New tailbiting encoders

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Abstract — In a tailbiting trellis encoder, the starting state of the encoder is set to the state at which the machine will be at the end of the encoded frame. By this means the probability of decoding error at the end of the frame can be kept low without the addition of termination bits and the consequent rate loss. We report on an exhaustive search for short and moderate-length convolutional encoders for tailbiting trellis representations of block codes at rates 1/4, 1/3, 1/2, and 2/3. The short tailbiting representations found are typically as good as the best known block codes.

I. INTRODUCTION

Consider a binary-symbol trellis representation of a block code of length $N$, 2$^N$ branches per trellis node, and $c$ symbols per branch; the number of codewords is $M = 2^K = 2^L$ and its rate is $R = K/N = b/c$ data bits per channel bit. For tailbiting trellis representations of the block codes, the codeword set is limited to those encoder output sequences which end in the same encoder states at which they began.

II. THE CODE SEARCH

An effective strategy for finding good generators for tailbiting (TB) trellis representations is to search exhaustively for the best generators. An early such study is [1]; we search to much higher $m$ than they do and correct some apparent errors. For TB circles out to $K = 50$ information bits, we have found the optimal generators by exhaustive search out to memory 5 at rate $R = 1/4$, $m = 6$ at rate $R = 1/3$, $m = 8$ at rate $R = 1/2$, and $m = 3$ at rate $R = 2/3$. Although these encoders suffice for most applications, good codes with longer memory are sometimes needed. A way to gain an idea of the capabilities of long memory TB encoders is to choose longer generators at random and keep the best found after, say, several days of computer search. We found this method quite effective. A complete listing of all these generators appears in [2].

The code trellis paths fall into two cases.

Case (i): (Intra minimum distance, $d_{\text{intra}}$). The neighbor path never touches the allzero path. We call this the intra minimum distance for the tailbiting trellis representation.

Case (ii): (Inter minimum distance, $d_{\text{inter}}$). The neighbor path touches the allzero path at least once; all paths considered are within the subset of paths leaving state 0. Finding the minimum weight such path is the same as finding the free distance for a convolutional code. We call this the intra minimum distance for the tailbiting trellis representation.

REFERENCES

