

Asymmetric Code Design for Remote Multiterminal Source Coding

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We perform asymmetric code design for remote multiterminal source coding (the CEO problem [1,2]) in the quadratic Gaussian case. For an i.i.d. Gaussian source $X \sim \mathcal{N}(0, \sigma_x^2)$, we have two noisy observations $Y_1 = X + N_1$ and $Y_2 = X + N_2$, where $N_1 \sim \mathcal{N}(0, \sigma_n^2)$ and $N_2 \sim \mathcal{N}(0, \sigma_n^2)$ are i.i.d. random noises that are independent of each other and X . For remote multiterminal source coding [1–3] of X , to achieve the minimum sum rate of the two independent encoders subject to a fidelity criterion d , theoretical bounds were derived independently by Oohama [1] and Chen *et al.* [2] as

$$R_i \geq \frac{1}{2} - \frac{1}{2} \log\left[1 + \frac{d}{\sigma_x^2}\right] - \frac{1}{2} \log^+\left[1 - \frac{\sigma_n^2(\sigma_x^2 - d)}{2\sigma_x^2 d}\right], \quad i = 1, 2, \quad (1)$$

$$R = R_1 + R_2 \geq \frac{1}{2} \log \frac{\sigma_x^2}{d} - \log^+\left[1 - \frac{\sigma_n^2(\sigma_x^2 - d)}{2\sigma_x^2 d}\right], \quad (2)$$

where $\log^+ x = \max\{\log x, 0\}$ and the sum-rate bound (2) is tight.

Our main idea is to quantize the first observation Y_1 and apply Wyner-Ziv coding on Y_2 by using the quantized version of Y_1 as side information in an efficient *asymmetric* coding scheme. Specifically, we rely on TCQ for quantizing Y_1 and employ Slepian-Wolf coded TCVQ described in our recent work [4] for Wyner-Ziv coding of Y_2 . Uniform-threshold quantizers are used, and a uniformly distributed dither is added to make the quantization noise independent of the input signal in Wyner-Ziv coding.

Assuming optimal quantization, we theoretically show that by varying the rate allocation between the two encoders for Y_1 and Y_2 , our scheme can achieve the two corner points A and B on the sum-rate bound (as depicted by the dashed lines in Fig 1).

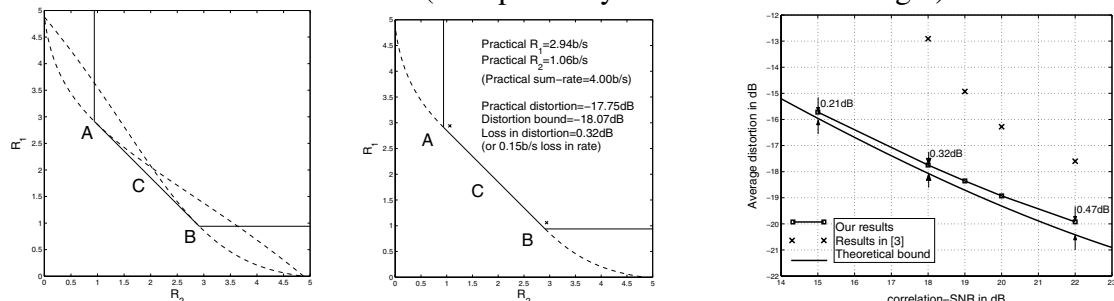


Fig 1: Achievable rate allocations Fig 2: Results for correlation-SNR of 18dB Fig 3: Results compared with [3] at sum-rate of 4b/s

Our practical code design gives results that are very close to the sum-rate bound (see Fig 2). For instance, at a sum-rate of 4b/s, we lose only 0.21 dB at a correlation-SNR of 15 dB and 0.47dB at 22 dB, as shown in Fig 3. These results are more than 2dB better than those of the only previous published design by Pradhan and Ramchandran [3]. For a longer version of this paper, please refer to our web page at <http://lena.tamu.edu>.

References

- [1] Y. Oohama, "The Rate-Distortion Function for the Quadratic Gaussian CEO Problem," *IEEE Trans. on Information Theory*, vol. 44, pp. 1057–1070, May 1998.
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- [4] Y. Yang, S. Cheng, Z. Xiong, and W. Zhao, "Wyner-Ziv coding based on TCQ and LDPC codes," *Proc. of 37th Asilomar Conference on Signals, Systems, and Computers*, Pacific Grove, CA, Nov. 2003.