Wavelet Coding for Remote Sensed Data

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Space missions are increasingly requiring high resolution imagery and, hence, high data compression—two tasks which are inherently incompatible. A tradeoff must, therefore, be made between the available bandwidth and achievable resolution. An efficient visual communication channel—the process from image acquisition to image display—is key to the efficient transmission of the high resolution data. Our algorithm uses wavelet decomposition followed by entropy coding for compression as an integral part of the design of the visual communication channel, where the encoding process constitutes an additional noise source\(^1\). This allows the development of analysis and synthesis filters which depend not only on the wavelet function, but also on the critical factors which constrain the visual communication channel itself. We feel that this approach is essential in designing a channel which provides the most information, and hence the highest resolution, for the least data.

Each wavelet coefficient contains a certain measurable amount of information, and Huck, et al.\(^2\) have shown that an increase in this information leads to an increase in the image quality. This can then be used to devise the following quantization scheme:

1. Quantize all the coefficients at the maximum rate.
2. Determine the loss in information due to a reduction in the quantization rate for each coefficient.
3. Reduce the quantization rate of the coefficient suffering the least loss.
4. Iterate this process until either the bit bank is empty, or the required information is reached.

The quantization table thus generated provide excellent results for a wide range of input radiance fields.

The restoration/synthesis filters account not only for blurring and noise but also for the insufficient sampling, the analysis filter response, and the degradations due to quantization. They also suppress the blurring and raster effects in image display by interpolating the image-gathering lattice on a finer image-display lattice. This ensures that the highest possible resolution restoration is obtained from the transmitted data.
