Improved Method for Lossless Compression of Images using Dithering

Veena Shukla, Prof. Nitin. R. Talhar

***Abstract*— Despite fast evolution in mass-storage density, system performance, processor speeds, demand for data storage capacity and data-transmission bandwidth continue to outstrip the capabilities of available technologies. Compression is an important constituent of the way out available for creating image file sizes of convenient and communicable dimensions. Lossless compression is always superior than lossy compression as it facilitate to keep the eminence of image. Dithering process applied over normal images that use less number of colours. In this paper Pseudo-distance transform technique of dithering is used to predict more pixels that in turn help to achieve compression gain. There are many compression algorithms; in this paper run length encoding algorithm is used, combining with pseudo-distance transform method in order to perform lossless compression. In this way to achieve higher compression gain, lossless compression offer improvement in the quality and storage.**

***Index Terms*— Dithering, Lossless compression, Image quality , Predict, Pseudo-Distance Transform**

I. INTRODUCTION

High resolution image needs more space hence it is necessary to carry out the bit reduction. Multimedia data requires large amount of storage. Multimedia data such as image, audio, video generally need significant data storage. Image compression is the increasing demand as it can increase the transmission speed. To store the image in a form that can speed up the systems and can save storage space, it is essentially needed to compress the image. In this paper Lossless compression technique has been used. It is a technique in which data bits remains same after compression and when the image is uncompressed, all the original data can be perfectly recovered. This technique is useful where it can pose problem to lose the data. This method basically redrafts the data of true file in a more competent way. Suppose using lossy compression when a file is compacted, its size may be very less as compared with the true one, if we use lossless compaction, and dimension of file can be smaller than half of the true one. But the quality of image would be more in lossless compression. Image compression plays essential role in many different applications e.g. remote sensing, image databases, image communications and medical imaging. The principle idea for image compression is to lessen the amount of data necessary for representing sampled digital images and therefore lessen the cost for storage and transmission. In this paper, technique of dithering is used for compression, therefore it is necessary to know about dithering.

***Manuscript received July, 2015*.**

***Veena Shukla**, Department of Computer Engineering, AISSMS College of Engineering, Pune, India, 020-26709129*

***Prof. Nitin R. Talhar**, Professor, Department of Computer Engineering, AISSMS College of Engineering, Pune, India.*

The process of portraying an image with fewer colours than are in image is called dithering. The most important application of quantization is for display devices that cannot deal with original colours. In this process, we possibly will have quantization errors, e.g., misrepresentation [1]. To rise above quantization errors, dithering is used. In order to reduce the errors this method appends a dither signal to the input image. The most eminent algorithm was proposed by Floyd–Steinberg, which is identified as the Floyd–Steinberg dithering technique in 1976. In this paper Pseudo-distance transform technique is used for bit reduction.

To measure the apparent image deficit, image quality is defined as the depiction that counterpart up to original image. Normally all the systems commence distortion so to consider this factor is very important. Image quality consists of various dynamics e.g. sharpness, contrast, correctness, vividness, range, artefacts and many more. So to achieve the quality in an image, it is important to consider all these factors. In this paper using the .bmp format images, compression is performed. Also, in today's communication environment huge image files stay a major holdup within systems. Therefore it is highly needed to represent the information in compact form. For creating image file sizes of manageable dimensions, So, Image compression is an imperative available solution to build images of convenient sizes.

II. LITERATURE SURVEY

In the paper Lossless compression of dithered images Basar Koc, Ziya Arnavut and Huseyin Kocak have used PDT (pseudo-distance technique) for dithered images which providing better compression gain.

In the paper Color quantization through dithering techniques C. Alasseur, A.G. Constantinides and L. Husson have proposed a method in which noise is filtered by using sigma-delta modulators. With the filtration of noise, the quality of quantized image is improved.

In the paper A lossless compression algorithm for color-indexed images using adaptive palette reordering Ka-Chun Lui and Yuk-Hee Chan have proposed a technique an adaptive palette reordering to reshape the statistical properties of color index map of color-index image with dynamic palette. In the paper A New Lossless Method of Image Compression and Decompression Using Huffman Coding Techniques Jagadish H. Pujar and Lohit M. Kadlaskar have proposed that lossless method of compression and decompression using the well-known Huffman coding technique. They have developed the algorithm for compression and decompression in MATLAB platform.

In the paper Compressing color-indexed images by dynamically reordering their palettes Yuk-Hee Chan, Ka-Chun Lui and P.K. Lun have proposed the technique which turns the index map of color-indexed image into a new

index map where each element serves the index pixel separately .

In the paper Lossless image compression algorithms for transmitting over low bandwidth line Dr. E. Kannan and G. Murugan have proposed a technique near-lossless image compression algorithm that is based on Bayer's format image and they have used Huffman coding technique for compression.

In the paper Image compression using DCT and Wavelet transformations Prabhakar Telagarapu,V. Jagan Naveen ,A. Lakshmi Prasanthi, G. Vijaya Santhi have done the analysis of compression using DCT and Wavelet transformation as there is the scope for high compression with better quality and they have concluded that the performance of DWT is better than DCT .

In the paper Image Compression using Approximate Matching and Run Length Samir Kumar Bandyopadhyay, Tuhin Utsab Paul, Avishek Raychoudhury have proposed approximate matching technique for image compression. Also authors have compared the technique with jpeg compression techniques over number of images.

In the paper Performance Analysis of Image Compression Using Fuzzy Logic Algorithm Rohit Kumar Gangwar, Mukesh Kumar et. al. have proposed the method rough fuzzy logic with Huffman encoding algorithm (RFHA) in which Huffman coding has been used for compression and rough fuzzy logic used for building the pixel.

III. Lossless Compression

In lossless compression techniques, the true image can be ideally received from the compressed image. This is also called noiseless compression since this technique do not put in clatter to the image [1]. It is also identified as entropy coding since it use statistics/decomposition techniques to remove/minimize redundancy. Lossless compression is used for a few applications with inflexible requirements such as medical imaging. It is used where it is necessary that the original and the decompressed data must be alike. There are number of techniques for lossless compression. In this paper Run-length encoding algorithm is used. The simplest technique in which the lengthy sequence of same symbols is replaced by shorter sequence is known as Run-length encoding algorithm. This algorithm is different from other algorithms in some aspects that it works faster, the coding of length information. Below figure shows typical lossless compression.

Fig.1. Lossless compression

From above figure it is clearly visible, that restored image is same as the true image hence there is no loss of data when lossless compression is used. The main purpose of this paper is to perform lossless compression of images with prediction of more number of pixels. The objective is to reduce the redundancy of the data in order to be able store or transmit the data in an efficient form. The user is inputting the image and performing number of steps to produce a compressed image.

IV. Dithering

To represent an image with few number of colors than actually are in image [10]. In this paper Pseudo-distance transform method is used that is the technique of dithering. It can be defined as to form a distance matrix D by calculating Euclidean distance between every pair of indices from a color palette. In each row of D, there may be similar values. To conquer the problem of non-uniqueness of the entries in rows of D, corresponding pseudo-distance matrix P is formed with more distinct entries in matrix. This is known as Pseudo-distance transform method.

V. Proposed System

This system mainly consists of three main parts. First is Pseudo-distance Transform method, second run-length encoding algorithm and then a binary arithmetic encoder. By following all these steps, we get a compressed original image as output.

Pseudo-Distance Transform: This transform method is used to find the distance between every pair of indices from its close neighbor. It will follow steps in this manner.

i. First step is that we form a distance matrix d and calculating Euclidean distance between every pair of indices and form a colour palette in each row of d as there may be similar values.

ii. Second step is we find out the reference in a, b, c, d .

iii. Third step is to use the predict method to find best prediction of x_1 and x_2 from its neighbour.

iv. Fourth step is the decoding process that reconstructs the original image file.

To conquer the problem of common entries in rows of D (Distance matrix), corresponding pseudo-distance matrix is computed. On this basis, a corresponding distance matrix will be formed by using prediction based compression technique. It predicts the value of current pixel by referring its neighbors. It will select the minimum value from its neighbor pixel to improve the compression gain. In this way this method may increase the more number of zeroes when the same color comes again, still it is preserving the uniqueness of entries of rows.

After following above steps of pseudo-distance transform, we will encode the image by using algorithm and then to reconstruct the original image, decoding is performed. As we have constructed the pseudo-distance matrix from above step. To decode the image reverse pseudo-distance transform method is performed. Also, Run-length encoding is used along with the binary arithmetic coder (BAC) as run-length encoder is used to replace large repetitive sequence to the shorter sequence. It will improve the performance of coder in determining non-zero symbol probabilities. By using RLE, compression gain will be improved. Below figure shows the flow of activity of system.

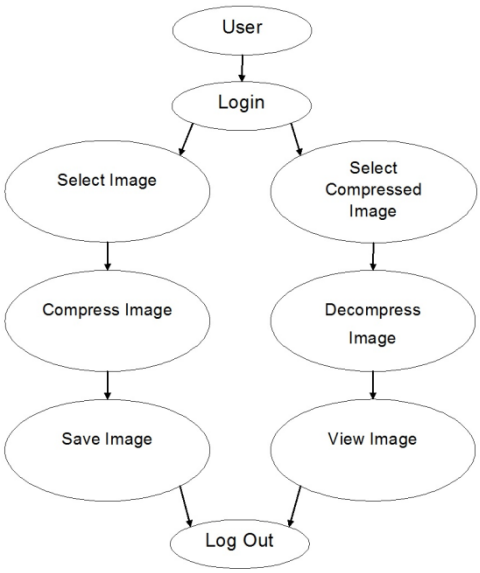

Figure.2. Flow of activity of system

For the purpose of compression, system has performing in this manner. And to perform compression there are mainly four operations in which firstly user input the image from the system and then performs a step to find distance from one pixel to another. After determining the distance, same value pixels have replaced to reduce the size. Finally to view the image decoding on the compressed image is performed. The basic architecture of the system include mainly two parts; first is to compress the image and then to decompress it. This architecture is used to encode and decode the image. The terms used in the architecture are PDT (Pseudo-distance Transform), RLE (Run length Encoding), BAC (Binary Arithmetic Coder).

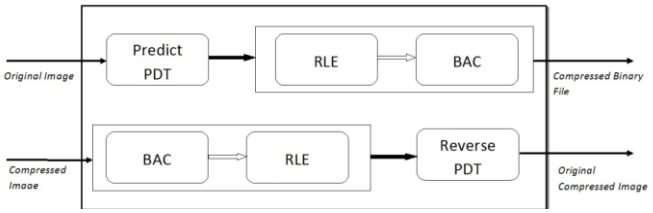

Figure.3. System Architecture

A. Algorithm

For the purpose of encoding and decoding the image, firstly the matrix would be formed by calculating euclidean distance between every pair of indices. To conquer the problem of non-uniqueness of the entries in rows of D (Distance matrix), we compute a corresponding pseudo-distance matrix. By using predicted based method, value of pixel x will be predicted by referring it neighbouring pixels. Let the neighbouring pixels are a, b, c, d. Out of the values of a, b, c, d; choose the neighbour have minimum value. Therefore prediction algorithm is used to predict out the values of pixels x_1 and x_2 with minimum of the neighbour pixel value.

Table 1: Example of Distance matrix D

	0	1	2	3	..	254	255
0	0	4.71	2.82	5.59	..	201.81	203.71
1	4.71	0	7.65	10.21	..	202.74	204.11
..	..	..	..	..	..	..	..
254	201.81	202.12	197.29	195.32	..	0	6.44
255	203.71	204.11	202.22	199.24	..	6.44	0

Table 2: Pseudo-distance matrix P

	0	1	2	3	..	254	255
0	0	1	1	3	..	254	255
1	1	0	2	3	..	254	255
..	..	..	..	..	..	..	..
254	254	255	253	252	..	0	1
255	254	255	253	252	..	1	0

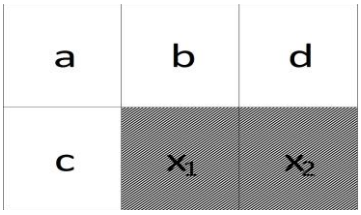

Figure.4. Predict pixels x_1 and x_2 with reference of neighbor pixels.

A. *Algorithm1*

PREDICT (a, b, c, d, pred [ ])
for (k=0, k <2, k++);
if a = b
then return pred [k] = c
if b = c
then return pred [k] = a
if a = c
then return pred [k] = b
end for;
else
return pred [ ]

Predict method is used to predict x_1 and $x_2$with minimum possible error. In place of choosing a, b, c, d as a reference pixel to predict out x_1 and x_2, To achieve superior compression gain, it would be better to choose minimum of reference pixels.

B. Algorithm2

Pseudo-Distance Transform
for (k=0, k < 2, k++);
repeat
p ← PREDICT (a, b, c, d)
e ← P[p, x[k]]
for k ← 1 to n
do if e > P [p,e_k]
then P [p,e_k] ← P [p,e_k] + 1
P [p, x[k]] ← 0
if p ≠c
then e_2 ← P [c, x[k]]
for k ← 1 to n
do if e_2> P [c,c_k]
then P [c, c_k] ← P[c,c_k] + 1
P [c, x[k]]
until all pixels are processed
end for;
return

By using this algorithm we can achieve unique entries in the matrix and prediction fault e that in turn improve the compression gains. Above two algorithms are used for

encoding the image, now to decode the image, inverse PDT is performed.

C. Algorithm3

Inverse Pseudo-Distance Transform
for (k=0; k<2; k++)
repeat
e ← P[q, e]
for k ← 1 to n
do if e > q_i
then P [q,x_k] ← P [q,x_k] + 1
release equivalent column values as the original values
x[k] ← q
till first column and row are processed
end for;
return

Here q is the retrieved value. At some point predicted pixel would be the retrieved value. Therefore by using the combination of above all algorithms, the encoding and decoding of image is performed.

VI. EXPERIMENTAL RESULTS

To achieve better quality, further compression gains are possible when we update two or more neighbors of predicted pixel in PDT matrix. With this alteration, better compression gains can be shown. The observed output is the compressed image with more predicted pixels. In this paper the lossless compression of images by using dithering PDT technique to speed up the systems and also to overcome from bottlenecks within the systems.

Table.3. Compression results (size and time analysis)

Index	File size (bytes)	File size (compressed)	File size (de-compressed)	Time (ms)
Car.bmp	151374	88833	151374	407
Greeny.bmp	149822	87098	149820	172
Light.bmp	152010	111756	152008	260
Pinklight.bmp	150354	65946	150351	140
Road.bmp	150006	92244	150001	157
Skyblue.bmp	148922	79501	148919	156

Table.4. Few more images tested

Index	Size Before compression	Size After compression
Image 1	147 Kb	81.5 Kb
Image 2	2.25Mb	1.21 Mb
Image 3	3.70 Mb	2.99 Mb
Image 4	382 Kb	131 Kb
Image 5	7.62 Mb	6.52 Mb
Image 6	6.59 Mb	5.09 Mb
Image 7	898 Kb	755 Kb
Image 8	2.25 Mb	1.98 Mb

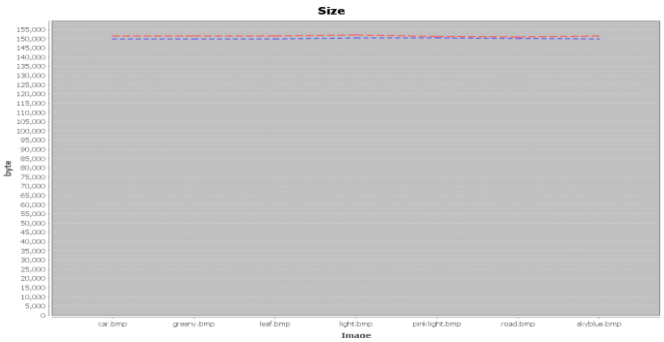

Fig.10. Graph shows the images with no loss

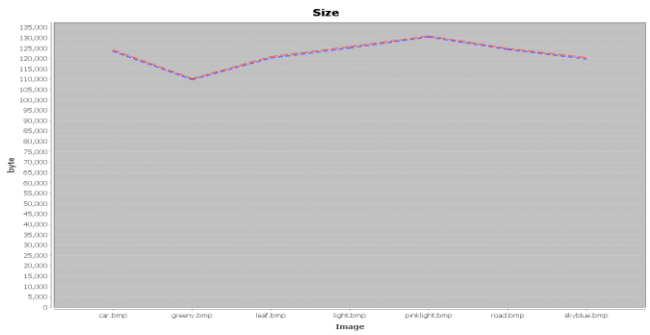

Fig.11. Graph shows the size of encode image

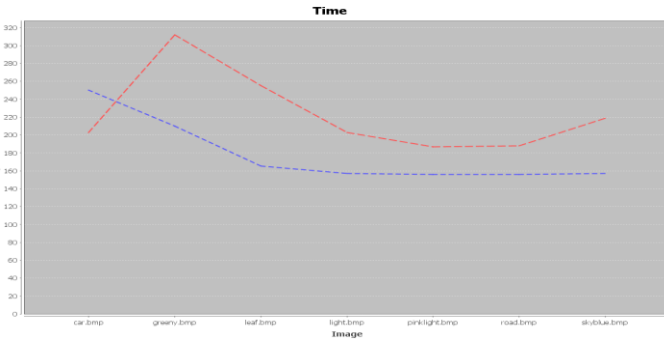

Fig.12. Graph shows the time for conversion of original and decompress image (ms)

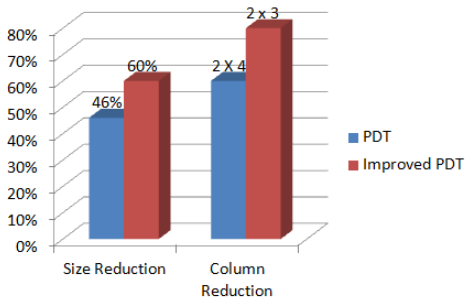

Fig.13. Size comparison with proposed technique

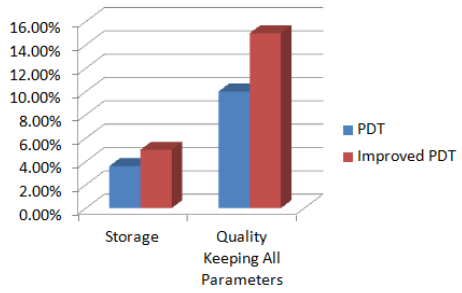

Fig.14. Quality and storage comparison

VII. Conclusion

To save the storage space and enhancing the performance of the systems and the networks, it is necessary to transmit and store the data/images in compressed form. For this purpose lossless compression of images; methods and techniques implemented in the process and how useful or error free they are. Prediction of two pixels providing better compression results. Also, performing lossless compression using dithering can be advantageous in terms of improving the quality of image apart from compressing the same. By using lossless compression, it is very useful wherein the loss of data could pose many problems. Therefore lossless compression gives better results with superior compression gain as comparing with the lossy compression. In future it is possible to predict multiple pixels.

Acknowledgment

I am profoundly grateful to Prof. Nitin R. Talhar for his expert guidance and continuous encouragement and their valuable support for this work.

References

[1] Basar Koc, Ziya Arnavut and Huseyyin Kocak, "Lossless Compression of Dithered Images" IEEE Photonics Journal 2013.

[2] C. Alasseur, A.G. Constantinides, L. Husson, "Colour Quantization through Dithering techniques", Electrical and Electronic Engineering Department, Imperial College, Exhibition Road, LONDON, SW7 2BT, UK.

[3] Ka-Chun Lui and Yuk-Hee Chan, "A Lossless Compression Algorithm For Color-Indexed Images using Adaptive Palette Reordering, Department of Electronic and Information Engineering, The HongKong Polytechnic University, Hong - Kong.

[4] Jagadish H Pujar and Lohit M Kadlaskar, "A New Lossless Method Of Image Compression And Decompression Using Huffman Coding Techniques", Department of EEE, BVB College of Engg. Tech. Hubli India.

[5] Yuk Hee Chan, Ka-chun Lui and P. K. Lun, "Compressing Color-Indexed Images by dynamically reordering their Palletes" EUPISCO 2008 Swizerland.

[6] Dr. E Kannan and G. Murugan, "Lossless Image Compression Algorithm For Transmitting Over Low Bandwidth Line", IJARCSSE 2012.

[7] Prabhakar Telagarapu, V. Jagan Navees, A LakshmiPrasanthi, G Vijaya Santhi, "Image Compression Using DCT and Wavelet Transformations", GMR Institute of Technology, Srikakulam , A.P. India.

[8] Samir Kumar Bandyopadhyay, Tuhin Utsab Paul, Avishek Raychoudhury, "Image Compression using Approximate Matching and Run Length", Department of Computer Science and Engineering, University of Calcutta, (IJACSA) International Journal of Advanced Computer Science and Applications, Vol. 2, No. 6, 2011.

[9] Rohit Kumar Gangwar, Mukesh Kumar, A.K.Jaiswal And Rohini Saxena, "Performance Analysis Of Image Compression Using Fuzzy Logic Algorithm", Department of Electronics Communication, SHIATS(deemed to be university) Allahabad, INDIA, Vol.5, No.2, April 2014.

[10] [Online]. Available: http://www.visgraf.impa.br/Courses/ip00/proj/Dithering1/

Veena Shukla is a graduate in Computer Science and Engineering from Institute of Information Technology & Management Gwalior under RGPV, Bhopal and is currently pursuing her Masters of Engineering in Computer Engineering from AISSMS College of Engineering under SPPU, Pune. Author has published a paper, "A Method For Lossless Compression Of Images Using Dithering To Improve The Quality: A Review" in International Journal of Engineering and Research Technology, Volume 3, Issue 11, November 2014.

Prof. Nitin R. Talhar is currently a Professor in Department of Computer Science at AISSMS College of Engineering, Pune. Author is a graduate in Computer Science and Engineering from G.C.O.E Amravati, and has completed his Masters of Engineering in CSE(IT) from SCOE, Pune. Author has published a paper, "Video Streaming Techniques For Reliable Video Conferencing Applications Over Communication Framework Architecture" in International Journal of Computer Science and Applications, May 2010, ISSN 0974-0767, pp 38-43. Also, author has published a paper, "Real-time and Object-based Video Streaming Techniques with Application to Communication System" in International Symposium of Computing Communication and Control, Singapore, 9-11 October 2009, IACSIT, ISBN 978-9-8108-3815-7, pp-25-29.

