Anne Margot F. Aaron
amaaron@stanford.edu

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EE398B

Wyner-Ziv Coding of Motion Video

Project Proposal

In current video compression standards (i.e. MPEG, H.263), interframe predictive coding is performed to exploit the similarities among successive frames. Since predictive coding makes use of motion estimation for good predictions, the video encoder is typically 5 to 10 times more complex than the decoder. This is beneficial for a system composed of low-complexity mobile video terminals that download compressed video which is then decoded in the terminals. However, future systems may require the opposite scenario – low-complexity mobile cameras uploading video to a server. For this system, what is desired is a simplified encoder which can send compressed video to a possibly more complex decoder.

An interesting result from information theory is the Wyner-Ziv theorem on source coding with side information at the decoder [1]. Assume that we have two correlated sources X and Y. Wyner and Ziv proved that for Gaussian sources and mean-squared error distortion, the conditional rate-distortion function for X given Y is the same, whether the side information is known both at the encoder and the decoder or only at the decoder. This suggests that it is possible to have an asymmetric video codec, which encodes frames independently but decodes conditionally (given the previous decoded frame), that achieves similar compression efficiency as a codec which encodes and decodes conditionally.

In this project we propose to build a video codec with a simplified encoder, compressing frames independently, and a decoder which decodes conditionally. In the encoder, each frame is divided into blocks and the blocks are transform coded. The transform coefficients are compressed (independent of the previous frame) using turbo codes. Studies have shown that turbo codes can perform well for distributed source coding [2][3][4][5]. In the decoder, turbo decoding is performed using the previous decoded frame as "side information." In order to apply the turbo coding technique, we model the correlation between two successive frames as a Laplace-Markov relationship.

References

[1] A. D. Wyner and J. Ziv, "The rate-distortion function for source coding with side information at the decoder," *IEEE Trans. Information Theory*, vol. IT-22, no. 1, pp. 1–10, Jan. 1976.

[2] J. Garcia-Frias, "Compression of correlated binary sources using turbo codes," *IEEE Communications Letters*, vol. 5, no. 10, pp. 417-419, October 2001.

[3] J. Bacjsy and P. Mitran, "Coding for the Slepian-Wolf Problem using turbo codes," *Proc. IEEE Global Communications Symposium*, pp. 1400-1404, San Antonio, TX, November 2001.

[4] A. Aaron and B. Girod, "Compression with side information using turbo codes," *Proc. IEEE Data Compression Conference*, Snowbird, Utah, April 2002.

[5] Y. Zhao and J. Garcia-Frias: ``Data compression of correlated non-binary sources using Punctured Turbo Codes", *Proc. IEEE Data Compression Conference*, Snowbird, Utah, April 2002.