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Compression of an image using Wavelet Transformation with Unsupervised Learning Approach

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Abstract-Image compression is a demanding research area in the field of visual communication, in entertainment, medical and business applications. A new method is proposed using unsupervised learning neural networks and wavelet transformations, since the wavelet transformation uses sub-band decomposition of an image, it provides enhanced picture quality at higher compression ratios, Also our new algorithm avoids blocking artifacts. In this paper, the performances of haar and DB2 wavelet family are compared with MSE and PSNR. The experiment was carried out with .jpeg images. It is a good reference for application developers to select a good wavelet transformation system.

Keywords-Wavelet transformation,Self Organizing Map (SOFM),Vector quantization, Two dimensional discrete wavelet decomposition

I. INTRODUCTION

Since neural network algorithms have several advantages to handle noisy or partial data it overcomes the drawbacks of conventional image compression algorithms.Different types of ANN algorithms can be used for training the pixels to perform image compression. Some of them are feed forward neural networks, self organizing feature maps and learning vector quantize network, back propagation algorithm. Our Proposed algorithm compresses an image using self organizing map algorithm by combining with different wavelet transformations like haar and DB2. The redundant pixel values are eliminated using unsupervised approach of winning neuron technology which is a neural network concept and thus the image is compressed. The neuron pixel values are stored to decompress the image again.

II. LITERATURE SURVEY

Pavlids proposed an algorithm of polynomial surface fitting for modifying the code vectors created by self organizing feature map algorithm. But it failed to reduce the block artifacts and dimensionality of reconstructed image.Lloyd introduced an incremental update algorithm through competitive learning, but there was higher loss of data, to overcome the above drawbacks a newalgorithm is constructed using haarwavelet transformation and self organizing feature map algorithm.When compressing different images using the existing algorithm of wavelet transformation, it had some drawbacks. It supports only tiff images which have square matrix pixel dimensions. Karen Leesalgorithm could not find a global threshold value which gives nearest optimum results. This paper explains how to select a threshold value using SOFM unsupervised learning concept. To eliminate redundant values, the nearest neighbor vector values are observed and compressed.

III. SOFM

SOFM (Self Organizing Map)[2] is a neural network concept in which one input vector layer and one output vector layers are introduced. Each input vector is multiplied with adaptive weights to produce output vector which generates codebook for vector quantization of the image pixels[7]. This code book and block size is considered to compress the given image. There are two different ways to interpret self-organizing map.The weights of the whole neighborhood are moved in the same direction during the training phase. And therefore similar items are exciting the adjacent neurons. Thus similar neurons are mapped close together and dissimilar items move apart. It may be visualized by Euclidean distance between weight vectors of neighboring pixels. The other way is handling neuron weights as pointers to the input space. In this form discrete approximation weights are distributed in the training samples.

A. Vector quantization

The compression of image file size allows more images to be stored in less memory space and it decreases the time taken to upload and download images over the network. After applying wavelet transformation vector quantization [8] is to be applied to quantize the given image as a group or block which produces better result. The proposed approach is based on wavelet transformations and self organizing map neural concepts. This method is very useful in the field of medical imaging, Telemedicine and Drugs Therapy monitoring systems. The results of practical implementations provides better PSNR value and brightness, also it reduces Mean square error value. The generation of code book is an important step involved in vector quantization.

B. Code book generation

In the field of image compression, the vector quantization should produce minimum distortion between original image and reconstructed image. To compress an image, the vector quantization divides an image into several vectors or blocks and each and every block is associated with the code words of a codebook. Based on these codewords the reproduction vector or

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block is defined. In the process of codebook generation, an image is divided into several multiple dimension training vectors. The Topmost codebook is generated from these training vectors. Using table look-up method, each vector in the training vector is encoded by the index of codeword. The original image can be reconstructed by translating the index of codeword back.

IV. METHODOLOGY

The proposed algorithm for compressing images usingwavelet transformation and SOFM(Self Organizing Map)[10] as follows:

- The pixel value of an input image is constructed using haar wavelet transformation.
- A random value is initialized as weight vector value.
- The training vectors are created based on this random value.
- The best matching winning pixel is identified by SOFM method.
- Using Euclidean distance measure formula, the nearest neighboring pixels are identified.
- The pixels which have smallest Euclidean distance are selected by traversing each pixel in the map.
- The update formula for a best matching pixel vector is $BM_p(t)$ is

$$BM_p(t+1) = BM_p(t) + \theta(V,t) + \alpha(t)(I(t) - BM_{p(t))} \quad (1)$$

$\alpha(t)$is a learning coefficient.
$I(t)$is the input vector.

The neighborhood function $\theta(v,t)$ depends on the Euclidean distance between the best matching node and a node in the map.The above formula is applied until we get only one single winning neuron pixel. The SOFM bases image compression approach requires less no of bits to compress the image. Hence the psycho visual quality of the decompressed image using the proposed method is much better than the other conventional compression methods. This algorithm can be used for cloud computing environments and real time image compression applications.The back propagation algorithm can be applied along with SOFM[10] to reduce the number of iterations and to produce accuracy, also other feed forward network techniques such as adaline networks can be applied to extend the algorithm of our proposed method to achieve higher compression ratio with less information lost. This novel method can be applied in medical image processing and in biometrics system, finger print notifications where lossless compression techniques are involved.

V. 2-D DISCRETE WAVELET DECOMPOSITION

Since wavelet transformations[1] are prone to low computational complexity of separable transforms, two dimensional transformations are applied successively to the rows and columns of image pixels.To explain this novel algorithm approximation region (A1) coefficients are used up to 4-level decomposition.Wavelet packets explain a generalization of multiresolution decomposition. The recursive procedure is applied to wavelet packets of coarse scale approximation along with approximation region, horizontal detail, vertical detail diagonal detail which provides a complete binary tree. The structure of wavelet decomposition up to level 1 in figure1, the tree structureof wavelet decomposition up to level 2 is in figure 2,The Pyramid structure of wavelet decomposition up to level3 is in figure 3, and the structure level 4 is in figure 4.

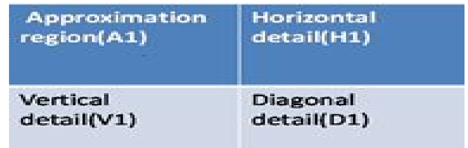

Fig-1.Level-1 decomposition

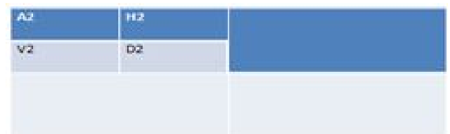

Fig-2.Level-2 decomposition in Approximation region

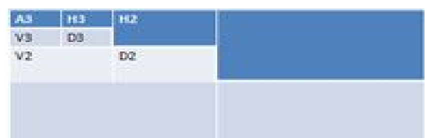

Fig-3 Level-3 decomposition in Approximation region

Fig-4 Level-4 decomposition in Approximation region

For our proposed algorithm we used haarwavelets [4] and Daubechies (DB2) wavelet transformation. The first discrete wavelet transformation [3] was invented by Alfred Haar. This wavelet transformation takes 2^n numbers, and pairs up the input values, after storing the difference and passing the sums. It is called recursively to provide next scale which leads to 2^{n-1} differences and final sum.Daubechieswavelets [5] are designed by Ingrid daubechies. It uses recurrence relations to generated discrete samplings.The images are converted into series of wavelets which can be stored efficiently and effectively rather than pixel blocks. Since wavelets [6] are used it eliminates the blockiness in the picture. The blockinessare eliminated because wavelets have rough edges.

VI. RESULTS AND DISCUSSION

The algorithm is implemented for the tablet image and the results are observed using MATLAB 7.0[9]. The quality of the image is measured using the quality measures like Mean squared error and Peak signal to noise ratio. The following figures and tables are the outputs of our proposed algorithm. Tablet.jpeg image is taken as a test image for our proposed algorithm. The quality measures like Mean square error was less after compressing the picture image. The compression ratio was high in the case of HAAR wavelets compared to Daubechies

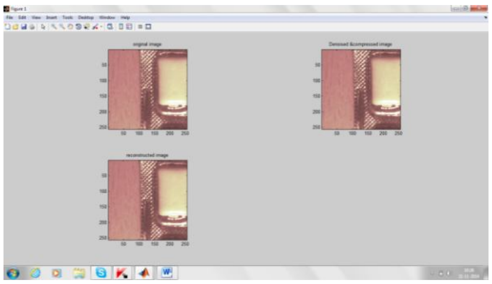

Fig.5: original, Denoised and compressed image, reconstructed image of tablet image using SOFM and wavelet transformations using MATLAB

Table1: compression ratio (CR), mean square error, (MSE) peak signal to noise ratio (PSNR) for tablet image for haar wavelet transformation

Level of decomposition	CR	MSE	PSNR
1	59.3	0.26	53.8
2	61.90	0,168	55.87
3	62.19	0.04	61.69
4	62.15	0.01	67.64

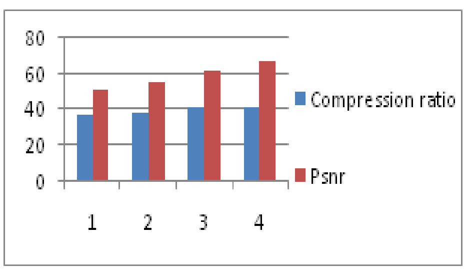

Fig 6

Table2: compression ratio (CR), mean square error, (MSE) peak signal to noise ratio (PSNR) for tablet image for DB2 wavelet transformation

Level of decomposition	CR	MSE	PSNR
1	37.5	0.51	50.97
2	37.9	0.16	55.9
3	41.3	0.04	61.68
4	41.36	0.0114	67.57

Chart2: The quality measures like compression ratio (CR), peak signal to noise ratio (PSNR) for tablet image for DB2 wavelet transformation

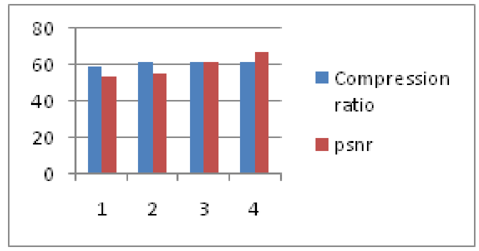

Fig 7

VII.CONCLUSION

In this paper, a pure Image compression algorithm which is based on wavelet transformations and self organizing maps is introduced. The code book generation and vector quantization concepts are applied to improve the better performance. The proposed algorithm is very useful for rendering and transmission procedures. But due to lengthy code, more storage is wasted. To eliminate the limitations of above algorithm TASOFM (Time adaptiveself organizing Map)[8] methods can be applied in future. It is extended version of SOFM. It uses adaptive learning rates and neighborhood functions. It can be applied to adaptive clustering, multilevel thresholding and input approximation. In TASOM, Every neuron considers its own learning rate and adjacent input vector size.The adjacent neuron's size and learning rate of the winning neuron is updated for every input vector. To execute scaling transformations, a scaling vector is applied with TASOM algorithm. The learning parameter values are increased or decreased for adaptation to a changing environment.

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