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# Comparison of Medical Images Compression Techniques

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**Abstract**

The medical images are very essential for the treatment of various health related diseases. The medical images incorporate images of the parts of human body by the use of numerous techniques. The specialist is able to treat the patient and diagnose his disease after careful examination of such images. The number of medical images is increasing day by day so it is really exorbitant to store these large sized images. It has become crucial to compress medical images before storing or sharing them across the networks. This paper compares the various looseless and loosy techniques of medical image compression. These techniques also prove helpful to remove data which is redundant and not pertinent.

**Keywords;** *Image Compression, Looseless Compression, Loosy Compression.*

## INTRODUCTION

Image compression is defined as the method of decreasing the size of the image without affecting its quality. So the method of compression is very helpful in transmission of images from one place to another as it saves a lot of space as well as resources. Therefore, the compression of medical images is very important plays a crucial part for storing them or transferring them across the Internet [1]. The compression techniques can be applied on all medical images like Magnetic resonance imaging (MRI), Computed tomography (CT) and Positron emission tomography (PET). The main objective behind compression technique is attainment of high compression ratios and very less degraded quality [2].

### Image Compression Model

The image compression system comprises of three distinct steps that helps eliminate redundancy. During the first step, an image enters the mapper which aims to lower down the spatial and temporal redundancy. During the second step, the quantizer discards the impertinent data. The final step includes symbol coder that can create code and plots the result according to the code [3]. The diagrammatic representation of Image compression model is represented below in figure 1.

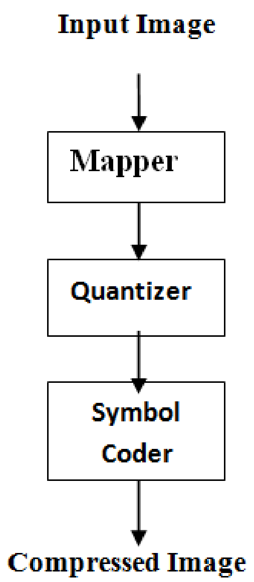


**Figure 1 Image Compression Model**

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**Medical Image Compression techniques**

The image compression techniques can be classified into two distinct classes known aslooseless compression and loosy compression. The looseless compression involves regeneration of original image from the compressed form. This technique is highly beneficial in medical field because it does not add any noise to the compressed representation [4]. On the other hand, the loosy compression technique involves some quality degradation in the regenerated image in contrast to the original image. Nonetheless, loosy technique yields higher compression ratios than looseless technique [5]. The various types of looseless and loosy compression techniques are listed below:-

1. Looseless Compression

I. Huffman Encoding
II. Run-length Encoding
III. LZW Coding
IV. Arithmetic Coding

2. Loosy Compression

I. Discrete Cosine Transform
II. Discrete Fourier Transform
III. Wavelet Coding
IV. Predictive Coding

**Huffman Encoding**

The Huffman technique proves useful for eliminating redundancy related to the coding [2]. The Huffman encoding possesses the characteristic of uniqueness and instantaneous as the code symbols can be decrypted in a single way only. The Huffman encoding can be static or dynamic encoding. The static model uses probability table where the trees are constructed and retained. These Huffman trees can be used for compression purposes. The Huffman method involves shorter code words for the commonly occurring symbols. In addition, the set of two symbols that turn up less commonly will have same length [6]. The figure 2 represents Huffman Encoding procedure.

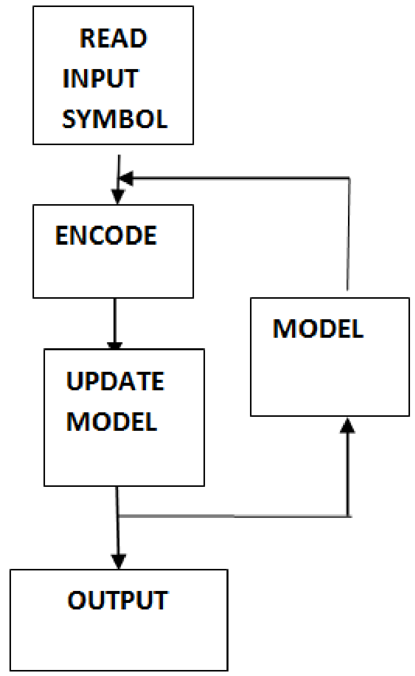


**Figure 2 Huffman Encoder Scheme**

The initial step of Huffman algorithm is accomplished by merging of two symbols having lowest probabilities into a single one. This procedure is performed many times until only two symbols are left behind [7]. This procedure is depicted in an example in table 1.

The one end of the table contains a sequence of symbols along with their probability that is organized in a declining manner. In order to obtain the first source reduction, the two smallest probabilities 0.06 and 0.04 are combined into a single probability having value 0.1. This probability is positioned in the very first column in source reductions. The procedure of merging the probabilities is performed till the two probabilities 0.6 and 0.4 are the only being left. The next step in this method involves the generation of a code tree beginning the process with the lowest source and travelling backwards in the direction of actual original source. This is demonstrated in the table 2. The two symbol source used the binary symbols 0 and 1. The two symbols obtained at the end conjoined by appending 0 and 1 so that both of them are differentiated from each other. This method is



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done again and again till a final code is generated at the other end of the table. This procedure of Huffman code assignment is shown in the

table 2. The average length of the code is represented as:-

Lavg = (0.4) (1) + (0.3)(2) + (0.1)(3) + (0.1)(4)

+ (0.06)(5) + (0.04)(5)

= 2.2 bits/symbols

The source has the entropy of 2.2 bits/symbols.

The resultant efficiency of Huffman code is 2.14/2.2 = 0.973

**Table 1 : Huffman source reductions**

| Original Source | | Source Reductions | | | |
|---|---|---|---|---|---|
| Symbol | Probability | 1 | 2 | 3 | 4 |
| $a_2$ | 0.4 | 0.4 | 0.4 | 0.4 | 0.6 |
| $a_6$ | 0.3 | 0.3 | 0.3 | 0.3 | 0.4 |
| $a_1$ | 0.1 | 0.1 | 0.2 | 0.3 | |
| $a_4$ | 0.1 | 0.1 | 0.1 | | |
| $a_3$ | 0.06 | 0.1 | | | |
| $a_5$ | 0.04 | | | | |

**Table 2. Huffman code assignment procedure**

| Original Source | | | Source Reductions | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| S | P | Code | 1 | | 2 | | 3 | | 4 | |
| $a_2$ | 0.4 | 1 | 0.4 | 1 | 0.4 | 1 | 0.4 | 1 | 0.6 | 0 |
| $a_6$ | 0.3 | 00 | 0.3 | 00 | 0.3 | 00 | 0.3 | 00 | 0.4 | 1 |
| $a_1$ | 0.1 | 011 | 0.1 | 011 | 0.2 | 010 | 0.3 | 01 | | |
| $a_4$ | 0.1 | 0100 | 0.1 | 0100 | 0.1 | 011 | | | | |
| $a_3$ | 0.06 | 01010 | 0.1 | 0101 | | | | | | |
| $a_5$ | 0.04 | 01011 | | | | | | | | |

## Huffman Decoding

The Huffman decoding procedure encompasses the reading of each bit from stream of input and travelling Huffman tree from one node to another[8]. In this way the stream of code is converted to its byte value. The Huffman tree is regenerated for this procedure. The character in Huffman encoding can be extended by adding B2B bits at the beginning of each character. One more way is by adding each bit of data to the existing bit in the stream of data produced. Suppose parent node is denoted by 0 and the leaf node by 1 then Huffman tree can be build by reading 8 bits and the value of character of a particular leaf can be examined. This process is continued till the last leaf node is reached when the regeneration of Huffman tree takes place. The end of the input can be denoted by transfer of length of decompressed data or by using special code symbols [9]. The Huffman process is represented in the figure 3.

## Discrete Cosine Transform

It represents the various data points in the form of cosine functions that oscillated at distinct frequencies. DCT finds immense use in engineering science field. DCT makes use of cosine functions in comparison to sine functions because cosine functions are more effective as there is a requirement of very less functions to verge a particular signal[10]. In case of differential equations, the boundary conditions can be best represented by cosine functions. DCT can be said equivalent to DFT with some difference that DCT operates on only real numbers. There are eight different types of DCT out of which four are commonly used. The most standard type of DCT transform is type II DCT and its inverse type III DCT or IDCT [2]. The other two types of transforms related to the DCT are Discrete Sine Transform (DST) or Modified Discrete Cosine Transform (MDCT).

The transform coding has a significant importance in the area of image processing. The method of transform coding includes the sub division of N x N image into lower n x n sub images. After this the operation of unitary transform is applied on each image. The transform coding is based on the aspect that pixel contained in an image presents a certain similarity with the pixel lying in its neighborhood [11]. The DCT transform is represented in figure 3. The DCT is considered better as compared to DFT because it is more efficient and does not involve any non continuity during periodic processes. Also, most



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of the coefficients get exhausted in this transform. The typical Discrete cosine transform is denoted by the equation:-

$$C_x[K] = \begin{cases} \sum_{n=0}^{N-1} 2x[n]\left(\cos\frac{\pi}{2N}K(2N+1)\right), & 0 \le k < N \\ & \text{otherwise} \end{cases}$$

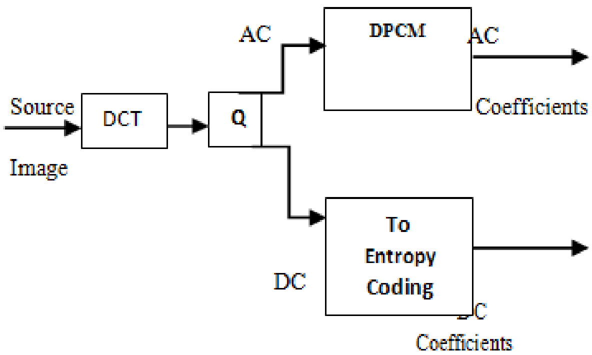


**Figure 3 Discrete Cosine Transform**

## I. Run Length Encoding

It is one of the commonly used methods for the compression of medical images. This method performs encoding of all runs of the bits, bytes and the various pixels present in the image[12]. This technique is very beneficial in case of frequently repeating character values. Consider an example as shown in figure 3. The string aaaaabbbbccc can be represented as (a;6)(b;4)(c;3).

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| a | a | a | a | a | a | b | b | b | b | c | c | c |

↓

RUN LENGTH ENCODING

↓

| | | | | | |
|---|---|---|---|---|---|
| a | 6 | b | 4 | c | 3 |

**Figure 4 Run length Encoding**

The algorithmic steps are defined as:-

Step 1: Input the particular string.

Step 2: A unique value can be taken from first character.

Step 3: Read the next distinct character and the process is repeated till we obtain a lastcharacter.

a) If the next character is same as the previous one then same unique value is presented

b) Else if next character is different fromthe previous one then write its new value.

Step 4: Calculate the extra symbols

Step 5: Repeat step 3 till a different value is obtained for the symbol [13].

## CONCLUSION

The paper presents the two compression techniques, the DCT along with the Huffman process. The DCT technique yields efficient results and the Huffman technique is used with DCT to obtain enhanced compressed outputs which is very beneficial in case of medical images.

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