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Neural Network based Image Compression for Memory Consumption in Cloud Environment

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Abstract

Background/Objectives: The Main aim of this Hybrid Image compression method is that it should provide good picture quality, better compression ratio and also it can remove block artifacts in the reconstructed image. **Methods/Statistical analysis:** To compress an image using the proposed algorithm, images are first digitized. With the digital Information of an image different types of transformations are applied. In this method wavelet transformations (haar, daubechies wavelet transformations) are used. The output of transformation coefficients are quantized into nearest integer values. Vector Quantization takes an important role in quantizing the transformation coefficients. After quantization they are encoded by using any one of the compression encoding techniques. Huffmann encoding is used for compressing Tablet images and Tablet strip images. It is derived from exact frequencies of text. The variable length code table is an output of Huffmann's algorithm. The source symbol is encoded and stored in the above table which is further transferred through the channel for decoding. **Findings:** Since Unsupervised Neural Network learning algorithms are added in this algorithm increase the picture quality is improved and it removes the problems of block artifacts. **Conclusion/Application:** Since cloud computing provides elastic services, high performance and scalable large data storage, to facilitate long term storage and efficient transmission Image files are compressed and stored using this hybrid compression algorithm to enhance the performance of recent compression algorithms. The compressed and reconstructed images are evaluated using the error measures like CR (Compression Ratio), PSNR (Peak Signal Ratio). It shows that the above explained algorithm provides better results than the traditional results.

Keywords: Cloud Architecture, Self Organizing Feature Map (SOFM), Vector Quantization, Wavelet Transformation

1. Introduction

Since cloud computing is a self–service computing or network access, transmitting data is a risk factor. Moreover storing data in the cloud storage, brings appealing benefits for IT enterprises and individuals. Since in cloud environment, universal data access with independent geographical area is possible. To avoid capital expenditure for hardware and software, the Image and video data must be reduced in size and they should have better quality. Actually, the human eye cannot detect a difference between an original image and compressed (or) decompressed image. So an improved Image compression approach or algorithm has to be introduced in cloud environment. Sherif E. Hussein[13] proposed a novel method on Hybrid Image compression for cloud storage and explained a novel method for lossless Image compression. If h decreases the required storage space with a distributed cloud storage layer to decrease the storage cost, and it enforces security measures also it increases the storage performance. Pavlids[12] 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

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of reconstructed image. In incremental update algorithms through competitive learning, there was higher loss of data, to overcome the above drawbacks a new algorithm is constructed using haar wavelet 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. This paper explains how to select a threshold value using SOFM unsupervised learning concept. To eliminate redundant values, the nearest neighbour vector values are observed and compressed.

2. Self-organizing Feature Map

SOFM (Self Organizing Feature 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.

2.1 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.

2.2 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 code words the reproduction vector or 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.

3. Methodology

The proposed algorithm for compressing images using wavelet transformation and SOFM (Self Organizing Feature 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

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

$\alpha(t)$ 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.

4. Cloud Architecture

The scanned images are sent to the embedded platform for lossless image compression. Then it is stored in the image database server. But during decompression, the images are retrieved and first sent to the platform then it is transmitted via the network to the client. In our scheme, only the browser is required for the client because the decompressed images are transmitted with the protocol of HTTP. The client can apply Image processing techniques like image sharpening, image segmentation, filtering and histogram equalization with respect to the image selected from the browser. Our proposed algorithm is very effective and efficient for the lossless compressions.

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 multi resolution 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 Figure 111, the tree structure of wavelet decomposition up to level 2 is in Figure 2. The Pyramid structure of wavelet decomposition up to level 3 is in Figure 3, and the structure level 4 is in Figure 4.

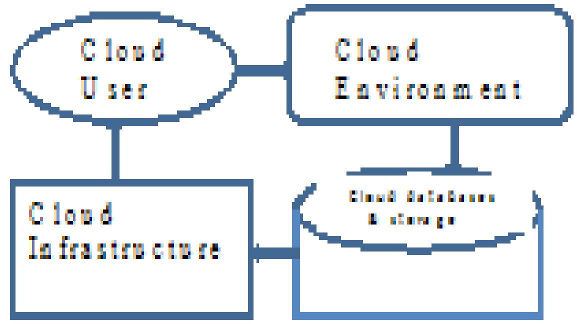


Figure 1. Cloud Architecture of proposed work.

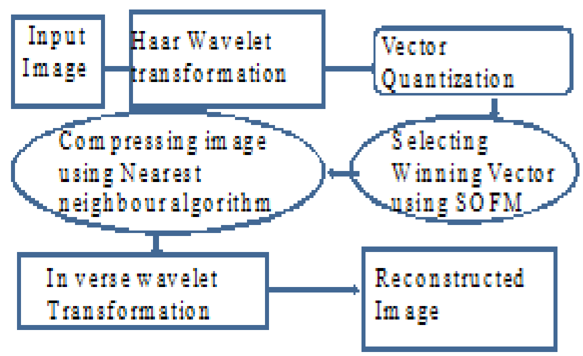


Figure 2. Diagram of Proposed work.

For our proposed algorithm we used haar wavelets[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. Daubechies wavelets[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 block artifacts in the picture. The blockings are eliminated because wavelets have rough edges.

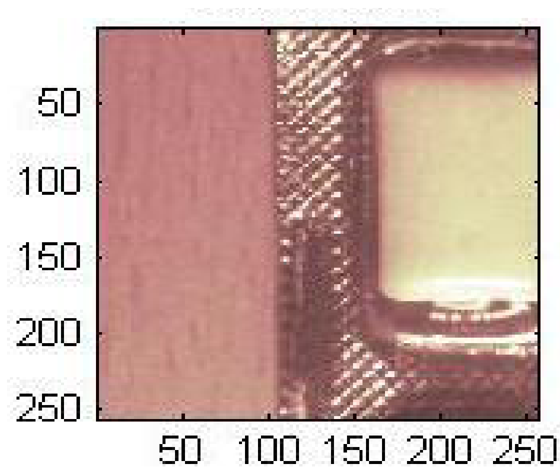
5. Results and Discussion

The algorithm is implemented for the tablet image and the results are observed using MATLAB 7.09. 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.

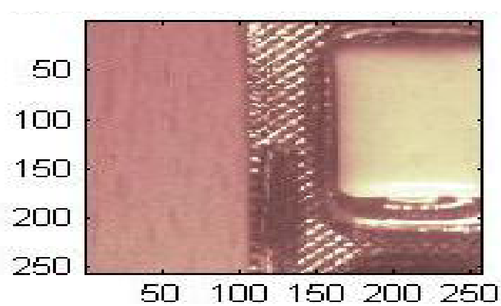
$$Error(E) = original - Reconstructed\ Image$$

$$MSE = \frac{E}{Image\ size}$$

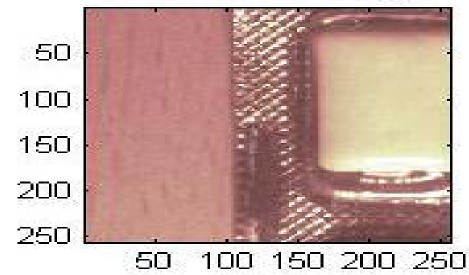
$$PSNR = 20 * log10\left(\frac{255}{MSE}\right)$$



(a)



(b)



(c)

Figure 3. (a), (b), (c) Original, Denoised and compressed, Reconstructed images of tablet.

Table 1. The Quality measures for tablet image for HAAR wavelet

Level of Decomposition	CR	MSE	PSNR
1	72.8745	37.3628	32.4064
2	89.7537	26.2589	33.9380
3	93.4998	12.1649	37.2797
4	94.2871	4.6102	41.4936

Table 2. The Quality measures for tablet image for DB2 wavelet

Level of Decomposition	CR	MSE	PSNR
1	74.9309	7.3247	39.4829
2	91.5839	25.9758	33.9851
3	95.3117	12.5049	37.1600
4	96.1095	4.6477	41.4584

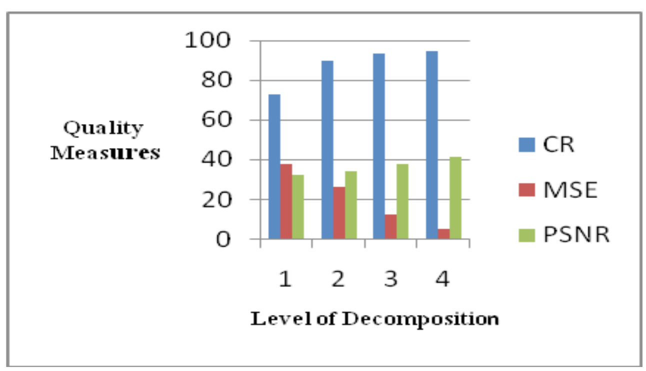


Figure 4. The Quality measures and level of decomposition of image tablet for HAAR wavelet transformation.

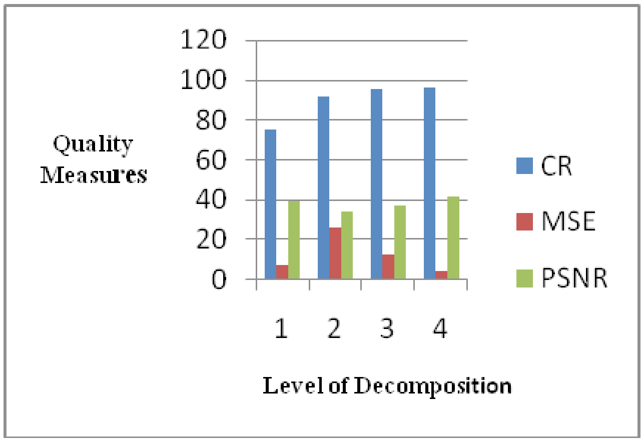
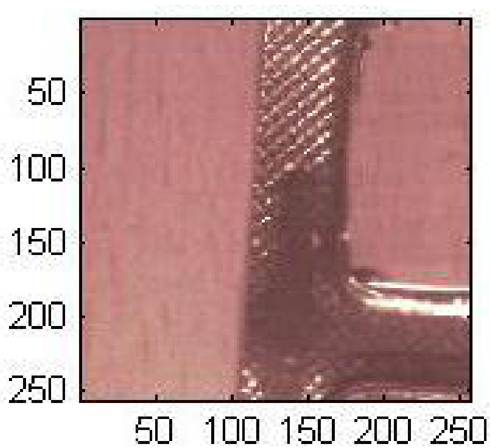
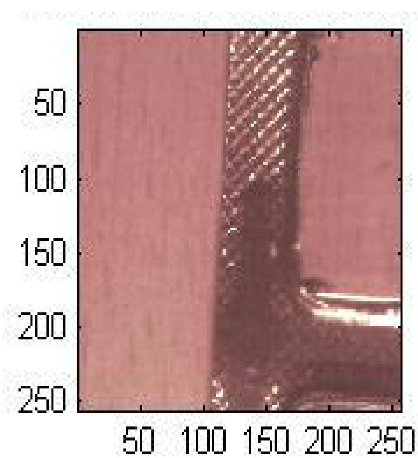


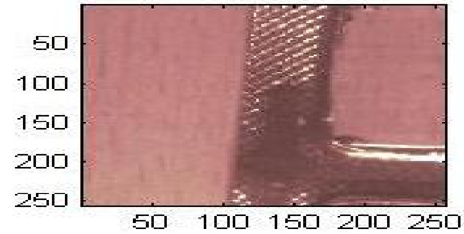
Figure 5. The Quality measures and level of decomposition of image tablet for DB2 wavelet transformation.



(a)



(b)



(c)

Figure 6. (a), (b), (c) Original, Denoised and compressed, Reconstructed images of tablet strip.

Table 3. The Quality measures for tablet strip image for HAAR wavelet

Level of Decomposition	CR	MSE	PSNR
1	74.9309	7.3247	39.4829
2	91.5839	25.9758	33.9851
3	95.3117	12.5049	37.1600
4	96.1095	4.6477	41.4584

Table 4. The Quality measures for tablet strip image for DB2 wavelet

Level of Decomposition	CR	MSE	PSNR
1	73.8174	21.9469	34.7171
2	91.5298	16.5946	35.9311
3	95.6131	8.8222	38.6750
4	96.5408	3.4526	42.7493

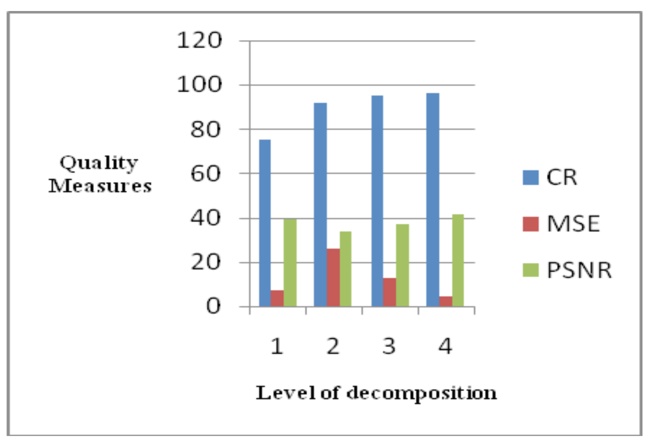


Figure 7. The Quality measures and level of decomposition of image tablet strip for HAAR wavelet transformations.

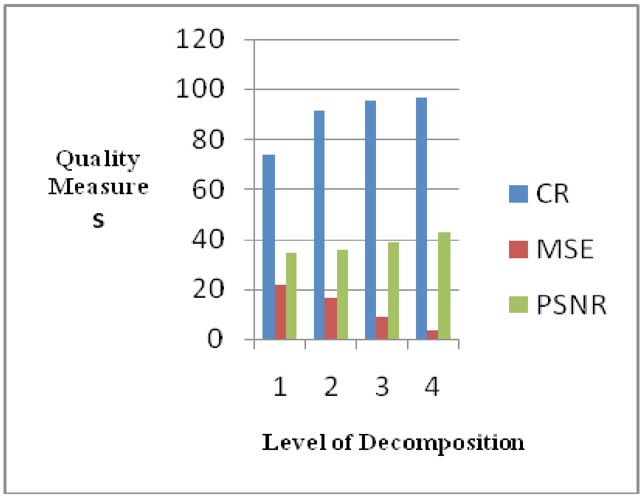


Figure 8. The Quality measures and level of decomposition of image tablet strip for DB2 wavelet transformations.

6. Conclusion

As no specific application technique is needed for the client other than browser, handling proposed system architecture is easy and efficient to maintain with, the picture quality of the original image is recovered after decompressing the compressed image. The computational burden is reduced. Since cloud environment is used sharing and transmission of images are done effectively. In this paper, a pure Image compression algorithm which is based on wavelet transformations and self–organizing maps is introduced. The proposed algorithm is very useful for rendering and transmission procedures.

7. References

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