Dequantization

- Nonlinear Reconstruction of Sampled Signals
- IMA Workshop in Film Restoration
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A conceptual sampled, quantized signal. (Dotted line: step reconstruction).

Superimposed: the uncertainty bounds of the signal before quantization.

One possible smooth reconstruction consistent with the quantized samples.

Figure 1: Smooth reconstruction of a quantized signal.
Sampled signals are reconstructed by interpolating midpoints of the quantization intervals.

This artificially imposes constraints that do not actually reflect our knowledge of the signal.

Figure 1: Smooth reconstruction of a quantized signal.
Example: Raster Contours

- These contours are “aliased,” but it is also true to say their coordinates are quantized.
- The smoothest contour that quantizes to the same original data is most parsimonious.
• The distinctive feature of this nonlinear reconstruction is that quantum changes are distributed over the whole intervals between them.
Example: a 4-bit image

- Suppose we can reconstruct this 16-level image with an arbitrary number of gray levels?
• The “dequantized” version, using 8 bits.
• This is a principled and useful way of increasing dynamic range.
Avideh Zakhor, 1992, applied this concept to blocking artifacts in JPEG images, using projection onto convex sets.

Comments on “Iterative Procedures for Reduction of Blocking Effects in Transform Image Coding”

Stanley J. Reeves and Steven L. Eddins

I. INTRODUCTION

In a recent paper, Rosenholtz and Zakhor [1] proposed an effective method for reducing blocking in transform coded images. Their method uses two projection operators and the theory of projection onto convex sets (POCS) to guarantee convergence of the iteration. One projection operator is defined from the known quantization levels used to code the transform coefficients. The other projection is based on the set of band-limited images with a given cutoff frequency. Unfortunately, the algorithm they actually implemented is only tenuously related to the theory of POCS. We offer a different basis for justifying their algorithm, one that provides an exact formal basis for establishing convergence and a more flexible theory for elucidating the possibilities of the algorithm.

II. NATURE OF THE ALGORITHM

As the authors indicated, a projection onto the set of band-limited images is equivalent to an ideal low-pass filter. However, the authors chose to approximate the ideal low-pass filter with

• Reeves and Eddins criticized this method, proposing constrained optimization instead.

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- This was the subject of an Apple patent, co-authored with Michael Kass.
- Pete Litwinowicz implemented the 1D spline and multigrid thin-plate spline at Apple, which formed the basis of these demonstrations, using constrained optimization.