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Huffman Based LZW Lossless Image Compression Using Retinex Algorithm

Bhupathiraju, Ratnala Raju,
PG scholar, Department of MCA, DNR college, Bhimavaram , Andhra Pradesh.
K. **RAMBABU**
(Assistant Professor),Master of Computer Applications,DNR collage, Bhimavaram,Andhra Pradesh.Pradesh.

bstract: This project presents an efficient approach to lossless image compression by integrating the Retinex algorithm with Huffman and LZW encoding techniques. The Retinex algorithm enhances image contrast and illumination consistency, which improves compressibility without sacrificing quality. Following enhancement, the image is encoded using a hybrid method combining LZW (Lempel-Ziv-Welch) compression and Huffman coding to achieve effective redundancy reduction. LZW efficiently identifies repeating patterns, while Huffman coding further optimizes the bitstream based on symbol frequencies. This dual-stage compression ensures high fidelity of the reconstructed image while significantly reducing file size. The proposed method is evaluated using standard image quality metrics such as PSNR and Compression Ratio, demonstrating superior performance in preserving image quality with optimal compression efficiency. This approach is suitable for applications where both image integrity and storage optimization are critical.

Keywords: Huffman Coding, LZW Compression, Retinex Algorithm, Lossless Image Compression, Image Enhancement, PSNR, Compression Ratio.

I. INTRODUCTION

Image compression is an application of data compression that encodes the original image with few bits. The objective of image compression is to reduce irrelevance and redundancy of the image data in order to be able to store or transmit data in an efficient form. Image compression means the reduction of the size of image data, while retraining necessary information. Mathematically this means transforming a 2D pixel array into a statically uncorrelated data set. The transformation is applied prior to storage or transmission of the image.

At late time the compressed image is decompressed to reconstruct the image and an approximation of it. So image compression is used to minimize the amount of memory needed to represent an image. Images often require a large number of bits to represent them, and if the image needs to be transmitted or stored, it is impractical to do so without somehow reducing. A common characteristic of most images is that the neighbouring pixels are correlated and therefore contain redundant information.

The foremost task then is to find less correlated representation of the image. Two fundamental components of compression are redundancy and irrelevancy reduction. Redundancies reduction aims at removing duplication from the signal source (image/video). Irrelevancy reduction omits parts of the signal that will not be noticed by the signal receiver, namely the Human Visual System.

1.1 Objective of the project:

Image compression is an application of data compression that encodes the original image with few bits. The objective of image compression is to reduce irrelevance and redundancy of the image data in order to be able to store or transmit data in an efficient form. So image compression can reduce the transmit time over the network and increase the speed of transmission. In Lossless image compression no data loss when the compression Technique is done.

In this research, a new lossless compression scheme is presented and named as Huffman Based LZW Lossless Image Compression using Retinex Algorithm which consists of three stages: In the first stage, a Huffman coding is used to compress the image. In the second stage all Huffman code words are concatenated together and then compressed with LZW coding and decoding. In the third stage the Retinex algorithm are used on compressed image for enhance the contrast of

image and improve the quality of image. This Proposed Technique is used to increase the compression ratio (CR), Peak signal of Noise Ratio (PSNR), and Mean Square Error (MSE) in the MATLAB Software.

II. LITEARTURE SURVEY

1. "A Brief Introduction on Image Compression Techniques and Standards"

This paper presents an extensive survey on image compression techniques and standards; it is applicable to various fields of image processing. Image compression is very important for efficient transmission and storage of image. On the basis of evaluating and analysing the current image compression techniques this paper presents the Principal Component Analysis approach applied to image compression. There are some techniques that perform this compression in different ways; some are Lossless and keep the same information as the original image using entropy coding some others lossy compression which losses information when compressing the image. A part from these techniques, JPEG, JPEG2000, MPEG, H.26x are the different existing standards in still and moving Image Compression. My aim with this paper is to make a comparison of some of the most used image compression technique on a set of images.

2. "Compression Using Huffman Coding"

Huge data system applications require storage of large volumes of data set, and the number of such applications is constantly increasing as the use of computers extends to new disciplines. At the same time, the proliferation of communication networks is resulting in massive transfer of data over communication links. Compressing data to be stored or transmitted reduces storage and communication costs. When the amount of data to be transmitted is reduced, the effect is that of increasing the capacity of the communication channel. Here efficient method for decoding the compressed data is proposed. This paper aims toward the implementation of a high speed Huffman decoding system. This proposed model enhances the speed of decoding operation. The model is implemented using VHDL language, simulated on Active HDL 5.1, synthesized, placed and routed and floorplaned using Xilinx tools.

3. "Images and Its Compression Techniques A Review"

The availability of images in different applications are augmented owing to the technological advancement which cannot impacts on several image operation, on availability of sophisticated software tools that manipulate the image and on image management. Despite the technological advances in storage and transmission, the demand placed on the storage capacities and on bandwidth of communication exceeds the availability. Hence, image compression has p r o v e d t o be a valuable technique as one solution. This paper gives the review of types of images and its compression techniques. Based on the review, we recommended some general guidelines to choose the best compression algorithm for an image.

4. "Lossless Grey-scale Image Compression using Source Symbols Reduction and Huffman Coding".

Usage of Image has been increasing and used in many applications. Imagecompression plays vital role in saving storage space and saving time whilesending images over network. A new compression technique proposed toachieve more compression ratio by reducing number of source symbols. Thesource symbols are reduced by applying source symbols reduction andfurther the Huffman coding is applied to achieve compression. The sourcesymbols reduction technique reduces the number of source symbols bycombining together to form a new symbol. Therefore, the number of Huffmancode to be generated also reduced. The Huffman code symbols reductionachieves better compression ratio. The experiment has been conducted usingthe proposed technique and the Huffman coding on standard images. The experiment result has analyzed and the result shows that the newly proposedcompression technique achieves 10% more compression ratio than theregular Huffman coding.

5. "DOUBLE COMPRESSION OF TEST DATA USING HUFFMAN CODE "

Increase in design complexity and fabrication technology results in high test data volume. As test size increases memory capacity also increases, which becomes the major difficulty in testing System-on-Chip (SoC). To reduce the test data volume, several compression techniques have been proposed. Code based schemes is one among those compression techniques. Run length coding is one of the most popular coding methodologies in code based compression. Run length codes like Golomb code, Frequency directed run Length Code (FDR code), Extended FDR, Modified FDR, Shifted Alternate FDR and OLEL coding compress the test data and the compression ratio increases drastically. For further reduction of test data, double compression technique is proposed using Huffman code. Compression ratio using Double compression technique is presented and compared with the compression ratio obtained by other Run length codes.

6. "Lossless Image Compression Technique Using Combination Methods"

The development of multimedia and digital imaging has led to high quantity of data required to represent modern imagery. This requires large disk space for storage, and long time for transmission over computer networks, and these two are relatively expensive. These factors prove the need for images compression. Image compression addresses the problem of reducing the amount of space required to represent a digital image yielding a compact representation of an image, and thereby reducing the image storage/transmission time requirements. The key idea here is to remove redundancy of data presented within an image to reduce its size without affecting the essential information of it. We are concerned with lossless image compression in this paper. Our proposed approach is a mix of a number of already existing techniques. Our approach works as follows: first, we apply the well-known Lempel-Ziv-Welch (LZW) algorithm on the image in hand. What comes out of the first step is forward to the second step where the Bose, Chaudhuri and Hocquenghem (BCH) error correction and detected algorithm is used. To improve the compression ratio, the proposed approach applies the BCH algorithms repeatedly until "inflation" is detected. The experimental results show that the proposed algorithm could achieve an excellent compression ratio without losing data when compared to the standard compression algorithms.

III. PROPOSED METHOD

For web designers who wish to develop websites that load more quickly and are more accessible to users, image compression is essential. By offering good quality images at a quarter of the file size, picture compression also saves a significant amount of needless bandwidth. For individuals who attach photographs to emails, image compression is especially crucial since it may expedite email delivery and save bandwidth expenses. Image compression is especially crucial for digital camera users and those who save a large number of photographs on their hard drives since it allows us to store more images on our hard drives and conserve memory.

An outstanding illustration of the significance of data compression is images sent over the internet. Assume we have a digital colour picture that has to be downloaded across a 33.6 kbps modem on a PC. The picture will have around 600 kilo bytes of data if it is not compressed (a TIFF file, for instance).

3.1.1 Disadvantages:

1. Less Accuracy
2. More time taking process

3.2 Proposed system

This study suggests a way for compressing images utilising the two lossless approaches of Lempel Ziv Welch coding and Huffman coding. The first step is compressing the picture using Huffman coding, which yields the Huffman tree and Huffman Code words. Using Lempel Ziv Welch coding, all Huffman code words are concatenated and compressed in the second step. The Retinex algorithm is used to a compressed picture in the third step to boost contrast and improve image quality.

3.2.1 Advantages:

1. High Accuracy
2. Takes less time

IV. RESULTS

To run this project double click 'run.bat' file to get below screen

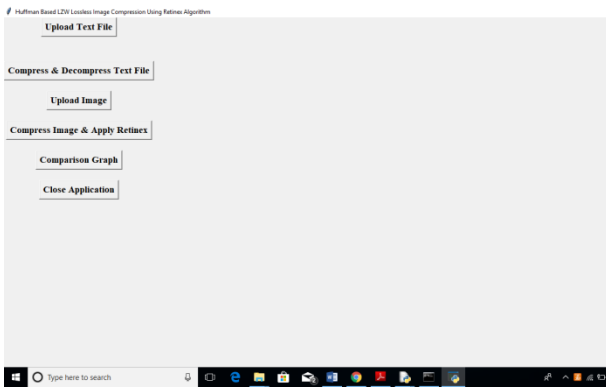

Fig.10.1 Upload Text File

In above screen if you want to compress text file then click on 'Upload Text File' button and upload text files.

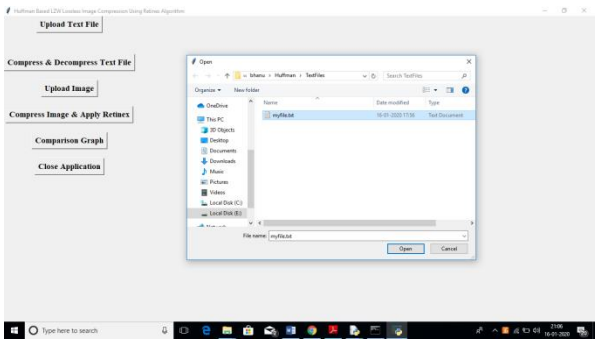

Fig.10.2 uploading 'myfile.txt' file

In above screen I am uploading 'myfile.txt' file and after upload will get below screen

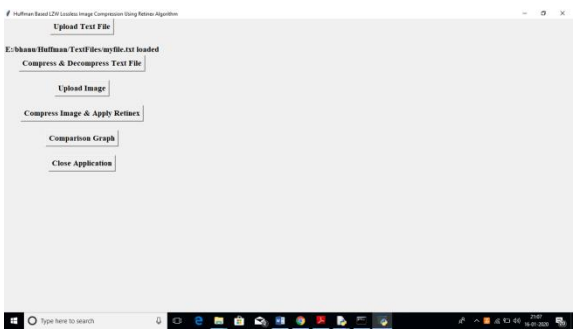

Fig.10.3 Compress & Decompress Text File

Now click on 'Compress & Decompress Text File' button to get compress and decompress text file.

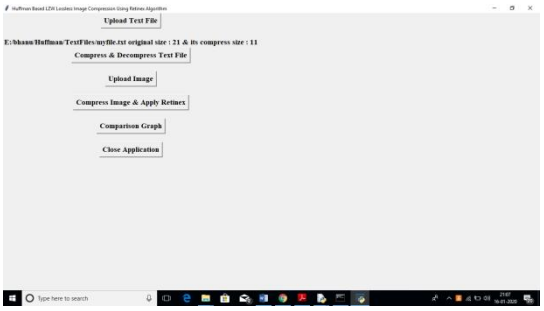

Fig.10.4 Size of original file

In above screen we can see message as original file size is 21 Bytes and after compress file size is 11 Bytes. Now you can see original file size inside 'TextFiles' folder

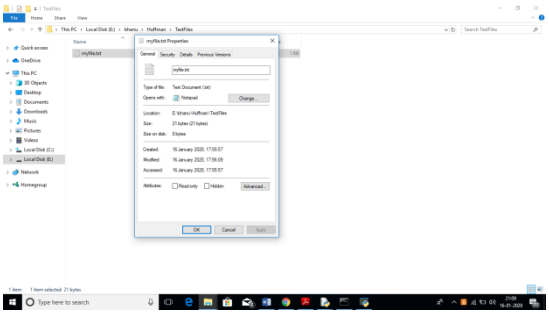

Fig.10.5 Size of original file

In above screen we can see original file size in directory also, now see compress file size inside 'compress' folder

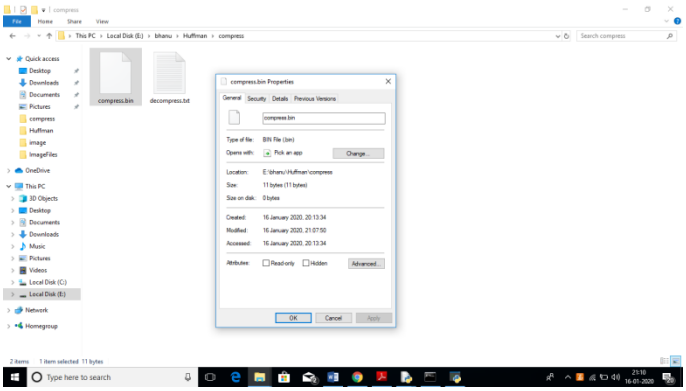

Fig.10.6 compress.bin files size

In above screen compress.bin files size is 11 Bytes and decompress file contains decompress data. Similarly click on 'Upload Image' button to upload image

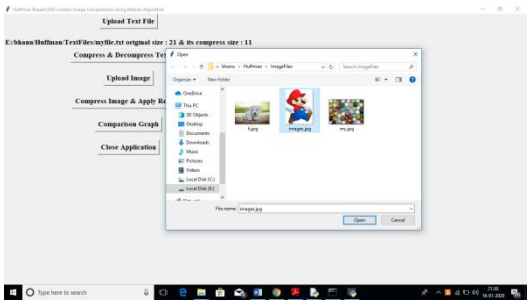

Fig.10.7 uploading 'images.jpg' file

In above screen uploading 'images.jpg' file and after uploading image will get below screen

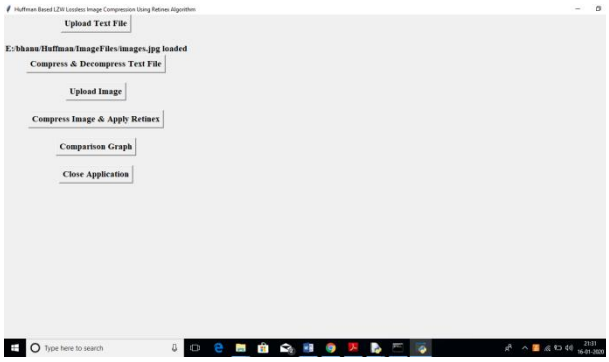

Fig.10.8 Compress Image & Apply Retinex

Now click on 'Compress Image & Apply Retinex' button to compress image

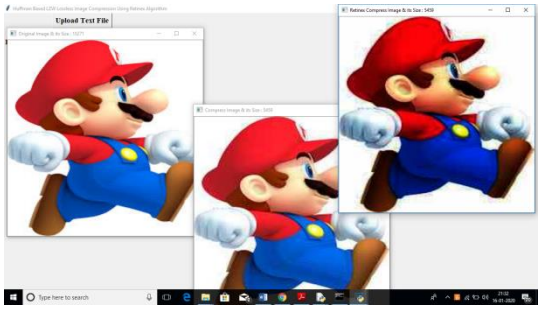

Fig.10.9 Image and its name

In above screen first image is the original image and you can see its name and size in title bar of the image, first image is the original image and its size is 10271 bytes and second image is the compress image and its size also u can see in title bar and compress image size is 5459 bytes and third image is Retinex algorithm applied compress image and its size also same and you can see after applying Retinex algorithm third image is looking little clean and bright. Now click on 'Comparison Graph' button to get below graph

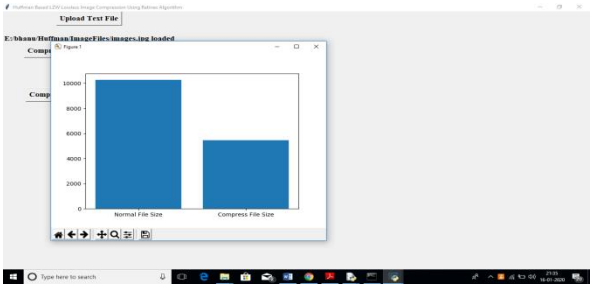

Fig.10.10 Graphical representation

In above graph x-axis represents normal and compress image and y-axis represents its size. Above graph clearly shows after applying compression we can reduce image size memory. Now you can see image size in directory

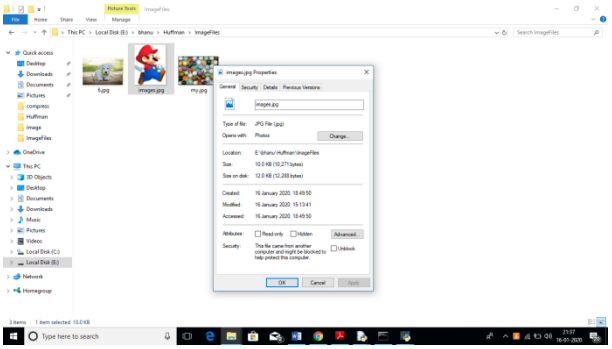

Fig.10.11 original images.jpg file size

In above screen original images.jpg file size is 10KB and now see compress file size in compress folder

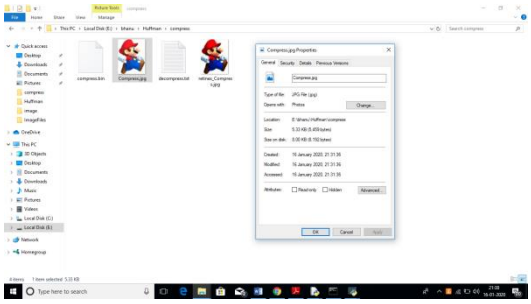

Fig.10.12 compress.jpg file size

In above screen compress.jpg file size is 5.33 KB and we can see Retinex applied image also along with compress image

V. CONCLUSION

Compression is a topic of much importance and many applications. This thesis presents the lossless image compression on different images. Different algorithms have been evaluated in terms of the amount of compression they provide, algorithm efficiency, and susceptibility to error. While algorithm efficiency and susceptibility to error are relatively independent of the characteristics of the source ensemble, the amount of compression achieved depends upon the characteristics of the source to a great extent. It is concluded that the higher data redundancy helps to achieve more compression. Reproduced image and the original image are equal in quality by using Retinex Algorithm, as it enhances the image contrast using MSR

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