Signal Compression for Joint Classification and Reconstruction

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In a variety of imaging applications (such as automatic target recognition and remote sensing) classification algorithms operate on compressed signals. In such applications, classification accuracy would be an appropriate design criterion for the coding system. Yet most systems use conventional compression algorithms , e.g., algorithms that minimize a mean-squared reconstruction error (MSE) or optimize visual quality. Can one do better?

We explore this question and focus on the optimal design of transform coders under using Chernoff bounds on probability of misclassification as the design criterion. Improvements in classification performance are obtained over MSE-based designs, at the expense of some degradation in reconstructed signal quality. The present work also develops a unified framework to address the design of transform coders optimally trading off classification accuracy versus MSE fidelity. Analytical expressions for the optimal coder are obtained for Gaussian-mixture signals under a high-rate quantization assumption. Optimality properties of the Karhunen-Loève transform in this more general setup are established, and optimal bit-allocation formulas are derived.