ENHANCED IMAGE COMPRESSION AND PROCESSING SCHEME

ABSTRACT

Image compression refers to the process of encoding image using fewer number of bits. The major aim of lossless image compression is to reduce the redundancy and irreverence of image data for better storage and transmission of data in the better form. The lossy compression scheme leads to high compression ratio while the image experiences lost in quality. However, there are many cases where the loss of image quality or information due to compression needs to be avoided, such as medical, artistic and scientific images. Efficient lossless compression become paramount, although the lossy compressed images are usually satisfactory in divers' cases. This paper titled Enhanced Lossless Image Compression Scheme is aimed at providing an enhanced lossless image compression scheme based on Bose, Chaudhuri Hocquenghem- Lempel Ziv Welch (BCH-LZW) lossless image compression scheme using Gaussian filter for image enhancement and noise reduction. In this paper, an efficient and effective lossless image compression technique based on LZW- BCH lossless image compression to reduce redundancies in the image was presented and image enhancement using Gaussian filter algorithm was demonstrated. Secondary method of data collection was used to collect the data. Standard research images were used to validate the new scheme. To achieve these, an object approach using Java net beans was used to develop the compression scheme. From the findings, it was revealed that the average compression ratio of the enhanced lossless image compression scheme was 1.6489 and the average bit per pixel was 5.416667. Gaussian filter image enhancement was used for noise reduction and the image was enhanced eight times the original.

Keywords: Enhanced, Image, Lossless, Compression, Processing

1. INTRODUCTION

The growth and development of modern information and communication technologies, has led the demand for data compression to increase rapidly. Recent development in the field of Computer Science and information has led to the generation of large amount of data always. As a result, the rate at which storage and transmission of data rapidly grows. According to Parkinson's First Law, the need for storage and transmission increases at least double as storage and transmission capabilities increases

Generally, image compression is the form of data compression where image information is represented in a reduced format for better image storage and transmission. The main issue in image compression is the redundancy in the image. Redundancy refers to the situation where the same data content is repeated or replicated several times in the image. Image redundancy can be inter-pixel, coding redundancy and psycho visual redundancy [3]. Coding redundancy exist when less than the normal code for representing the information are used. Inter pixel redundancy exist when there are correlations among the pixels of an image. On the other hand, when date is ignored due to human visual system, it is best known as psycho visual redundancy. Compressing an existing file to look partial of its real size is corresponding to exact repetition of the capability of the storing data [12]. It can then develop reasonable to collection the data at a developed equal, hence quicker,

equal of the storing order also decrease the capacity on the input/output channels [9].

2. LITERATURE REVIEW

There are many literatures in the field of lossless image compression and image processing. Each of these research is channeled towards improving either the compression ratio, bits per pixel, and other parameters.

[6] implemented block estimation and image distortion rate to optimize the compression ratio and to minimize the error rate. Results from the experiment indicated that the proposed model gives a high compression ratio and less rate compared to traditional compression schemes.

[14], presented analysis image compression uses three transform methods which includes discrete cosine transform (DCT), discrete wavelet transform (DWT) and hybrid (DCT+DWT) transform. They used MATLAB code to understand the image compression algorithm followed by coding each of the method and the result obtained shows that SVD-DCT-DWT schemes performs much better than the JPEG based DCT, DWT schemes in terms of Peak Signal to Noise Ratio (PSNR), Compression Ratio (CR) as well as visual appealing at higher Compression Ratio.

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[16] aimed to increase the compression ratio of an image by applying pre-defined low pass filter before applying standard image compression encoders. Low pass filter has the effect of increasing interdependence between the neighboring pixels which can significantly improve the compression Ratio. The development of the restoration process in their study is based on the theory of least squares and take into consideration the knowledge of the filtered image and the low-pass filter applied to the original image.

[22] proposed a VLSI implementation of an enhanced lossless compression scheme for electrocardiogram (ECG) data encoding to reduce storage space and scale down transmission time. The algorithm was able to achieve a lossless bit compression rate of 2.77. [14] presented an analysis of histogram sparseness impact on lossless image compression and come up with an improved compression performance for sparse histogram images. The scheme takes an advantage of high neighboring blocks. There experimental results show that their method performs more than JPEG-LS, CALIC and JPEG 2000 while achieving lower bit rate. [21] performed a lossless image compression on satellite images using a hybrid Discrete Wave Transform and Run Length Encoding (DWT-RLE) algorithm leading to a higher compression ratio. The algorithm was implemented and run using software tools provided by MABLAB. From the result obtained, it was observed that RLC enhances the compression result by replacing the repetitive long runs of truncated data with only a single value and count. [24] presented a big data mining approach to represent an image codebook. They proposed a soft compression scheme on multi-components medical images which represents the basic image structure. The results show that their soft compression scheme performs more than the popular standard PNG and JPEG2000 in respect to compression ratio. In a related research by [19], they proposed a hybrid lossless scheme with features of 3D medical images. They utilized three stages as follows: they determine the volume of interest (VOI) for the 3D medical imagery by selective bound volume (SBV) method, then the selected VOI is encoded by the use of LZW which is hybrid lossless algorithm the followed by arithmetic coding, from the result, it indicated that proposed 3D medical image compression method can be compared with other existing

lossless compression standards such as RLE, LZW, Arithmetic coding and Huffman coding. And the result obtained is far better. In a research conducted by [16] on the analysis of lossless data compression schemes. They based their research on the low bandwidth networks. They tested the various lossless image compression algorithms and compared Huffman, LZW and RLE algorithms which they concluded that Huffman performs better on huge data than LZW and RLE algorithms. [14] proposed a new lossless image compression method that is based on pixel values learning and contexts through multi-layer perceptions (MLPs). They combined channel-wise progressive learning, residual learning and duple network in their MLP which improved coding gain compared to conventional methods. This shows that their method performs more than the conventional non-learning schemes and the new learning based compression methods in terms of time complexity.

[4] in his work explained how image and picture are defined in our daily life and clearly discussed three operations that can be performed on an image which include sharpening the edges, noise removal and removing the motion blur for an image. [7] , proposed an algorithm to improve the overall accuracy of the hand written character under pattern recognition field using image processing techniques like feature extraction, image restoration and image enhancement. [23] however stated that the digital image processing concepts are carried out by different techniques and highlighted noise and edge detection algorithm. They further stated another two concepts like mean and median filtering for radiographic images and compared them. [11] focused on the security-based system by modern digital image processing. Also, this paper gives a way to process a video from variety of video devices. First set the continuous frames from the videos then it had been processed under SUSAN for extracting the features. [16] presents the data clustering for clustering of objects. A particular algorithm is used for group detection from an image using distance metrics through linear features. [2] proposed that the main contribution of this research is plant phenotyping research or the automation of research in image acquisition to minimize the data at geo referencing errors and for modular data visualizations and also fastest data collections.

[20] proposed a JPEG image compression and decompression by Huffman coding, the main concern of their research is based on compression and decompression of gray scale images. According to the research, 2D-DCT can be used for the transformation of 8 x 8 matrix of images to an elementary frequency of elements.

[11] reviewed various image processing operations to illustrate the basic concepts and to use them in different fields with minor changes in the methodology. The work also discusses about the basic technical aspects of digital image processing with reference to be categorized into three groups as: Image Rectification and Restoration, Enhancement and Information Extraction. Importance of digital image processing and its applications are also discussed from the fields of computer vision and other applications. An image is defined as an array, or a matrix, of square pixels arranged in rows and columns. Image processing is a procedure of converting an image into digital form and carry out some operation on it, in order to get an improved image and to retrieve some important information from the image.

[5] proposed a hardware implementation of an image filtered using 2D Gaussian Filter. The Gaussian filter architecture described using a different way to implement convolution module. Thus, multiplication is in the heart of convolution module, for this reason, three different ways to implement multiplication operations was presented. The first way is done using the standard method. The second way uses Field Programmable Gate Array (FPGA) features Digital Signal Processor (DSP) to ensure and make fast the scalability of the effective FPGA resource and then to speed up calculation. The third way uses real multiplier for more precision and the maximum uses of FPGA resources. Also, they compare the image quality of hardware (VHDL) and software (MATLAB) implementation using the Peak Signal-to-Noise Ratio (PSNR). Finally, the FPGA resource usage for different sizes of Gaussian kernel were presented in order to provide a comparison between fixed-point and floating point implementations.

3. MATERIAL AND METHODS

Bose Chaudhuri and Hocquenghem (BCH), for image encoding, error detection and correction, LZW for dynamic compression of the image file and Gaussian filter to improve the enhancement of the image, filter and reduce noise in the image data was used for the purpose of this research. For the purpose of this research, fifteen research images were used to test the validity of the scheme and later, 2D Gaussian filter algorithm was used to enhance the image and reduce noise. Image 1 describe the general compression method and the decompression steps involved. Java NetBeans programming Language was used to implement the algorithm and the images were used for test data. Some of the analysis was done using MATLAB

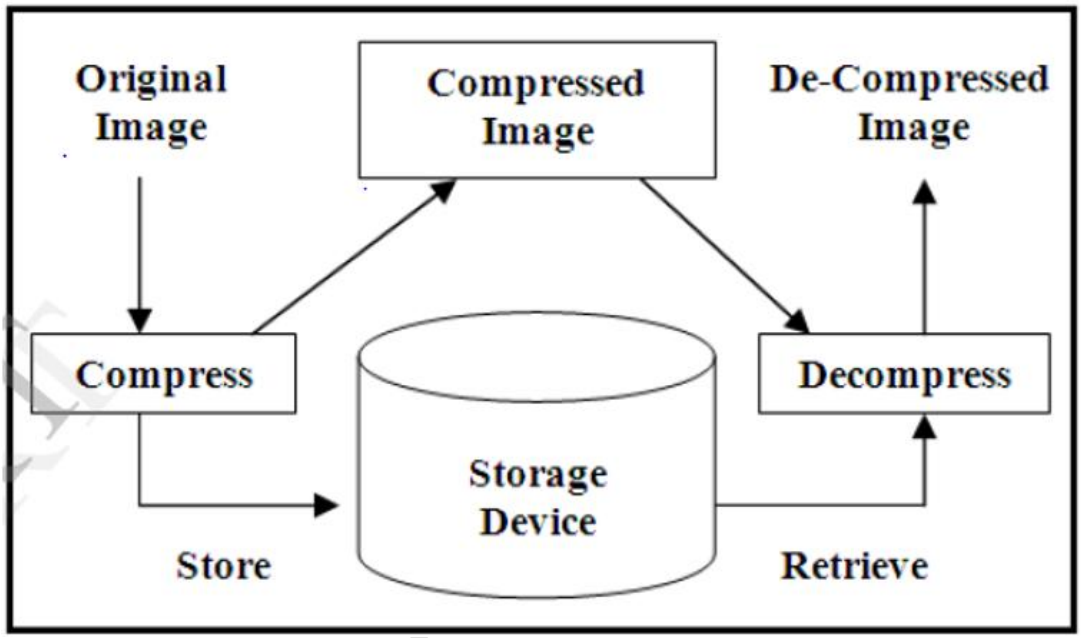

Figure.1. General Image Compression System Model

3.1 LZW ENCODING AND DECODING ALGORITHM

LZW Encoding: LZW encoding is working based on the occurrence multiplicity of bit sequences in the pixel to be encoded. Its principle consists in substituting patterns with an input image, by progressively building a dictionary.

i. Initial table with initial character strings
ii. Q=first input character
iii. WHILE not end of input stream
iv. S=next input character
v. IF Q+S is in the string table
vi. Q=Q+S
vii. ELSE
viii. output the code for P
ix. add Q+S to the string table
x. Q=S
xi. END WHILE
xii. output code for P

LZW Decoding: In decoding process, the algorithm rebuilds the dictionary in the opposite direction; it thus not needs to be stored.

i. Initialize table with single character strings

ii. OLD = first input code
iii. output translation of OLD
iv. WHILE not end of input stream
v. NEW = next input code
vi. IF NEW is not in the string table
vii. S = translation of OLD
viii. Q = S+C
ix. ELSE
x. S = translation of NEW
xi. output S
xii. C = first character of S
xiii. OLD + C to the string table
xiv. OLD = NEW
xv. END WHILE

3.2 Bose, Chaudhuri and Hocquenghem (BCH) Algorithm

The image is first converted into binary input image and is divided into blocks of size 7 bits each; only 7 bits needed to represent in each byte, 128 value in total, while eighth bits represent sign of the number (most significant bit) that don't affect the total value of blocks, and converts it to a galore field to be accepted as an input to the BCH. Each block is decoded using BCH decoder, then is checked if it is a valid codeword or not. The BCH decoder converts the valid block to 4 bits. The proposed method will adds 1 as an indicator for the valid codeword to an extra file called (map), otherwise if it is not a codeword, it remains 7 and adds 0 to the same file. The benefit of the extra file (map) is that it is used as the key for image decompression in order to distinguish between compressed blocks and the not compressed ones (codeword or not). After the image is compressed, the file (map) is compressed by RLE to decrease its size, and then it is attached to the header of the image. conclude that if we try to decode more it will affect the other performance factor that leads to increase time needed for compression, and the map file becomes large in each time the image is decode by BCH. The following are the basic steps involved in the BCH encoding processes of image compression:

Step 1: A pre-processing step: This step converts the image into a series of binary numbers or digits.

Step 2: This step applies the (7, 4) BCH decoders on these binary digits in step 1 and converts each block of size7 bits into a 4-bit length. Note that not all blocks of size 8 bits are codewords; some of the 8-bit blocks are non-codewords. Therefore, we use an extra bit to distinguish between codewords and non-codewords. We add 1 bit if the bit block is a codeword and 0 bits if it is not a codeword to an additional file called an added bitfile. The block that is a valid codeword is converted to a 4-bit block instead of a 7-bit block.
Whereas the invalid codeword moves as it is, without any compression, into the compressed binary file.

Step 3: Implement the compression LZW on the binary numbers to compress the image file.

Step 4: Output the compressed file.

Step 6: Decompressed the file.

3.3 Gaussian Filter Algorithm

Gaussian smoothing is one of the most common image smoothing method. Gaussian filter is a non-uniform low pass filter. It is used to blur images and remove noise and detail.
The general equation and function of Gaussian filter in one dimension is given by:
The standard deviation of a Gaussian function plays a vital role in the behavior of the function.

$$G(x) = \frac{1}{\sqrt{2\pi\sigma x^2}}\, e^{-x^2/2\sigma^2} \qquad (1)$$

Where σ is the standard deviation deviation of the distribution.
The standard deviation of the Gaussian function plays a vital role in the behavior of the function. The values located between $+/-\sigma$ account for about 68% of the set, while two standard deviation from the mean value (blue and brown) account for 95%, and three standard deviations(blue, brown and green) account for 99.7 %. This information is very vital when designing a Gaussian Kernel of fixed length.
The Gaussian function is used to defines a probability distribution for noise or data and used as a smoothing operator.
The Gaussian function can be verified with respect to its integral given below:

$$I = \int_{-\infty}^{\infty} exp(x^2)dx = \sqrt{\pi} \qquad (2)$$

Where *I*is the Gaussian integral and *x* is a variable and *π=3.142*
In probability distribution, it describes 100% of the possible values of any given space when alternating from negative to positive values. Gauss function is never equals to zero but a symmetric type of function.
Two-dimensional Gaussian function is used when working with images because images are in two dimensions. Product of two 1D Gaussian functions one for each direction is given by:

$$G(x,y) = \frac{1}{2\pi\sigma^2} e^{-\frac{x^2+y^2}{2\pi\sigma^2}} \qquad (3)$$

Where *x and y* represent the dimensions, σ represents the standard deviation.
Which is the Gaussian kernel coefficients sampled from the 2D Gaussian function where σ isthe standard deviation of the distribution. The distribution mean is assumed to be zero. The continuous Gaussian function need to be discretized to store the values as discrete pixels.

Gaussian Blur Algorithm

Step one: Take a pixel as the average value of its surrounding pixel.
Step two: The center point pixel will take the average value of its surrounding points, from the value perspective, it is smoothing. The Centre point will lose its details.
Step three: If the value length is very large, then the blur effect is very strong.

4. RESULTS AND DISCUSSION

Table 1 BCH Code Table.

S/n	Image name	Original image size (kb)	Codeword	Non codeword	No of block
1	Cameraman	256	34854	226307	261161
2	House	512	201175	272798	573973
3	Jet Plane	512	206174	385176	591320
4	Lake	513	194326	374195	568521
5	Lena Colour256	192	249072	179256	204228
6	Lena colour512	969	100598	716714	816772
7	Lena gra256	64.2	8722	60141	68863
8	Lena Gray512	256	337990	229412	273211
9	Living Room	256	106309	229412	808200
10	Mandrill Colour	768	106304	701891	808200
11	MandrillGray	256	34596	244217	278813
12	PeperColour	514	200913	361370	562283
13	Pepper Gray	512	1900089	378228	568317
14	Pirate	256	33760	236295	270055
15	Walk Bridge	512	199067	368394	567461
16	Woman Blonde	256	36170	246278	282448
17	Woman Darkhair	245	30513	230821	262333
18	Rusty Disc Gray	1066	261618	753843	1015461
19	Rusty Disc	1066	447056	750508	1199564
20	Boat	128	23427	117558	140985

Table 1. shows the code words in each of the images Using BCH. It forms a class of cyclic error-correcting codes that are constructed using polynomials over a finite field (also called Galois field). The table shows image name, image size, codeword in each of the images, non-codes and the number of blocks. As explained above, if a string of bit is a codeword, it is called valid otherwise invalid. For example, a cameraman image of size 256 has codeword of size 34854 and 226307 and the number of blocks is 261161 respectively.

Table 2 Compression Ratio (CR)

Image name	Original image size (kb)	Compressed image size (kb)	Compression ratio (cr)
Cameraman	256	225	1.14
House	512	229	2.24
Jet Plane	512	298	1.72
Lake	513	359	1.43
Lena Colour256	192	123	1.56
Lena colour512	969	650	1.49
Lena gra256	64.2	40	1.61
Lena Gray512	256	168	1.52
Living Room	256	170	1.51
Mandrill Colour	768	490	1.57
MandrillGray	256	160	1.60
PeperColour	514	340	1.51
Pepper Gray	512	340	1.46
Pirate	256	155	1.65
Walk Bridge	512	355	1.44
Woman Blonde	256	172	1.49
Woman Darkhair	245	165	1.48
Rusty Disc Gray	1066	610	1.75
Rusty Disc	1066	690	1.54
Boat	128	72	1.78

Table 2. shows the compression ratio (CR) for various images. CR is the ratio of the original image to the compressed image. The higher the compression ratio the lower the quality of the image. When it comes to lossless image compression, the lower the compression ratio the better the image. Although lossless compression is applied in many applications, compression ratios obtained with lossless techniques are significantly lower than those possible with lossy compression. Depending on the type of image, standard lossless compression ratios range from about1.5:1 to:3.1.

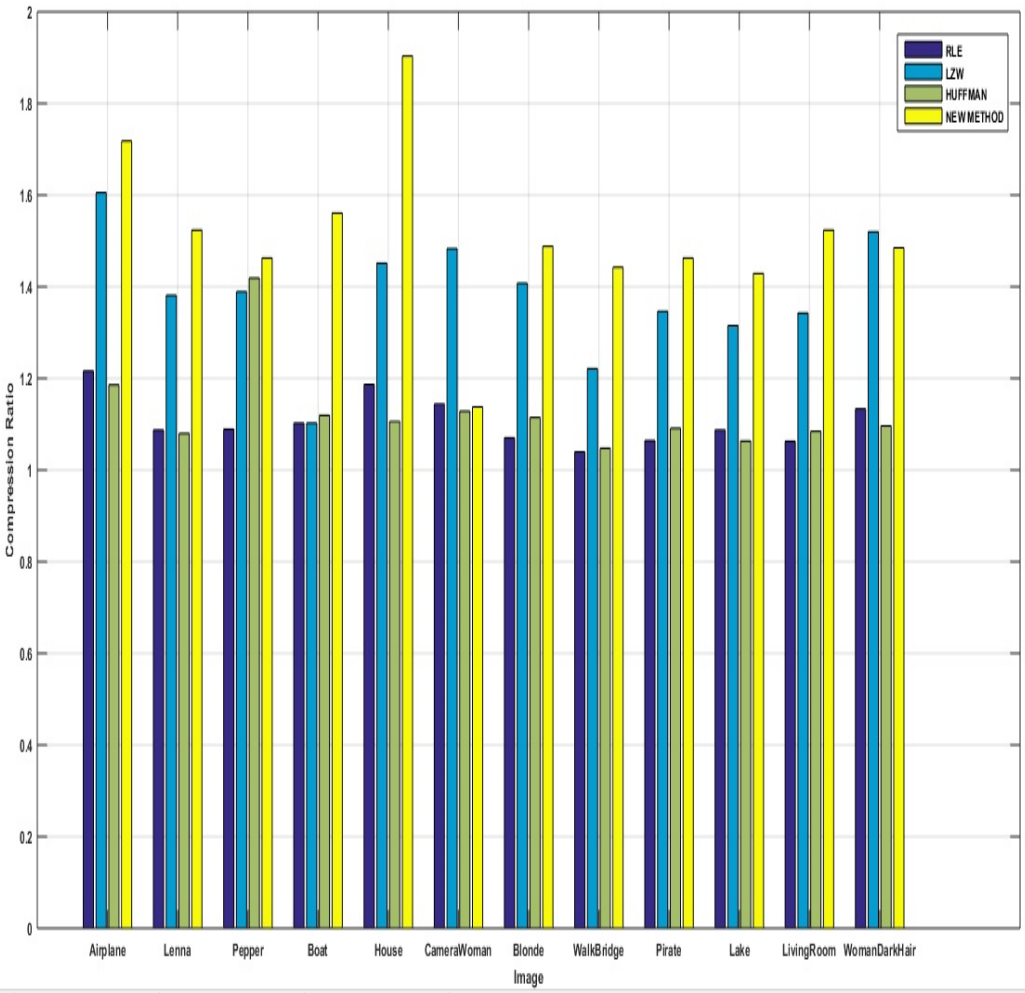

Figure 2. A Bar Chart showing the compression Ratio

Table 3. Encoding Time

S/no	Image name	Original image size (kb)	Encoding time (s)
1	Cameraman	256	5
2	House	512	6
3	Jet Plane	512	5
4	Lake	513	7
5	Lena Colour256	192	3
6	Lena colour512	969	7
7	Lena gra256	64.2	3
8	Lena Gray512	256	4
9	Living Room	256	3
10	Mandrill Colour	768	7
11	MandrillGray	256	3
12	PeperColour	514	5
13	Pepper Gray	512	6
14	Pirate	256	3
15	Walk Bridge	512	6
16	Woman Blonde	256	2
17	Woman Darkhair	245	3
18	Rusty Disc Gray	1066	10
19	Rusty Disc	1066	9
20	Boat	128	3

Table 3 shows the encoding time of the individual image using BCH encoding. The time it takes to encode an image depends on the size of the image. The higher the size the image the higher the time it takes to encode the image. For example, rusty disk has a size of about 1066 KB and has an encoding time of 10 seconds compared with woman dark hair that has a size of 245 KB and compression time of 3 seconds.

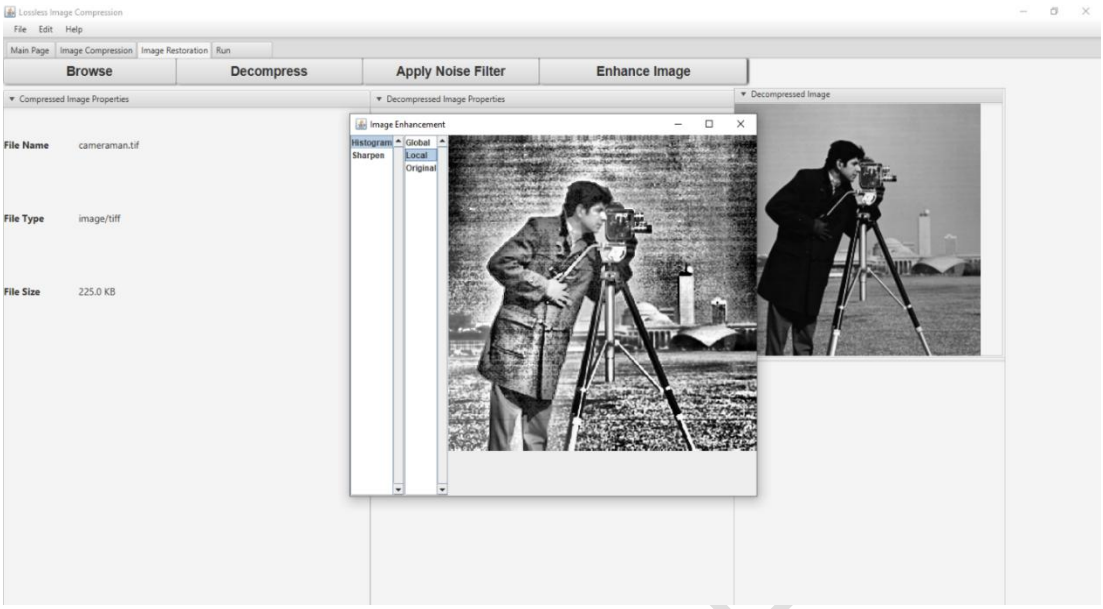

Figure 3. Image enhancement Histogram Local

Figure.3. shows the result of the reconstructed image after undergoing through compression. Decompression is the process reconstructing the image back to the normal form, to reveal more features of the image, the image undergoes through a process called an enhancement through a Gaussian process. The enhance image looks clearer than the original image as shown in the imge above. A global histogram is a gray-scale value showing the number of times gray scale values appeared in the image.

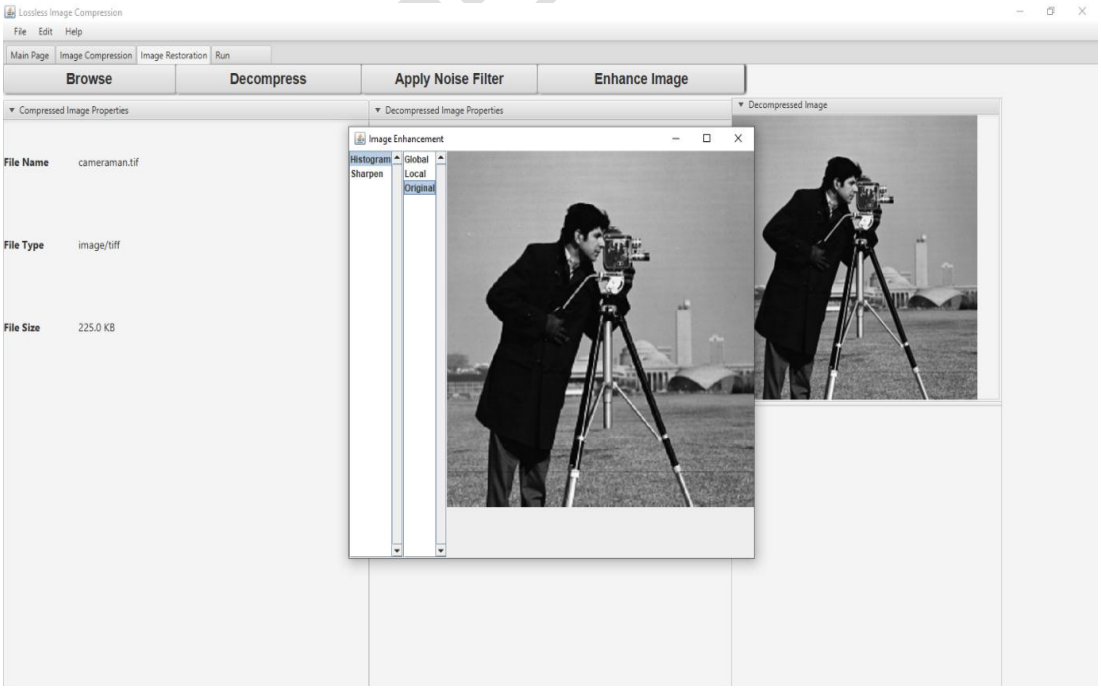

Figure 4. Image Enhancement output

Figure 4. shows the output histogram for enhanced image which reveals the output image after undergoing through enhancement process.

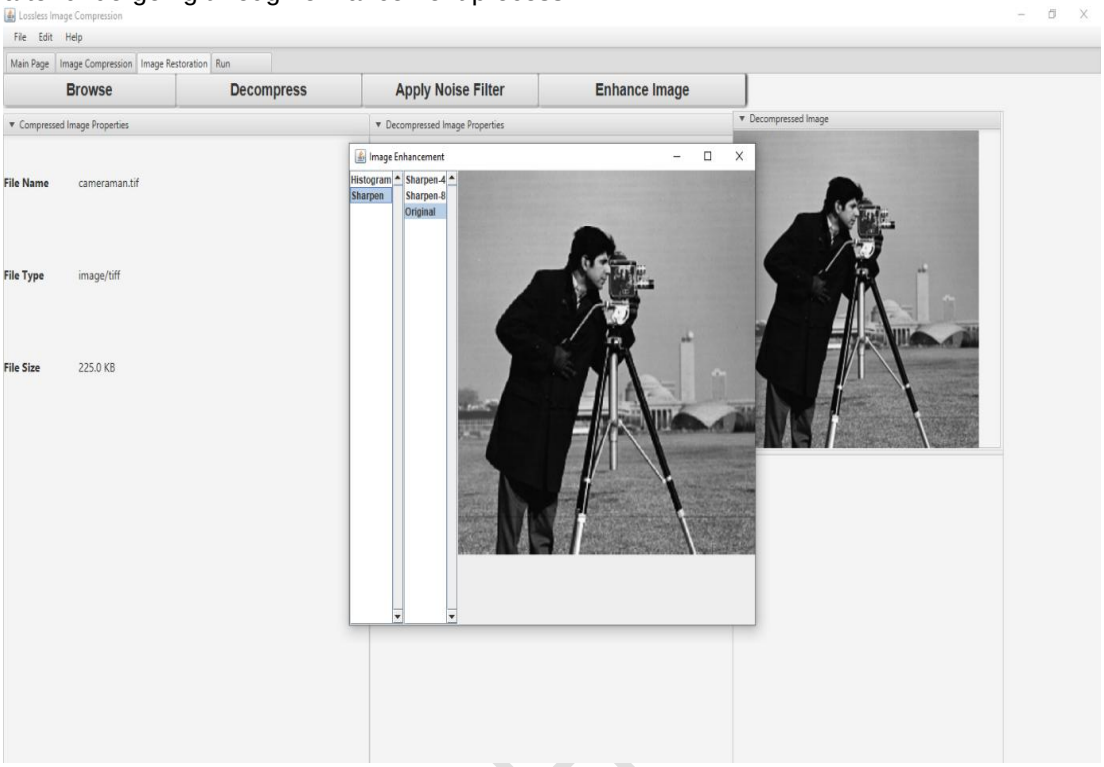

Figure 5. Sharpen original image

5. CONCLUSION

Image compression as an important area of research because of its diverse application in the field of image processing. this research gives a fundamental idea of what an image compression is all about. concepts of lossless image compression were discussed. These concepts include the redundancies (psycho visual and inter pixel) in the image which needs to be reduced. many literatures in the field of data compression with emphasis on image compression were reviewed. in the literatures reviewed, existing lossless image compression includes the run length encoding (RLE), Huffman algorithm and the Lempel Ziv welch (LZW) algorithm. also, existing lossless image compression using the combination of existing lossless methods were reviewed, to find the weaknesses of the existing schemes, hence the enhanced lossless image compression schemes improves the compression ratio, bits per pixel and the complexity in terms of memory space and time utilization. from the result, it was revealed that the average compression of the images is about 1.65 which is better than the individual methods. the average bit per pixel of all the tested images are 6.904287, 5.656522, 6.774273 and 5.416667 to RLE, LZW, Huffman and the new method respectively.

DISCLAIMER:

Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly use products in our area of research and country. There is

absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

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