QUADTREE-BASED DATA COMPRESSION USING LATTICE VECTOR QUANTIZATION

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ABSTRACT

As data compression algorithms evolve, so do the interest in the compression of ever larger amounts of data, particularly those encountered in the remote sensing and medical fields, just to name a few. Techniques have been developed and modified, like those first directed at video coding applications, and improvements in compression efficiency have been steadily attained.

Information theoretical results indicate there is always some gain in jointly encoding a number of samples and that the larger this number is, the greater the expected payoff. However, complexity issues and smaller marginal increases in gain show that a practical limit in encoder dimensionality exists.

Even though no particular encoding rules are described while proving those results, the idea of grouping samples prior to encoding led to a number of methods based on the concept of vector quantization, some of which are simply extensions of known scalar techniques that are modified to deal with vector samples.

This work presents compression algorithms which build on a state-of-the-art codec, the Set Partitioned Embedded Block Coder (*SPECK*), by incorporating a lattice vector quantizer-type codebook, therefore allowing it to process multiple samples at one time. In our tests, we employ scenes derived from standard AVIRIS hyperspectral images, which possess 224 spectral bands.

The first proposed method, LVQ-SPECK, uses a lattice vector quantizer-based codebook in the spectral direction to encode a number of consecutive bands that is equal to the codeword dimension. It is shown that the choice of orientation codebook used in the encoding greatly influences the performance results. In fact, even though the method does not make use of a 3D discrete wavelet transform, in some cases it produces results that are comparable to those of other state-of-the-art 3D codecs.

The second proposed algorithm, DWP-SPECK, incorporates the 1D discrete wavelet transform in the spectral direction, producing a discrete wavelet packet decomposition, and simultaneously encodes a larger number of spectral bands. This method yields performance results that are comparable or superior to those attained

by other 3D wavelet coding algorithms such as 3D-SPECK and JPEG2000 (in its multi-component version).

For both algorithms, we investigate how different input vector setups (i.e. purely spectral vectors vs. spatial-spectral ones) influence their compression performance, particularly in the case of hyperspectral images, which contain considerable correlation among spectral bands.

We also look into a novel method for reducing the number of codewords used during the refinement pass in the proposed methods which, for most codebooks, provides a reduction in rate while following the same encoding path of the original methods, thereby improving their performance. We show that it is possible to separate the original codebook used into two distinct classes, and use a flag when sending refinement information to indicate to which class this information belongs.

In summary, given the results obtained by our proposed methods, we have shown that they constitute a viable option for the compression of volumetric datasets with large amounts of data.