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Feed Forward Backpropagation Neural Network Image Compression for Better SNR, PSNR and BPP

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***Abstract*—**Artificial Neural Networks (ANNs) as the name suggest are based on network of neurons in the human brain. Neural Networks have a parallel processing network. Neural networks are make adaptations of highly interactive communications between its basic elements. They form a multilayered and multiprocessing scheme with simple logic building components which are extensively interconnected to perform specific tasks for which they are created in a simplistic order. Neural Networks are used many digital image processing applications and image compression and decompression is one of the fields where use of neural networks has been highly appreciated. Image Compression techniques are employed to reduce the size of image without reducing the quality of the image. This reduction in size saves a lot of storage space and makes image data transmission and reception faster over different channels of communication. This paper proposes as new improved lossless image compression technique which uses Huffman Coding and Artificial Neural Networks. The use of a new improved feed-forward back propagation neural network enhances the previously available Huffman Coding Technique and provides better image compression results. The system is implemented using MATLAB and the results are presented.

***Keywords*—**Image; compression; decompression; huffman coding; neural networks; feed forward backpropagation; MATLAB

I. INTRODUCTION

The multimedia and internet world has a really big problem of image faster data transmission and reception and reducing data storage space. The main aim to compress an image is to make image files that of reduced sizes to make them easier and fast to store, transmit and receive. Image Compression techniques should be such that they reduce the size of the images while retaining all the important information. Therefore, it becomes highly necessary to adopt the best technique possible to achieve lossless image compression.

This paper aims to achieve its main objective of applying Huffman Coding with feed forward back propagation neural network technique for lossless image compression. The proposed method should be able to make image files smaller in size thus being able to send images faster over the internet or downloaded from the websites. The compressed images will require less memory space to store and will have no loss of data. To achieve this artificial neural networks are applied feed forward back propagation along with Huffman Coding Technique and compression results are obtained.

Image Processing is a very interesting and a hot area where day-to-day improvement is quite inexplicable and has become an integral part of own lives. Image processing is the analysis, manipulation, storage, and display of graphical images. An image is digitized to convert it to a form which can be stored in a computer's memory or on some form of storage media such as a hard disk or CD-ROM [1]. This digitization procedure can be done by a scanner, or by a video camera connected to a frame grabber board in a computer. Once the image has been digitized, it can be operated upon by various image processing operations. Image processing is a module that is primarily used to enhance the quality and appearance of black and white images. It also enhances the quality of the scanned or faxed document, by performing operations that remove imperfections. Image processing operations can be roughly divided into three major categories, Image Enhancement, Image Restoration and Image Compression.

Image compression is familiar to most people. It involves reducing the amount of memory needed to store a digital image. Images play an important role in the world of multimedia and its transmission with storage has become really a big burden as it occupy more space in memory. So the concept of image compression evolved. By compressing the images, users find the storage media much more voluminous. So Image Compression enhances the progress of the world in communication [2].

Images are stored on computers as collections of bits representing pixels, forming the picture elements. Many pixels are required to store even moderate quality images. Image compression plays a pivot role in diminishing this amount of information. Most images contain some amount of redundancy that can sometimes be removed when the image is stored and replaced when it is reconstructed, but eliminating this redundancy does not lead to high compression. The amount of data associated with visual information is so large that its storage would require enormous storage capacity. So image compression is very important to reduce the storage and transmission costs while maintaining good quality. Image compression is the process of effectively coding digital images to reduce the number of bits required in representing an image. If the compression is effective, the resulting stream of codes will be smaller than the original symbols [3].

Image Compression has been pushed to the forefront of the image processing field. This is largely a result of the rapid growth in computer power, the corresponding growth in the multimedia market, and the advent of the World Wide Web, which makes the internet easily accessible for everyone.

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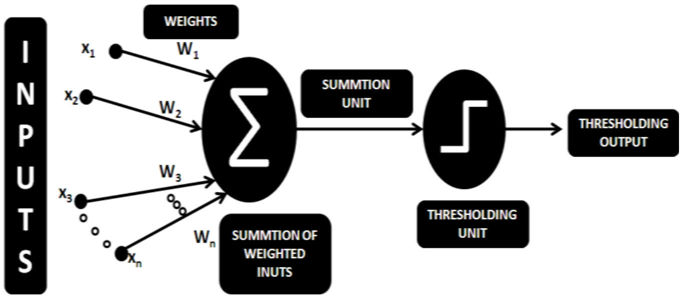
Compression algorithm development starts with applications to two-dimensional (2-D) still images. Because video and television signals consist of consecutive frames of 2-D image data, the development of compression methods for 2-D still data is paramount importance [3].

The goal of image compression is to create smaller files that use less space to store and less time to send. Image compression involves reducing the size of image data files, while retaining necessary information. The reduced file is called the compressed file and is used to reconstruct the image, resulting in the decompressed image. The original image, before any compression is performed, is called the uncompressed image file. The ratio of the original, uncompressed image file and the compressed file is referred to as the compression ratio. The basic types of image compression methods are Lossless compression method and Lossy compression. method. Lossless compression is a compression without any loss of image quality. This means the compression method will not cause any loss of data or errors. This is possible because all read data contain repeating patterns of some sort that a compression processor can search out and then arrange to transmit more efficiently. Generally these methods are used in applications where the loss of even a single bit is dangerous [1].

In order to achieve high compression ratios with complex images, lossy compression methods are required. Lossy compression provides tradeoffs between image quality and degree of compression, which allows the compression algorithms to be customized to the application. With some of more advanced methods, images can be compressed 10 to 20 times with virtually no visible information loss, and 30 to 50 times with minimal degradation. Image enhancement and restoration techniques can be combined with Lossy compression schemes to improve the appearance of the decompressed image. In general, a higher compression ratio results in a poorer image, but the results are highly image dependent. A technique that works well for one application may not be suitable for another. Lossy compression is a compression with loss of image quality. In this compression method, the image is not an exact replacement of the original image [1].

The biological neural networks are made to work in their simplest form when they are made into basic artificial neural network models. They try to mimic the computational process and analysis of a human brain. The generalized definition of a neural network is that it is a complex interconnection of neurons (in brain) or processing logics or elements in the computational process. ANNs are simple, multi-parallel adaptive, non-linear interconnections of computing elements known as neurons. These neurons are connected in such a way that they are modeled to harness the analytical and functional dynamics of a biological nervous system as an in intention to create the artificial access of computational analysis system and strengths of a biological brain.

A simplest neural network comprises of eight different components namely neurons, activation state vector, signal function, pattern of connectivity, activity aggregation rule, activation rule, learning rule and environment [1]. The human brain no doubt is a highly complex structure viewed as a massive, highly interconnected network of simple processing elements called neurons. However, the behavior of a neuron can be captured by a simple model as shown in figure 1. Every component of the model bears a direct analogy to the actual constituents of a biological neuron and hence is termed as artificial neuron [2]. It is this model which forms the basis of artificial neural networks.



Fig, 1. Simple model of a artificial neuron.

Here, x_1, x_2, x_3 …x_n are the n inputs to the artificial neuron, w_1, w_2, w_3,… w_n are the weights attached to the input links. A biological neuron receives all inputs through the dendrites, sums them and produces an output if the sum is greater than a threshold value. The input signals are passed on to the cell body through the synapse which may accelerate or retard an arriving signal [2]. It is this acceleration or retardation of the input signals that is modeled by the weights. An effective synapse which transmits a stronger signal will have a correspondingly larger weight while a weak synapse will have smaller weights. Thus, weights here are multiplicative factors of the inputs to account for the synapse.

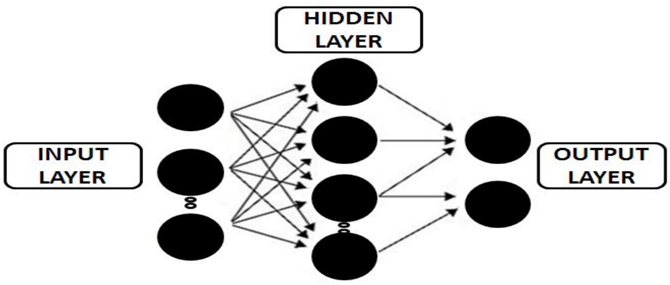


Fig. 2. Multi-layer feed forward back propagation method.

Backpropagation is a systematic method of training Multilayer Artificial Neural Networks. The Backpropagation derives from the fact that computations are passed forward from the input to the output layer. The Feed forward Backpropagation Network is a very popular model in Neural Networks [1]. In Multilayer Feed forward Networks, the processing elements in adjacent layers are connected. This is represented by the following figure 2. The Feed forward process involves presenting an input pattern to input layer neurons that pass the input values onto the hidden layer. The

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hidden layer nodes compute a weighted sum of its inputs and present the result to the output layer.

II. METHODOLOGY

The proposed scheme of artificial neural network based image compression is shown in figure 3.

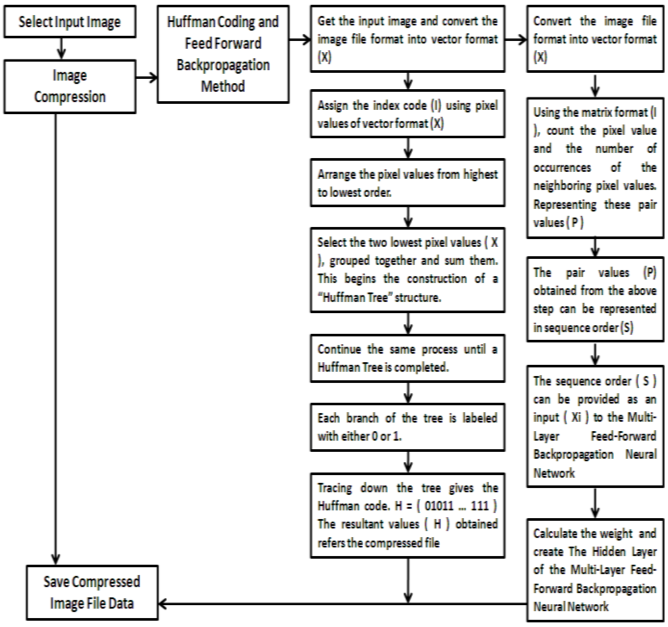

Fig. 3. Steps involved in image compression.

The proposed scheme of artificial neural network based image decompression is shown in figure 4.

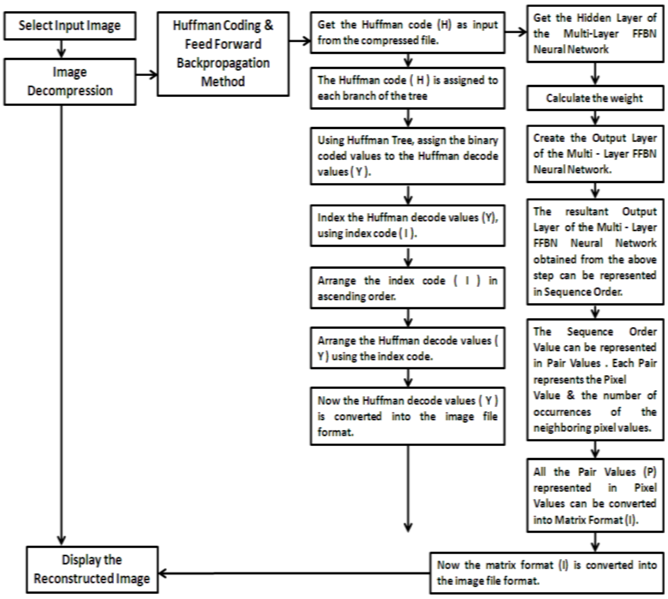

Fig. 4. Steps involved in image decompression.

III. RESULTS

The changes in Signal to Noise Ratio (SNR) over 100 iterations of training set of 400 to 40000 are calculated and plotted for the input image lena.bmp. The graph is shown in figure 5.

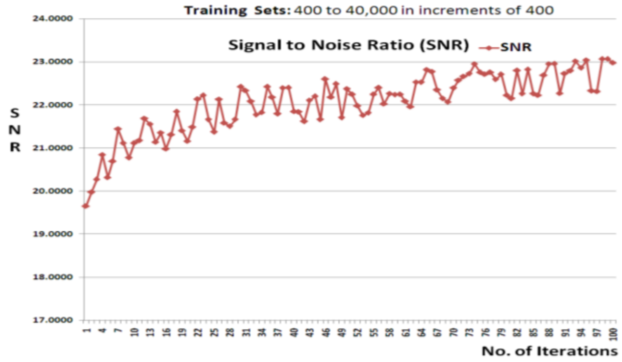

Fig. 5. Graph: iterations vs SNR.

The changes in Peak Signal to Noise Ratio (PSNR) over 100 iterations of training set of 400 to 40000 are calculated and plotted for the input image lena.bmp. The graph is shown in figure 6.

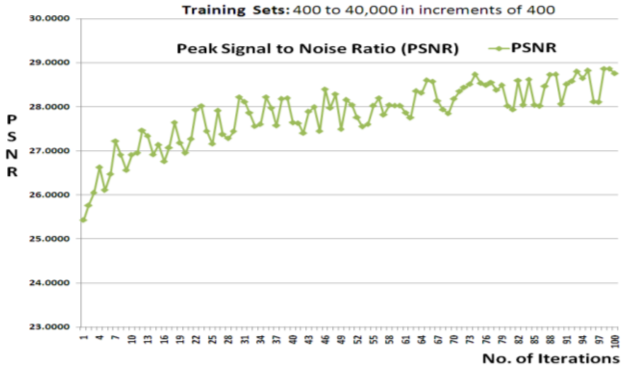

Fig. 6. Graph: iterations vs PSNR.

The changes in Bits per pixels Compression (BPP) over 100 iterations of training set of 400 to 40000 are calculated and plotted for the input image lena.bmp. The graph is shown in figure 7.

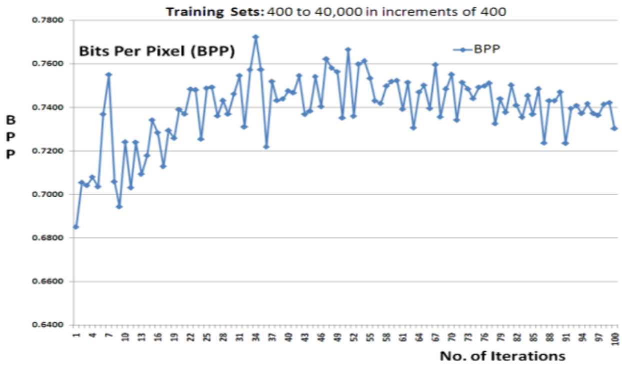

Fig. 7. Graph: iterations vs BPP.

The testing was performed on lena.bmp and the result for the image is shown below in figure 8.

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Fig. 8. Original image and compressed image.

IV. Conclusion

Artificial Neural Network Feed –forward Backpropagation technique implemented using MATLAB is used for image compression and decompression. The results show a constant improvement in SNR, PSNR and BPP as the number of training iterations increase from 400 to 40,000 in increments of 400. The results are plotted for all the 100 observations and the graphs are plotted. This shows that neural networks when applied to image compression and decompression give better results than huffman coding alone. This paper helps to understand the compression and decompression operations using feed forward backpropagation neural network is an effective technique and should be used for image compression applications.

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