Performance Analysis of Haar Wavelet Transform and Huffman Coding Compression Techniques for Human Object

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***Abstract*- Image compression is one of the most important steps in image transmission and storage. The need for an efficient technique for the compression of images is ever increasing because the raw images need large amounts of disk space is a big disadvantage during transmission and storage. In order to have an efficient utilization of disk space and transmission rate, images need to be compressed. For this purpose there are basically two types of methods introduced, namely, lossy and lossless image compression techniques. In this proposed work a Huffman algorithm is analyzed in detail and compared with another common compression technique HAAR wavelet transform. The results are analyzed to compare the efficiencies of the compression between the two methods. Different parameters like compression ratio, elapsed time and size have been used to compare. The result shows that the time of compression using lossy compression wavelet method is less than Huffman method and the compression ratio in the wavelet is greater than the Huffman coding.**

Keywords: Image Compression, HAAR Wavelet Transform, Huffman Coding, Lossy Compression, Lossless Compression.

1. INTRODUCTION

The use of digital images is increasing rapidly. Along with this increasing use of digital images comes the serious issue of storing and transferring the huge volume of data representing the images because the uncompressed multimedia data requires considerable storage capacity and transmission bandwidth. Images are important documents today; to work with them in some applications, there is need to be compressed. Compression plays a very important role in the transmission and storage of image data. The main aim of image compression is to represent an image in the fewest number of bits without losing the essential information content within an original image. To compress something means that have a piece of data and decrease its size. Compression (Mohammad Kabir Hossain, 2008) techniques are being rapidly developed for compress large data files such as images. With the increasing growth of technology a huge amount of image data must be handled to be stored in a proper way using efficient techniques usually succeed in compressing images. There are different techniques available to do that and they all have their own advantages and disadvantages. There are some algorithms that perform this compression in different ways, some are lossless and lossy.

Huffman coding (Sharma, 2010) is a lossless data compression technique. Huffman coding is based on the frequency of occurrence of a data item i.e. pixel in images. The technique is to use a lower number of bits to encode the data into binary codes that occurs more frequently. Wavelets (T.Santhanam, 2014)(Navjot Kaur P. S., 2012)is a lossy compression technique essentially a type of multi resolution function approximation that allow for the hierarchical de-composition of a signal or image. Any given decomposition of a signal into wavelets involves just a pair of waveforms (mother wavelets). The two shapes are translated and scaled to produce wavelets at different locations and on different scales. The wavelet coefficients preserve all the information in the original image.

This article is organized as follows: Section 2 describes about the recent survey of Lossless Huffman coding and Lossy HAAR wavelet transform techniques. Section 3 presents an outline of Huffman Coding and Encoding techniques for human objects. Section 4briefly explains about the performance metrics mainly used in compression techniques. The Performance result of compression and Conclusion is described in Section 5.

1.1 Image Compression Techniques

Image compression techniques are broadly classified into two major categories. They are Lossless compression and Lossy compression (S.Vijayarani, 2016).

1.1.1 Lossless compression

Lossless compression compresses the image by encoding all the information from the original file, so when the image is decompressed, it will be exactly identical to the original image.

The advantage of this technique is that the original image is reconstructed and the disadvantage is the compression ratio is very poor.

There are four types of Lossless compression. They are Run length encoding, Entropy encoding, Huffman coding and Arithmetic encoding.

In this proposed work, Huffman coding method is used to compress the human object.

1.1.2 Lossy compression

In Lossy compression scheme the reconstructed image allows more degradation in the image and there is more loss in the information. The advantage of Lossy compression technique is, this scheme provides much higher compression ratios than lossless schemes and the disadvantage of Lossy compression technique is some loss of data.

There are three types of Lossy compression techniques. They are Chroma sampling, Transform coding and Fractal compression.

2. REVIEW OF LITERATURE

Image compression addresses the problem of reducing the amount of information required to represent a digital image. It is a process intended to yield a compact representation of an image, thereby reducing the image storage transmission requirements.(Jagadish H. Pujar, 2010) proposed image compression is to reduce the amount of data required for representing sampled digital images and therefore reduce the cost for storage and transmission. (Harada, 2013) proposed wavelet transform as a base function of the image compression and found the quality of the image. They have used HAAR wavelet transform as a base function. (A. A. Shaikh, 2015) proposed that converted an image into an array using the Delphi image control tool. An algorithm is created in Delphi to implement Huffman coding method that removes redundant codes from the image and compresses a BMP image file (especially gray scale image) and it is successfully reconstructed. This reconstructed image is an exact representation of the original because it is lossless compression technique. (Sindhu M S, 2016)proposed image compression is to scale back the size and form of image without degrading the quality retrieving the back the original image. The best HAAR moving ridge transform, it is the foremost simplest method among separate wavelet remodel [DWT] is mistreatment. Together with HAAR moving ridge remodel, laborious thresholding has been applied to a picture. Later Run Length Entropy committal to writing has been adopted.(D. Venkatasekhar, 2012) proposed Huffman coding can offer better fast fractal compression than arithmetic coding when compare to arithmetic coding, Huffman coding is best for compression. It increases the speed of compression and produces high PSNR. In (Rahul Shukla, 2015) proposed Huffman coding technique is basically based on frequency of occurrence of a data item. The principle behind this technique is to use the lower number of bits to encode the data that occurs most frequently.(Gupta, 2016) proposed the lossless method of image compression and decompression using a simple coding technique called Huffman coding. This technique is simple in implementation and utilizes less memory.

3. LOSSY IMAGE COMPRESSION TECHNIQUE

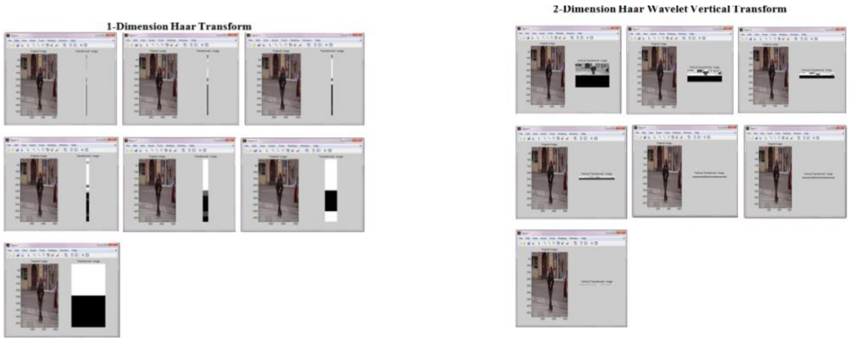
3.1 Haar Wavelet Transform

Wavelets are non-linear basis. When projecting a function in terms of wavelets, the wavelet basis functions are chosen according to the function being approximated. Wavelets are functions generated from a single function by its dilations and translation. Haar transforms the simplest compression process of this kind.

The Haar transform provides a multi resolution representation of an image with wavelet features at different scales

Capturing different levels of detail; the scale wavelets encode large regions, while the fine scale wavelets describe smaller, local regions. The wavelet coefficients preserve all the information in the original image. Haar transform decomposes each signal into two components. One component is called an average and the other is known as a difference . It is used to reduce the memory requirements and the amount of inefficient movement of Haar coefficients.

Now see the effect of 1-dimension and 2-dimension step averaging and differencing of an image. The Figure 1(a) and (b) shows the original image and the transformed image of 1d wavelet and the original and vertical transformed image for 2d wavelet of after applying the averaging and differencing. More steps produce more decomposition.



(a) (b)

Figure 1. (a) 1-D Haar Wavelet Transform (b) 2-D Haar Wavelet Vertical Transform

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4. PROPOSED METHOD OF LOSSLESS IMAGE COMPRESSION TECHNIQUE

4.1 Huffman Coding

A Huffman code is a particular type of optimal prefix code that is commonly used for lossless data compression. The Huffman’s algorithm is generating minimum redundancy codes compared to other algorithms. The Huffman coding are used in text, video compression image, conferencing system such as, JPEG, MPEG-2 etc. It collects unique symbols from the source image and its probability value is calculated for each symbol. The process of finding and using such a code proceeds by means of Huffman coding. Huffman coding is a form of statistical coding, which attempts to reduce the amount of bits required to represent a string of symbols. The algorithm accomplishes its goals by allowing symbols to vary in length. Shorter codes are assigned to the most frequently used symbols, and longer codes to the symbols which appear less frequently in the string. A Huffman code dictionary(Li, 2004), which associates each data symbol with a code word, has the property that no code-word in the dictionary is a prefix of any other codeword in the dictionary(M., 2004).Code word lengths are no longer fixed. Code word lengths vary and will be shorter for the most frequently used characters.

4.2 Huffman Decoding

Huffman decoding is the reverse process of encoding, which is used to decompress the image. Before starting the compression of a data file, the compressor has to determine the codes. It does that based on the probabilities of the symbols. The probabilities or frequencies have to be written, as side information, to the output, so that any Huffman decoder will be able to decompress the data. This is easy, because the frequencies are integers and the probabilities can be written as scaled integers. It normally adds just a few hundred bytes to the output. It is also possible to write the variable-length codes themselves on the output. Decoding a Huffman-compressed file by sliding down the code tree for each symbol is conceptually simple, but slow. The compressed file has to be read bit by bit and the decoder has to advance a node in the code tree for each bit.

This work so far has been carried out (Sindhu M S, 2016) using Huffman coding algorithm, but the proposed research work is used for human object compression of various types of images like JPEG, BMP, TIFF and PNG. No one has attempted so far.

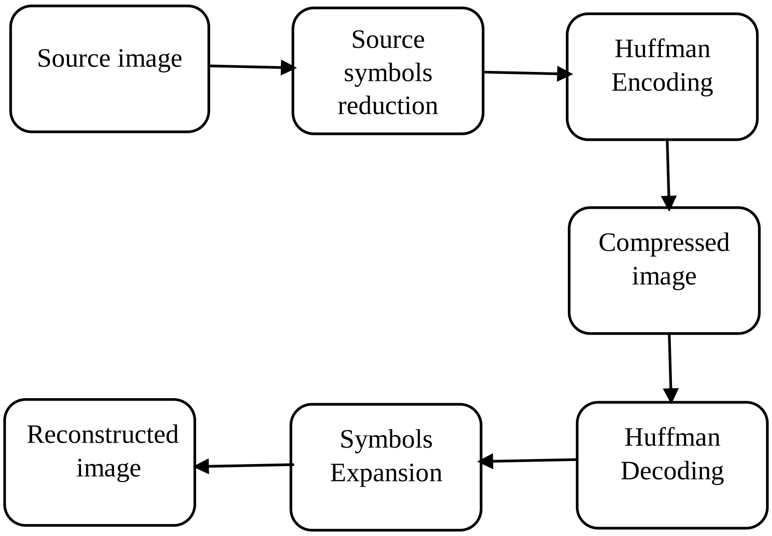


Figure 2. Overview of Proposed Method

The following Figure 3 shows (a) original image, (b)compressed image and (c) reconstructed image using Huffman coding and decoding.

(a) (b) (c)

Figure 3.(a) Original image (b) Compressed image (c) Reconstructed image

4.3 Algorithm

The Algorithm for Huffman Coding and Decoding is given below.

Step 1: Read the image.

Step 2:Calculate the size of the image.

Step 3:Define the symbols for an image.

Step 4:Compute the probability of each symbol.

Step 5:Determine the Huffman code dictionary for each symbol.

Step 6:Apply Huffman encoding for compression.

Step 7: Apply decoding for decompression. i.e. reconstruction is done by huffman decoding.

Step 8:Output there constructed image.

5. PERFORMANCE METRICS

To compare the uncompressed with compressed image, the following performance measures are used.

5.1. Compression ratio

One success measurement in image data compression is the Compression Ratio. The Compression ratio(Gaurav Kumar, 2015)is to measure the ability of data compression by comparing the size of the image being compared with the original size. The Greater the compression ratio means better performance.

The Compression ratio is defined as the ratio of an original image and compressed image(Gaurav Kumar, 2015)(Navjot Kaur P. S., 2012).

Compression Ratio = Original Image / Compressed Image. (1)

5.2. Elapsed Time

Quality analysis has been presented by measuring overall elapsed time(T.Santhanam, 2014) for the wavelet transform and for the Huffman coding with help of start watch timer and stopwatch timer functions. They are used to determine how long it takes for a program to run.

5.3. Size

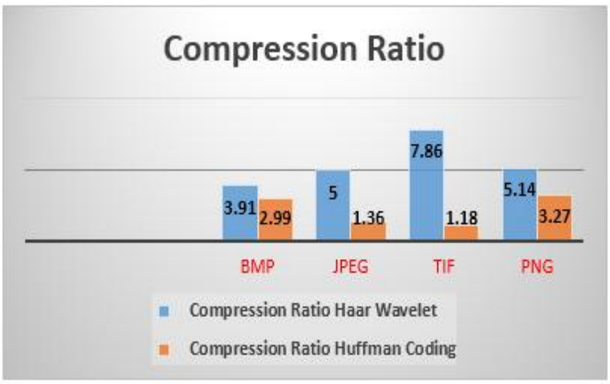
It specifies the memory size (T.Santhanam, 2014) of objects before and after the compression.

6. RESULTS

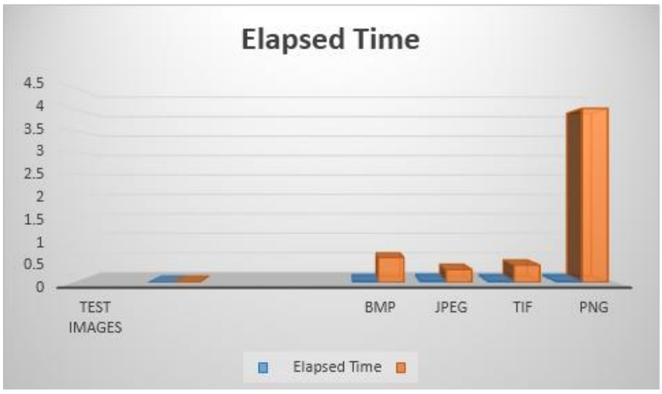
In this proposed research work algorithm is implemented in MATLAB and tic and toc MATLAB function is used to evaluate the Elapsed time of Huffman coding technique in the field of image compression. The proposed algorithm has been applied on different image formats like Bitmap (BMP), Joint Photographic Experts Group (JPEG), Tag Image File Format (TIFF) and Portable Network Graphic (PNG).The experimental results of the implemented algorithms, Haar wavelet transform and Huffman coding for compression ratio, elapsed time and memory size before and after the compression are depicted in Table 1.

Table 1. Comparison results of Haar wavelet transform and Huffman coding

Test Image Types	Compression Ratio in Bytes		Elapsed Time(sec)		Memory size(KB)					
					Haar Wavelet transform			Huffman Coding		
	Haar Wavelet	Huffman Coding	Haar Wavelet	Huffman Coding	Before	After	Percent -age (%)	Before	After	Percen-tage (%)
BMP	3.91	2.99	0.0381	0.57415	900	230	25.55	900	301	33.44
JPEG	5.00	1.36	0.0464	0.29508	27.1	5.41	19.96	27.1	19.8	73.06
TIFF	7.86	1.18	0.0392	0.39929	103	13.1	12.71	103	87	84.46
PNG	5.14	3.27	0.0381	4.00515	422	97	22.98	422	129	30.56



(a)



(b)

Figure4. (a) Compression Ratio of Haar wavelet Transform and Huffman coding (b) Elapsed Time of Haar wavelet Transform and Huffman coding

From the result of experiments Haar wavelet transform gives a high compression ratio, less elapsed time and memory size when compared to Huffman coding. The graphical representation of compression ratio and elapsed time of both Haar wavelet transform and Huffman coding is shown in Figure 4.

7. CONCLUSION

Compression is a technique to reduce the size of any image at the time of storing or transmitting. This article shows a comparison between the various types of images using a lossless Huffman coding technique and lossy Haar wavelet technique for human object. Some important performance measures as compression ratio, elapsed time and memory size before and after the compression have been used. The research work is to implement both Haar wavelet transform and Huffman coding in MATLAB for human object and compare the performance of both algorithms on three parameters. In this study it is found that Haar wavelet transform performance is comparably better than Huffman coding. The other compression techniques can be explored in the future for human objects.

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