ENHANCED IMAGE COMPRESSION USING WAVELET MODIFIED SINGLE LAYER LINEAR COUNTER PROPAGATION NETWORK

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***Abstract*—** Image compression is an active area of research in digital image processing. Neural network model has been applied in image compression. For solving the problem of image compression, Wavelet -Modified single Layer Linear forward only Counter Propagation Network technique is used. This methodology inherits the properties of localizing the global spatial and frequency correlation from wavelets with the help of neural network. This results in the consideration of counter propagation network because of its superior performance

Keywords—compression, Neural network, Wavelet, Propagation, spatial, frequency

I. INTRODUCTION

Data compression is the technique to reduce the redundancies in data representation in order to decrease storage requirements and hence communication costs. Data is represented as a combination of information and redundancy. Information is the portion of data that must be preserved permanently in its original form in order to correctly interpret the meaning or purpose of data. Redundancy is that portion of data that can be removed when it is not needed or can be reinserted to interpret the data when needed. A technique to reduce the redundancy of data is defined as Data compression.

The name data compression refers to the practice of reducing the quantity of data required to signify a specified quantity of information. A common characteristic of most images is that the adjacent pixels are associated and therefore contain redundant information. The primary mission then is to find less correlated representation of the image. Two essential components of compression are redundancy and irrelevancy reduction. Redundancy reduction focuses on removing duplication from the signal source (image). Irrelevancy reduction eliminates parts of the signal that will not be noticed by the signal receiver.

II. LITERATURE SURVEY

Nasrabadi *et al.,* [1] presented a review on Image coding using vector quantization. A review of vector quantization techniques used for encoding digital images is presented. First, the concept of vector quantization is introduced, and then its application to digital images is explained. Spatial, predictive, transform, hybrid, binary, and subband vector quantizers are reviewed. The emphasis is on the usefulness of the vector quantization when it is combined with conventional image coding techniques, or when it is used in different domains.

Jiang *et al.,*, [2] given a survey on Image compressing with neural networks. Apart from the existing technology on image compression represented by series of JPEG, MPEG and H.26x standards, new technology such as neural networks and genetic algorithms are being developed to explore the future of image coding. Successful applications of neural networks to vector quantization have now become well established, and other aspects of neural network involvement in this area are stepping up to play significant roles in assisting with those traditional technologies. This paper presents an extensive survey on the development of neural networks for image compression which covers three categories: direct image compression by neural networks; neural network implementation of existing Techniques, and neural network based technology which provide improvement over traditional algorithms.

Robert *et al.,* [3] proposed a Neural Network Approaches to Image Compression. This paper presents a tutorial overview of neural networks as signal processing tools for image compression. They are well suited to the problem of image compression due to their massively parallel and distributed architecture. Their characteristics are analogous to some of the features of this own visual system, which allows to process visual information with much ease.

Kalra *et al.,* [4] suggest a neural and interpolation method for wavelet transform based image compression. The characteristics of providing spatial and frequency information in the transform domain by wavelet transform, plays a crucial role in forming a significance map of coefficients that needs to be coded in the case of image compression. This paper presents a wavelet based image compression technique where transmission of spatial locations of wavelet decomposed lower sub bands coefficients is eliminated.

Dwivedi *et al.,* [5] gives a Novel Hybrid Image Compression Technique: Wavelet-MFOCPN. In this paper a novel hybrid image compression technique is proposed. This technique inherits the properties of localizing the global spatial and frequency correlation from wavelets and classification and functional approximation tasks from modified forward-only counter propagation neural network (MFOCPN) for image compression.

G. K. Wallace [6] proposed the JPEG Still Picture Compression Standard. A joint ISO/CCITT committee known as JPEG (Joint Photographic Experts Group) has been working to establish the first international compression standard for continuous-tone still images, both grayscale and color. JPEG's proposed standard aims to be generic, to support a wide variety of applications for continuous-tone images. To meet the differing needs of many applications, the JPEG standard includes two basic compression methods, each with various modes of operation.

David Jeff Jackson *et.al* [7] addressed the area of data compression as it is applicable to image processing. An analysis of several image compression strategies are examined for their relative effectiveness. Several topics concerning image compression are examined in this study including generic data compression algorithms, file format schemes and fractal image compression. An overview of the popular LZW compression algorithm and its subsequent variations is also given.

III. METHODOLOGY

3.1 Forward only counter propagation modification

The modification to the original counter propagation network was accomplished by constructing a network for each cluster. Each cluster's network will approximate a supervised learning. As first step, the constructed network will be multi-layered network with two hidden layers network with two hidden layers since cybenko showed that two hidden layers network with continuous sigmoid non linearity can approximate any continuous function arbitrarily well on a compact set. The resulting modified counter propagation network is shown in fig.1. Fig 2 shows the structure of the two hidden layered networks referred to in fig 1.

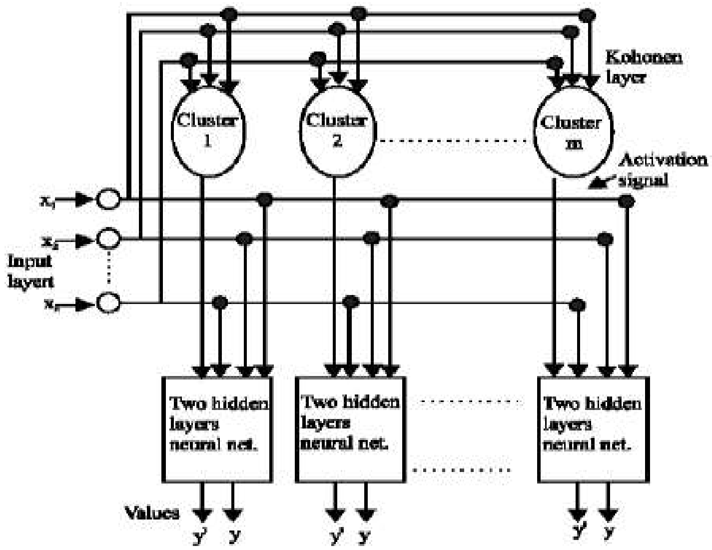

Fig 1.Modified Single Layer Linear Counter propagation Network

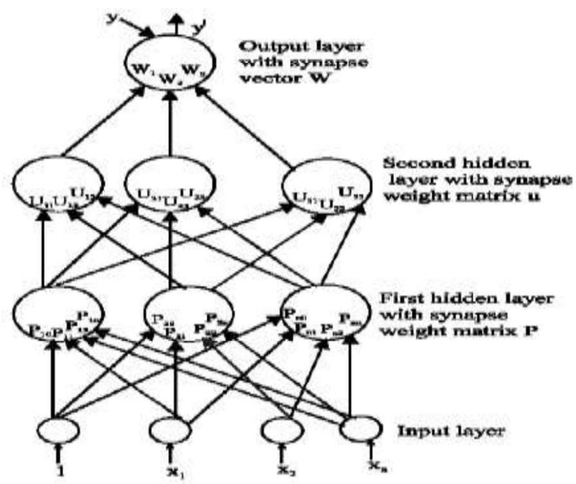

Fig 2.Structure of two hidden layer Net

As a further refinement, the two hidden layers of the network of fig 2 are replaced by single layer linear network. Although the former is more robust than the later the single layer linear net is simpler, require less processing elements, does not need normalization process and it is easily understood. In single layer linear network robustness can be achieved by increasing number of clusters in the network.

The final resulting architecture of the single layer linear counter propagation network shown in fig 1 consist of a number of cluster's each of these clusters contains single processing elements that approximate a function for the subset of examples associated with that cluster.

In this thesis the use of Wavelet-Modified Single Layer Linear Forward Only Counter Propagation Network (MSLLFOCPN) networks is explored to predict wavelet coefficients for image compression. In this method, we integrate the classical wavelet based method with MSLLFOCPN. Instead of passing whole pixel values of image we pass the significant wavelet coefficients obtained after applying wavelet transform to image. This provides better compression because at one stage compression is achieved by wavelet transform and in next stage compression is done by MSLLFOCPN.

IV. EXPERIMENTAL RESULTS

The proposed technique is experimented using three clusters (namely 32, 64 and 128) of different image size for Lena (256 x 256, 512 x 512) is shown below. First the DWT is applied to the input images and then the SLLIC is used to achieve the better compression. The first part of the experiments describes the DWT technique and the remaining part gives the experimental results when using both DWT and SLLIC.

The methodology adapted for quantization is explained as follows.

4.1 Quantization / Thresholding

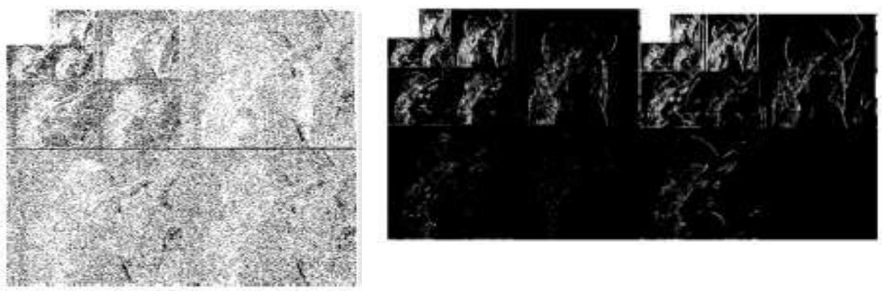

Figure 1 (a) Binary image for wavelet coefficients obtained using db9/7, 3 Level decomposition (b) Multi-resolution wavelet representation (three levels shown) and Full-DWT quantization table (number with alpha)

Figure 2 Binary Image for Wavelet Coefficients obtained using db9/7, 3 level Decomposition with (a) hard thresholding (b) interpolation Schematic of read /write operation in the fiber loop buffer.

<table>
<tr><td>LL2
64X64</td><td>LH2
64X64</td><td rowspan="2">LH1
128X128</td><td rowspan="3">LH0
256X256</td></tr>
<tr><td>HL2
64X64</td><td>HH2
64X64</td></tr>
<tr><td colspan="2">HL1
128X128</td><td>HH1
128X128</td></tr>
<tr><td colspan="3">HL0
256X256</td><td>HH0
256X256</td></tr>
</table>

The quantization table formulated in the form of 8x8 matrix for DWT-JPEG like coder has been adapted for full image dimension as shown in Fig. 1-b, to apply at once (i.e., Full-DWT) for quantization. In Fig. 1-b, the number with alpha, are the values representing quantizing element filled in particular sub band and α is scaling parameter that can be selected depending upon the requirement. Although, the number of calculations in both DWT-JPEG [29] block based and Full-DWT is same for an image dimensions, there are additional complexities involved in DWT-JPEG in the form of block based processing in the same structure of JPEG-like coder. Adapting the quantization table in the form of Full-DWT eliminates the complexity involved with block based approach.

An adaptive hard Thresholding approach is applied for finding the significant wavelet coefficients. The Thresholding parameter is intuitively tuned for each different sublevel of image after several experimentations based on subjective quality of reconstructed image and required compression ratio. Fig. 2-a, shows the binary image after applying the adaptive Thresholding.

Table 1: Performance and comparison of existing and proposed technique for image size 256 X 256

Image Size 256 Lena	Wavelet – MSLLFOCPN		
	Cluster 32	Cluster 64	Cluster 128
PSNR	27.9068	28.2028	28.2233
MSE	105.294	98.356	97.8917

Image Size 256 Lena	Wavelet - MFOCPN		
	Cluster 32	Cluster 64	Cluster 128
PSNR	24.4335	24.5442	24.5471
MSE	234.2800	228.3801	228.2283

Table 2: Performance and comparison of existing and proposed technique for image size 512 X 512

Image Size 512	Wavelet - MSLLFOCPN		
Cameraman	Cluster 32	Cluster 64	Cluster 128
PSNR	30.9335	31.5442	31.8199
MSE	42.2800	42.3801	42.7655

Image Size 512	Wavelet - MFOCPN		
Lena	Cluster 32	Cluster 64	Cluster 128
PSNR	24.2335	24.3541	24.4252
MSE	234.2800	234.3801	234.7253

When comparing the above table, this result to the previous work without SLLIC the compression ratio is very high and the retrieved images after decompression are better.

CONCLUSION

As the need for image compression increases rapidly, this thesis presents a better image compression scheme. In this thesis, the Wavelet-Modified Single Layer Linear Forward Only Counter Propagation Network (MSLLFOCPN) for image compression is presented. In the first phase of image compression, the compression is carried out by help of Discrete Wavelet Transform and in the next step, Single Layer Linear Counter propagation Network (SLLIC) is applied for compression. In this proposed thesis, only the significant wavelet coefficients obtained after applying wavelet transform to image is passed for compression rather than passing whole pixel values of image. The counter propagation network with two hidden layers is modified by single layer linear network in the proposed technique. This layer reduction helps in achieving the compression in less time and with reduced computation. The proposed method uses only fewer elements for processing. SLLIC neural can automatically determine number of clusters with minimum error ratio. It can be concluded that the proposed method achieves better compression as it involves two compressions such as first by wavelet transform and then second by MSLLFOCPN. As the experimental results shows, MSE for the image is lower when compared to the existing method, thus, results in better compression ratio when compared to the conventional methods. PSNR value obtained experimentally shows that the original image can be retrieved after compression without any distortion with the high compression ratio.

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