



S-72.333 Postgraduate Course in Radio Communications

Turbo Coding

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History

- Discovered by Claude Berrou et al. in 1993
- Based on convolutional codes and Viterbi algorithm



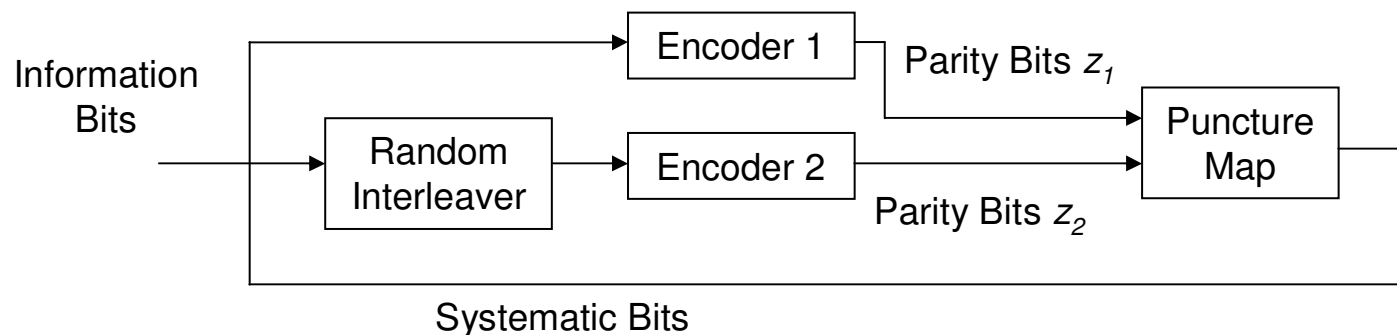
Combining two ideas

- Pair of encoders, separated by a pseudo random interleaver, or turbo interleaver
- Iterative detection with feedback



Turbo Encoding

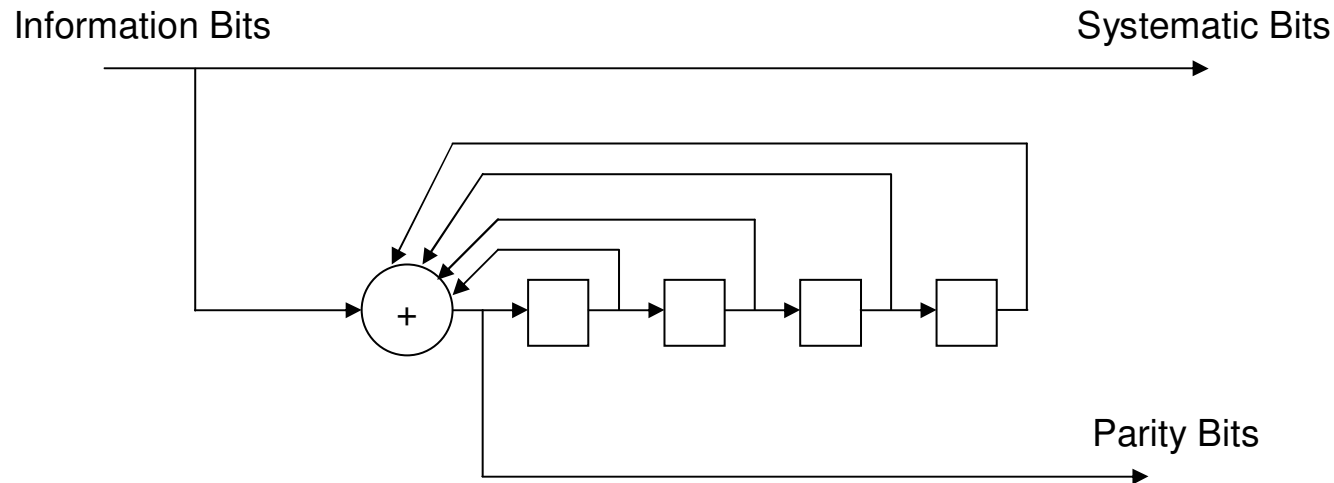
- Parallel forward error-correction coding (FED)
- Two identical encoders





Recursive convolutional code

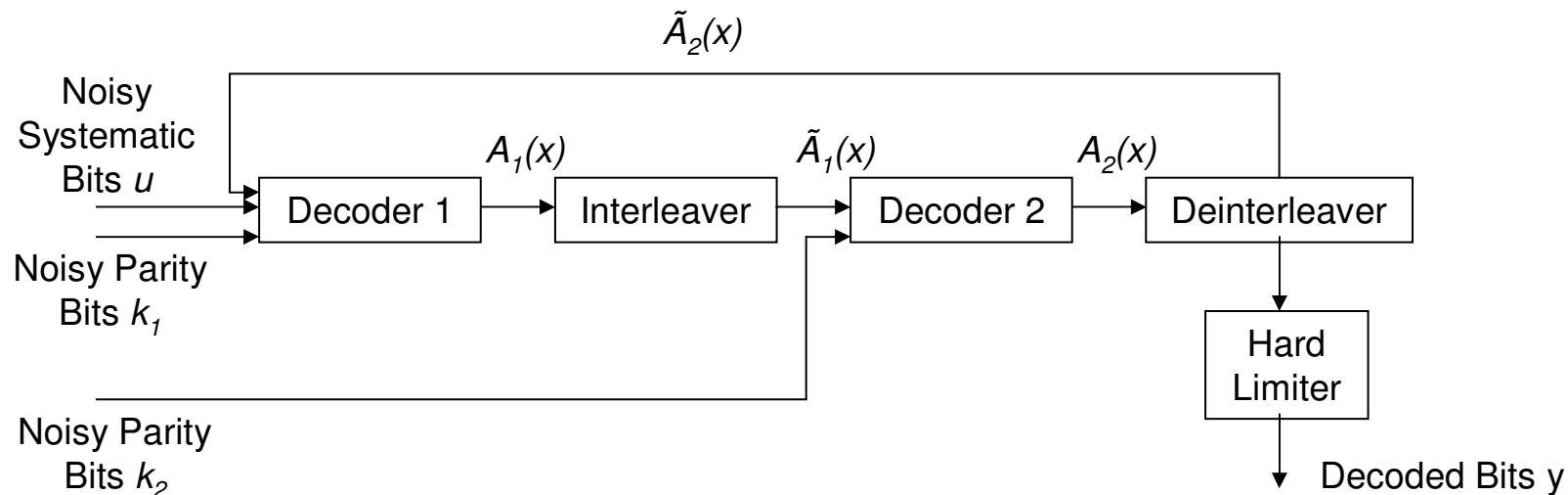
- The feedback nature means that single bit error corresponds to an infinite sequence of channel errors





Turbo Decoding

- Feedback around a pair of decoders separated by a deinterleaver and an interleaver
- Extrinsic information





Turbo decoding (2)

- Soft-input, soft-output (SISO) decoding
- Estimate $A_1(x(j)) = \log(p/(1-p))$, where $p = \text{Prob}(x(j)=1 | u, k_1, \tilde{A}_2)$
- Maximum A Posteriori, recursively for A_1 and A_2



Performance

- Nearly achieves Shannon capacity
- Robust for noise
- Decoding may be complex



Homework

- Stopping criteria for iterative decoding of turbo codes



References

- Berrou C., Glavieux A.: *Near Optimum Error Correcting Coding And Encoding: Turbo-Codes*, in IEEE Transactions on Communications, pp. 1261-1271, Vol 44, No 10, October 1996
- Haykin S., Moher M.: *Modern Wireless Communications*, ISBN 0-13-124697-6, Prentice Hall 2005
- MacKay D. J. C., *Information Theory, Inference, and Learning Algorithms*, Cambridge University Press, Cambridge, 2003