Unequal Error Protection Scheme Using Several Convolutional Codes

Mari MATSUNAGA†, David K. ASANO‡ and Ryuji KOHNO†
†Division of Electrical and Computer Engineering, Faculty of Engineering, Yokohama National University, Japan
‡Department of Information Engineering, Faculty of Engineering, Shinshu University, Japan
Email: mari@kohnolab.dnj.ynu.ac.jp

Abstract — **This paper proposes and investigates a coding and decoding scheme to achieve for unequal error protection (UEP) using several convolutional codes with different error–correcting capabilities. An upper bound of decoder–selection–errors (DSE) in decoding is derived. We search good sets of codes which can reduce DSE, and introduce a biased metric in decoding to compensate performance degradation due to DSE.**

I. Introduction

We have researched intelligent communication, in which the content of the information is taken into account in coding and decoding[1]. Human receivers don't need every symbol of information to understand meanings of the information. Therefore, it is more efficient for intelligent error control schemes to use a coding method of unequally protecting information corresponding to its importance. In this paper, we consider UEP codes for intelligent error control of a serial data stream which contains a random mixture of several importance information.

II. Proposed System

The proposed scheme is outlined in Fig. 1. Convolutional codes which have different error-correcting capabilities are used. The codes are switched so that the error correction capability can be matched corresponding to the importance level. These encoders have the same number of output bits but different rates.

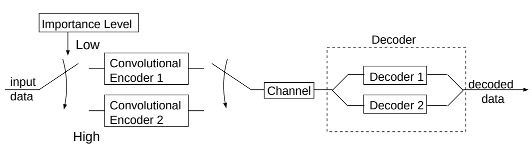

Fig. 1: Proposed System

The received signals are decoded using Viterbi algorithm. The decoder uses a trellis diagram which consists of combined trellis diagrams of each code and that of encoder transition. Therefore, By using the combined trellis we can decode without the supplymental information. However, there are DSE, when the wrong decoder is used to decode the data. If a DSE takes place, the decoded data gets longer or shorter, because the encoders have different code rates. Therefore, DSE degrades the system performance.

This error occurs unidirectionally. For example, this error occurs from code 2 to 1, but doesn't occur from 1 to 2. This is because the number of code sequences is different between the codes. The upper bound of DSE probability is given by this equation.

$$P_{2\to 1} \simeq \frac{1}{2^{k_1 T}} 2^{d_{ave(2\to 1)}} p^{\frac{d_{ave(2\to 1)}}{2}} (1-p)^{\frac{d_{ave(2\to 1)}}{2}} N_{d_{ave(2\to 1)}} \quad (1)$$

where d_{ave} is the average of minimum distance between codes and N_{ave} is the average number of the path which separate d_{ave}. From this equation, the combinations of the codes which have large d_{ave} and small N_{ave} are searched by computer.

In Viterbi decoding, we use the following metric.

$$metric_A = (x-m)^2 : EuclideanDistance \quad (2)$$

$$metric_B = \frac{d_{ave(1\to 2)}}{d_{ave(2\to 1)}}(x-m)^2 \quad (3)$$

By using these equations, the average distances between codes become almost same.

III. Simulation

The DSE and bit error rate(BER) is shown in fig 2 and 3. It is noted that the important bits are protected more than in an equal error protection scheme. The channel that is used is an additive white Gaussian noise (AWGN) one. $Metric_A$ and $Metric_B$ defined by eq. (2) and (3) are used. We assume that the importance level is changed every 16 channel symbols.

IV. Conclusions

In this paper, we proposed an unequal error protection scheme using several codes for the information sources that contain a mixture of data with various importance.

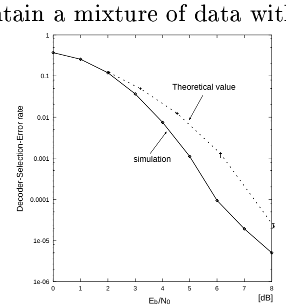

Fig. 2: DSE performance

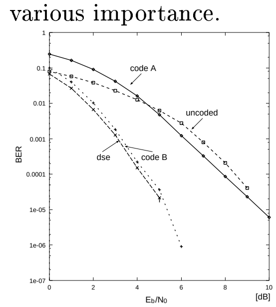

Fig. 3: BER performance

References

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[2] M. Matsunaga, D. K. Asano and R. Kohno, "Unequal Error Protection Based on Multidimensional Coded Modulation Using Several Convolutional Encoders," ISPACS'96, pp.1658 – 1662 Nov.1996