation transforms a system with memory into a system without memory in the frequency domain, by decomposing the channel into parallel narrowband sub-channels, each of which sees a scalar channel gain.

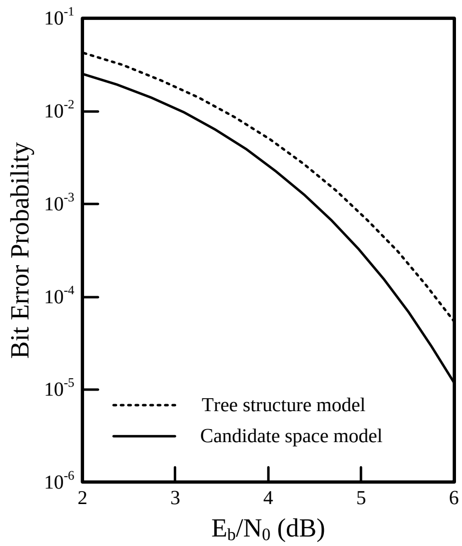

Figure 1. Bit error probability of (63,30) BCH code

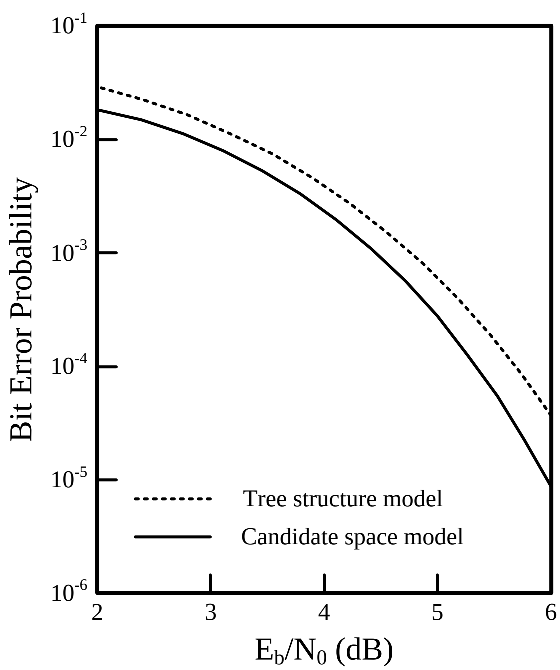

Figure 2. Bit error probability of (24,12,8) extended Golay code

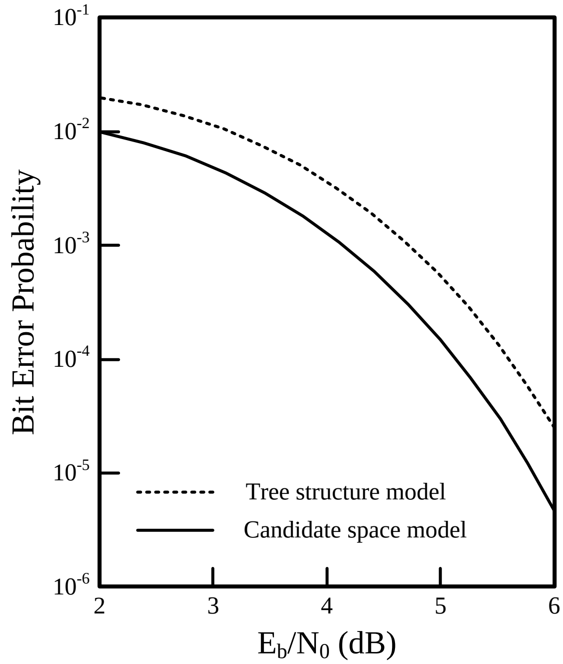

Figure 3. Bit error probability of (64,42) RM code

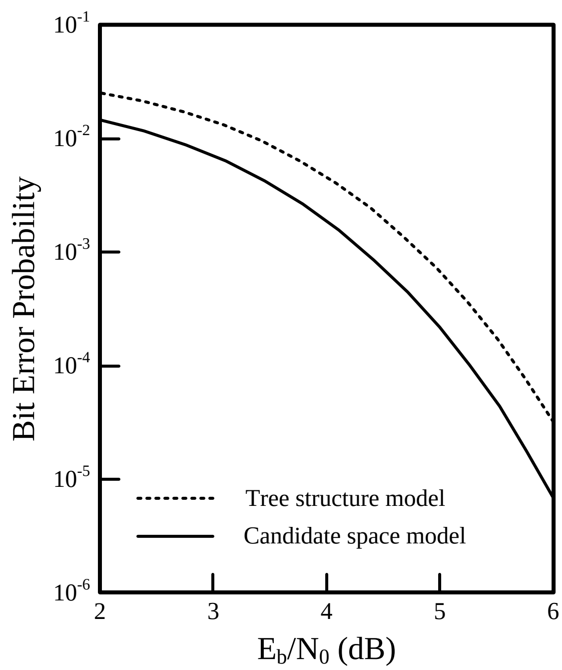

Figure 4. Bit error probability of (128,99) extended BCH code

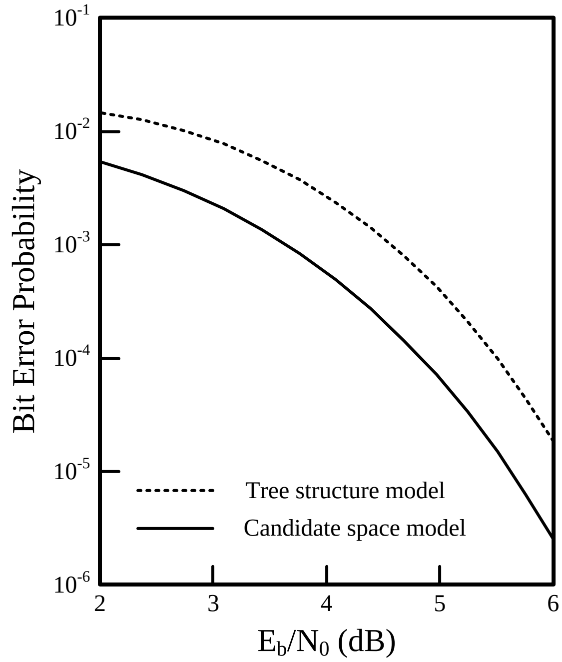

Figure 5. Bit error probability rate of (128,64) extended BCH code

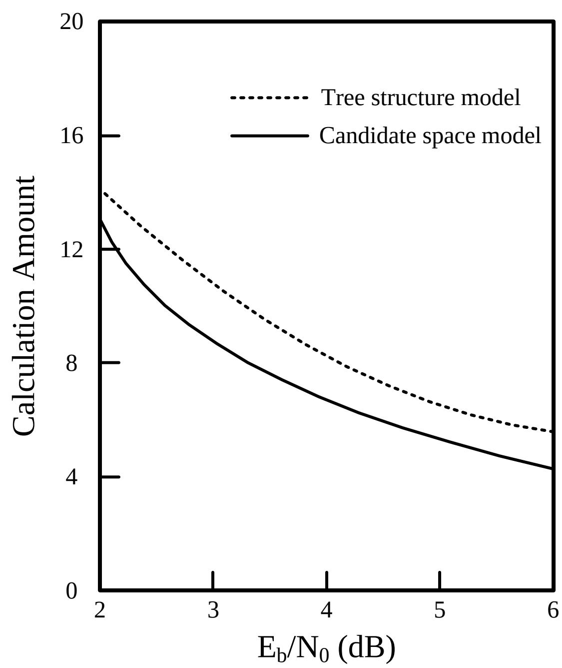

Figure 6. The calculation amount of (63,30) BCH code

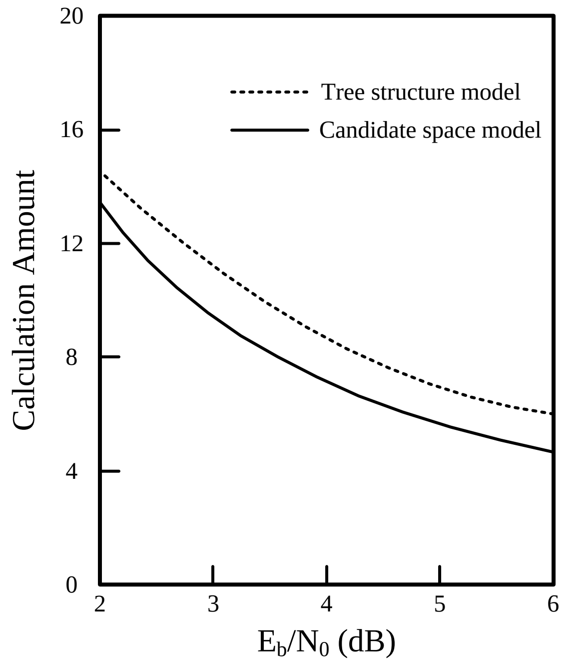

Figure 7. The calculation amount of (24,12,8) extended Golay code

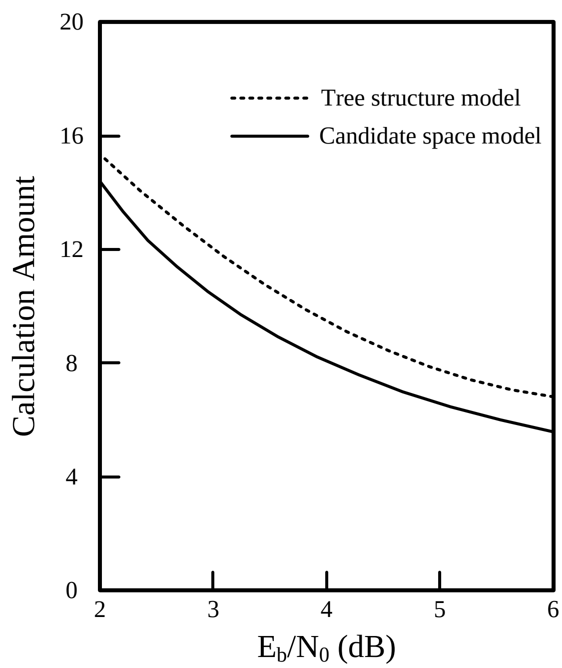

Figure 8. The calculation amount of (64,42) RM code

4. Conclusion

A coding and decoding scheme controlling run length is presented. The proposed scheme limits the run length of data 0 in digital communication systems. We present a transformation approach to reduce the implementation complexity. The new adaptive scheme is implemented by combining the tree structure model and the candidate space model.

While the matched filter is an analog filter, it can be implemented in discrete time using samples at the output of a wideband analog filter. The matched filter is implemented in discrete time after estimating the effective discrete time channel from the input to the transmit filter to the output of the sampler after the analog filter.

The optimality conditions state that each term making a nontrivial contribution to the average mutual information must be equal. That is, each term equals the average, which for the optimal input distribution equals the capacity.

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