Image Compression Based on Spectral Graph Wavelet Transform

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ABSTRACT

A new approach for image compression based on spectral graph wavelet transform (SGWT) is presented in this work. By converting the image into the frequency domain with the SGWT, the resulting frequency components can be quantized to eliminate the visually insignificant data, thereby decreasing the amount of information required for storage. Entropy and Huffman coding are then employed to exploit the redundant properties of the quantized frequency samples, resulting in a compressed representation of the image. The entire process is reversible, enabling the reconstruction of the original image from the compressed form. Our approach was applied to gray scale and colored images, and the results of the experiments were encouraging.

Keywords: Image compression, Spectral graph wavelet transform (SGWT), Quantization

1 Introduction

The growing demand for efficient data storage and transmission techniques has resulted in the need for image compression, which is a crucial tool for reducing image size in bytes without degrading image quality [1]. This need is particularly evident in image processing applications such as meteorological and hyper spectral imaging [2], [3], which require considerable storage capacity and transmission bandwidth. Therefore, using compression is essential to reduce the redundancy and enable efficient storage and transmission of data for multiple applications.

The image compression approach is based on the Spectral Graph Wavelet Transform. The SGWT involves passing the image to the frequency domain and quantizing the resulting coefficients. The compression is performed only on the high frequency values; entropy and Huffman coding are then applied to further reduce the size of the compressed image. The resulting binary sequence is then decoded using Huffman and entropy decoding, followed by inverse SGWT to reconstruct the original image. The quality of the reconstructed image is evaluated using the peak signal-to- noise ratio (PSNR) and the compression ratio (CR).

2 Methodology

The algorithm is summarized in five steps. The first involves dividing the original image into 8x8 blocks. Next, the (SGWT) is applied to each block, resulting in a set of scaling coefficient images and wavelet coefficient sub-bands of the same size. The scaling function sub-band captures the global topology, while the wavelet coefficients represent various high-frequency sub-bands. Then, quantization is performed only on the scaling coefficient obtained from each block. Entropy and Huffman encoding are then applied to the quantized outputs to produce the compressed image. To reconstruct the original image from the compressed version, the decoder performs inverse SGWT followed by decoding.

For color image data, it is necessary to convert the image into the YCbCr format. This format separates the image into its luminance (Y), blue difference (Cb), and red difference (Cr) Chroma components. After the conversion, the compression algorithm can be performed using the steps as mentioned earlier. See Figure 1 that resume the compression approach for both gray scale and color images.

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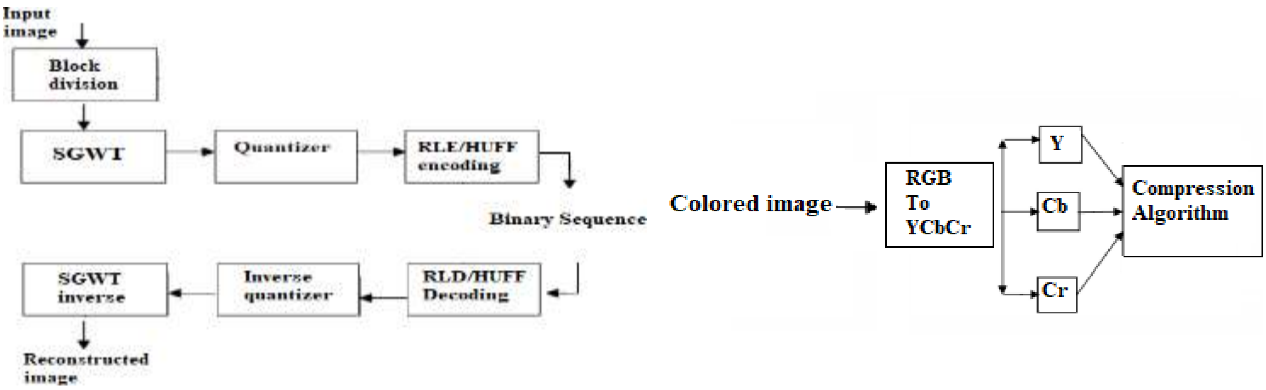

Figure 1: *Compression schema for grayscale and color images*

3 Results and Discussion

Table 1: *Experimental results for gray Lenna image with comparison with other algorithms*

Algorithm	**PSNR Value(db)**	**Compression ratio**
Wavelet transform [1]	34.66	>32
Jpeg/DCT [1]	34.27	<=50
Fractal [1]	27.21	>=16
VQ [1]	28.26	<32
Proposed algorithm	32.2	60.36

As demonstrated in Table 1, our algorithm produced a high compression ratio (CR) with a good reconstructed image quality comparing to Jpeg, and fractal compression algorithm. The image reconstructed are shown in figure 2, the reconstructed images has a good quality and close to the initialimages. These results demonstrated a significant improvement in compression ratio compared to the performances reported in [1].

Figure 2: *Results of the compression method. a) Original image, b) Compressed image*

4 Conclusion

In conclusion, we have presented a new image compression algorithm based on the Spectral Graph Wavelet Transform (SGWT) and evaluated its performance on a range of gray scale and color images. Our results showed that the SGWT-based approach achieved high compression ratios while maintaining good image quality, outperforming other traditional algorithms such as DCT and JPEG.

How to Cite

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