Two-Phase Priority-First Search Decoding Algorithm for Tail-Biting Convolutional Codes

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***Abstract*—Current maximum-likelihood (ML) decoders for tail-biting convolutional codes (TBCCs) often achieve only either *low average decoding complexity* or *stable decoding complexity* but not both. For example, with optimality in performance, BEAST [1] is shown to have a low average decoding complexity; however, it may induce a high system latency due to its large variant decoding complexity with respect to different SNRs. By contrast, PFSA [2] has a stable decoding complexity but a relatively high average decoding complexity. In this work, an extension decoder from PFSA is proposed and is named *two-phase Priority-First Search Algorithm* (tpPFSA) because it conducts the priority-first Search decoding process in two phases. Simulations show that tpPFSA not only achieves the lowest average decoding complexity among all existing ML decoders for TBCCs but has a highly stable decoding complexity in comparison to BEAST.**

I. tpPFSA

The proposed tpPFSA is a two-phase ML decoding algorithm for TBCCs. In the first phase, it performs the priority-first search algorithm (PFSA) over the supper trellis of TBCCs in a backward manner in order to obtain some estimates for use of the second phase. In the second phase, it performs again PFSA over all subtrellises of TBCCs simultaneously in a forward manner and guarantees to output the ML codeword. The details of the two phases are given below.

Phase One: Backward PFSA over the super trellis of TBCCs

- The reverse accumulative metric at node (i, j) is retained as $h_{i,j}$.
- The accumulative metric associated with the final reached node at level 0 is $\bar{h}$. For those unreached nodes, their $h_{i,j}$ are all set to be $\bar{h}$.

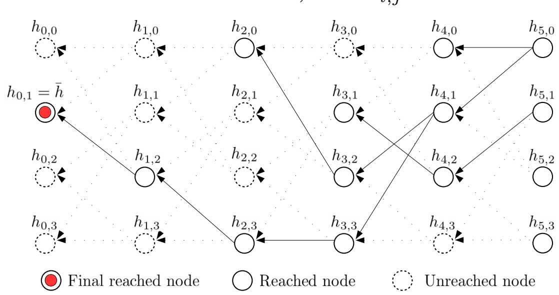

Fig. 1. An example of phase-one process

Phase Two: Forward PFSA over all subtrellises of TBCCs

- The search metric of a node is the sum of the accumulative metric and $h_{i,j}$ corresponding to this node.

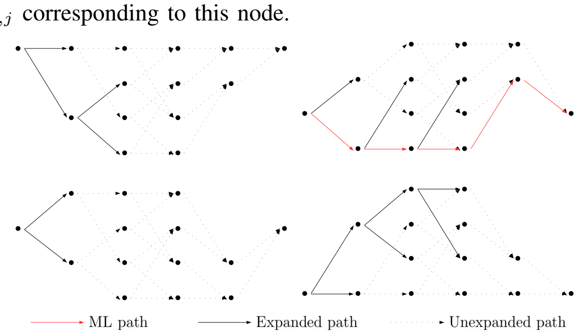

Fig. 2. An example of phase-two process

II. Simulations over AWGN Channels

The computational effort of tpPFSA is compared to those of BEAST [1] and PFSA [2] over AWGN channels. Two different TBCCs with generator polynomials $103, 166$ (octal) and $133, 171$ (octal) are simulated; the former is equivalent to extended Golay code with information length 12, and the latter is of information length 48. The ML performances of the two codes are depicted in Fig. 3.

The average decoding complexities of BEAST, PFSA, and tpPFSA are depicted in Fig. 4. Results show that tpPFSA has the lowest average decoding complexities among three ML decoders. Also, its decoding complexity is highly stable against varying SNRs.

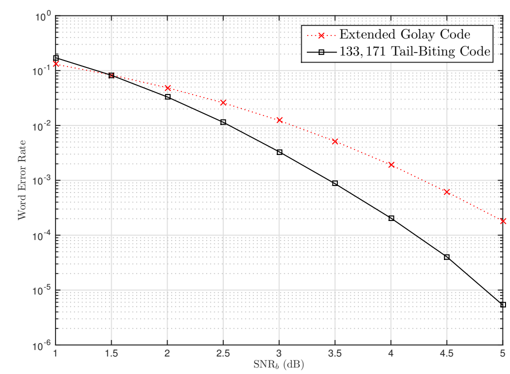

Fig. 3. WERs of ML decoders for $133, 171$ (octal) TBCC and extended Golay code

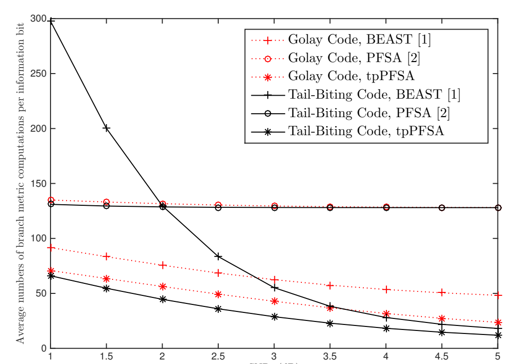

Fig. 4. Average numbers of branch metric computations per information bit for BEAST, PFSA and tpPFSA for the codes in Fig. 3.

References

[1] I. E. Bocharova, M. Handlery, R. Johannesson and B. D. Kudryashov, "Beast decoding of block codes obtained via convolutional codes," *IEEE Trans. Inform. Theory*, vol. 51, no. 5, pp. 1880–1891, May 2005.

[2] Y. S. Han, T.-Y. Wu, H.-T. Pai, P.-N. Chen and S.-L. Shieh, "Priority-first search decoding for convolutional tail-biting codes," *Int. Symp. Inform. Theory and its Applications (ISITA)*, Auckland, New Zealand, Dec. 7–10, 2008, pp. 1–6.