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Three Dimensional Based SPHIT Algorithms for Image Compression

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A B S T R A C T

Data compression which can be lossy or lossless is required to decrease the storage requirement and better data transfer rate. One of the best image compression techniques is using wavelet transform. It is comparatively new and has many advantages over others. Wavelet transform uses a large variety of wavelets for decomposition of images. The state of the art coding techniques like EZW, SPIHT (set partitioning in hierarchical trees) and EBCOT(embedded block coding with optimized truncation)use the wavelet transform as basic and common step for their own further technical advantages. The wavelet transform results therefore have the importance which is dependent on the type of wavelet used .In our project we have used different wavelets to perform the transform of a test image and the results have been discussed and analyzed. The analysis has been carried out in terms of PSNR (peak signal to noise ratio) obtained and time taken for decomposition and reconstruction.

Keywords: EZW, SPIHT, PSNR, Optimization

1. Introduction

Uncompressed multimedia (graphics, audio and video) data requires considerable storage capacity and transmission bandwidth. Despite rapid progress in mass-storage density, processor speeds, and digital communication system performance, demand for data storage capacity and data-transmission bandwidth continues to outstrip the capabilities of available technologies. The recent growth of data intensive multimedia-based web applications have not only sustained the need for more efficient ways to encode signals and images but have made compression of such signals central to storage and communication technology. To enable Modern High Bandwidth required in wireless data services such as mobile multimedia, email, mobile, internet access, mobile commerce, mobile data sensing in sensor networks, Home and Medical Monitoring Services and Mobile Conferencing, there is a growing demand for rich Content Cellular Data Communication, including Voice, Text, Image and Video. One of the major challenges in enabling mobile multimedia data services will be the need to process and wirelessly transmit very large volume of this rich content data. This will impose severe demands on the battery resources of multimedia mobile appliances as well as the bandwidth of the wireless network. While significant improvements in achievable bandwidth are expected with future wireless access technology, improvements in battery technology will lag the rapidly growing energy requirements of the future wireless data services. One approach to mitigate this problem is to reduce the volume of multimedia data transmitted over the wireless channel via data compression technique such as JPEG, JPEG2000 and MPEG . These approaches concentrate on achieving higher compression ratio without sacrificing the quality of the Image. However these Multimedia data Compression Technique ignore the energy consumption during the compression and RF transmission. Here one more factor, which is not considered, is the processing power requirement at both the ends i.e. at the Server/Mobile to Mobile/Server. Thus in this paper we have considered all of these parameters like the processing power required in the mobile handset which is limited and also the processing time considerations at the server/mobile ends which will handle all the loads.

2. Methodology

Quantization involved in image processing. Quantization techniques generally compress by compressing a range of values to a single quantum value. By reducing the number of discrete symbols in a given stream, the stream becomes more compressible. For example seeking to reduce the number of colors required to represent an image. Another widely used example — DCT data quantization in JPEG and DWT data quantization in JPEG 2000.

Quantization in image compression

The human eye is fairly good at seeing small differences in brightness over a relatively large area, but not so good at distinguishing the exact strength of a high frequency brightness variation. This fact allows one to get away with greatly reducing the amount of information in the high frequency components. This is done by simply dividing each component in the frequency domain by a constant for that component, and then rounding to the nearest integer. This is the main lossy operation in the whole process. As a result of this, it is typically the case that many of the higher frequency components are rounded to zero, and many of the rest become small positive or negative numbers.

Entropy Encoding

An entropy encoding is a coding scheme that assigns codes to symbols so as to match code lengths with the probabilities of the symbols. Typically, entropy encoders are used to compress data by replacing symbols represented by equal-length codes with symbols represented by codes proportional to the negative logarithm of the probability. Therefore, the most common symbols use the shortest codes. According to Shannon's source coding theorem, the optimal code length for a symbol is $-\log_b P$, where b is the number of symbols used to make output codes and P is the probability of the input symbol. Three of the most common entropy encoding techniques are Huffman coding, range encoding, and arithmetic coding. If the approximate entropy characteristics of a data stream are known in advance (especially for signal compression), a simpler static code such as unary coding, Elias gamma coding, Fibonacci coding, Golomb coding, or Rice coding may be useful.
There are three main techniques for achieving entropy coding:

- Huffman Coding - one of the simplest variable length coding schemes.
- Run-length Coding (RLC) - very useful for binary data containing long runs of ones of zeros.
- Arithmetic Coding - a relatively new variable length coding scheme that can combine the best features of Huffman and run-length coding, and also adapt to data with non-stationary statistics.

1) Huffman encoding

Huffman coding is a lossless data compression algorithm which was proposed by David Huffman in1951.Huffman algorithm creates a frequency sorted binary tree in a bottom up approach. The core idea behind this algorithm is to represent the less frequently occurring symbols using more bits and frequently occurring symbols using fewer bits of data[14]. To achieve this it uses variable length encoding.This algorithm is very effective when there is a high variation in symbol probability.

The steps involved in Huffman coding is given below:
Step 1: Read a medical image from the workspace.
Step 2: Compute the probabilityof the each symbol of the image.
Step 3: Arrange the probabilities of the symbols in decreasing order and merge the symbols which have the lowest probability.
Step 4: The previous step is repeated until only two probabilities are left and generate a Huffman tree.
Step 5: Based on the Huffman tree, assign the codes to the symbols based on their probability. High frequency symbol will have smaller code and vice versa.
Step 6: Decompression of the image is done by using the Huffman decoding to get back the original image. This is done by traversing the Huffman tree node by node and separating the prefix codes to match the corresponding samples.

2) JPEG Compression

JPEG compression was developed by a committee known as the Joint Photographic Experts Group (JPEG). JPEG provides both lossy and lossless image compression techniques which was developed to compress still images. It works well with the continuous-tone images, where the adjacent pixels tend to have similar colours [15]. JPEG allows the user to adjust the amount of data lost during compression which allows to adjust the compression ratio. JPEG lossy variant is a DCT-based method which is known as the Baseline method.

The following are the steps involved in JPEG Compression technique:

Step 1: Read the medical image from the workspace.

Step 2: Segment the image into 8 × 8 blocks of pixels from top left.

Step 3: Apply Discrete Cosine Transform(DCT) to each block segmented earlier from the top left block to the bottom right block.

Step 4: Now compress every single block in the image by using quantization.

Step 5: The compressed blocks are preserved as array which contains the compressed data to represent the image.

Step 6: The Inverse Discrete Cosine Transform (IDCT) is used to decompress the image whenever required.

3. Results and discussion

The results show the compression results of the Huffman coding method which shows an average compression ratio (CR) of 1.43 with an average compression percentage of 28.77% while compressing the entire medical image using this method. However the Table II displays the results of the compression of ROI, eliminating the background data using the same Huffman coding. Here it clearly indicates that the average compression ratio is higher than the whole image compression. This gives us an average compression ratio (CR) of 1.80 with average compression percentage of 42.99 % which will save a huge amount of space required to store the medical image and also increases the transmission speed of the images. The same improvement is also observed in the encoding time of the Lossless Huffman coding method while implementing Background elimination in medical images.

4. Conclusion

Haar wavelet transform for image compression is simple and crudest algorithm. as compared to other algorithms it is more effective. The quality of compressed image is also maintained. In future hybrid wavelet approach are implemented in the natural images..

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