Analysis of Trellis Quantization for Near-Lossless Image Coding

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In near-lossless image coding the original and the reconstruction image are only allowed to differ by $\pm\tau$ grey levels in *each* pixel, where τ is a pregiven threshold. In a predictive coding scheme the simplest way to guarantee this L_∞ bound is to perform a uniform quantization of the prediction residues with quantizer bin size matching the required tolerance. The near-lossless version of CALIC[1] uses this mechanism. Since quantization is inside the DPCM loop, changing a pixel value at the current position affects subsequent predictions of forthcoming pixels. The trellis quantization (TQ) scheme proposed in [2] tries to take into account those global implications of quantization. However, despite its high computational cost the TQ scheme is inferior to the near-lossless CALIC.

For a one-dimensional signal $s \in \mathbb{Z}^n$ one has to find the reconstruction signal $\bar{s} \in \mathcal{N}_\tau(s) := \{t \in \mathbb{Z}^n \mid \|t - s\|_\infty \leq \tau\}$ that can be coded most efficiently, i.e., whose corresponding sequence of prediction residuals has minimal entropy. The TQ scheme provides a local optimum solution to this problem in an iterative fashion. The method is extended to the 2-dimensional case by using the planar predictor and by doing the optimization for each row seperately. The context modelling used in [2] only involves the 3 pixels that are also used for the prediction. Our study was motivated by the following questions: Is the iterative method unable to find a 'near-optimal' solution? Or is the simplicity of the prediction/context-modelling scheme itself the reason for the inferior performance?

In this poster we discuss several variations to the original algorithm. We have extended the TQ scheme by performing *two-row joint optimizations* instead of optimizing row by row. Unfortunately, while increasing the computation time quite a bit, this has lead only to marginal coding gains. A *progressive probability update* scheme has lead to much better convergence and to a 0.3 bpp gain over the original fixed scheme. When using *lossy plus near-lossless coding* the lossy version can be used for better context modelling without increasing the computational complexity of the near-lossless residual coding. Improvements of 0.1–0.2 bpp were observed.

Since it is computationally infeasible to include more pixels to be determined by the TQ process, one has the choice of *either* using better prediction/context-modelling *or* doing TQ. Our tests indicate that the preference should be given to sophiticated prediction/modelling. A full version of this paper including coding results for various standard test images and another near-lossless coding technique can be obtained via [3].

[1] Wu, X., Memon, N., *Context-based, adaptive, lossless image coding*, IEEE Trans. Communications, vol. 45, no. 4, April 1997

[2] Ke, L., Marcellin, M. W., *Near-lossless image compression: minimum-entropy, constrained-error DPCM*, Proc. IEEE ICIP, Washington, D.C., Oct. 1995.

[3] Hartenstein, H., Wu, X., *Analysis of trellis quantization for near-lossless image coding*, Technical Report, Institut für Informatik, Universität Freiburg, 1998 (available via ftp://ftp.informatik.uni-freiburg.de/documents/reports/report99/report00099.ps.gz)

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