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An Optimized Algorithms for Compression and Transformation

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Abstract: *In this paper we have discussed well known state of the art image compression algorithms. A well known algorithm of Pearlman Set Partitioning In Hierarchical Trees SPIHT to restrict the necessity of random access to the whole image to a small sub images only is presented. The main idea is based on partitioning of sets, which consists of coefficients or representatives of whole sub trees. The decoder duplicates the execution path of the encoder to ensure this behavior; the coder sends the result of a binary decision to the decoder before a branch is taken in the algorithm. Thus, all decisions of the decoder are based on the received bits. The name of the algorithm is composed of the words set and partitioning. The algorithm is suitable for transmission of compressed images over any network as well. We modified algorithm for small mobile devices having limited resources on board. The compression performance is measured with peak signal to noise ratio compared to the original codec remains still the same or nearly the same. This code can be implemented through MATLAB.*

1. INTRODUCTION

Image storage and transmission has become an important part in modern wireless data services such as mobile multimedia, email, 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 is the need to efficiently process and wirelessly transmit very large volume of this rich content data. However, this imposes severe demands on the battery life, resources and memory of multimedia mobile appliances as well as the bandwidth of the network.

In this paper an image compression and transmission algorithm is proposed which is suitable for low bit rate applications over Internet or any other wireless network. Low bit rate is needed as files compressed at low bit rate needs less bandwidth while transmitting over any network [9] [10]. It must be well suited for the heterogeneous networks like wireless network where the bandwidth of the link cannot be guaranteed. This codec algorithm is being proposed for the small hand held mobile devices having limited resources like limited battery life, limited processing power and limited memory. It is assumed that user is using these devices for image capturing, storing and transmitting over any network.

2. IMAGE COMPRESSION

Image compression is the application of Data compression on digital images. In effect, the objective is to reduce redundancy of the image data in order to be able to store or transmit data in an efficient form. Image compression can be lossy or lossless. Lossless compression is sometimes preferred for artificial images such as technical drawings, icons or comics. This is because lossy compression methods, especially when used at low bit rates, introduce compression artifacts. Lossless compression methods may also be preferred for high value content, such as medical imagery or image scans made for archival purposes. Lossy methods are especially suitable for natural images such as photos in applications where minor (sometimes imperceptible) loss of fidelity is acceptable to achieve a substantial reduction in bit rate. After locating those 'redundant' or irrelevant locations/pixels/values, a very simple task to achieve compression would be to remove/reduce the redundant information. This line of thought represents two very important theories for compression viz. redundancy and irrelevancy reduction [1]. They can be further subdivided in to:

- Spatial Redundancy or correlation between neighboring pixel values.
- Spectral Redundancy or correlation between different color planes or spectral bands.(in color image compression)
- Temporal Redundancy or correlation between adjacent frames in a sequence of images (in video applications) [2].

2.1. Wavelet Transform

Wavelet transform consists of two related mathematical function that transforms the signal data into a time frequency domain. The first function in wavelet transform [3] is known as wavelet and the second function is known as the scaling

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function. The wavelet and scaling function can be as considered as high pass and low pass filter. The coefficient of each high pass filter represents the detail in the signal; coefficient from each low pass filter represents the average value.

3. SPIHT CODING ALGORITHM

The SPIHT (Set Partitioning In Hierarchical Tree) method is not a simple extension of traditional methods for image compression, and represents an important advancement in the field. The method deserves special attention because it provides the following [4] [5].

- Good image quality and high PSNR
- It is optimized for progressive image transmission
- Produce fully embedded code
- Simple quantization algorithm
- Can code to exact bit rate
- Efficient combination with error protection

3.1. Steps in SPIHT Algorithm

- In the sorting pass, the LIP (List of Insignificant Pixels) is scanned to determine whether an entry is significant at the current threshold. If an entry is found to be significant, output a bit '1' and another bit for the sign of the coefficient, which is marked by either '1' for positive or '0' for negative. Now the significant entry is moved to the LSP (List of Significant Pixels). If an entry in LIP is insignificant, a bit '0' is output.
- Entries in LIS (List of Insignificant Sets) are processed. When an entry is the set of all descendants of a coefficient, named 'type A', magnitude tests for all descendants of the current entry are carried out to decide whether they are significant or not. If the entry is found to be as significant, the direct off springs of the entry are undergone magnitude tests. If direct offspring is significant, it is moved into LIP; otherwise it is moved into LSP. If the entry is deemed to be insignificant, this spatial orientation tree rooted by the current entry was a zero-tree, so a bit '0' is output and no further processing is needed. Finally, this entry is moved to the end of LIS as 'type B', which stands for the set of all descendants except for the immediate off springs of a coefficient, if there are still descendants of its direct off springs. Alternatively, if the entry in LIS is type B, significance test is performed on the descendants of its direct offspring. If significance test is true, the spatial orientation tree with root of type B entry is split into four sub-trees that are rooted by the direct offspring and these direct off springs are added in the end of LIS as type A entries. The important thing in LIS sorting is that entire sets of insignificant coefficients, zero-trees, are represented with a single 0. The purpose behind defining spatial parent-children relationships is to increase the possibility of finding these zero-trees.
- Finally, refinement pass is used to output the refinement bits (nth bit) of the coefficients in LSP at current threshold. Before the algorithm proceeds to the next round, the current threshold is halved.

3.2. Proposed Algorithm

STEP 1. START
STEP 2 . Input the image and bit rate
STEP 3 . Calculate the Bitbudget
STEP 4 . Calculate the Discrete Wavelet Transform of the image
STEP 5 . Is bitstream > Bitbudget
THEN
Image encoding
Bitstrem generation
GOTO step. 5
ELSE
Stop the process. GOTO Step 6
STEP 6 . Bitstream Decoding
STEP 7. Image Reconstruction
STEP 8 . Calculate PSNR
STEP 9 . STOP

4. SYSTEM IMPLEMENTATION

MATLAB7.0 has been used for implementation of proposed algorithm. First of all, the input image is loaded into the MATLAB workspace [8]. A digital image is composed of pixels which can be thought of as small dots on the screen. The size of the standard test images is generally available in 256 × 256 or 512 × 512 pixels. Various image file formats like .jpeg, .bmp, .gif, .tif, .png etc. are supported by Matlab. The image to be compressed is first read, by doing so the pixel values of input image are loaded workspace. For gray scale images the pixels represent the brightness. There are two ways to represent pixel values.

- edouble precision : This type or class assigns a number between 0 and 1 to each pixel. The value 0 corresponds to back and 1 corresponds to white.
- uint8 precision : This type or class assigns a number btween 0 and 255 to represent the brightness of each pixel. Each number of this type occupies one byte for storage.

5. TESTING

The standard test image tested is Baboon which is GIF image. Its size is 512 × 512. The proposed codec was test on the image and following results are obtained.

5.1. Image Quality

Table 1, show the PSNR values obtained through the proposed algorithm and comparison of the obtained value with current image codecs and original SPIHT algorithm. PSNR values are calculated at various bit rates from 0.1 bpp to 1 bpp.

PSNR Value

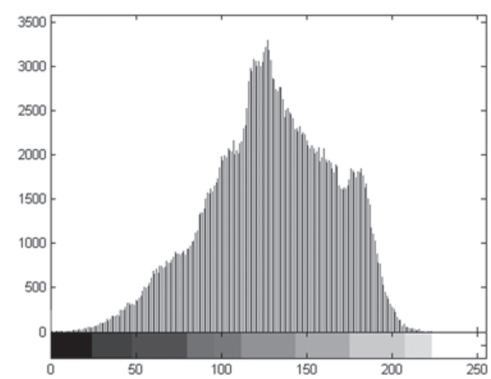
S. No.	*Bit Rat (bpp)*	*JPEG*	*JPEG-2000*	*Original SPIHT*	*Optimized SPIHT*
1	0.1	19.0083	21.3211	29.8008	29.6954
2	0.2	20.8713	22.6913	30.1282	29.9711
3	0.3	22.0333	23.6591	30.5848	30.2916
4	0.4	22.8200	24.6781	30.9663	30.6148
5	0.5	23.6726	25.5832	31.3306	30.9053
6	0.75	25.0003	27.4183	31.7677	31.1918
7	1.0	26.4469	29.1106	33.7299	32.5755

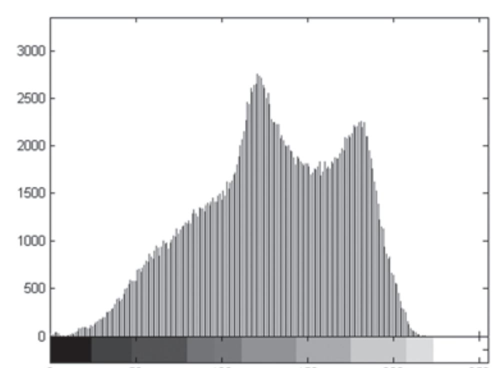
5.2. Coding Time Test

The Table 2, shows the reduction in time of execution using optimized algorithm as compared to original SPIHT.

Elapsed Time

S. No.	*Bit Rate (bpp)*	*Time Consumed in SPIHT (sec)*	*Time Consumed in Optimized SPIHT (sec)*
1	0.1	4.889155	3.944101
2	0.2	13.707346	13.40873
3	0.3	23.395492	25.453314
4	0.4	37.800971	33.422382
5	0.5	68.210289	45.972334
6	0.6	95.183986	70.493703
7	0.7	126.569473	99.359990
8	0.8	159.095579	119.373451
9	0.9	204.662268	137.192203
10	1.0	225.92668	136.509769





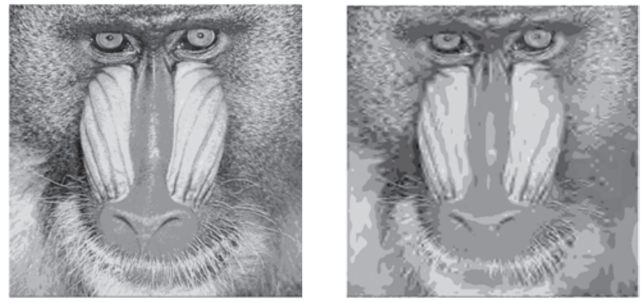


Figure 1:

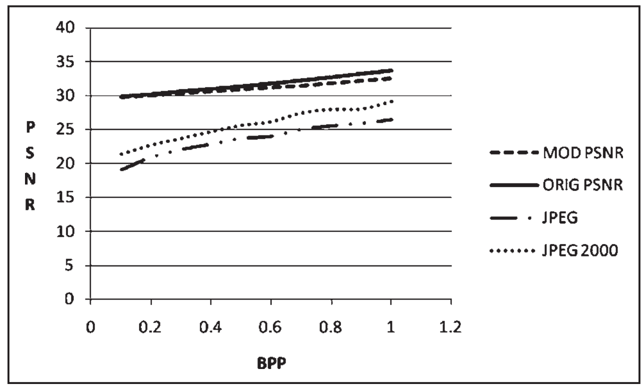


Figure 2: Comparison of Different Image Codecs

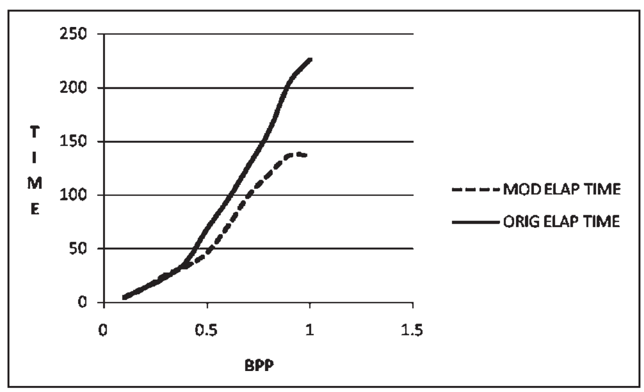


Figure 3: Coding Time Comparison at Various Bit Rates

6. CONCLUSION

An optimized algorithm for wavelet based image compression has been proposed. The results shown above clearly indicate that the algorithm has been successfully modified for low memory applications and fast encoding time.

The results also show that modified algorithm is applicable to natural images as well as texture images. Better PSNR values at low bit rates obtained from the proposed algorithm make it is well suited for the low bit rate applications. The low memory modification makes the proposed algorithm well suited for low capacity and battery dependent devices. The algorithm gives sufficient compression and a good visual and objective quality of the reconstructed image.

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