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# Hexadecimal Key-Integrated Watermarking In Compressed Images For Secure Transmission

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**Abstract**

In Today's technological world images play a vital role. With the tremendous growth of digital media, protecting and transferring of images has become progressively important. With the usage of images everywhere, there arise the storage and network issues during transfer of data. To overcome this disadvantage a concept called Compression is introduced where the redundant data is eliminated. In this paper we discuss about compression, need for compression, types of compression, different types of compression techniques that are used and the new method we are going to use. This study introduces a hybrid framework that combines image compression, watermarking and hexadecimal conversion to protect data. This method not only verifies the authenticity but also prevents tampering or unauthenticated or unauthorized access. The proposed method establishes equilibrium between compression efficiency and data security, making it experimental for real world applications.

**Key words:** Image Compression, Digital Watermarking, Hexadecimal Conversion, Key Insertion, Secure Image Transmission.

## 1. Introduction:

The real magic of the world lies in images as they portray everything from minute details to the very secrets of the world. Images play a vital role in today's technological world as they convey concepts and information in a very easy and effective way. It is a visual representation like a drawing, Photograph, Graph, Painting. Anything that can be represented visually can be called as image. Anything and everything that can be or cannot be described in words can be depicted in a single image. Thus the need and usage of images is tremendously increased over the time. Images act as a communication tool as they attract attention and helps in reinforcement of the message.

The way of storing digital images using different data structures and encoding methods is called Image Format.

Different image formats are JPEG( Joint Photographic Experts Group) , PNG( Portable Network Graphics) , GIF( Graphics Interchange Format ) , TIFF( Tag Image File Format ) , SVG( Scalable Vector Graphics) , BMP( Bitmap). Images can be two dimensional as well as three dimensional.

## 2. Image Compression:

Since the need of the images have been tremendously increasing in every field such as medical imaging, remote sensing it becomes very difficult to handle large amount of data in storage systems. So a concept called Image Compression is introduced. The main goal of image compression is to achieve best quality of images with less compression rate and less loss of data. We can say that the quality of the image depends on the compression rate so high compression rate means less quality of image and vice versa. Even if we minimize the size of the image by 10kb also it is acceptable as a single bit can make a difference.

Image Compression is a process in which the size of the image can be reduced without losing or with minimal loss of actual data in the image. It can be achieved by removing redundant or non-important data resulting in faster access. It reduces the size of the image, helpful in fast transfer of data, reduces storage space as it leads to more storage. Image compression is very much useful in video Conferencing, remote sensing, satellite TV, FAX, documents and medical imaging etc.

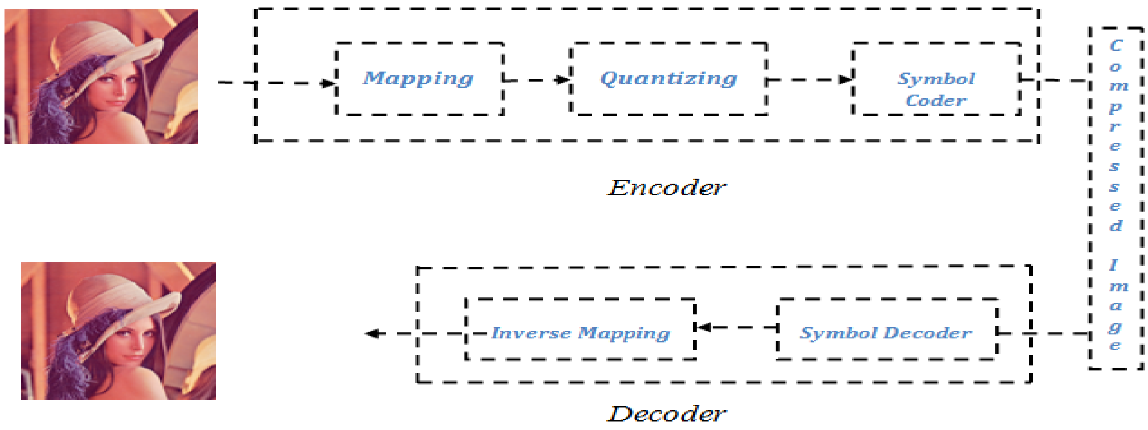
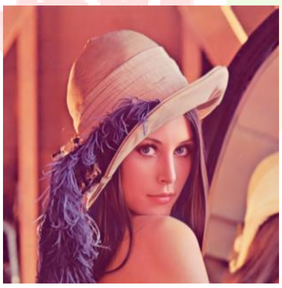



*Fig.1 Block diagram of Image Compression*

Generally, image compression is of two types i.e. Lossless and Lossy. Encoding (compressing the image) and Decoding (Reconstructing the compressed image to its normal form) are the two main processes involved in Image Compression.

Before Compression



After Compression

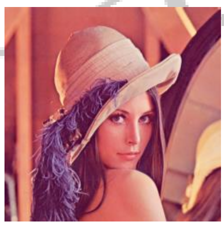


*Fig.2 Lenna Image before Compression*

*Fig. 3 Lenna Image after Compression*

### 2.1 Need for Compression:

This is the basic working structure of compression. Here f(x, y) is an image and f^(x, y) is the reconstructed image after decompression.

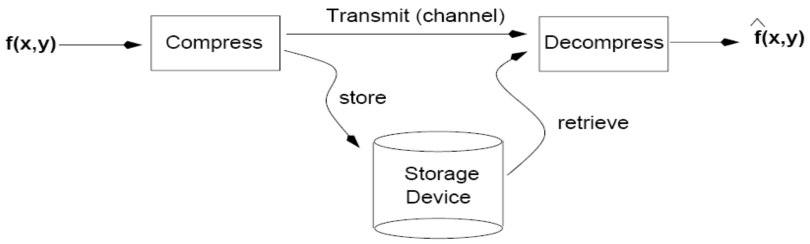



*Fig.4 Image Compression*

The need for image Compression is advancing with the usage of loads of images. Image Compression is becoming a need because

- It reduces the storage space by removing the redundant data there by reducing the file size.
- It decreases the data transmission time by making it easier to access.
- It decreases the communication bandwidth ultimately leading to better communication.
- It increases the rate of transfer which makes it faster across the network.
- It enhances the user experience.
- It provides better security as they are encoded during the time of compression.

## 3. Types of Image Compression:

Image Compression can be divided mainly into two types namely.

I. Lossless Image Compression
II. Lossy Image Compression

### 3.1 Lossless Image Compression:

The Lossless Image Compression is an Image Compression technique in which the size of the image is reduced without losing any actual data. It mainly focuses on the redundant data. The unnecessary data in the image is removed without changing any original data that may affect the image making it the same as Original Image. It is called as Lossless because of this Capability. This kind of compression is used to store as much of the original image as possible. In some cases we may find some slight difference whereas in others we can't even find a single difference as they seem identical. Lossless Compression makes it easier to store, transfer and Upload high quality images. It we need to maintain the highest Possible Standards of Quality Image then Lossless is the best Option. The main advantage of lossless compression is that the original image can be restored even after compression. It is reversible with no loss of image quality and smaller file sizes. Compression can be achieved by removing coding and/or inter pixel redundancy.

Common image formats that are used are GIF, TIFF, BMP and PNG.

It is mainly used in Archiving, Medical Imaging, remote sensing and high-Quality Image storing or text and bank records or articles. The main advantage is its reversible capability which is useful in reconstructing and quality of the image whereas the disadvantage of lossless is that the compression ratio is lower compared to lossy and its limited applicability.

Example for Lossless image Compression:

*Fig (5) Before Compression*

*Fig (6) After Compression*

The original image fig (5) before compression is of 350kb whereas the compressed image fig (6) is of 170kb. The Compressed is as identical as the original image with slight difference in the brightness. We cannot even distinguish these details without proper identification. Here we got the compressed image as same as the original image without any loss in its quality except its size. With these minute changes it is hard to say that the image is compressed.

### 3.2 Lossy Image Compression:

Lossy Image Compression is an image compression technique in which the data that is not important or not perceptible to the human eye is removed to reduce the size of the image. It is a permanent method of reducing data size as the data removed cannot be restored. It is also known as Irreversible Compression. Compared to Lossless, in lossy compression we can find the difference in brightness, contrast and in the size and features of the image which in turn reduces the quality of the image.

Lossy Compression is widely used in Video Conferencing, satellite TV, FAX, documents and multimedia (in Televisions and news broadcasting), web images where storage and transmission bandwidth matters. It is used to reduce storage space for data storing and handling.

The main advantage of lossy is it is suitable for visual data like images and videos with less file size and its disadvantage of lossy is the irretrievability of the discarded data and the loss of image details. It is an acceptable choice for various applications because of its small size and its effective storage and transmission.

Common Image formats that are used are JPEG, HEIF and Web P.

Example of Lossy Image Compression:

*Fig (7) Before Compression*

*Fig (8) After Compression*

The Original image fig (7) before compression is of 450 kb whereas the compressed image fig (8) is of 200 kb. The Compressed is as identical as the original image with slight difference in the brightness and features. We can distinguish these details with proper identification. With these changes the size of the image is compressed remarkably.

## 4. Different Image Compression Techniques:

The very common techniques that are used in lossless compression are

1. Transform Coding
2. Run Length encoding
3. Huffman coding
4. LZW (Lempel-Ziv-Welch)

5. DCT
6. DWT

### 4.1 Transform Coding:

Transform Coding is the fundamental image compression technique which works by image subdivision means converting the (spatial domain) pixels of the image into the (transform domain) coefficients. It is particularly used for images and audio signals. Generally DCT or DWT Transformation technique is applied to perform transformation.

JPEG is an example of Transform Coding.

### 4.2 Run Length Encoding:

Run Length Encoding is a lossless compression technique in which the consecutive occurrences of the data are stored as a single occurrence with the number of occurrences. This technique is mainly used for the data with long sequence of consecutive values in text, images and graphics. It is mainly used for sequential data. The sequence of consecutive identical data is called Run. During decompression also it is easy to restore the original data as we have the data and its number of occurrences.

For Example, if we have the data

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

↓

Then it can be written as

| | | | | | |
|---|---|---|---|---|---|
| a | 2 | b | 4 | c | 2 |

Which implies the data an occurred 2 times, b occurred 4 times and c occurred 2 times in the given data.

### 4.3 Huffman Coding:

Huffman Coding is a lossless compression algorithm. Based on their frequency of occurrence this algorithm assigns variable-length codes to symbols or input characters. The characters that are frequently appeared are given shorter codes whereas the less frequently appeared are given longer codes, resulting in reducing the overall size of data. The variable-length codes that are assigned to input characters are prefix codes (means the code assigned to one character is not assigned to another).

Based on the frequencies given a binary tree (in bottom up manner) is constructed which is known as Huffman tree.

Example:
We have the string “BABBAC”
Step1: Calculate frequencies of each character
A: 2, B: 3, C: 1
Step 2: Building Priority Queue
C: 1, a: 2, B: 3
Step 3: Building Huffman tree
Tree: (C: 1 + A: 2): 3 + B: 3 =6
Step 4: Generating Huffman Codes
B =1, A = 01, C = 00

### 4.4 LZW (Lempel-Ziv-Welch):

LZW is a lossless compression technique created by Abraham Lempel, Jacob Ziv and Terry Welch that depends on dictionary to identify the recurring patterns in the data to replace them with shorter codes which in turn reduces the size of the file. This dictionary coding is of either static or dynamic. It is very simple to implement. On Computers LZW was the first widely used universal image compression method. It is widely used in GIFs and TIFF images. It is mainly based on the two older compression algorithms LZ77 & LZ78.

### 4.5 DCT (Discrete Cosine Transform):

DCT is a lossy compression method as some data will be lost while transformation. It can also be referred as Block compression as the data is converted into blocks for compression. It converts the image from pixels (Spatial domain) into frequency components (frequency domain). It is most commonly used in digital media such as Streaming Media, Television Streaming, digital cinema etc.

Formula for 1D version:

$$X_k = \sum_{n=0}^{N-1} x_n \cos\left[\frac{\pi}{N}\left(n+\frac{1}{2}\right)k\right] \qquad \text{for } k = 0, \ldots N-1 .$$

### 4.6 DWT (Discrete Wavelet Transform):

DWT can be used in both Lossy and Lossless Compression. It converts the image from pixels (Spatial domain) into Wavelets (Wavelet domain). It decomposes an image into various sub-bands of frequency which is helpful in reconstruction of the image and in selective removal of data or encoding the data according to its need. The process of dividing an image into sub-bands is known as sub-band coding there by applying high pass and low pass filters to the bands. As compared to DCT, DWT is more in advantage as it maintain the overall details and the structure of the image.

The basic steps DWT compression follows are:

- Decomposition,
- Quantization,
- Entropy Coding,
- Transmission / Storage,
- Reconstruction.

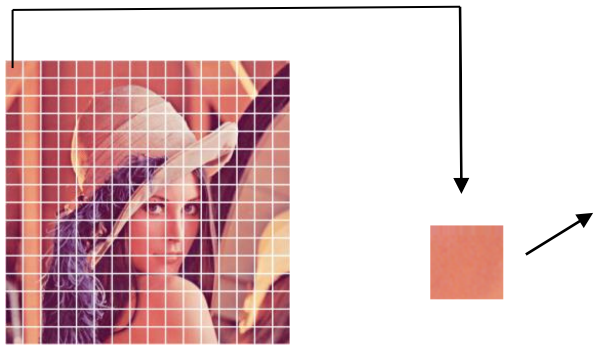
## 5. Proposed Compress Method:

The main aim of this method is to use a new method which is simpler and easy to implement to compress audios, images or even videos without losing the critical data with utmost security. The size of the data (audio, video or image) is reduced leading to faster access, better transmission, less storage space, less internet bandwidth ultimately resulting in conserving time and cost.

Here we are proposing a new compression method which is very useful in compressing different types of images (jpeg), audios, videos and Multimedia scenarios where loss of some data is negligible. The size of the image and a noticeable loss of intensity and features of the image may not actually hold that much importance in some cases where we can still work efficiently and effectively with very insignificant amount of loss of data. Watermarking is the concept of embedding an image or text in an image to prevent unauthorized access. We are using Hexadecimal for conversion as it gives more repetitive values. Considering the repetitive values as one will reduce automatically reduce the size of the image.

Here let us take an example of Lenna image and generate a key and insert it into the image. The process of inserting key into an image is called Water marking. Key may be text or an image. Key is used for providing a layer of protection to the image from an unauthorized access. If we are using same key for both encryption and decryption then they are called as Symmetric keys, if both keys are different then they are Asymmetric keys, Key can be of public or private which is used in encrypting the text which in turn converts into cipher text and by decrypting we can achieve the original text. Public key is used in encrypting whereas a private key is used for decryption.

Here we are using key of size 128, after inserting key, the image becomes watermarked image which is then segmented (dissected) into 8*8 blocks each block has different intensity values as represented below.



| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 162 | 162 | 162 | 162 | 161 | 161 | 161 | 161 |
| 162 | 162 | 162 | 162 | 161 | 161 | 161 | 161 |
| 162 | 162 | 162 | 162 | 161 | 161 | 161 | 161 |
| 162 | 162 | 162 | 160 | 159 | 161 | 161 | 161 |
| 162 | 162 | 162 | 160 | 159 | 161 | 161 | 161 |
| 162 | 162 | 162 | 162 | 161 | 161 | 161 | 161 |
| 162 | 162 | 162 | 162 | 161 | 161 | 161 | 161 |
| 162 | 162 | 162 | 162 | 161 | 161 | 161 | 161 |

*Fig.9 Pixel Representation of first 8*8 block*

Here we perform average function on above block of values we acquire a number as its average value. The average value obtained by performing average function on the above intensity values of matrix 8*8 is 162.

Similarly, the average function is applied on every block of values. Again, each value obtained has different intensity value which is further converted into binary value (bit format) and then into hexadecimal.

So, the first 8*8 block after segmentation is replaced by this average value likewise all the blocks are replaced by their average intensity values. The average value of first block is 162 which are converted into binary value (i.e. bit format).

Decimal 162 = $(10100010)_2$

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **1** | **0** | **1** | **0** | **0** | **0** | **1** | **0** |

Binary Format

| | |
|---|---|
| **A** | **2** |

To Hexadecimal Format

The binary value $(10100010)_2$ is again converted into hexadecimal value A2. Similarly, we are converting all the binary values into hexadecimal values because the intensity values obtained are in decimal format whose range is 0 to 255 bits whereas hexadecimal format is of range 0-9 and A-F.

Let's take another example

$11101100_2 = EC_{16}$

The hexadecimal conversion of 11101100 is EC.

Thus, when we convert into hexadecimal there happens to be the repetition of values which in turn reduces the size of the data. We are converting into hexadecimal because of its range and the maximum repetition values which makes the compression easier and faster. After converting into hexadecimal, we are considering it as text and performing text compression on the data. We can apply any text compression method to reduce the size of the text.

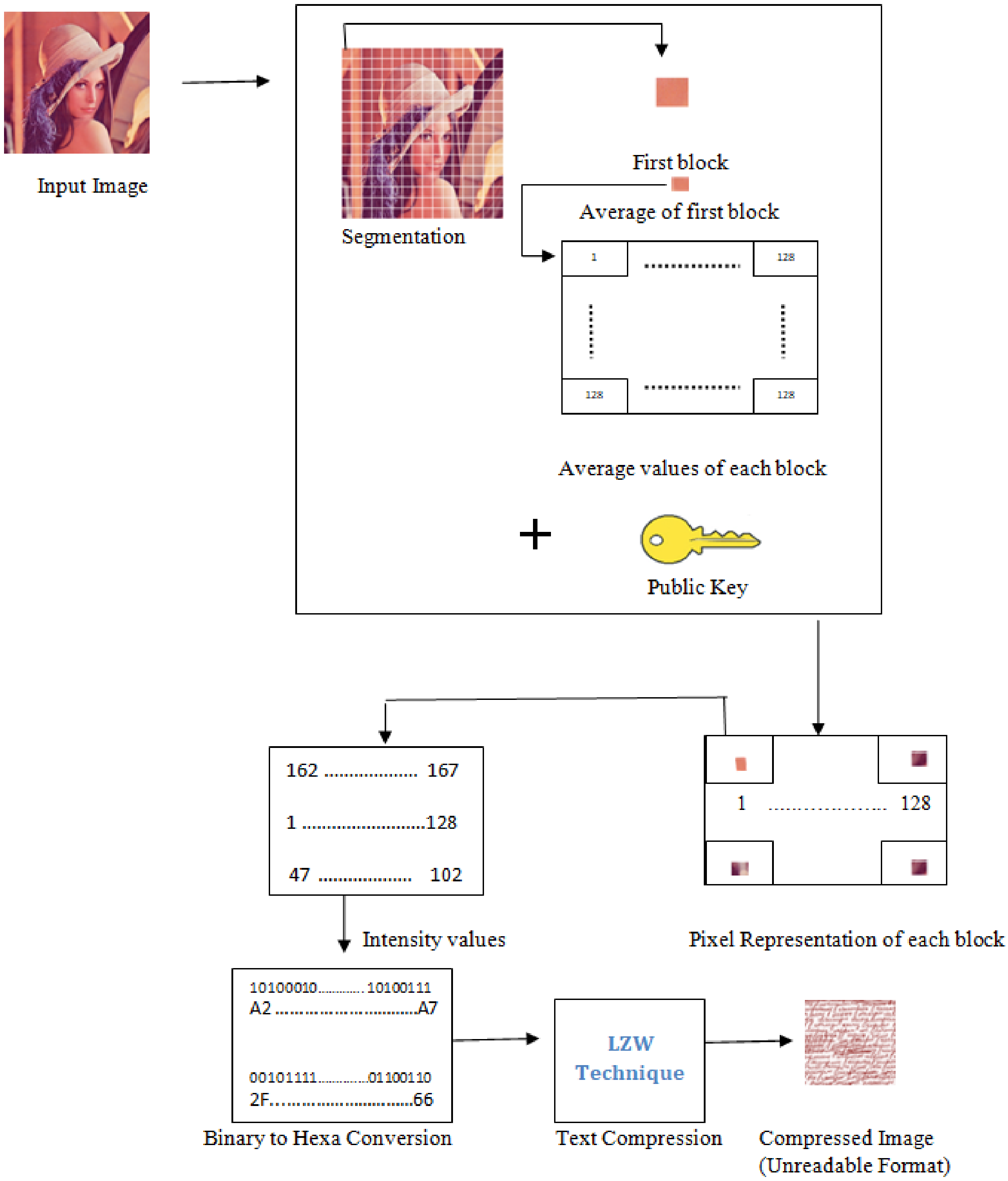



*Fig.10 Image Compression*

## 5.1 Text Compression:

Text compression techniques are used to reduce the size of the text without actually losing its content. In a way we can say that the content is retained along with size reduction.

Many text compression techniques are available such as

- LZW (Lempel-Ziv-Welch)
- Burrows-Wheeler Transform (BWT)
- Run Length Encoding
- Huffman Coding
- Arithmetic Coding
- Deflate
- Shannon-Fano Encoding etc.

Here we are using LZW technique mentioned above to compress the obtained hexadecimal value which is regarded as text. LZW is a lossless compression algorithm. It replaces the recurring or repeating character sequences from dictionary. It is dictionary based with simple implementation and good compression rate. After compression the data obtained i.e. the compressed image can't be understood as it is in unreadable format, which can be identified or understood after decompressing and reconstructing the input image.

**A Comparative analysis of Image Formats for Medical Images with a Proposed Compression Method (raw, bmp, jpeg)**

*Fig.11 Tabular representation of different image formats with proposed method*

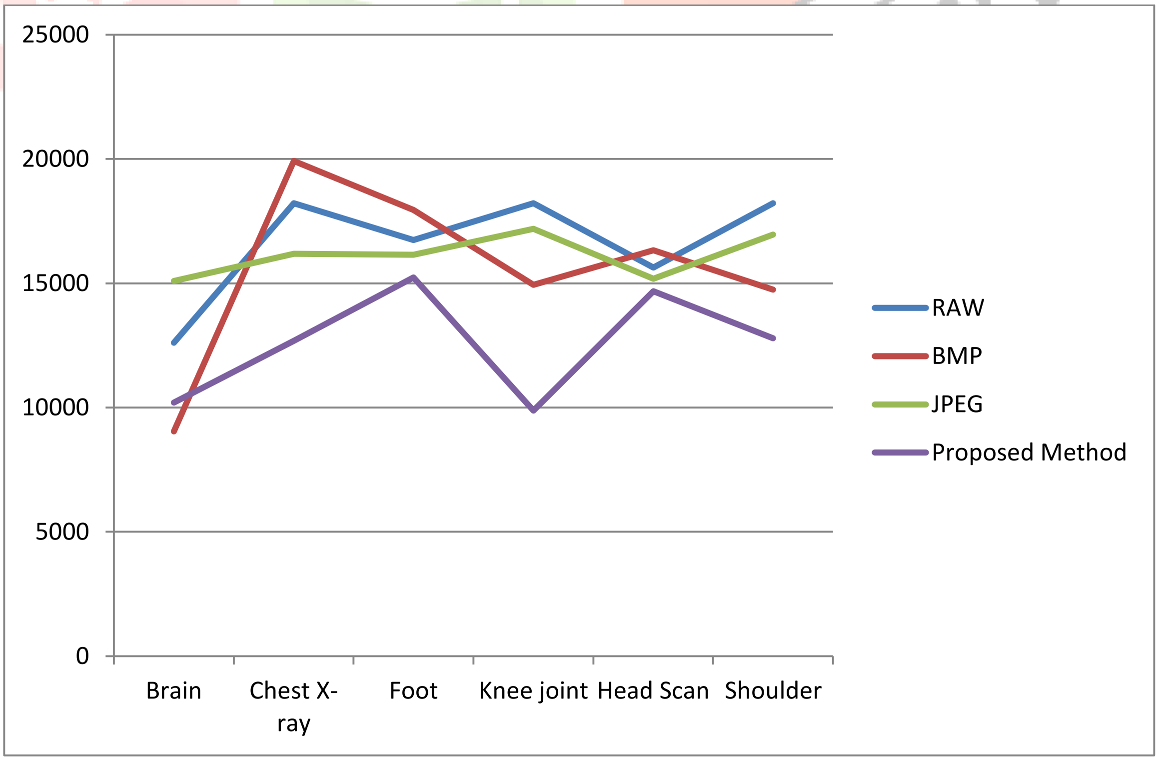
| Image Name | RAW | BMP | JPEG | Proposed compressed Method |
|---|---|---|---|---|
| Brain | 12610 | 9044 | 15094 | 10200 |
| Chest X-ray | 18225 | 19920 | 16180 | 12678 |
| Foot | 16740 | 17944 | 16144 | 15229 |
| Knee joint | 18225 | 14940 | 17193 | 9876 |
| Head Scan | 15625 | 16328 | 15184 | 14675 |
| Shoulder | 18225 | 14740 | 16962 | 12789 |

This table compares the file sizes (in bytes) of six different medical images in different formats. The file size of the proposed method is less because the averaging method we had used reduces the size of the data.

Here we are segmenting the image into 8 x 8 blocks. After performing average function on each block 8 x 8 = 64 values are replaced by a single average value which in turn reduces the size of the image. From the comparison table above, it is evident that the proposed method reduces the image size comparatively higher in comparison with other compression techniques.

**Graph showing the comparison of different images formats with Proposed Method**

*Fig.12 Graphical representation of different image formats with proposed method*




The Graph above clearly shows the variation between different image formats with proposed compression method. The adjacent pixels of the image are highly correlated, which means they have same intensity values of the pixels.

By taking advantage of this, we are performing average function because there won't be much change in the intensity values which means it has redundant data and average value obtained is approximately equal or same. So, the rate of compression is higher.

**Difference between raw image and Reconstructed image (zoom at 1600%)**

*Fig.13 Difference between Raw Image and Reconstructed Image at its maximum level magnification*

The image above shows the difference between the raw and reconstructed image at utmost magnified level i.e. 1600%. Here the data that is obtained is the redundant data that is lost during compression. The data that is negligible or that is not visible to the naked eye which doesn't make any difference in the image with its loss except for its size and resolution. That means we cannot find much difference and also it helps in reducing network traffic and faster access and transfer with less size.

The above image is of the data that is lost which is visible only if we zoom out at 1600%. At normal level i.e. at visible level or standard level we cannot find this difference as it seems like a blank page.

### 5.2 Decompression:

Decompression is the reverse process of compression. The compressed image is used as input and the output will be the reconstructed image. The compressed image is again reconstructed by the reversing the same process. The same process that is applied to compress the image is reversed to perform decompression.

Reverse LZW Technique is applied on the compressed image (non-readable content) which produces the text in hexadecimal format. The decoder uses the code table in reconstructing the compressed data. The Hexa decimal data obtained is converted into binary value. Again, the binary value is converted into decimal value which gives the average intensity value of the 8*8 segmented blocks. Here we cannot exactly obtain all the values in each block through the average value. Since we have performed the average function, we cannot exactly retain all the values. We can retain the minimum values with this average value which generates an encrypted or watermarked image on which the private key is used to decrypt the data. After decryption the image that is obtained is called the Reconstructed Image.

Thus, by performing the whole process in reverse we can reconstruct our input image with a negligible amount of loss.

## 6. Conclusions:

A new approach of performing image compression – by converting into text there by performing text compression. Here we are encrypting the image by using a public key and then segmenting the given image or frame (video) into any dimension 8*8 or 16*16 or 32*32…. Then we replace the block of values by average value of that block. Thereafter convert the average values obtained into bit values thereby converting into Hexadecimal which can be treated as text. Text compression technique is applied which in turn automatically reduces the size of the file. We can achieve the input image by decoding the obtained compressed file.

**References**:


1. Chiou-Ting Hsu and Ja-Ling Wu, "Hidden digital watermarks in images," in IEEE Transactions on Image Processing, vol. 8, no. 1, pp. 58-68, Jan. 1999, doi: 10.1109/83.736686.
2. Kaur, Simrandeep, Design and Implementation of LZW Data Compression Algorithm (July 27, 2012). International Journal of Information Sciences and Techniques (IJIST) Vol.2, No.4, July 2012, Available at SSRN: https://ssrn.com/abstract=3916673
3. Dr. T.bhaskara reddy, Mr. G. Thippanna, Hema Suresh “a re-examine of gen on an assortment of images, compression techniques and its algorithms” , International Journal of Advanced Research in Computer Science (IJARCS), ISSN No. 0976-5697, pp: 112 – 119.2012.
4. Cox, I. J., Miller, M. L., and Bloom, J. A., “Digital Watermarking”, New York: Morgan Kaufmann Publishers Inc., San Francisco, CA, 2002
5. Dr. T. Bhaskara Reddy, Dr. S. Kiran, G. Thippanna “Image Masking and Compression Using user Private Key Generation” International Journal of Emerging Trends & Technology in Computer Science (IJETTCS), Volume 3, Issue 5, September-October 2014, ISSN 2278-6856.Dhawan, Sachin. (2020). A Review of Image Compression and Comparison of its Algorithms. 2. 22-26.
6. Mohammed Ismail.B, Dr. T .Bhaskara Reddy, Dr. B. Eswara Reddy “HYBRID FRACTAL IMAGE COMPRESSION BASED ON RANGE BLOCK SIZE”, Graphics, Vision and Image Processing Journal, ISSN 1687-398X, Volume 16, Issue 2, ICGST LLC, Delaware, USA, Dec. 2016.
7. Gavini, Narasimha & Borra, Surekha. (2014). Lossless watermarking technique for copyright protection of high resolution images. IEEE TENSYMP 2014 - 2014 IEEE Region 10 Symposium. 73-78. 10.1109/TENCONSpring.2014.6863000.
8. Ms. Lavanya Kandikunta, Mrs. B. Hari Chandana, Prof. T. Bhaskar Reddy, © “ Data Security Using Nested Randomization and Lossless Compression Techniques” International Journal of Applied Engineering Research ISSN 0973-4562 Volume 13, Number 15 (2018) pp. 12373-12378
9. Dr. Bhaskara Reddy, C. Sasikala and P. Anusha Reddy, G. thippanna “Medical Image Encryption and Compression Using Masking Algorithm Technique”, http: //www.pubicon.info/~AuthorUpload/18PA.pdf. AJCSIT [3] [1] [2015] 089-096.
10. Kaur, Rajandeep & Pooja. (2016). A Review of Image Compression Techniques. International Journal of Computer Applications. 142. 8-11. 10.5120/ijca2016909658.
11. Thresholding Segmentation and Classification in Automated Ultrasonic Testing Image of Electrical Contact H. D. Chen, Z. J. Cao, Y. W. Wang, and J. Xue Welding Research Institute, School of Materials Sci. & Eng., Xi’an Jiaotong Univ.

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