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Implementation of Hybrid Algorithm for Image Compression and Decompression

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Abstract— **The paper addresses the area of image compression and decompression using hybrid algorithm as it is pertinent to different grounds of image processing. On the basis of evaluating and analyzing different image compression techniques this paper presents the hybrid technique applied to different sets of images for compression and decompression. It also includes various benefits such as minimizing the size in bytes of a graphics file without degrading the quality of the image to an undesirable level. This devaluation allows more images to be stored in a given amount of memory space. Image compression involves the identification and removal of redundant and unnecessary elements of source image. A software algorithm has been refined and implemented to compress and decompress the given image using hybrid techniques in MATLAB software.**

Keywords—Lossless Image Compression; Lossless; Lossy; Redundancy; Irrelevancy; Huffman Algorithm; Lempel-Ziv-Welch; Simple Compression Technique; Compression ratio; Compression time; Compression factor; Saving percentage.

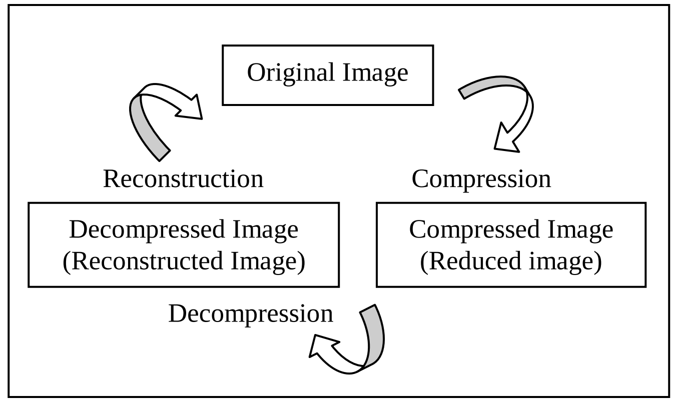

Fig 1: Compression and decompression process

I. INTRODUCTION

An image is an optical concept of a subject or the surrounding, by an individual. Although in the digital world, it is an assembly of precised building blocks, called as "picture element" or “pixels”. These pixels are arranged in a two-dimensional array. Images are very essential documents nowadays; depending on the purpose of the application they sometimes needs to be compressed. Now images are regarded as the leading information reservior in the world. They can fetch a lot more information to the receptor then a few pages of drafted information. Due to this authentic reason image processing has become a ground of research today. The transformations are basically are of two types; lossy that loose information when compressing the image and lossless that keep the same information as the original image. Since the information is power, so having it complete and discrete is of great concern in the leading edge. Thereupon in such cases lossless techniques are the best preference.

On the basis of evaluating and analyzing different image compression techniques this paper presents the hybrid technique applied to different sets of images for compression and decompression. It also includes various benefits such as minimizing the size in bytes of a graphics file without degrading the quality of the image to an unacceptable level. This devaluation allows more images to be stored in a given amount of memory space. Image compression involves the recognition and removal of redundant and unnecessary elements of source image. A software algorithm has been developed and executed to compress and decompress the given image using Hybrid techniques in MATLAB software.

II. LITERATURE SURVEY

The process of encoding rules that allows consequent devaluation in the absolute number of bits to store or transmit a file is called compression. It is the mechanism of making numerical or other information expressed in a form suitable for processing by computer more compact [7]. Image compression involves the identification and removal of redundant and unnecessary elements of source image. As cameras and display systems are moving high quality and as the amount of memory is reduced, one may also intend to preserve the aesthetic and precious images free from compression antiquity. Consequently, adequate lossless compression will become more meaningful, despite the fact that lossy compressed images are generally satisfactory in most of the cases. Autonomously, plenty of lossless image compression algorithms have been proposed.

The main goal of compression is to reduce the number of bits used to store or transmit information. A mechanism to encode the data so as to reduce the redundancy, could possibly provide a 30-80% reduction in the amount of data in a large commercial database[3].

This paper presents various types of image compression techniques[3]. There are basically two types of compression techniques first one is lossless Compression and other is lossy Compression Technique. Comparison between these techniques can be done accurately when comparison is done on same data , with same performance measures. SCZ(Simple Compression Technique) is applied for image compression .For compression and decompression it has separate routines in SCZ known as SCZ compression routines and SCZ decompression routines[16]. It leads to better compression and decompression ratio[16]. The proposed Huffman image compression algorithm is applied on different images. The experimental results for PSNR are between 39.55 dB to 67.83 dB and we achieved highest CR up to 1.61. The reconstruction of image is near lossless with Huffman algorithm[14].

Now images are regarded as the leading information reservoir in the world. They can fetch a lot more information to the receptor then a few pages of drafted information. Due to this authentic reason image processing has become a ground of research today. The experiment confirms that the higher data redundancy helps to achieve more compression. The presented new compression and decompression technique called as HL design based on Huffman coding and Lempel Ziv coding is very productive technique for compressing the image to a greater extent [13]. The HL technique also results in an algorithm with convincing time and becomes most apparent for big images [13]. Since, the reproduced image and the actual image are equal; the HL technique is a lossless compression technique [13]. The execution of the proposed compression technique using hashing and human coding is operated on GIF,TIFF formats[10]. This technique can be applied on luminance and chrominance of color images for getting better compression [10]. The benefit of such a technique is that it can shrink the image more as compared to other techniques [17]. The flaw afterwards is that if pixel of an image replay relative than its described position then this technique is not much suitable. Hence KMK technique will compress the pixels when they will be reciprocated in three directions either vertically, horizontally or diagonally [17]. It can even increase the capacity of an image however this is not possible because maximum filling of pixels[17].

Medical imaging appliances bring about large volumes of medical information leading to challenges for transmission and communication. In this paper, a novel lossless 3D compression scheme for medical image delivery is proposed[18]. It is based on Prediction by Partial Matching (PPM) in amalgamation with 3D JPEG-4 compression [18]. This scheme is intended for stimulating the delivery of data over the Internet and consequently we are concerned with both compression ratio and decompression time[18]. Experimental results illustrate that the proposed scheme is efficient and feasible in terms of both compression ratio and decompression speed[18]. In this letter, an efficient lossless compression scheme for hyperspectral images is presented[19]. The proposed scheme uses a two-stage predictor[19]. The stage-1 predictor takes benefit of spatial data correlation and formulates the derivation of a spectral domain predictor as a process of Wiener filtering[19]. The stage-2 predictor takes the forecasting from the stage-1 predictor as an initial value and performs a backward pixel search (BPS) scheme on the current band for the concluding prediction value[19].

Image compression plays a key role in many crucial applications, along with image database, remote sensing, image communications, etc [11]. The Proposed Technique is used to enhance the Peak signal of Noise Ratio (PSNR), compression ratio (CR), and Mean Square Error (MSE) in the MATLAB Software [5]. Based on the hierarchical prediction and context-adaptive arithmetic coding, a new lossless color image compression algorithm is proposed [9]. An entropy rule-based generative coding method is used to generate variable length codewords, and the resulting codewords are utilized to encode image where codewords are designated to pixel extremity values based on their possibility of occurrence [5]. The Golomb family of codes is ideally suited to the transformation of data with geometric distribution. Since it does not require a coding table, it has greater coding efficiency than Huffman coding[5]. For the lossless compression of an RGB image, it is first decorrelated by a shifting color transform and then Y component is encoded by a conventional lossless grayscale image compression method [2].

These compression techniques endow with the assurance that no pixel difference between the actual and the compressed image is above a given value.

III. BACKGROUND FOR IMAGE PROCESSING

Images are characterized by the pixels. A common aspect of most of the images is that the neighboring pixels are correlated and accordingly contain redundant information. The two supporting components of compression are irrelevancy and redundancy.

1. ***Redundancy*** - The property induced in an image due to redundant bits is called as redundancy. It means the duplication of data in the image. Elimination of such data is called redundant data reduction. It thus helps to achieve a minimal storage space for an image and results in image compression. There are three types of redundancies.

A. Inter Pixel Redundancy

The intelligence carried by individual pixels is comparatively small. In image neighboring pixels are not numerically independent, due to the correlation between them. The dependencies between values of pixels in the image is called interpixel redundancy sometimes also called as spatial redundancy. Transformations that expel interpixel redundancies are termed as mapping.

B. Psycho Visual Redundancy

This type of redundancy correlate different sensitivities to all image signals by human eyes. Consequently, eliminating some less referring information in the visual processing is acceptable. Many tests on the physical aspects of human vision represents that, the human eye does not respond with same sensitivity to all incoming visual information. Eradicating psychovisual redundancy results in the loss of quantitative information which is referred to as quantization. Quantization refers to mapping of a broad range of input values to a limited number of output values. The algorithms used to exploit this type of redundancy are the Discrete Cosine Transform (DCT) based algorithm.

C. Coding Redundancy

Coding redundancy is usually implemented using lookup tables (LUTs) and it is always reversible. The uncompressed image is coded with each pixel by a anchored length. The Huffman codes and the arithmetic coding technique are the examples of schemes that explore coding redundancy.

2. ***Irrelevancy –*** Irrelevancy deals with the actual information in the picture that is purposely removed in order to reduce the required bits for storing. Eradication of such irrelevant information comes at the cost of information loss that cannot be recovered. In order to justify this, the removal of information which is least perceivable by the human visual system is performed. Irrelevance reduction is only used in lossy coding.

IV. NEED FOR HYBRID LOSSLESS COMPRESSION

Lossless image compression makes use of compression algorithms that allows the exact original image to be reconstructed from the compressed image. As cameras and display systems are moving high quality and as the amount of memory is lowered, one may intend to keep the creative and aesthetic pictures free from compression flaws. Thus efficient lossless compression will become more essential. This can be contrasted to lossy image compression, which does not follow the exact original image reconstruction from the compressed image. Lossless compression is beneficial if it is necessary for the original and the decompressed image to be identical. It is generally used when no assumption can be made on whether certain deviation is uncritical.

Since raw images need large amounts of disk space it seems to be a big disadvantage during transmission & storage. Thus there is a need for an efficient technique for compression of images.

V. IMAGE DECOMPOSITION AND PIXEL PREDICTION

The chrominance channels usually have different statistics from luminance channels, and also different from the original color planes R(red), G(green), and B(blue). The overall signal variation in chrominance channels is suppressed by the color transformation., but the variation is still large near the object boundaries. Hence, the prediction errors in a chrominance channel gets more decreased in smooth region, however it remains comparatively large close to the edge or in reach of a texture region. It is thus necessary to evaluate the pdf of prediction error correctly for better compression. For this, we propose a decomposition scheme as shown in Fig. 2, which shows that pixels in an input image *X* is separated into two subimages: an even subimage *Xe* and an odd subimage *Xo*. Then, *Xe* is encoded first and is used to predict the pixels in Xo. In addition, *Xe* is also used to find out the statistics of prediction errors of *Xo*. For the compression of *Xo* pixels using *Xe*, directional prediction is hired to avoid large prediction errors in the adjoining edges. For each pixel *xo(i, j)* in *Xo*, the horizontal predictor $\hat{x}_h(i,j)$ and vertical predictor $\hat{x}_v(i,j)$ are defined as

$$\hat{x}_h(i,j) = x_o(i, j-1)$$
$$\hat{x}_v(i,j) = \text{round}\{x_e(i, j) + x_e(i+1, j)/2\}, \quad (i)$$

and one of them is preferred for predicting f *xo(i, j).*

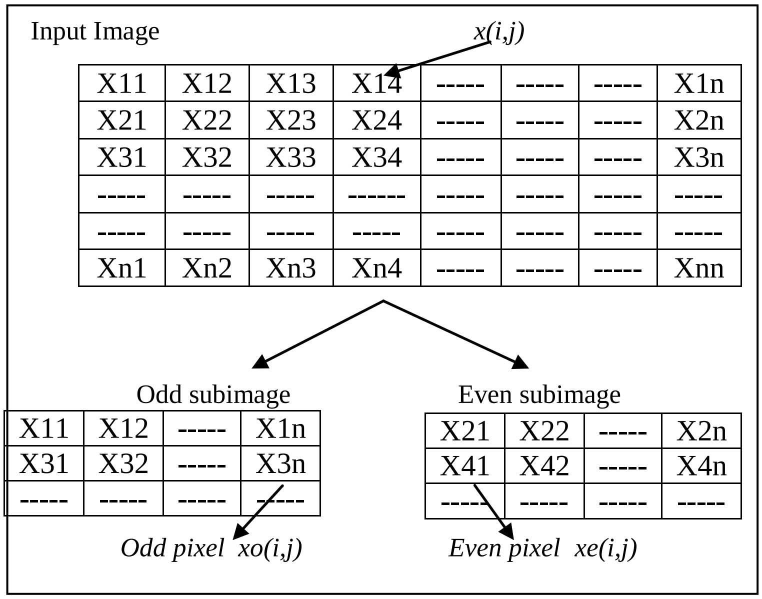

Fig 2: Image Decomposition

With these two possible predictors, the most common way to encoding is “mode selection,” where better predictor for each pixel is selected. The horizontal predictor is more definite only when there is a firm horizontal edge. The vertical predictor is used for most pixels, and mode selection is used only when the pixel seems to be on a firm horizontal edge. For implementing this idea, we define a variable for the direction of edge at each pixel *dir(i, j)*, which is given either H or V. It is given H only when the horizontal edge is strong, and given V for the rest. Based on the directions of pixels, the overall prediction scheme is summarized in the flow chart shown below.

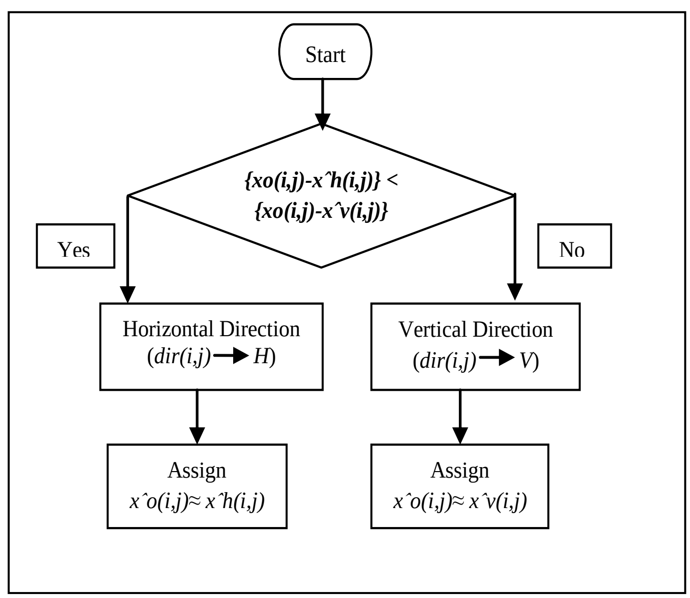

Fig 3: Flow chart for finding the odd component and the direction of prediction.

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VI. PROPOSED WORK

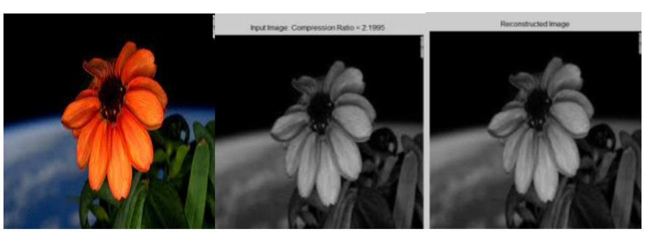
An input RGB color image is first transformed into color space by an RCT. The color space consists of luminance channel and chrominance channel. The luminance channel is encoded by any of lossless grayscale image coders. The chrominance channel is first decomposed into two parts i.e. even subimage xe and odd subimage xo and its pixels are defined as *xe(i,j)* and *xo(i,j). xe* is compressed first and then it is used to estimate the errors in *xo*. The chrominance channels usually have different statistics from luminance channels , and also different from the original color planes R(red), G(green), and B(blue).The chrominance images are encoded using image decomposition. To be specific, a chrominance image *X* is decomposed row by row into an even subimage *Xe* and an odd subimage *Xo* as shown in Fig. 2. The subimage Xo is predicted and encoded using *Xe*. The subimage Xe can be further decomposed column by column into the even subimage *Xe*. For the adequate compression, the prediction errors should be characterized by a relevant model. Here, *Pn* is the level of quantization steps of pixel activity $\sigma(i,j)$ represented as

$$\sigma(i, j) = |xe(i, j) - xe(i + 1, j)|. \qquad (ii)$$

The local activity and its quantization steps are evaluated with the pixels in an even subimage (*Xe*), since all the pixels of *Xe* possess almost same statistical properties as that of *Xo*. The local activity is quantized into M steps such that *Pn* represents the step.

$$qn-1 \leq \sigma(i, j) < qn \qquad (iii)$$

for $n = 1, . . . , M$ with $q0 = 0$ and $qM = \infty$. The length of quantization steps is determined such that every step consist of the same number of elements (local activities). Hence the proposed model can be effective for the compression with huffman coding.



Original Image Compressed Image Decompressed Image

Fig 4: Image Output

VII. SIMULATION RESULTS

The compressed file size is compared with the source file size. Also the compression time increases as the source file size increases and in contrast the compression ratio decreases as the source file size increases This algorithm gives a good compression ratio that lies between 30% and 50%. The results are depicted in the table 1.

Table 1. Result analysis for Hybrid algorithm

SN	Files	Original File size (bits)	Compression Ratio	Compression Time (seconds)	Decompression Time (seconds)
1	Girl	153×153	3.6324	3.142	3.942
2	Rose	240×240	2.7726	2.107	3.338
3	Eye	256×256	2.6224	2.299	2.891
4	Lena	512×512	2.3212	4.199	4.514
5	Brain	800×800	2.8087	3.431	3.850

An experimental comparison between various existing lossless compression algorithm and hybrid algorithm for different images is carried out. The CPU time utilized for compression and decompression are also compared. The values obtained after comparing are in an acceptable range. After comparison it can be observed that the hybrid method performs in an efficient manner and gives better results. The results obtained are shown in t, table 2 and table 3.

Table 2. Comparison based on compressed bit rates.

SNo.	Files	Original File size (bits)	Compression Ratio		
			Huffman	LZW	Hybrid
1.	Girl	153×153	1.143	1.911	3.632
2.	Rose	240×240	1.041	1.856	2.772
3.	Eye	256×256	1.126	1.347	2.622
4.	Lena	512×512	1.079	1.381	2.321
5.	Brain	800×800	1.091	1.346	2.808

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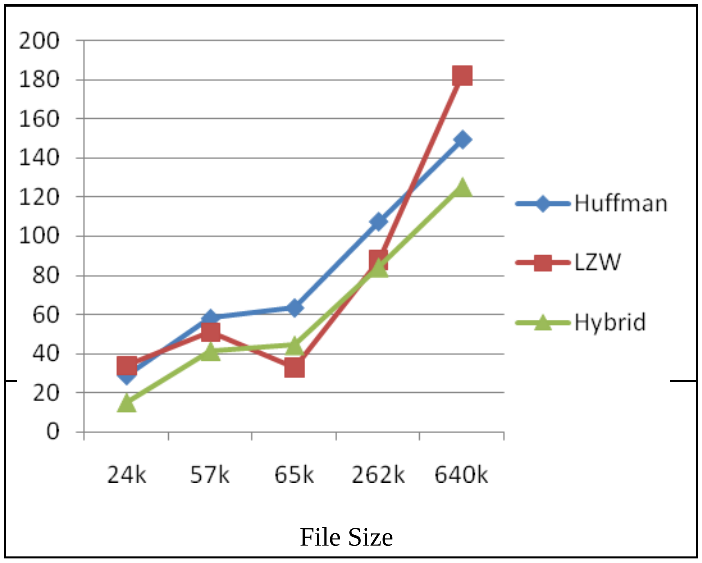

Fig 5: Compression Times

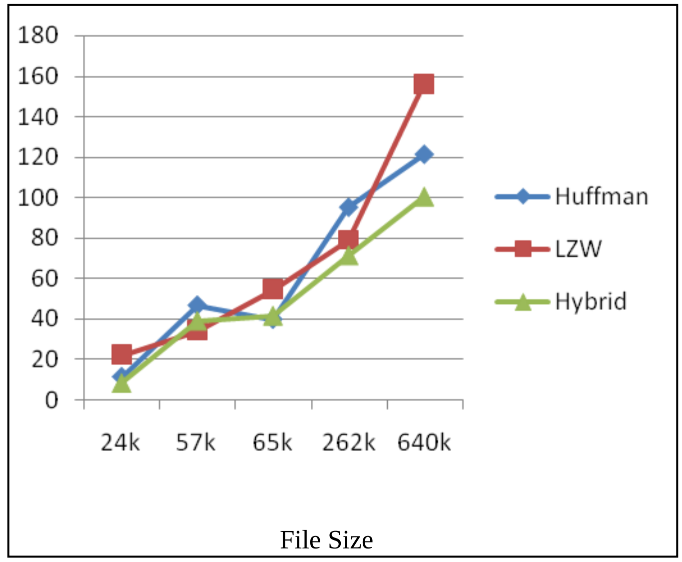

Fig 6: Decompression Times

The CPU time utilized for compression and decompression by the hybrid algorithm is also shown in the table 2 & table 3.

Table 3. Comparison based on CPU time utilized for compression and decompression.

Files	Lossless Algorithms					
	Compression time			Decompression Time		
	Huffman	LZW	Hybrid	Huffman	LZW	Hybrid
Girl	18.407	13.101	3.142	19.345	13.899	3.942
Rose	17.979	13.215	2.107	18.396	13.944	3.338
Eye	13.033	12.667	2.299	13.078	12.443	2.891
Lena	5.281	18.697	4.199	5.930	19.011	4.514
Brain	8.412	8.331	3.431	9.021	8.912	3.850

An experimental comparison between various existing lossless compression algorithm and hybrid algorithm for different images is carried out. The values obtained after comparing are in an acceptable range.

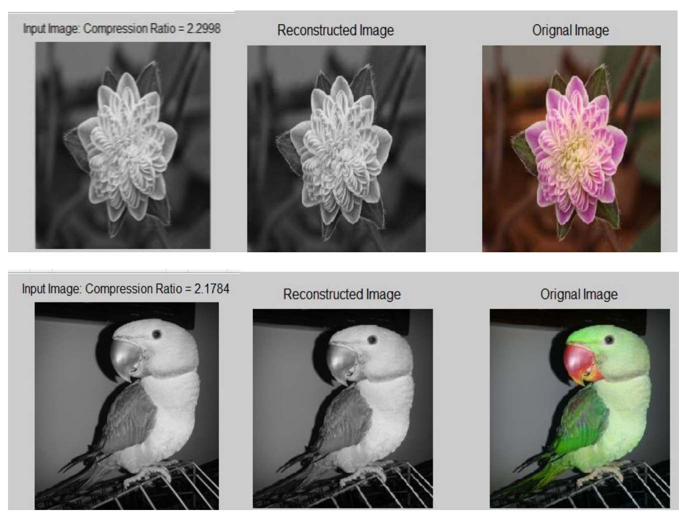

Fig 7. Processing of the input image

The proposed method is applied on various types of images such as medical images, classical images, commercial digital camera images etc. The simulation results shows that the proposed scheme has better efficiency and it outperforms other schemes.

The compression ratio lay between 43% to 52% . The values obtained after comparing are in an acceptable range.
Some of the images that has been used to compress using the hybrid technique as well as other lossless techniques is shown below.

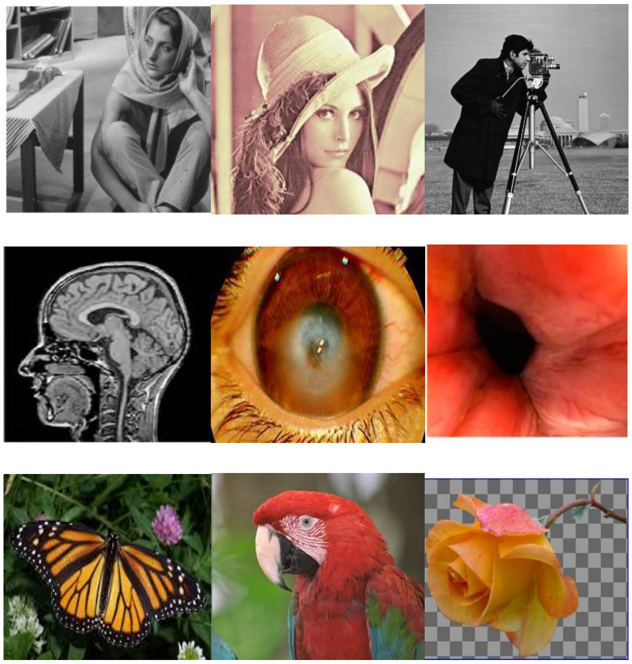

Fig 8:Test images used for compression and decompression.

VIII. CONCLUSION

The paper presents a hybrid compression and decompression algorithm. The proposed method is lossless. The paper has also discussed the performance of the hybrid scheme with other existing lossless schemes. The simulation results shows that the proposed scheme has better efficiency and it outperforms other schemes that are shown in the table(2). The advantage of such a technique is that it can compress the image more as compared to other techniques. The hybrid technique proposed in the paper will give us better image resolution without any loss in the image. It will not only reduce the storage requirement but also the overall execution time. Compression and decompression times for hybrid algorithm are comparatively low. The compression ratio lay between 43% to 52% .

IX. FUTURE SCOPE

Today images are regarded as the leading information reservoir in the world. They can fetch a lot more information to the receptor then a few pages of drafted information. Due to this authentic reason image processing has become a ground of research today. The main goal of compression is to reduce the number of bits used to store or transmit information. The advantage of the proposed lossless hybrid technique is that it can compress the image more as compared to other techniques and it will give us better image resolution without any loss in the image. It will reduce feasibility of transmission errors on account of fewer bits are transformation and will even provide security against unauthenticated users in future. As a future prospect more focus shall be on the enhancement of compression ratio.

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