Method of Performing High Efficiency Coding of Image Signal and System

Patent No. 5534927 (U.S.), Patent No. 0542261 (England, Germany, France), Patent No. 3069174 (Japan))

The invention relates to a method of performing high-efficiency coding of an image signal such as a video signal for a digital television system, and more particularly, to a method and apparatus for performing optimal coding of the image signal depending upon its properties.

Digital satellite broadcasting started in 2000, and digital terrestrial broadcasting will begin in the Tokyo, Nagoya and Osaka regions in 2003, using systems incorporating the MPEG-2 standard for high-efficiency coding of image signals.

Conventional high-efficiency coding in MPEG-2 is performed with a two-dimensional orthogonal transform such as two-dimensional discrete cosine transform (2D-DCT) processing to eliminate spatial redundancy in a single frame/field image signal, and by transmitting only the differences between the current frame/field image signal and the previous one to remove time-wise redundancy. 2D-DCT processing is done on the current image signal in the intra frame/field mode and the prediction error signal in the inter frame/field mode to generate the signals to be transmitted. The prediction error signal is obtained by calculating the difference between the current image signal and the prediction image signal derived from the previous image signal.

However, the prediction error signal has a spatial frequency characteristic that is quite different from that of the image signal. The power of the prediction error signal tends to be concentrated in low frequencies only in the horizontal direction, while the power of the image signal is concentrated in both the horizontal and vertical directions. DCT processing of the prediction error signal in the vertical direction may increase the redundancy or induce artifacts distinctive of DCT in the reproduced image.

The present invention was made to overcome the above mentioned problems, and provides an optimal coding system by employing appropriate processing circuits for both the image signal and the prediction error signal. The figure shows an embodiment of the coding system composed of a subtractor, a controller, a processing section including a one-dimensional processing section and a two-dimensional processing section, a variable length coder (VLC) section, and a reproducing section.

The coding system sequentially receives the previous, current, and next image signals. The subtractor derives the prediction error signal. The controller is supplied with the current image signal and the prediction error signal to generate a mode signal indicating either an inter mode or an intra mode. The processing section is switched with the mode signal to either the one-dimensional processing section for the inter mode or the two-dimensional processing section for the intra mode.

The one-dimensional processing section performs 1D-DCT processing on the prediction error signal to generate a train of quantization coefficients, and the two-dimensional processing section performs 2D-DCT processing on the current image signal. The quantizer Q and Q' quantize with independent predetermined weights, and the scanning circuits have independent scanning paths. The VLC is supplied with one of the trains of quantization coefficients depending on the mode signal, and the mode signal itself. The VLC converts them into code words and outputs the result as the transmission signal. The reproducing section receives quantization coefficients from both the one-dimensional and two-dimensional processing sections, reproduces the current image signal for the next image signal, and supplies it to the subtractor.

As mentioned above, switching the processing in accordance with the properties of image signals enables optimal efficiency coding compatible with the improvement of image quality. We expect that the present invention will contribute to high-quality digital broadcasting in the near future.