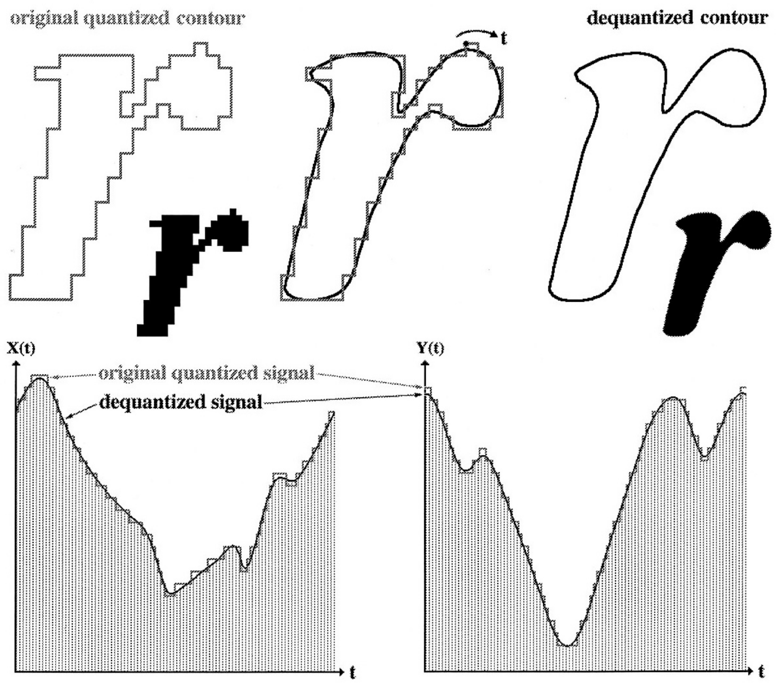
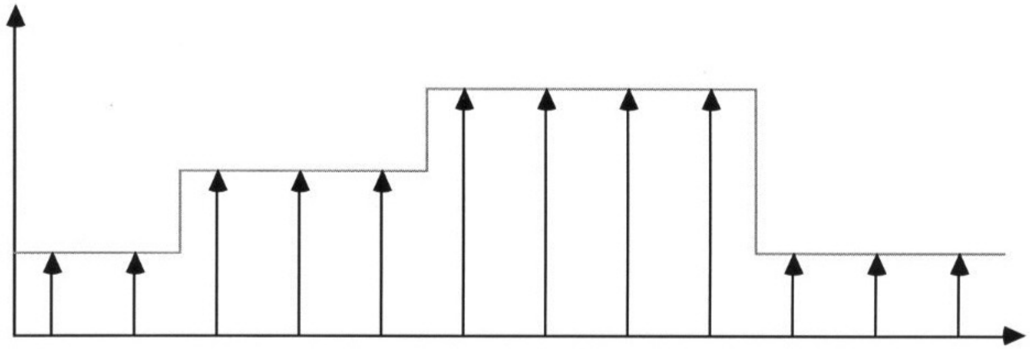
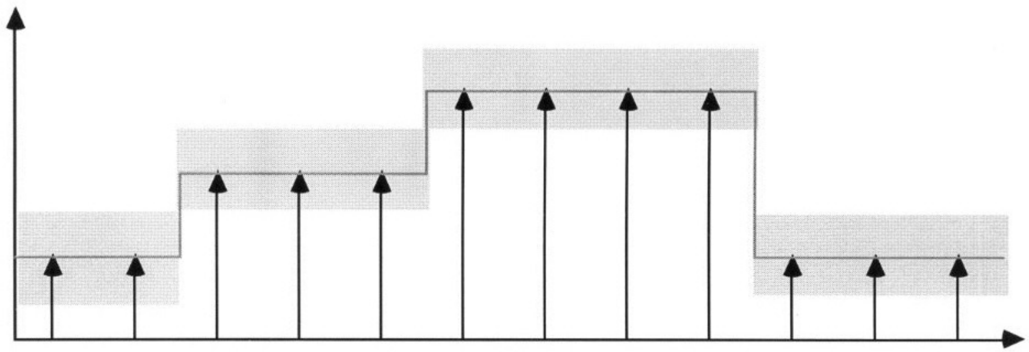
Dequantization

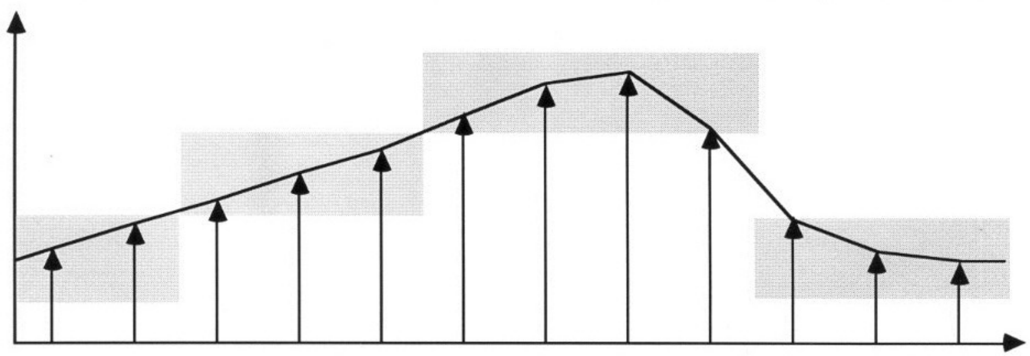




A conceptual sampled, quantized signal. (Dotted line: step reconstruction).

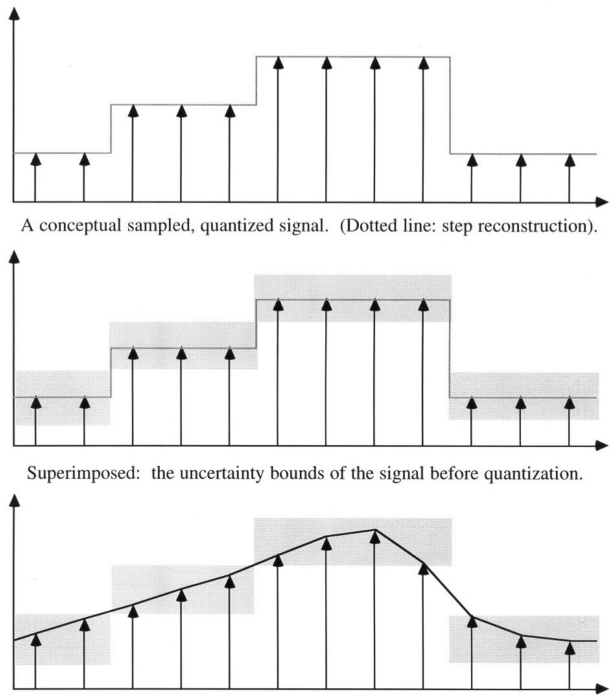


Superimposed: the uncertainty bounds of the signal before quantization.



One possible smooth reconstruction consistent with the quantized samples.

Figure 1: Smooth reconstruction of a quantized signal.



A conceptual sampled, quantized signal. (Dotted line: step reconstruction).

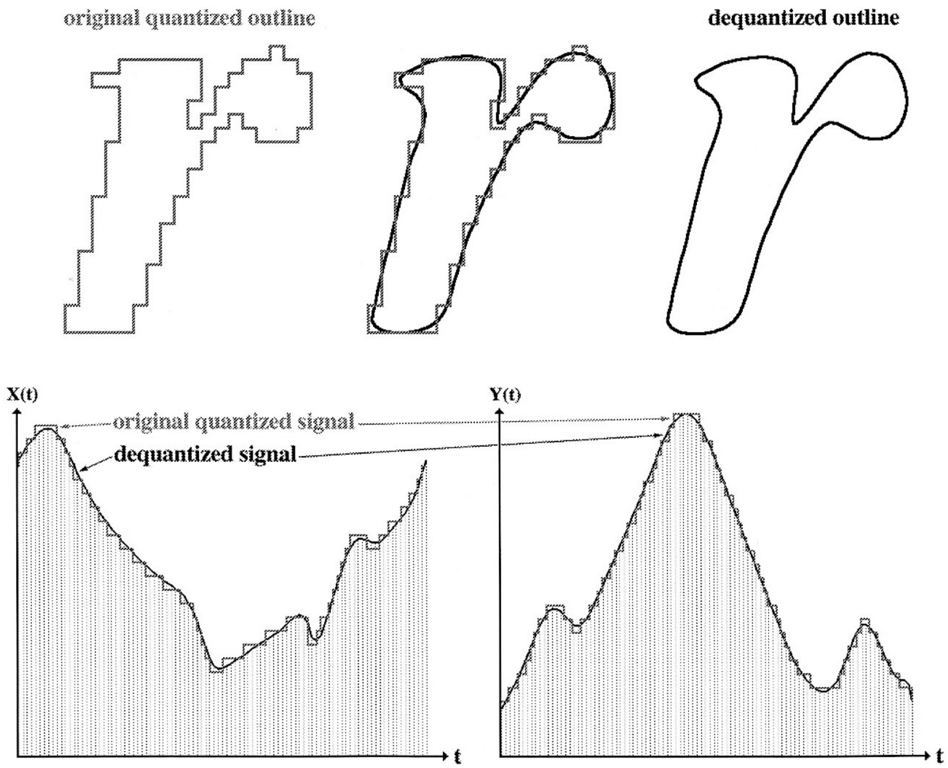
Superimposed: the uncertainty bounds of the signal before quantization.

One possible smooth reconstruction consistent with the quantized samples.

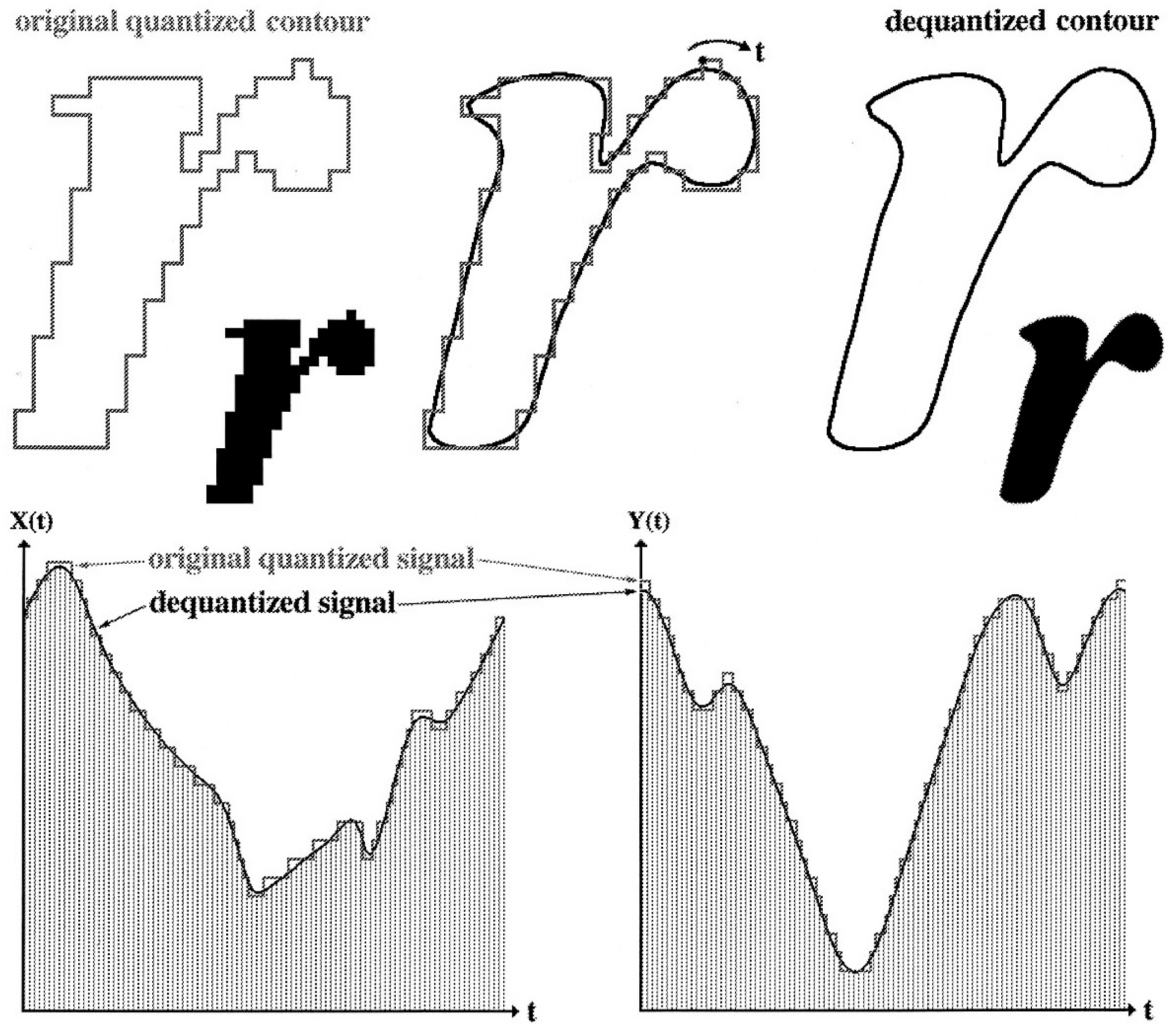
Figure 1: Smooth reconstruction of a quantized signal.

- 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.

Example: Raster Contours

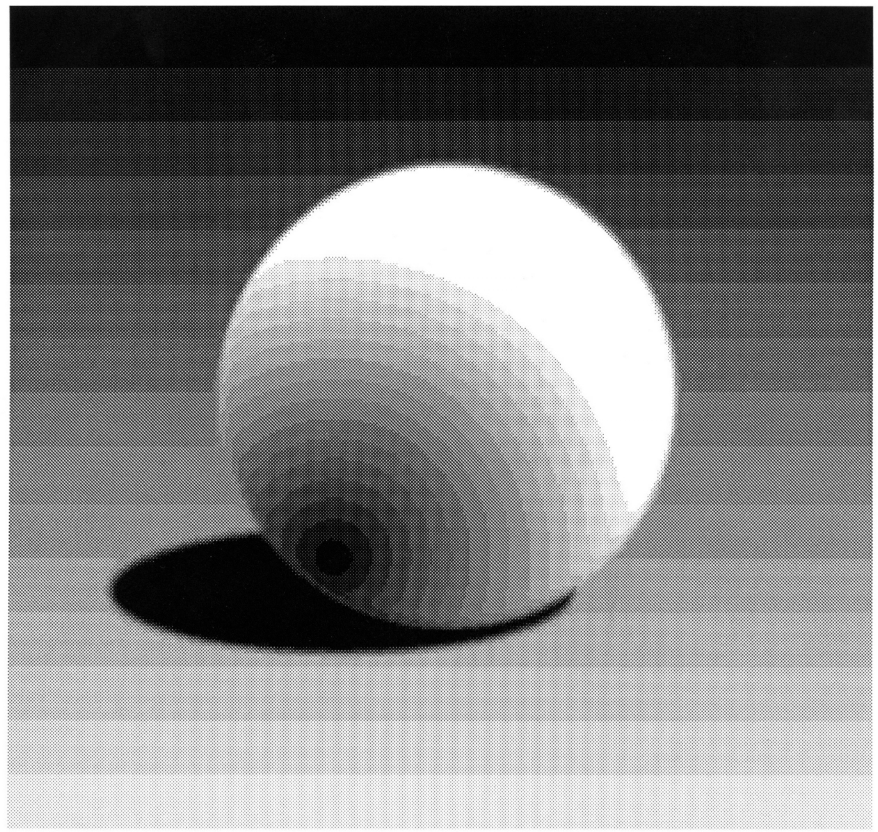


- These contours are "aliased," but it is also true to say their coordinates are quantized.
- The smoothest contour that quantizes to the same original data is most parsimonious.

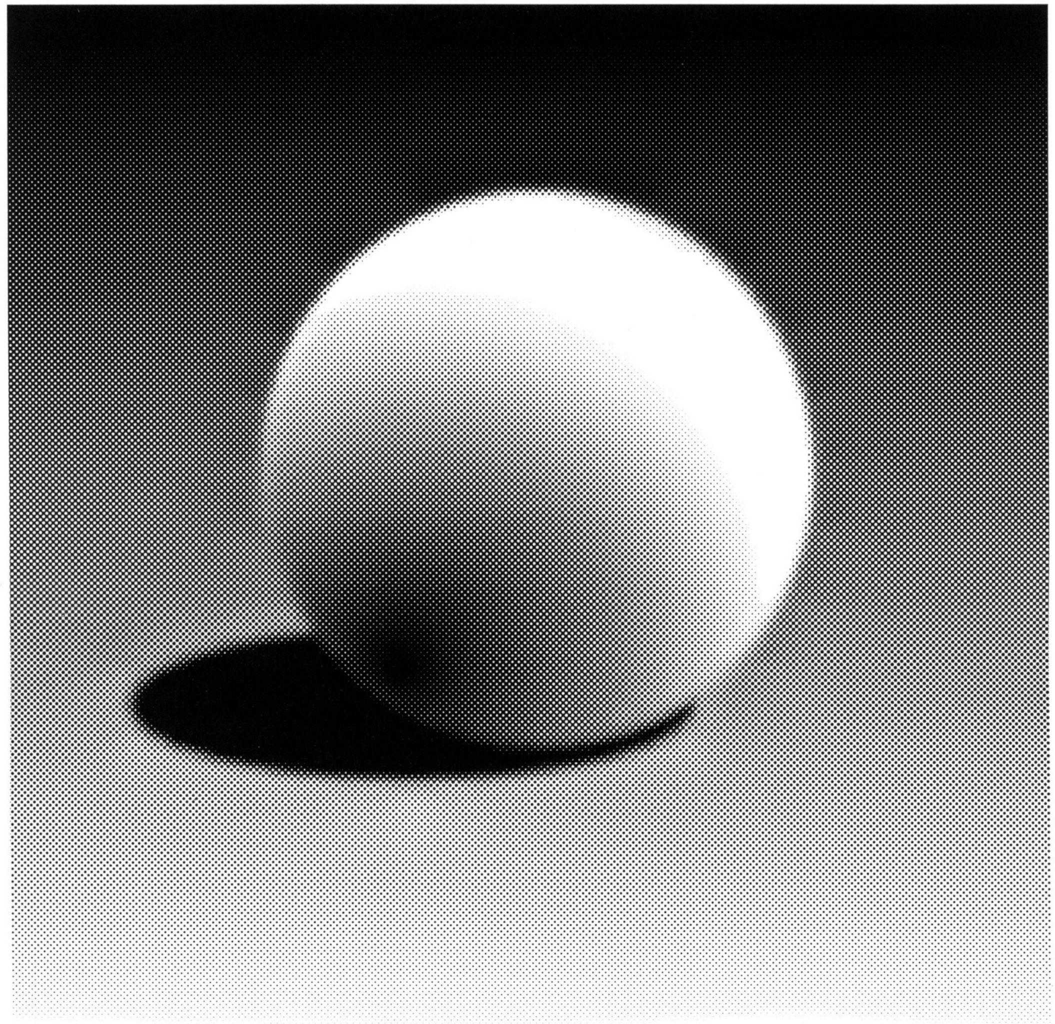


- The distinctive feature of this nonlinear reconstruction is that quantum changes are distributed over the whole intervals between them.

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.

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Iterative Procedures for Reduction of Blocking Effects in Transform Image Coding

Avideh Zakhor

Abstract—**We propose a new iterative block reduction technique based on the theory of projection onto convex sets. The basic idea behind this technique is to impose a number of constraints on the coded image in such a way as to restore it to its original artifact-free form. One such constraint can be derived by exploiting the fact that the transform-coded image suffering from blocking effects contains high-frequency vertical and horizontal artifacts corresponding to vertical and horizontal discontinuities across boundaries of neighboring blocks. Since these components are missing in the original uncoded image, or at least can be guaranteed to be missing from the original image prior to coding, one step of our iterative procedure consists of projecting the coded image onto the set of signals that are bandlimited in the horizontal or vertical directions. Another constraint we have chosen in the restoration process has to do with the quantization intervals of the transform coefficients. Specifically, the decision levels associated with transform coefficient quantizers can be used as lower and upper bounds on transform coefficients, which in turn define boundaries of the convex set for projection. Thus, in projecting the "out-of-bound" transform coefficient onto this convex set, we will choose the upper (lower) bound of the quantization interval if its value is greater (less) than the upper (lower) bound. We present a few examples of our proposed approach.**

I. Introduction

Transform coding is one of the most widely used image compression techniques. It is based on dividing an image into small blocks, taking the transform of each block and discarding high-frequency coefficients and quantizing low-frequency coefficients. Among various transforms, the discrete cosine transform (DCT) is one of the most popular because its performance for certain class of images is close to that of the Karhunen–Loeve transform (KLT), which is known to be optimal in the mean squared error sense.

Although DCT is used in most of today's standards such as JPEG and MPEG, its main drawback is what is usually referred to as the "blocking effect." Dividing the image into blocks prior to coding causes blocking effects—discontinuities between adjacent blocks—particularly at low bit rates. In this paper, we present an iterative technique for the reduction of blocking effects in coded images.

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1051-8215/92$03.00

- Avideh Zakhor, 1992, applied this concept to blocking artifacts in JPEG images, using projection onto convex sets.
- IEEE Transactions on Circuits and Systems for Video Technology, Vol. 2, Number 1, March, 1992

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

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IEEE Log Number 9209872.

1051-8215/93$03.(

- Reeves and Eddins criticized this method, proposing constrained optimization instead.
- IEEE Transactions on Circuits and Systems for Video Technology, Vol. 3, Number 6, December, 1993.

Dequantization

- 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.