Image Compression using Huffman Encoding

Manjari Singh Rathore, Sushil Kumar
Lakshmi Narayan College of Technology

Abstract - This paper presents the compression of images in Mat lab using Huffman coding algorithm in a way that has never been used before. A Huffman code is a particular type of optimal prefix code that is commonly used for lossless data compression. Image compression can be defined as a method of reducing image data that is not relevant and has redundancy so that it can be stored and transferred in well-organized and easy form. Compression of images is of two type .i.e. Lossless and Lossy. In Lossy compression inaccurate estimations are used to represent the content. Lossy Compression technique is used to decrease the size of data for storing, handling, and transferring content. In lossless compression, each single bit of data that was originally in the file remains after the file is decompressed. Every Information is completely restored. Lossy compression reduces a file by permanently discarding some information, specially that information which is redundant. A part of the original information remains there when the file is decompressed. Lossy compression is usually used for video and sound, where some amount of information failure will not be diagnosed by many users. The JPEG image file, generally used for photographs and other complicated motionless images on the network, is an image that has lossy compression. Using JPEG compression, the designer can decide how much loss to bring in and make a trade-off between file size and quality of image. We have used lossless compression technique.

Keywords: Lossy , lossless, JPEG, Huffman encoding, Matlab.

I. INTRODUCTION

Many image processing and computer vision algorithms are applicable to large-scale data tasks. It is often desirable to run these algorithms on large data sets (e.g. larger than 1 TB) that are currently limited by the computational power of one computer. These tasks are typically performed on a distributed system by dividing the task across one or more of the following features: algorithm parameters, images, or pixels [White et al. 2010]. Performing tasks across a particular parameter is incredibly parallel and can often be perfectly parallel. Face detection and landmark classification are examples of such algorithms [Li and Crandall 2009; Liu et al. 2009]. The ability to parallelize such tasks allows for scalable, efficient execution of resource-intensive applications. The Map Reduce framework provides a platform for such applications.

Multichannel signal processing has been the subject of extensive research during the last ten years, primarily due to its importance to colour image processing. The amount of research published to date indicates a great interest in the areas of colour image filtering and analysis. It is extremely adopted that colour giving information regarding that objects and further that information is utilize in increasing the performance of the image system. Colour images are studied in this paper using a vector approach. Three-channel vector is used to represent the value at each image pixel, by giving the colourful image that any vector field where all the dimensions of the vector are associate with pixel's chromatic properties. Being a two-dimensional (2-D), three-channel signal, a colour image needs more computation and storage area, in comparison with grey image, during processing.

In particular, the most common processing tasks are noise filtering and enhancement, since these are essential functions of any image processing system, regardless of whether the processed image is utilized for visual interpretation or automatic analysis.

"In imaging science, image processing is any form of signal processing for which the input is an image, such as a photograph or video frame; the output of image processing may be either an image or a set of characteristics or parameters related to the image. Most image-processing techniques involve treating the image as a two-dimensional signal and applying standard signal-processing techniques to it."

Now it becomes possible to modify the multi-dimensional signals with the help of the system ranging from a common digital circuit to those high tech parallel computers.

The reason of all these modifications are being divided into 3 parts:-

- Image Processing image in → image out
- Image Analysis image in → measurements out
- Image Understanding image in → high-level description out

Image Features

For object detection or classification, the image features should carry enough information of the object in the image and should not contain any irrelevant and redundant knowledge from the extraction. They should be easy to compute in order to make the approach feasible for a large collection of images and rapid extraction. They should relate well with the human perceptual characteristics since users will finally determine the suitability of the retrieved images. Besides, the image features should also provide invariance to changes in illumination, background, etc. To achieve these goals, rather than directly applying raw image intensities or gradients, one often uses some form of more advanced local image feature descriptors. Such features can be based on points, blobs, intensities, gradients, colour or their combinations. In a word, the final feature descriptor needs to represent the image sufficiently well for the detection and classification tasks. There are various kinds of approaches for image feature representation, which in general can be divided into four categories. One consists of sparse representations based on points, image fragments or regions, while the other three contains dense representations using image intensities, gradients or wavelets, respectively.

II. PREVIOUS WORK

In 2014 Swapnil Sonwane a student of University of Mumbai M.E. Information Technology VIT, Mumbai, India, developed a system "Compressed chatting over internet" using which it is possible to send text files rather compressed text files as well as compressed images while chatting over the internet to save the bandwidth. He used Huffman and LZW encoding techniques for compression. and It was observed that using Huffman and LZW, we will get around 50-60 percent compression ratio on text files and around 80 percent compression ratio on images [1].

In 2011 Sameer Kumar Bandopadyaya Tuhin Utsab Paul, Avishek Raychoudhury Department of Computer Science and Engineering, University of Calcutta Kolkata-700009, India made a Study that concentrates on the lossless compression of image using approximate matching technique and run length encoding. The performance of this method is compared with the available jpeg compression technique over a wide number of images, showing good agreements**.** This compression technique proves to be highly effective for images with large similar locality of pixel lay out. This technique will find extensive use in medical imaging sector because of its lossless characteristics and the medical images has large area of similar pixel layout pattern, like in X – ray images large area are black.[2]

In 2014 Puneeth Kumar D N Basavaraju C R Assistant Professor Lecturer Dept. Of Tele communication Engg. Dept. of E & C Engg. SSIT, Tumkur, Karnataka, India. B I T, Tiptur, Karnataka, India presented a paper the novel hybrid wavelet transform generation technique using two orthogonal transforms. This paper proves the worth of hybrid wavelet transforms for the image compression which can further be extended to other image processing applications like Steganography, biometric identification, content based image retrieval etc. Here the hybrid wavelet transforms are generated using four orthogonal transforms alias Discrete Cosine transform (DCT), Discrete Hartley transform (DHT), Discrete Walsh transform (DWT) and Discrete Kekre transform (DKT).[3][4]

G.P. Bhole Head of department Information Technology Dept V.J.T.I.,Mumbai – 400019 proposed an algorithm that combines the features of both Huffman's algorithm and LZW algorithm to achieve more compression ratio. This algorithm is named as VJ Zip. In the new algorithm VJ Zip, for compression, firstly every duplicate occurrence of data is replaced with the pointer to its previous occurrence to obtain partially compressed data. From this partially compressed data, the literals and pointers are further compressed using two separate Huffman trees. Also this paper compared the performance of new algorithm with the existing software 7Zip.As compared to 7Zip new modified algorithm gives almost same compression ratios for text format while achieves 1% more compression ratio for images and videos.[5][6][7][8]

In 2014 Varsha Bansal**,** Pratishtha Gupta**,** Suhail Tomar Computer Science, Banasthali University, Jaipur, Rajasthan, India1 Computer Science, Banasthali University, Jaipur, Rajasthan, India2 Computer Science & Engg. Department, SRM University, Kattankulathur, Kancheepuram, Tamil Nadu, India, Presented a paper studying the implementation of Run Length Encoding that is one of the lossless image compression techniques. This paper gives the implementation of Run length encoding compression algorithm which is proficiently suited for RGB images. Here considered coloured and natural images for the inspection of implemented technique. By which image can be compressed and occupy lesser space in memory, and improve the performance of the system. Such that run length encoding split larger sequences of runs that affects compression ratio into small sequences of runs without degrading the quality of image.[9]

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III. PROPOSED WORK

We have converted coloured images into greyscale images for carrying out compression.

Gray Scale Images

This kind of Image (also known as gray-scale or gray scale or gray-level) is an image in which the value of each & every pixel is 1 sample, such that it carries nothing but intensity info.

Fig 3.1 : Gray Scale Image.

Images of this kind also called black-and-white and are made exclusively of greyish shades, altering from black at the lowest intensity to white at the hardest. A gray scale image is nothing but a data matrix whose values demonstrates intensities amongst small range. MATLAB stores a greyscale image a unity matrix, with every element of the matrix equating to one image pixel. This matrix could be of class uint8 or uint16 or int16 or single or double. Although greyscale images are scarcely saved with a colour map, MATLAB applies a colour map to show them.

IV. PROPOSED ALGORITHM

Proposed by DR. David A. Huffman in 1952. It is a method for the construction of minimum redundancy code. Huffman code is a technique for compressing data. Huffman's greedy algorithm looks at the occurrence of each character and it as a binary string in an optimal way. Huffman coding is a form of statistical coding that attempts to decrease the amount of bits needed to represent a series of symbols. This algorithm achieves its goals by allowing symbols to differ in length. Smaller codes are allotted to the most repeatedly used symbols, and longer codes are assigned to the symbols which appear less frequently in the string. Code word lengths are no longer fixed like ASCII Code word lengths differ and will be shorter for the more frequently used characters.

Input: Image I

Output: Compressed Image CI

1. We first convert the colour input image into a greyscale image.

2. Loop 1:m. Then we convert it into a single dimension matrix where m is the number of rows.

```
        pixel[1, count] = horzcat(I[m,:])
        count <-- count +1
  EndLoop
3. Loop x = 1:count

        if pixel[1,x] >0
        counter = 0

        Loop y = 1: count

                if pixel[1,x] = pixel[1,y]

                  counter <-- counter +1
                Endif

ymbols<-- pixel[1,x]
        total_count <-- [counter]
```

4. CI<--huffman_code(symbols, Ratio)

Image De-Compression Algorithm
Input: Compressed Image CI
OutPut: decompresses Image I

1. CI<--Huffman_Decode(CI)

2. Loop 1:m // put pixel in two dimension. m is number of values in CI

I[y,:] = vercat(I[count: count+x])

count <-- count +x

y <-- y +1

3. EndLoop

V. OUTPUT

Firstly we select the image and then do the proposed compression without any attack and record the SNR and PSNR values. After that we do the compression using the algorithm used in base paper and again record the SNR and PSNR values. Finally we do the proposed compression including noise attack and record the SNR and PSNR values.

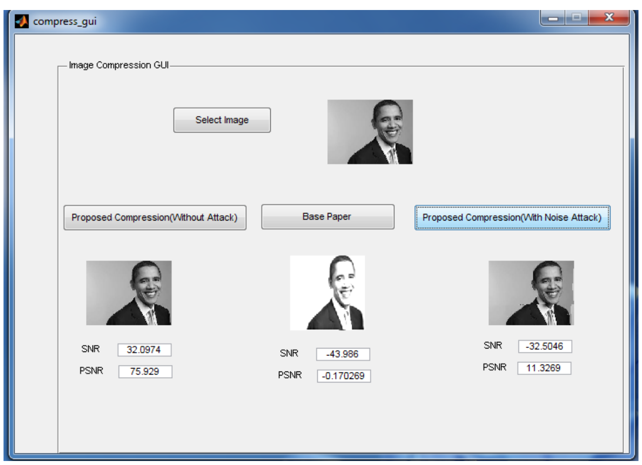

Fig 5.1: Final output snapshot.

VI. PERFORMANCE ANALYSIS

This graph compares the quality of compression done by base paper algorithm as well as our proposed algorithm.

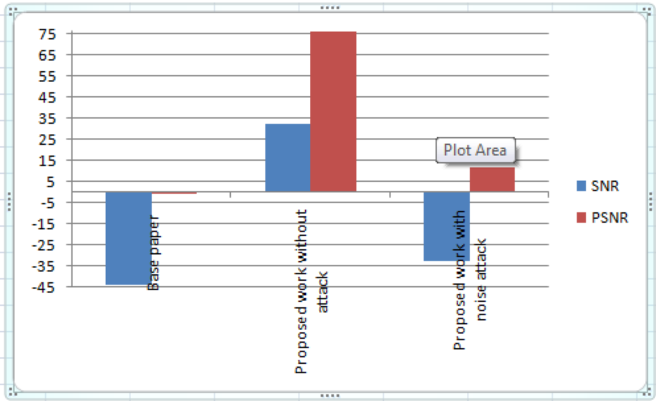

Fig 6.1: Graph showing SNR and PSNR values.

SNR-Signal-to-noise ratio

Signal-to-noise ratio (generally known as **SNR**) is used in science and engineering that compares the level of a required signal to the level of background noise. The ratio of signal power to the noise power is defined as SNR , which is often expressed in decibels.

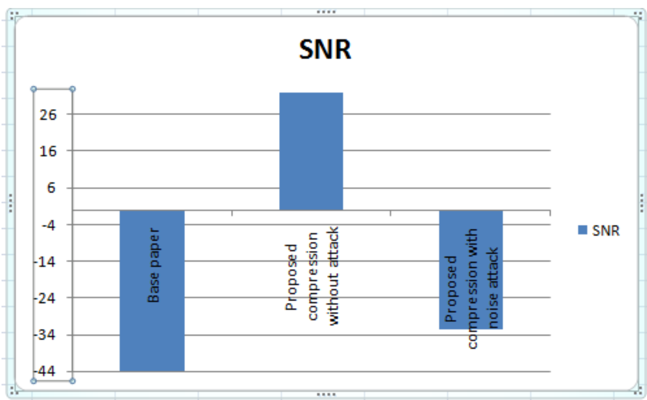

Fig 6.2: Comparison of SNR values

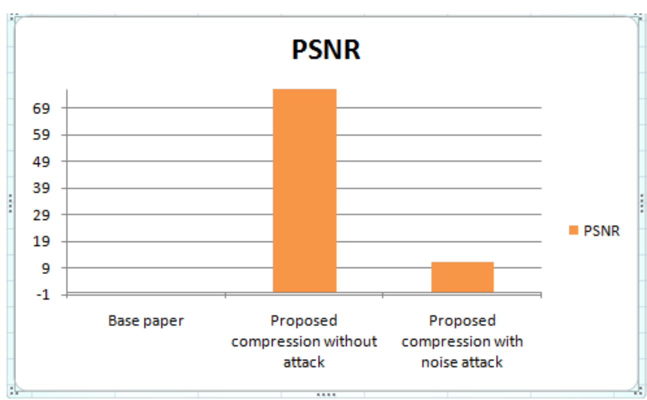

Fig 6.3: Comparison of PSNR values

PSNR

Peak signal-to-noise ratio (**PSNR**) is the ratio of the maximum possible value (power) of a signal to the power of distorting noise that affects the quality of its representation. We can see that the value of SNR and PSNR is smaller in base paper work and greater in our proposed work.

Note: Higher the value of SNR and PSNR, the higher will be the quality of compression. Compression ratio for gray scale image is better as compared to other standard methods.

VII. EXPERIMENTAL OUTPUT

INPUT IMAGE-

Fig 7.1: Input image

RECONSTRUCTED IMAGE WITHOUT ANY ATTACK-

Fig 7.2: Reconstructed Image

RECONSTRUCTED IMAGE WITH NOISE ATTACK-

Fig 7.3: Reconstructed Image with noise attack

VIII. CONCLUSION AND FUTURE WORK

This paper proves to give better results than what we have seen in the base paper and Huffman encoding is used in a different way to produce commendable results. This image compression method is well suited for gray scale (black and white) bit map images .This method can be improved using adaptive Huffman coding technique that is an extension to Huffman coding. This method works best for small size Images, it can be extended in the future for large size images also.

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