Image Encryption and Compression using Graphical User Interface (GUI) on MATLAB

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Abstract— Compression and encryption are two basic steps for the secure transmission of large size image over the channels. Compression process is needed because of limitation of storage and transmission bandwidth. Encryption is study of encoding and decoding the provided information for the security purpose through internet. In general compressed data and encrypted data are transmitted separately so time consumption and computation become expensive. In this paper, separately and simultaneously compression & encryption processes have been simulated in a single program to reduce entire operation time. Yet MATLAB is commonly used software and easily available for us. A GUI (graphical user interface) using MATLAB to image compression and encryption using the discrete cosine transform (DCT). The implemented GUI is used to observe the images by getting compression and encryption.

Keywords: Color Image Compression, DCT, Decompression, Decryption, Encryption Algorithm, Graphical User Interface (GUI), MATLAB

I. INTRODUCTION

A color image compression process is represented the original image without introducing the least bit of image data. Compressed image is a shirked form of original image without losing original integrity. In digital color image each color components (R, G, B) contains 8 bits data, and also color image contains lots of data redundancy and requires large amount of data space. To save the storage space as well as transmission bandwidth, image compression plays a crucial role in transmission and storage of data. Getting the best possible compression ratio, we are applying DCT transform for each (n, n) DCT block a corresponding (n×n) vector having the maximum possible run of zeroes at its end. The last step of this application of modified systematic lossless encoder.

Based on compression factors:

A. Compression Ratio (CR):

This is a process to calculate how much or to what extent a color image is shrink. Compression ratio shown in equation (i).

$$CR = \frac{C_{sa}}{C_{sb}} \quad (1)$$

B. Compression factor (CF):

Compression factor is inverse of compression ratio shown in equation (ii).

$$CF = \frac{C_{sb}}{C_{sa}} \quad (2)$$

C. Compression time:

A time required by a compressor to compress a color image.

D. Saving percentage (SP):

Saving percentage is how much a color image compressed in a size, as a percentage value i.e. shown in equation (iii).

$$SP = \frac{C_{sb}-C_{sa}}{C_{sb}} \ \% \quad (3)$$

Where C_{sa}= size after compression
C_{sb}=size before compression

There are some algorithms that perform compression in various ways some are lossless while others are lossy. In this paper, we are going to propose the method for a color image compression to getting the better compression ratio by compressing the some parts of the color image with high quality. Fusion implementation of encryption process together with color image compression process will discuss in this paper. Encryption is a process of encoding and decoding of an image and information with using encryption and decryption keys. In this process a secret image is divided into random parts to getting the better security and again merged at the end of the receiver by decompression and decryption process.

Various confidential data in an image form are transmitted over the internet. Thus using the secret image security should be taken into consideration because hackers/ third party may use information over the communication network, encryption is introduced as a process for secure communication and different methods developed to encrypt and decrypt data image.

II. RELATED WORK

In line with a growing need for data and information transmission in a safe, and quick manner, research work has been done by researchers in the area of image encryption, and color image compression. Some of them encryption processes and color image compression processes are discussed below.

A comparative study has been carried out on image compression using DCT and DWT (discrete wavelet transform). A comparison is outlined to emphasize the results of this compression system between DCT and DWT using JPEG (joint photographic experts group) and PNG (portable network graphics) color images [1].

To reduce spatial correlation and concentrate the energy of the image. An iterative process based on the bisection method is used to determine the required threshold and control compression quality via achieving the prefixed peak signal-to-noise ratio (PSNR) [2].

Introduce the process for lossless compression of discrete-color images, like map images, graphics, GIS, as well as binary images. This method comprises two main components. The first step is going on fixed-size code book encompassing 8×8 bit blocks of two-tone data along with their corresponding Huffman codes and their relative probabilities of occurrence. From a very large set of discrete color images is being obtained relative probability which can

also used for arithmetic coding. The second component is the row-column reduction coding [3].

Based on efficient color and texture feature, adaptive color image compression process is used. An image conversion from RGB to YCBCR is done to extract color, and texture features. The non-zero (significant) DCT coefficients are used to select by the extracted features. Encoded non-zero DCT coefficients are efficiently utilized to storage space and bandwidth during transmission and thereby preserving texture and color information in the reconstructed image [4].

Digital watermarking technology is an effective measure for copyright protection. This paper presents the design of a Flash digital watermarking application which is implemented using the Graphic User Interface (GUI) function of the MATLAB software [5].

A hybrid DCT and DWT compression method is employed to capitalize the advantages of both the techniques. The methods are involved to generate color data of the white band and narrow band images in an intermediate format, and then we are generating the decompressed image [6].

A method is used for encryption and decryption of color images using RGB pixels displacement. In the proposed method the original plain image is divided into three basic components, that are RGB components and the key image is also divided into RGB components [7].

Illustrates a low cost novel method for ECG signal acquisition, display and storage using a Graphical User Interface (GUI), which provides a user- friendly front end by using MATLAB-based tool sets. At first, analog ECG has been converted to its digital equivalent with the help of an ADC [8].

The article is briefly presented how to use the software of Graphical User Interfaces (GUI) in MATLAB and shows its application to a traditional problems of dynamics of the electric machines: the simulation of the starting of an asynchronous machine. The goal of this paper is to provide electrical engineers and students with an introduction to the GUI [9].

GUI is used to secure breast cancer identification system through a combination of cryptography and biomedical image watermarking. Through this scheme 2nd level of security can be applied for a embedded data in mammographic images. Several information are related to patient (EPR), infected region (ROI), doctor's name and diagnosis of symptoms are encrypted in the 1st level using RSA encryption and they are embedded in the mammographic image by itself in the 2nd level using bit plane slicing watermarking technique [10].

III. PROPOSED WORK

The prime object of GUI implemented here, is to get image from a directory and shows the compressed image and encrypted image in the single display to compare easily by original image.

An image is selected as an input, and this image is first compressed by using DCT. Now compressed image is encrypted by encryption process. This encrypted image is transmitted over the communication network. At the receiver end this encrypted image initially decrypted and this decrypted image is decompressed by using inverse DCT and finally original image is revealed. The entire process is as shown in figure 3.1. In this process colored image is compressed using DCT matrix. DCT convert the information contained by a color image in block (8×8) of pixel from special domain to frequency domain. The original color image is divided into 8-8 block and two- dimensional DCT is computed for each block. Color image decompression is done by decoding each of 8×8 blocks of compressed image, the entire operation done by inverse DCT.

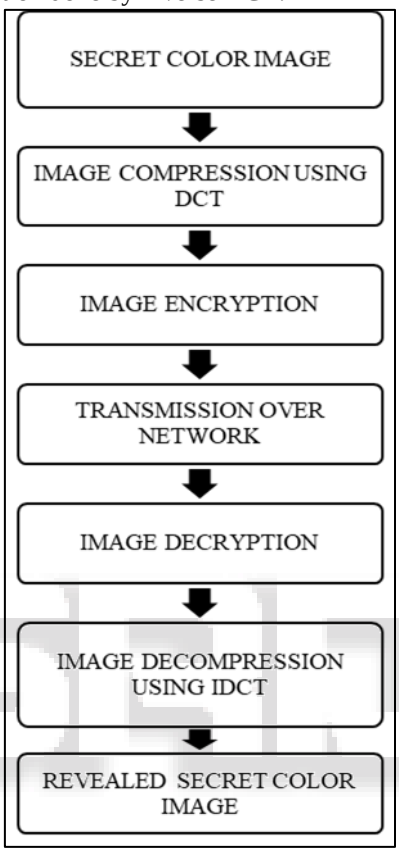

Fig. 3.1: Block Schematic of the proposed approach

A. *Graphical user interface*

A graphical user interface (GUI) is a user interface built with graphical function blocks (block components of GUI) such as push button, edit text, sliders and axes. The MATLAB GUI provides a set of tools for creating GUI shown in fig. 3.2. These tools generally specify the process of laying out, and programming in MATLAB callback to GUI. GUI generates ".fig" file and ".m" file that contain codes to handle the initialization of process, and GUI display shown in fig. 3.3. The ".m" file provides a frame work for the implementation of the callback function that functions execute when users active components in GUI.

B. *Observation*

For testing we have taken two different images. One is 'Lena.tif' and the second is 'bird.png'. The test images are chosen in such a way they can serve the purpose of through analysis of the algorithm. 'Lena.tif' is a 256×256×3 image and has homogeneous regions and gradual change of shades, and intensities of different color components. 'bird.png' on the other hand is a 320×320×3 image. This image has more heterogeneous regions as compared to the previous image and the different color components are more prominent.

Moreover the images taken for testing the algorithm are of different formats, i.e., one is tagged image file (.TIF) format and other is portable network graphics (.PNG) format So, the compatibility of the algorithm is also testified for different kind of image formats. We have analyzed the above process and implemented coding in MATLAB.

C. Component of RGB

A color image is consists of three primary colors red, green, and blue. So any system which displays a color image actually combines these three primary colors in different ratios to form any colors. The first operation that is performed on the image is to split the image into three different color component images. After that, the encryption and compression is done on each component image. After encryption and compression on three component images separately, the outputs again combined to form the final encrypted and compressed image.

D. Encryption and decryption

A given image is first compressed, and then the compressed image is encrypted by rearranging the bits of the compressed image. Conversely, a compressed-encrypted image is decrypted by reversing the rearrangement of the bits, using the same set of encrypt key which is used for encryption. Encryption and decryption process illustration of a single image matrix is shown in fig. 3.4. After the decryption, the compressed image can be decompressed to obtain the original image.

E. Encryption

This is done twice to reach a higher order of security and to achieve a higher compression as well. The first encryption is done by keeping the image pattern for compression, secret. This image pattern is the first key of the encryption, and after the compression another image pattern is applied to rearrange the bit sequence again, and this image pattern also kept secret. This encryption keys is applied after merging all the compressed bit planes. The second image pattern another key for encryption. The receiver should have the knowledge of both the keys to decrypt and decompress the received image. As encryption and decryption is done by the same set of keys, the encryption is known as symmetric key encryption that is shown in fig. 3.5.

F. Decryption

Once run length decoding is performed on each bit plane, the output bit stream is put back to the matrix form of its original size. Then the image pattern used prior to the image compression is again applied on the output image to rearrange the bits in correct order. This is done on each bit plane, and then all bit planes are merged to form the color component (red/green/blue) image. Then in the final step all these color component images are put together to form the retrieved RGB color image.

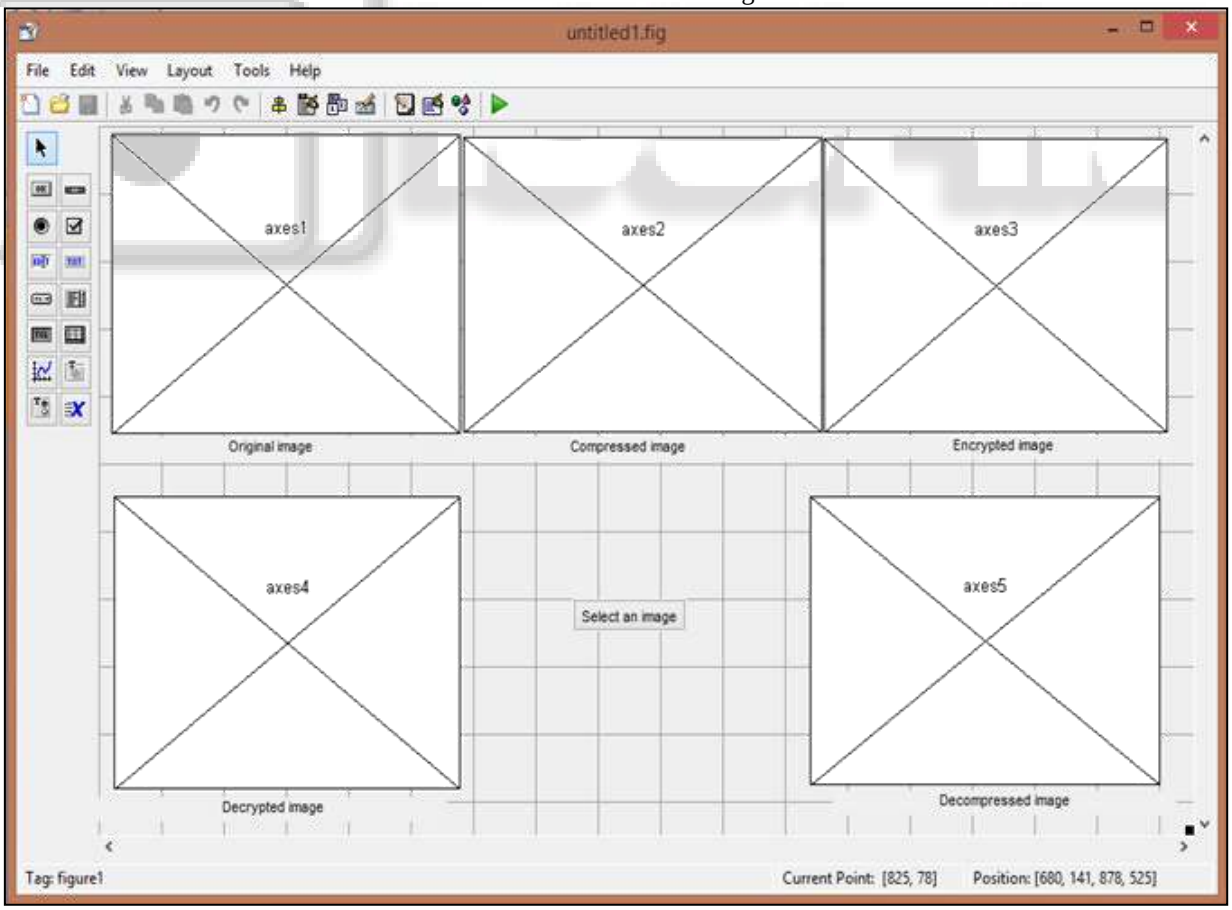

Fig. 3.2: Layout OF Axes

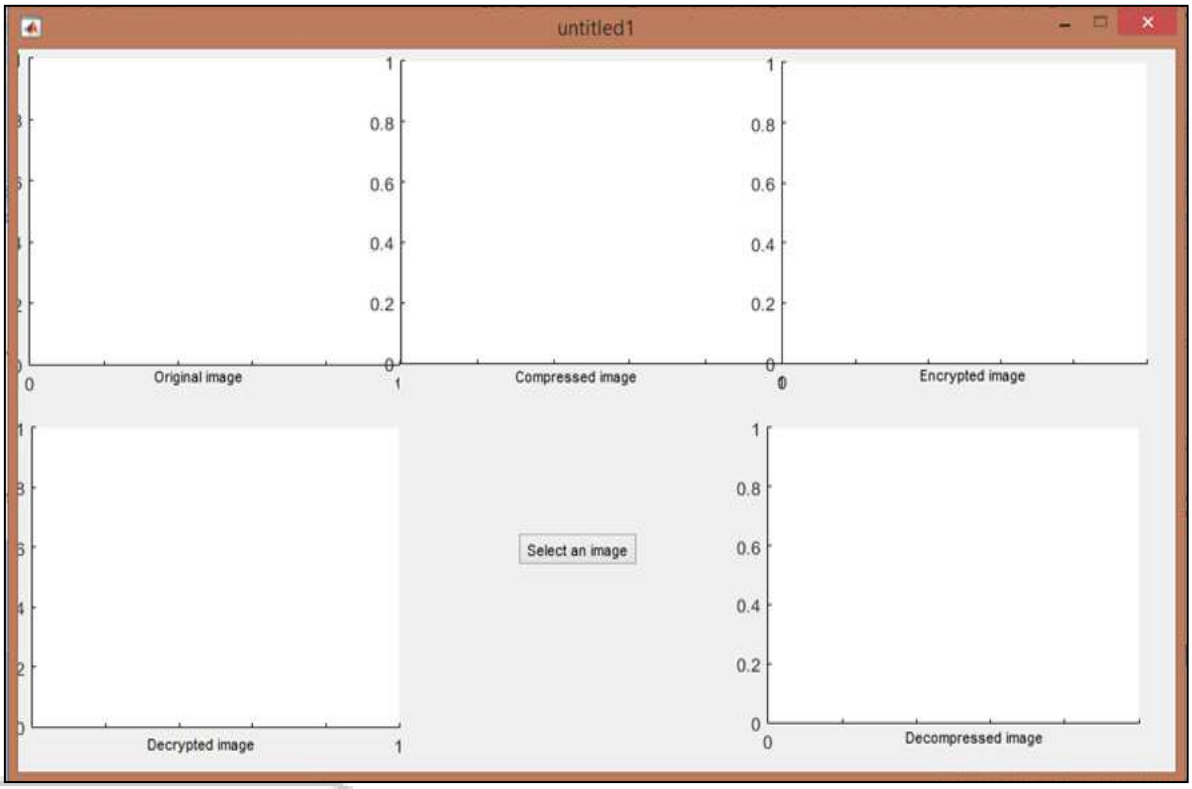

Fig. 3.3: Format of GUI Process

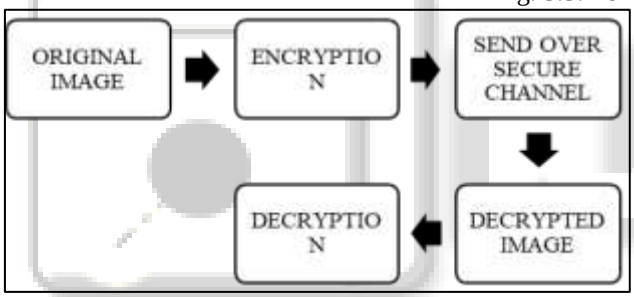

Fig. 3.4: Block Diagram of Encryption and Decryption Process

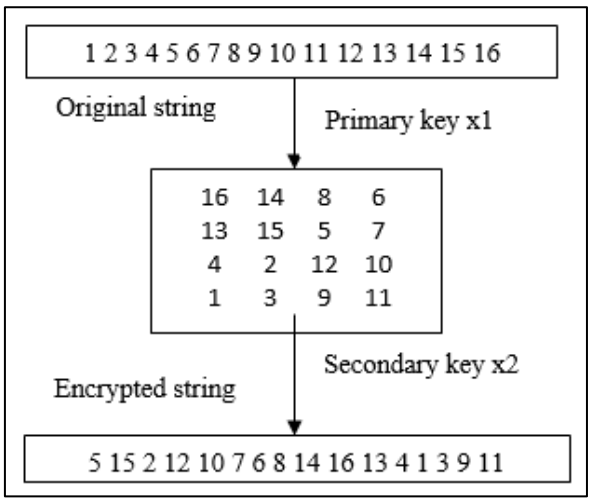

Fig. 3.5: Illustration of Encryption

IV. RESULT & ANALYSIS

The main advantage of GUI is that we don't required to edit program again and again for any image by using push button we can select any image that we want to perform compression and encryption process. Color image is implemented according to the description in section III and here we tested with different size of color image.

Initially we select first color image as an input. That is ".tif" format shown in fig. 4.1 by original image. This image is compressed by using DCT. This compressed image shown is as fig. 4.1 by compressed image. Then this compressed image is encrypted by encryption process, and this encrypted image shown in fig. 4.1 by encrypted image. The encrypted image is sanded over the communication channel. At the receiver end. Now encrypted image is first decrypted by decryption process. Now this decrypted image is decompressed by using inverse DCT process and reconstructed original image.

Now we select the second color image as an input that is in ".jpg" format is shown in fig.4.2 by original image. Second input image is compressed by using same process that used in first image and compressed image shown in fig.4.2 by compressed image. Now this compressed image is encrypted for the secure transformation that is shown in fig4.2 by encrypted image. Again this image receives at receiver end. The encrypted image is first decrypted then decompressed by decompression process.

The description of results for lena.tif and bird.jpg images shown in the form of table.4.1. explain compression ratio and compression factor based on original image size, and compressed image size. And the values of saving percentage and compression time are shown in table 4.2.

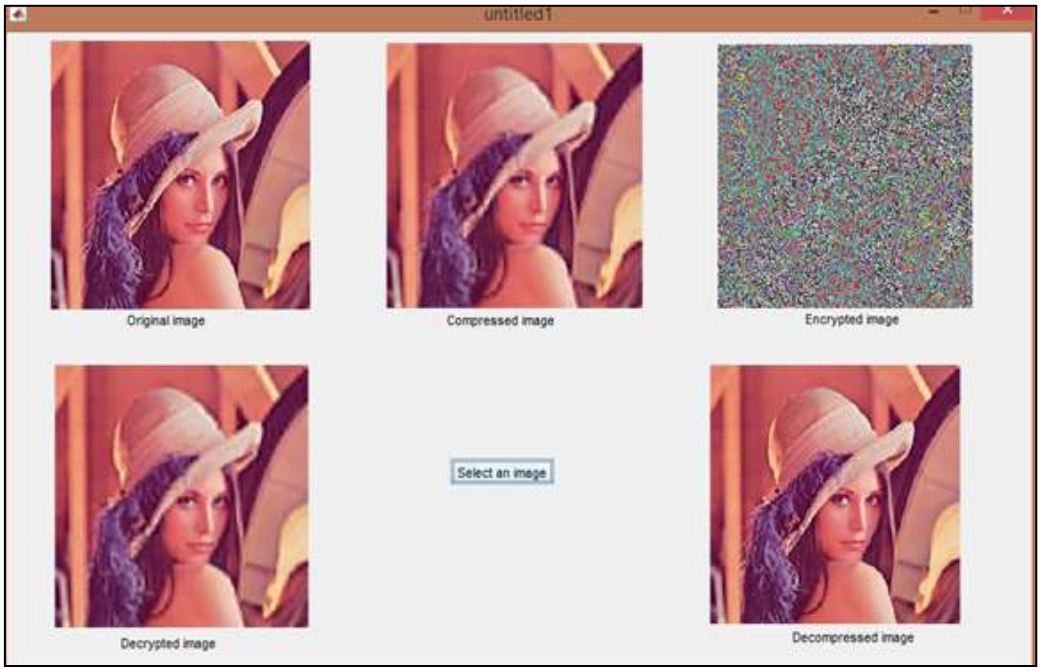

Fig. 4.1: ".tif" Image Compressed and Encrypted on MATLAB Based GUI

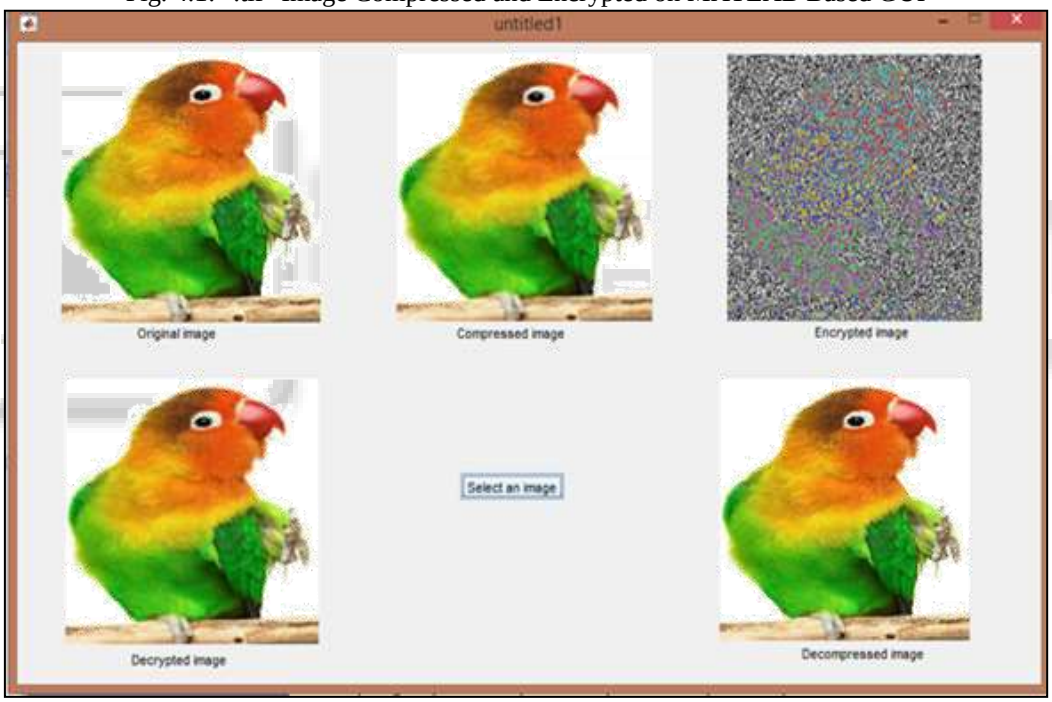

Fig. 4.2: ".jpg" Image Compressed and Encrypted on MATLAB Based GUI

Name of input image	Original image size (bytes)	Compress & encrypt image size (bytes)	Compression ratio (%)	Compression factor
Lena.tif	20401	6853	33.59	2.97
Bird.jpg	15919	9152	57.49	1.73

Table 4.1: Compression Ratio & Compression Factor

Name of input image	Original image size (bytes)	Compressed & encrypted image size (bytes)	Saving percentage (%)	Compression time
Lena.tif	20401	6853	66.40	12.57ms
Bird.jpg	15919	9152	42.50	18.01ms

Table 4.2: Saving Percentage & Compression Time

V. CONCLUSION

This paper use GUI in MATLAB performs both compression and encryption processes for color images. The main advantage of GUI is that we don't required to edit program again and again for any image. The encryption and compression processes are based on DCT. The first and foremost advantage of this algorithm is that it performs

compression and encryption simultaneously. So there is no need to go through separate algorithm to perform compression and encryption of a single image. As we know that LSB (least significant bit) has the least information about the image, while using this algorithm we can achieve great amount of compression. This will cost minimum information loss and compression ratio will much better. Also, it takes lesser compression time as compared to other techniques. The proposed compression process with encryption ensure more data security as compare to the existing image compression techniques while using transmission.

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