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 x^2 gray levels in each pixel, where x is a prechosen threshold. In a predictive coding scheme the simplest way to guarantee this L_x bound is to perform a uniform quantization of the prediction residuals with quantizer bin size matching the required tolerance. The near-lossless version of CALIC1 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 ∈ Z^* one has to find the reconstruction signal e ∈ Z^* such that ||s - e||_2 ≤ x. This 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 linear predictor and by doing the optimization for each row separately. The context modeling 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 still able to find a 'near-optimal' solution? Or is the simplicity of the prediction/context modeling scheme itself the reason for its inferior performance? In this paper we discuss several variations to the original algorithm. We have extended the TQ scheme by performing row-wise joint optimization instead of optimizing row by row. Unfortunately, increasing the computation time quite a bit, this has lead only to marginal coding gains. A progressive probable update scheme has lead to much better performance and to a 0.1 bpp gain over the original fixed scheme. When using lossless plus near-lossless coding the lossless version can be tried for better context modeling without increasing the computational complexity of the near-lossless residual coding. Improvements of 0.1 - 0.2 bpp were observed.

Since it is computationally impossible 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 sophisticated predic-tion/modelling. A full version of this paper including coding results for various standard test images and another near-lossless coding technique can be observed via [3].


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561