Reliable Resynchronization of Sequential Decoders

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Summary

Sequential decoding presents the drawback that the number of computations required for the decoding process to advance by one branch in the decoder tree is a random variable with a Pareto distribution. As practical sequential decoders can perform only a finite number of operations in a given time interval, resynchronization of the decoder must take place if the maximum number of operations that is allowed for decoding without incurring buffer saturation is exceeded. In this paper, a method for reliable resynchronization of sequential decoders based on probabilistic inference is presented. In particular, a reduced-state forward-backward algorithm is considered. To further reduce the complexity required by auxiliary decoding functions, two modes of operation for the auxiliary decoder are defined. The method can be applied for sequential decoding of code sequences generated by either systematic or nonsystematic encoders. The performance of practical sequential decoders with the proposed resynchronization method is investigated via simulations, with reference to single-pair high-speed digital subscriber line transmission employing a 512-state 16-PAM trellis code. The results indicate that gains of about 1 dB are achieved at a symbol-error rate of 10^{-5} over a decoder employing the Viterbi algorithm with length of path memory equal to 64 symbols.

References

[1] R. M. Fano, "A heuristic discussion of probabilistic decoding," *IEEE Trans. Inform. Theory*, vol. IT-9, pp. 64-74, Apr. 1963.

[2] A. J. Viterbi, "Error bounds for convolutional codes and an asymptotically optimum decoding algorithm," *IEEE Trans. Inform. Theory*, vol. IT-13, pp. 260-269, Apr. 1967.

[3] B. J. Frey, *Graphical models for machine learning and digital communications*, Cambridge, MA: MIT Press, 1998.

[4] L. R. Bahl, J. Cocke, F. Jelinek, and J. Raviv, "Optimal decoding of linear codes for minimizing symbol error rate," *IEEE Trans. Inform. Theory*, vol. IT-20, pp. 284-287, Mar. 1974.

[5] R. G. Gallager, *Information theory and reliable communication*, New York, NY: John Wiley & Sons, Inc., 1968.

[6] F.-Q. Wang and D. J. Costello, "Erasure-free sequential decoding of trellis codes," *IEEE Trans. Inform. Theory*, vol. 40, pp. 1803-1817, Nov. 1994.