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A Novel Scheme for Medical Image Compression using Huffman and DCT with Water Marking

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Abstract

Image compression is one of the data compression applications in which we convert the original data into a few bits. In image compression we can simply preserve the data needed by removing unwanted data to be proficient to record or refer data in a functioning form. Hence the image compression reduces the communication time and increases the communication speed. We mainly use lossy & lossless technics to remove this type of problem. There is no data loss when we compress images with a lossless image compression technique while some of the unnecessary data losses in lossy image compression technique. By using these processes, we can reduce the data size, which we can save more data in less memory. Here we have done the uses of Huffman & DCT techniques for image compression. In order to analysis medical image we have used the DWT feature extraction technique. Here for security we have done watermarking tool in medical image.

Keywords-*Image Compression, Lossy & Lossless techniques, Huffman & DCT coding, DWT feature extraction technique and Watermarking****.***

I. INTRODUCTION

Image compression is an application of data compression in which we convert the original image to some bits. With the help of image compression, we compress the medical image to facilitate transfer of this from one place to another [1]. In image compression we can reduce the dimensions of the original data to reduce the size of the original data. When we compress a medical image, our purpose is to make sure that none of the original image is the lost of the required data. Compression technics are technically advanced to allow large files to be compressed easily. By quick improvement in a suitable way via impressive procedures a huge scope of image data ought to store those images typically outcomes in the compressing images. There are some algorithms used to complete these. Types of compression in several actions such as lossless and lossy. The image that needs to be compressed to a pixel range of grayscale, ranging from 0 to 255.While compressing any data it must be kept in mind that any data required will not be lost in the body [2]. Also, low bits are needed in saving data in digital media and sending. Compression to some range shows that there is a section of data whose size is required to decrease. Now this JPEG format is absolute option for digital image. The Joint Photographic Expert Group (JPEG) which depends on discrete cosine transform (DCT) is a very extensively second choice formula for compression. Image compression is one of the incredible femiliar way in image operation. In this way we can have many basis ideas and play a significant role in the actual storage and transmission of images. In image compression, in the proposed model to reduce unnecessary data we will use less sample to facilitate sending and saving of this. The main goal of reducing the number of bits per large base to compress images is to decrease the transmission time to display this image and broadcast the image and regenerate once again by Huffman encoding [3].

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The purpose of feature extraction technique in image processing is to represent the image in its compact and unique form of single values or matrix vector. Most transformation techniques produce coefficient values with the same size as the original image. Further processing of the coefficient values must be applied to extract the image feature vectors.
Digital data can be easily copied, modified and forgeries be created by anyone having a computer. Most prone to such malicious attacks are the digital images published in the Internet. Digital Watermarking can be used as a tool for discovering unauthorized data reuse and also for copyright protection.

II. IMAGE COMPRESSION

The main purpose of image compression is to compress data allowing it to be saved and transmitted. This technic uses three initial stage in which first stage converts image to each other symbol [4]. In second stage we decrease pixel and third stage we are coding it with the help of coefficient. This technique is better than analytical techniques because it has compression of data easily and well. Realization of compression of any data occurs by removing one or more redundancies:

1) Coding redundancy: We use that over there where we must use a small code word.
2) Inter-pixel redundancy: It gives the result of similarity between pixels of the image.
3) Psycho-visual redundancy: In it some information is ignored by human visual system (i.e. Don't need useless information). For more operative coding in image compression we are use redundancy.

What is the need for compressing image?

- Suitable growth of memory size.
- Broadcasting time reduces so it makes it easier to send image through internet and download from webpages.
- Telemedicine
- Tele-radiology

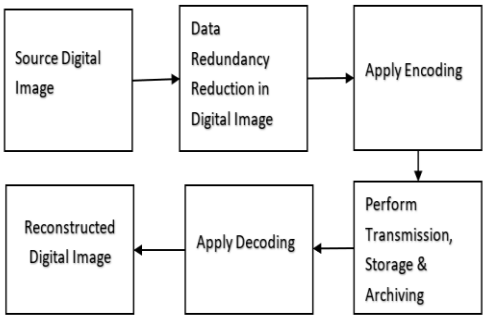

Fig.1.Block Diagram of Proposed System

III. TYPES OF IMAGE COMPRESSION

Image compression we can divided into two types like lossy image compression and lossless image compression. In lossy compression as the name itself suggests it leads to some information loss [5]. In this technique we do not get original data if again decompress after compressing original data because it has loss of some data during process. So, this technique we use in compressing generally photographs. The best example of lossy compression technique is a JPEG [6]. Whereas no data is lost in lossless compression technique when we compress any image using this technique, so when we again decompress data in this case, we get the original image again. Uses of this technique we do in compressing PNG and GIF file. GIF file over here is just 8-bit images. We use either of the two techniques according to our need [7].

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A. Lossless Compression

There is no any information loss during this when we compress an image by lossless image compression so when we decompress this compress image again, we get the original data again. In this case when we compress binary data like image, video, audio etc. [8]. then we must decompress it to get the original data. It is important to remember that there is some or no error between the original image and the compress image. It contains no any noise add in signal or compress image, so it is called cool process. This technique we also called entropy technique coding because it is also used to remove or reduce redundancy. It is only use in medical image and application required [9]. Which of the following we use some technique as lossless technique:

a. Huffman coding
b. Run-length coding
c. Arithmetic coding
d. Dictionary Techniques
e. Bit Plane coding

IV. HUFFMAN CODING

Huffman coding technics we use to compress the data. This technique to we also called greedy technique. In it we convert data in digital form. It contains all the character defined by a unique bit.

The Huffman code procedure needs the two explanations professed below:

a) First of it we pick the characters of two smallest frequency.
b) Two characters that originate the smallest frequency may have an identical length.

In its first we select the character of the two smallest frequency then by totaling them we get a new character. Which we also called base element. In the left of this base element write the small character and write the big character in right. Do this until all characters are finished. In this way we get a tree. Top element of this tree is called root element. From this root element we do numbering. Write the zero in its left and write the one in its right [10]. For any character element that needs to go we'll follow the path from root element to that element. Then after we write down all the numbers of path on it. Thus, we get the code of that character.

A Huffman code has been created as of the classification of the code tree. This is the best proposed code which we use to compress the data. By it we change the dimension of data. As a result, the average length of the code is decreased, and we are thus compressing the data. In order to reduce redundancy, we use Huffman algorithm.

Table-I. ALGORITHM OF HUFFMAN CODE

ALGORITHM OF HUFFMANCODE
Step 1: Generate organized nodes created on the possibility
Step 2: Jump loop
Step 3: Discover & take away two lowest likelihood nodes
Step 4: Generate new node[W[Node]=W[N1] + W[N2]]
Step 5: Pull-out new node, posterior to arranged list.
Step 6: Recurrence the loop while waiting for only one preceding node is existing in the list

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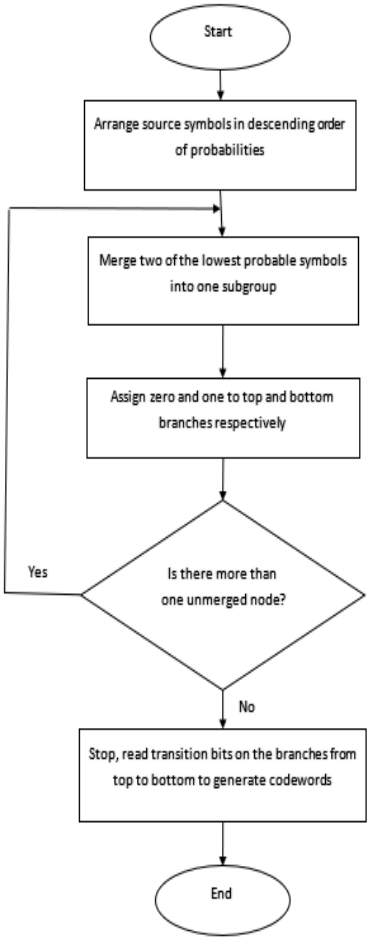

Fig.2.Flow chart of Huffman Algorithm

B. Lossy Compression

In lossy compression techniques we remove the unnecessary data, so it reduces the data bits. The process of reducing the size of data file is usually called data compression before its send even through it is formally called source coding. Some data losses may be acceptable during this process. Storage capacity should be increased by removing unnecessary data from the source data. Lossy image compression technique we use in digital camera in which we can increase storage capacity by reducing quality of image. Similarly, by removing unnecessary data in DVDs also we use data by compressing [11]. In the lossy audio compression, the techniques of psycho audibility have been used to remove the non-audible or less perceptible components of the signal.

Some benefits of the Image compression technique are:

1) Sending data requires less cost because the telephone network allows us to send less data saving time and money.
2) This not only reduces storage but also reduces execution time.
3) The possibility of getting an error at time of transmission decreases as we already remove some data.
4) It is highly valued in terms of security.

V. MATHEMATICAL MODELLING OF HUFFMAN AND DCT TECHNIQUE

The entropy of the weighted sum of Huffman technique

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$$H(A) = \sum_{w_i>0} w_i\, h(a_i) = \sum_{w_i>0} w_i log_2 \frac{1}{w_i} = -\sum_{w_i>0} w_i\, log_2 w_i \quad (1)$$

Where, h $(a_i) = log_2 \frac{1}{w_i}$

The DCT equation (Eq. 2) computes the ith, jth input element of the DCT of an image.

$$D(i,j) = \frac{1}{\sqrt{2N}} C(i)C(j) \sum_{x=0}^{N-1}\sum_{y=0}^{N-1} p(x,y) \cos\left[\frac{(2x+1)in}{2N}\right] \cos\left[\frac{(2y+1)jn}{2N}\right] \quad (2)$$

$$C(u) = \begin{Bmatrix} \frac{1}{\sqrt{2}}\ if\ u = 0 \\ 1\ if\ u > 0 \end{Bmatrix} \quad (3)$$

Here P (x, y) is data element represented by the matrix p. N are the number of blocks on which we apply the DCT. By the equation we obtain the value of pixels of a compressed image from the matrix of the original image. Original image we have represented by matrix of 8x8 blocks then apply DCT on it. The range of x and y is 0 to 7 while N is equal to 8. Thus, the value of D (i, j) can we find out from Equation (4).

$$D(i,j) = \frac{1}{4} C(i)C(j) \sum_{x=0}^{7}\sum_{y=0}^{7} p(x,y) \cos\left[\frac{(2x+1)i\pi}{16}\right] \cos\left[\frac{(2y+1)j\pi}{16}\right] \quad (4)$$

$$T_{i,j} = \begin{Bmatrix} \frac{1}{\sqrt{N}}\ if\ i = 0 \\ \sqrt{\frac{2}{N}} \cos\left[\frac{(2j+1)i\pi}{2N}\right]\ if\ i > 0 \end{Bmatrix} \quad (5)$$

VI. JPEG: DCT-BASED IMAGE CODING STANDARD

JPEG can be compressed for that we firstly compressor it's pixel. This data occurs in continuous time. It is easier to compress with the DCT method than it is very fast. Its depth is 6 to 24 bits. Discrete cosine transform (DCT) a secure array of data points in the relation of the sum of the variable cosine purposes at different incidences [12]. DCTs are significant for several executions in the ground of science and engineering, for a sample from lossy compression of audio, for example, MP3 and JPEG in which unimportant high-frequency basics can be discarded, partial differential equations are used for to find out their arithmetical value. Replacing the sine function is to use the cosine this operation creates confusion: for compression, in which it was originated that the cosine purpose is so actual as labelled here, some roles would need an exact signal to be accurate, While the differential equation for, the cosine function clarifies a precise variety of borderline conditions. JPEG image compression achieves non-essential bits of data in part complete rounding. There is a related trade-off amid data loss and size reduction. Dissimilar information of different compression techniques has attained these spontaneous differences, by means of composition files, videos, and images. So lossy image compression technique is best for JPEG but it's less good for colourful image [13]. DCT separates some part of the image based on the frequency of the image, with the lesser serious

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incidences being disregarded out through the quantization procedure and the extra critical rate of recurrence being used to save the image throughout the fragmentation process.

Table-II. ALGORITHM OF DCT CODE

ALGORITHM OF DCT
Step 1: Deliver the image as a matrix. Step 2: Divide the matrix in a wedge of 8x8. Step 3: DCT is used for each pixel from left to right and top to bottom. Step 4: All pixels are compressed with quantization. Step 5: Compressed pixels of the image reduce the memory size.

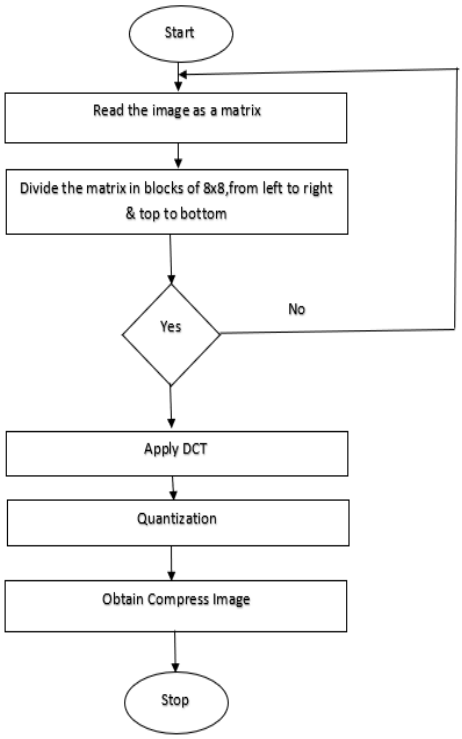

Fig.3. Flow Chart of DCT Algorithm

VII. Digital Watermarking

Digital watermarking is the method of embedding data into digital multimedia content. This is used to verify the credibility of the content or to recognize the identity of the digital content's owner [14].

Digital watermarking can be employed for multiple purposes, such as:

- Copyright protection
- Source tracking
- Broadcast tracking, such as watermarked videos from global news organizations
- Hidden communication

There are two types of digital watermarking:

1. Visible Digital Watermarking: Visible data is embedded as the watermark. This can be a logo or a text that denotes a digital medium's owner.

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2. Invisible Digital Watermarking: The data embedded is invisible or, in case of audio content, inaudible.

Watermarking Process

a) Watermarking System

We complete the watermarking system in two steps: Embedding and Detection. The Watermark embedding needs an algorithm that is encoded into the host media by this. The figure.4 shows the embedding process. The embedding algorithm E accepts the watermark w and embeds this in the image I to create the watermarked signal I'.

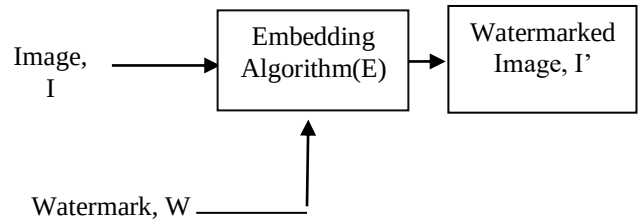

Fig.4.Embedding Operation

The decoding section retrieves the watermark from the watermarked signal when it is required to of the owner to prove his ownership rights. Figure 5 illustrates the decoding operation.

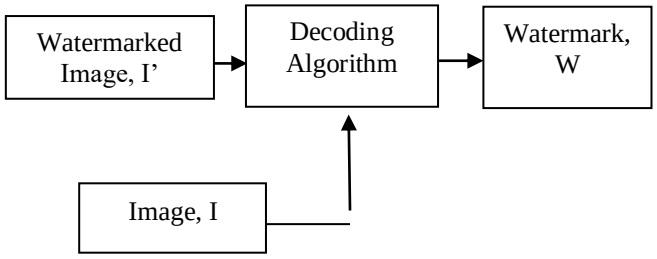

Fig.5.Decoding Operation

The decoding algorithm retrieves the watermark w from I'. When decoding, there are techniques that do need the original image and others that do not need original images. The above is a blind watermarking technique that the original image to generate watermark w.

b) Watermarking Techniques

Watermark embedding can be considered as superposition of the watermark signal on the original image. Digital Image Watermarking is the process of embedding some information w into an image x to form a Watermarked image, say x´.

$$x´ = E(x, w)$$

The original image is referred to as the host image/data into which the watermark w is hidden imperceptibly. A variety of algorithms are used for information integration. Watermarking methods are broadly classified as:

- Spatial domain method
- Transform domain methods

In spatial domain watermark integration is done by modulating the intensity of certain pixels from the host image. The watermark is embedded to the least significant bit (LSB) of the original image. While some methods use DWT transforms domains for selecting the coefficients whose magnitude is then changed. Spatial domain methods are less complex; however, they are easier targets to attacks.

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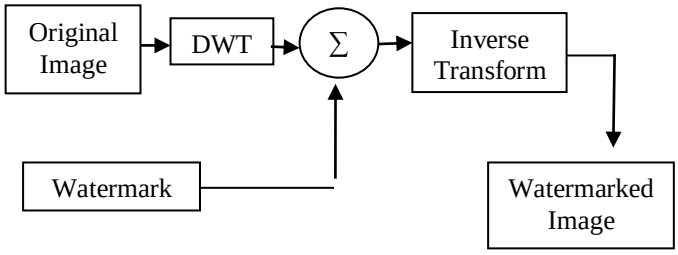

Fig.6.Watermarking Procedure

Transform domain watermarking methods uses transforms as DCT (Discrete Cosine Transform), DFT (Discrete Fourier Transform) or DWT (Discrete Wavelet Transform). Figure.3 shows how a Watermarked image is generated. Transform domain watermarking methods have gained popularity as they are more robust to attacks. This is attributable to the fact that when image is inverse wavelet transformed the watermark w is distributed irregularly over the entire host image thus making the watermark removal almost impossible for attackers.

VIII. RESULTS & DISCUSSION

A. Lossless Image Compression Technique

As you can see in the image below, we took a Cervical Spine image. Which has original size 58.207 KB and which we have compressed by using the Huffman coding technique. The size of this compressed image is 17.6523 KB and the compression ratio of the image is 0.30

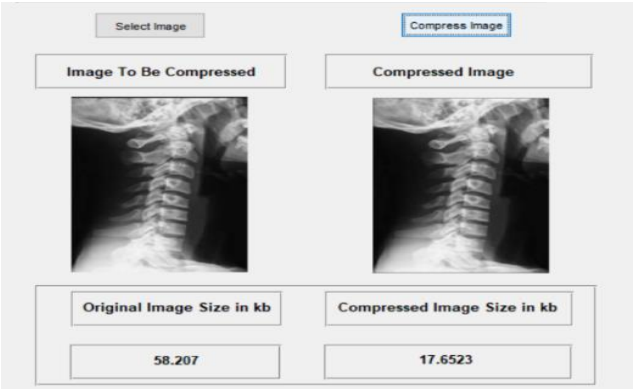

Fig.7.Cervical Spine by lossless technique

As you can see in the image below, we took an Ultrasound image. Which has original size 33.1338 KB and which we have compressed by using the Huffman coding technique. The size of this compressed image is 4.4248 KB and the compression ratio of the image is 0.133

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Fig.8.Ultrasound by lossless technique

As you can see in the image below, we took a Knee display image. Which has original size 34.0986 KB and which we have compressed by using the Huffman coding technique. The size of this compressed image is 4.9668 KB and the compression ratio of the image is 0.145

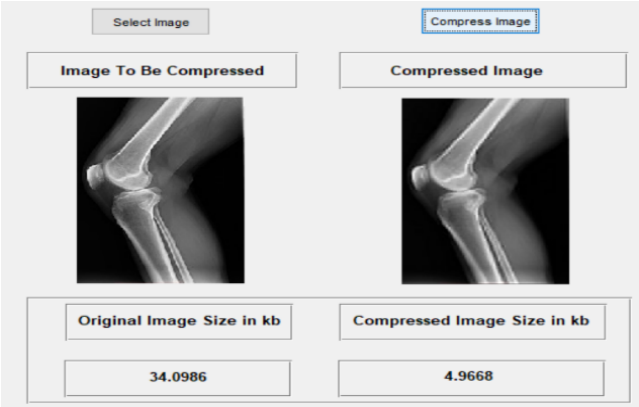

Fig.9.Knee display by lossless technique

Here Huffman Coding is been used in Lossless Technique where the compression of actual data is done with none of the information loss. The Table 3. illustrates that the compressed image has smaller size as compared to original image with no data loss.

Table-III. LOSSLESS TECHNIQUE

Image	Original Size(KB)	Compressed Size(KB)	Compression Ratio
Cervical	58.207	17.6523	0.30
Ultrasound	33.1338	4.4248	0.133
Knee	34.0986	4.9668	0.145

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B. Lossy Image Compression Technique

As you can see in the image below, we took a Cervical Spine image. Which has original size 58.207 KB and which we have compressed by using the DCT coding technique. The size of this compressed image is 5.6 KB and the compression ratio of the image is 0.096

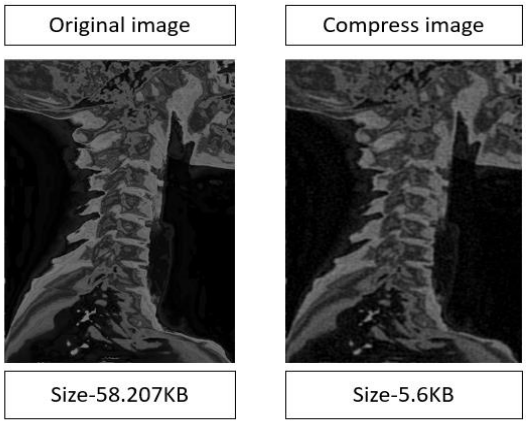

Fig.10.Cervical Spine by lossy technique

As you can see in the image below, we took an Ultrasound image. Which has original size 33.1338 KB and which we have compressed by using the DCT coding technique. The size of this compressed image is 3.25 KB and the compression ratio of the image is 0.098

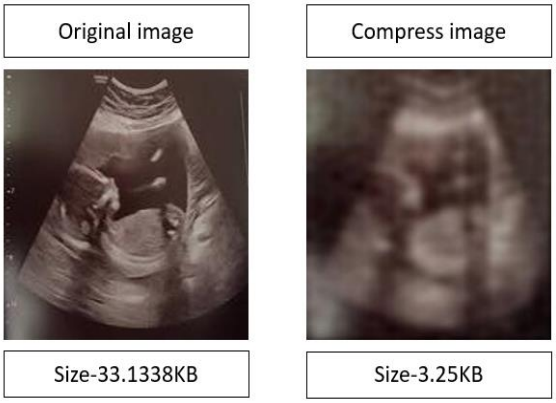

Fig.11.Ultrasound by lossy technique

As you can see in the image below, we took a Knee display image. Which has original size 34.0986 KB and which we have compressed by using the Huffman coding technique. The size of this compressed image is 4.17 KB and the compression ratio of the image is 0.12

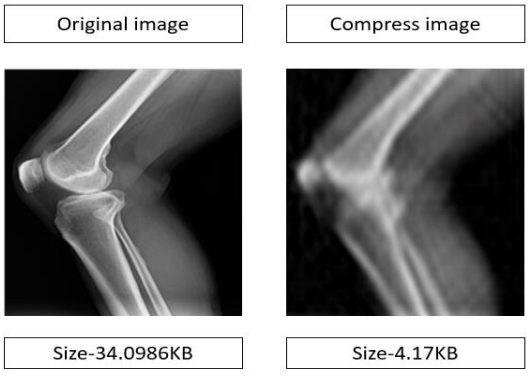

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Fig.12.Knee display by lossy technique

Here the DCT based image coding technique is used in lossy technique. The compressive image in lossy technique are less in size than lossless but its loss some information. In Table 4. compressed image is much lesser that the compressed image in Table 3.

Table-IV. LOSSY TECHNIQUE

Image	Orginal Size(KB)	Compressed Size(KB)	Compression Ratio
Cervical	58.207	5.6	0.096
Ultrasound	33.1338	3.25	0.098
Knee	34.0986	4.17	0.12

Table-V. COMPARISON BETWEEN LOSSY & LOSSLESS TECHNIQUES

Parameters	Lossless Technique	Lossy Technique
Information	Have Information without losses	Have Information Some losses
Size	Reduce data size	Reduce more data size compare to lossless
Transmission	Harder to transmit Compressed File	Easy to transmit due to less bandwidth

C. Watermarked Image

As you can see in the image below,we took a cervical Spine Image.Which we have made a watermarked for which we have used the logo of Gautam Buddha University and you can see in the watermarked image.

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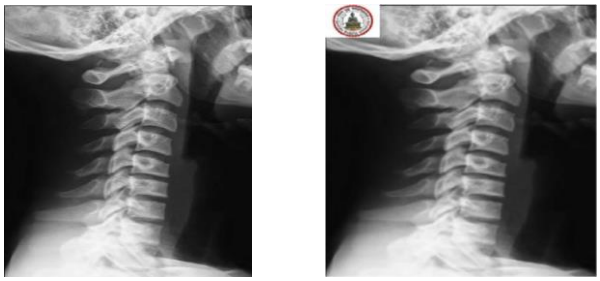

Original Image | Watermarked Image

Fig.13.Cervical Spine image after Watermarked

As you can see in the image below,we took a Ultrasound Image.Which we have made a watermarked for which we have used the logo of Gautam Buddha University and you can see in the watermarked image.

Original Image | Watermarked Image

Fig.14.Ultrasound image after Watermarked

As you can see in the image below,we took a knee Image.Which we have made a watermarked for which we have used the logo of Gautam Buddha University and you can see in the watermarked image.

Original Image | Watermarked Image

Fig.15.Knee image after Watermarked

IX. CONCLUSION

With Huffman coding here DCT image compression technique has been used to compress the image. Huffman technique have no information lost while compressing the image in the DCT technique has a loss of some information .In a Huffman compressed image can be obtained again in original form by using the decompression, while in the DCT we cannot retrieve the original image

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again in the original form. This paper can be useful for people who are developing new software to compress the image. By using the above technique, we can reduce both memory size and communication time. Testing of these two techniques leads to the conclusion that lossless technique is more useful for medical field [15]. Lossy compression methods are secondhanded for advanced compression fractions and lossless compression is secondhand in the situation of the actual image and for the recreated image that requirements to be the same.

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