Distributed Joint Source-channel Coding of Video Using Raptor Codes

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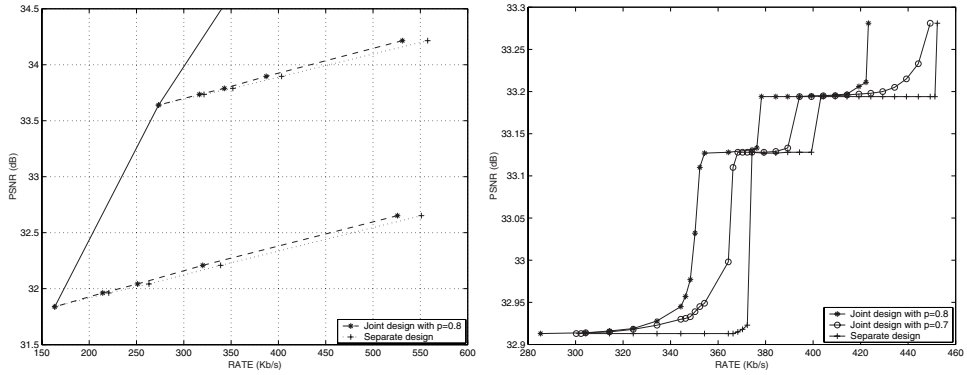
Wyner-Ziv coding (WZC), or lossy source coding with decoder side information, has recently found important applications in video communications. Extending recent works on source-channel coding for WZC, we consider the case with noisy channel in WZC and address distributed joint source-channel coding (JSCC), while targeting at video transmission over packet erasure channels. For video compression, we resort to layered Wyner-Ziv video coder of [1]. Instead of using two separate channel codes – one for Slepian-Wolf coding (SWC) in WZC and the other for erasure protection, our idea is to use a $single$ Raptor code, for both SWC and erasure protection. Raptor codes are the latest addition to a family of low-complexity rateless fountain codes which consist of a high-rate precode and an LT code. We use IRA codes as the precode of our Raptor code, as IRA codes are well suited for distributed JSCC [2]. We vary the rate of the IRA precode and introduce a bias towards the IRA parity bits when making the random connections in forming the sparse-graph of the LT code, i.e., we connect each LT check node with the IRA parity nodes with probability p. This bias is motivated by the fact that a correlated version of the IRA systematic bits is already available as side information at the decoder, and its optimization is embedded in the overall Raptor encoder design. For decoder design, due to the presence of side information, we develop a new iterative soft-decision Raptor decoder for $joint$ decoding that combines the received packets and the side information.



(a) (b)

Figure 1: Performance comparisons of our joint Raptor code design vs. a separate design for the CIF Foreman sequence at packet erasure rate 0.1. (a) Average PSNR over all 300 frames. (b) Detailed comparison using two different p's in the LT code design for the fourth bitplane, assuming the first three bitplanes have already been decoded and only the first group of frames is transmitted.

Simulation results (see Figure 1) show that, compared to a separate design using SWC plus additional erasure protection, our joint design with a single Raptor code for both SWC and erasure protection provides better video quality with the same number of received packets. Our work represents the first in capitalizing the latest in distributed source coding (e.g., Wyner-Ziv video coding) and near-capacity channel coding (e.g., fountain codes) for robust video transmission over erasure channels.

References

[1] Q. Xu and Z. Xiong, "Layered Wyner-Ziv video coding," submitted to *IEEE Trans. Image Processing*, July 2004.

[2] A. Liveris, Z. Xiong, and C. N. Georghiades, "Joint source-channel coding of binary sources with side information at the decoder using IRA codes," *Proc. IEEE MMSP-2002 Multimedia Signal Processing Workshop*, St. Thomas, US Virgin Islands, Dec. 2002.

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