Title
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Using PQS to Improve Coder Performance

PQS, the perceptually relevant image quality metric for coders, allows the systematic improvement of the performance of coding schemes. As an example, we consider the improvement of a subband coder by changes in the coefficient quantization rule.

For any coder, the rate and the distortion depend on the coefficient quantization matrix or vector so that, at any image quality level, R and D are implicit functions of an independent vector α, that defines the quantization rules or levels.

Optimization Procedure

- We perform a search in $R(D)$ space by variations of the $\boldsymbol{\alpha}$ vector which specifies the quantization matrix.
- Use the PQS quality scale as the distortion measure.
- Given a reference encoder and quantization scheme (characterized by $\boldsymbol{\alpha}$)
  1. Determine the rate versus distortion (PQS) trade off for the reference scheme.
  2. For a given operating point, $\boldsymbol{\alpha}_0$, find a direction incrementally orthogonal to the corresponding $R(\text{PQS})$ curve.
  3. For an incremental change $\Delta\boldsymbol{\alpha}$, conduct a numerical search to minimize R or PQS, constrained by (1) and

$$||\Delta\boldsymbol{\alpha}|| \leq \text{threshold}.$$

Improvement of Coding Algorithms

Quantization matrix optimization

- Reference scheme: $\boldsymbol{\alpha} = \beta\boldsymbol{\alpha}_0$,
- Given $R(\boldsymbol{\alpha})$ and $D(\boldsymbol{\alpha})$, the parametric rate and distortion functions as a function of $\boldsymbol{\alpha}$,
- Let

$$A \triangleq \left[\frac{\partial R}{\partial \alpha_i}\right]^T \text{ and } B \triangleq \left[\frac{\partial D}{\partial \alpha_i}\right]^T,$$

  then

$$\boldsymbol{\Delta}\mathbf{R} = A\boldsymbol{\alpha} \text{ and } \boldsymbol{\Delta}\mathbf{D} = B\boldsymbol{\alpha}.$$

- For the reference coder C_1, we have $\boldsymbol{\alpha}_1 = \Delta\beta\boldsymbol{\alpha}_0$ and

$$\Delta R_1 \Delta R_2 + \Delta D_1 \Delta D_2 = 0, \qquad (1)$$

  by searching over $\boldsymbol{\alpha}$.

Subband Coding Example

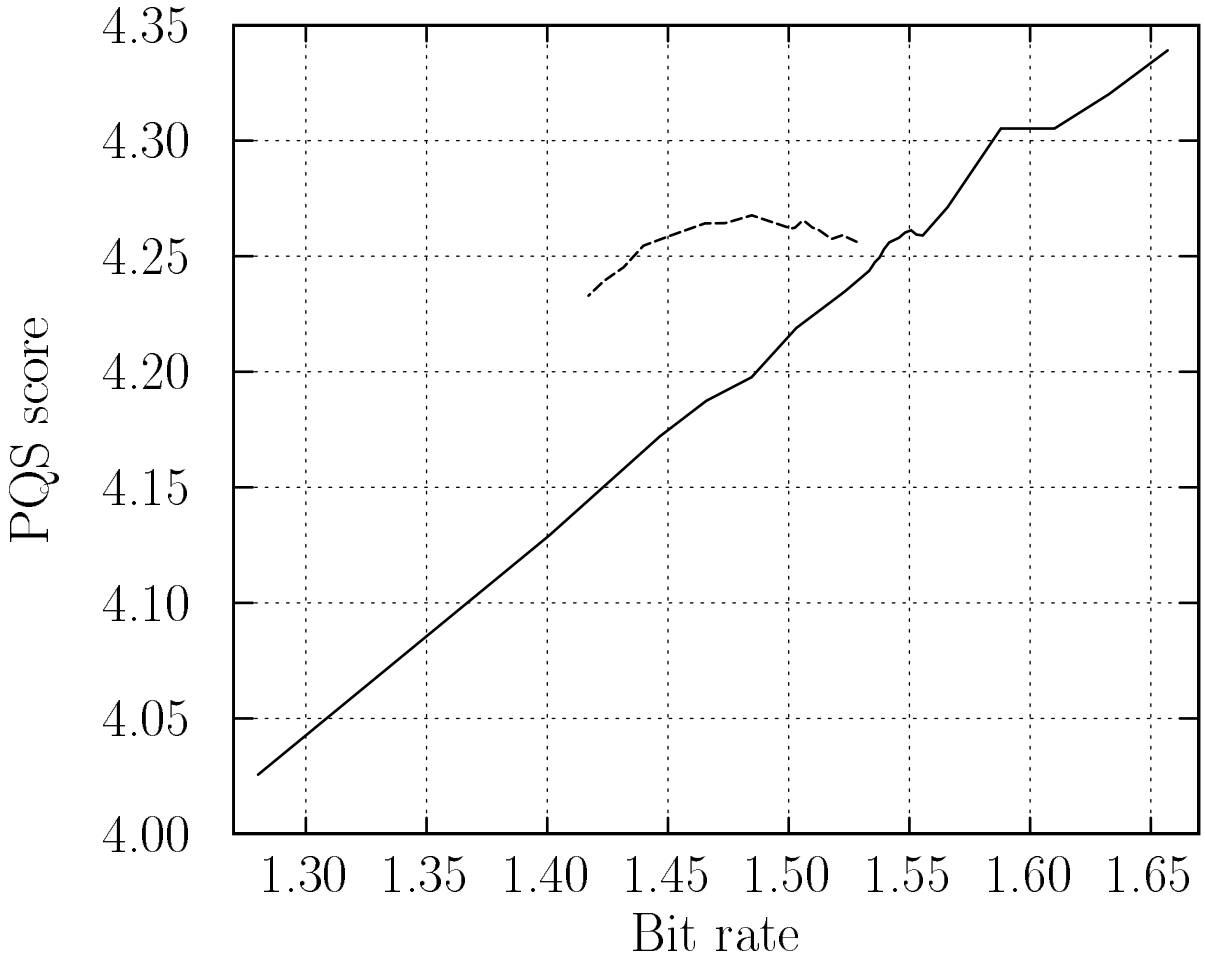

Figure 1: The performance improvement, shown by the dotted line, starts from an operating quality level and improves it incrementally, by the determination of a new quantization matrix.