Decoding of Non-Systematic Turbo Codes for Stationary Memoryless and Piecewise Stationary Memoryless Sequences

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Redundancy left in channel coded data can be utilized in channel decoding most efficiently with non-systematic channel codes using techniques from universal data compression to trace the data statistics. In an iterative decoder, this can be done between decoding iterations, where statistics are learned and then passed to the next decoding iteration as *a-priori* bit information. We consider channel decoding of sequences generated by i.i.d. sources and *Piecewise Stationary Memoryless Sources* (PSMS's). We design a turbo decoder that utilizes compression techniques for PSMS's [2]. Non-systematic channel codes are superior to systematic codes when utilizing known source statistics. However, it becomes much more difficult to learn and utilize unknown statistic with such codes because they do not usually perform well at the waterfall region, and also cannot initialize convergence of estimates of the source statistics because initial iterations' *extrinsic* information is rather unreliable. To solve these problems, we use codes that have the *quick-look-in* (QLI) property [1], where two parity sequences generated by one of the constituent recursive convolutional codes sum modulo-2 to the systematic message sequence. This allows good performance of the code in the waterfall region, and also generation of initial source estimates (which rely mainly on channel information before convergence of the iterative process). During the first decoding iterations, source statistics are obtained between iterations by segmentation of the PSMS data, estimation of the i.i.d. statistics in each segment, and then enhancement of these estimates by reversing the channel transition probabilities. Then, during later iterations, the extrinsic information can be used for the same algorithm without need to reverse the channel. To improve code performance, an interleaver, that diversifies the channel code from the PSMS structure is included in the encoder between the source output and the channel code. Simulations show that this universal system's performance almost meets that of a decoder that has prior knowledge of the PSMS parameters, and of course, is better than that of a standard decoder that does not utilize source statistics. There is a gain to the new interleaver, whose actual level depends on the actual PSMS coded.

References

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[2] G. I. Shamir, D. J. Costello, Jr., "Asymptotically optimal low complexity sequential lossless coding for piecewise stationary memoryless sources - Part I: The regular case," *IEEE Trans. Inform. Theory*, Vol. 46, No. 7, pp. 2444-2467, Nov. 2000.

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