Image Compression and Reconstruction Using Artificial Neural Network

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Abstract: *In this paper a neural network based image compression method is presented. Neural networks offer the potential for providing a novel solution to the problem of data compression by its ability to generate an internal data representation. This network, which is an application of back propagation network, accepts a large amount of image data, compresses it for storage or transmission, and subsequently restores it when desired. A new approach for reducing training time by reconstructing representative vectors has also been proposed. Performance of the network has been evaluated using some standard real world images. It is shown that the development architecture and training algorithm provide high compression ratio and low distortion while maintaining the ability to generalize and is very robust as well.*

Key Words: **Artificial Neural Network (ANN), Image Processing, Multilayer Perception (MLP) and Radial Basis Functions (RBF), Normalization, Levenberg-Marquardt, Jacobian.**

1. INTRODUCTION

Artificial Neural networks are simplified models of the biological neuron system and therefore have drawn their motivation from the computing performed by a human brain. A neural network, in general, is a highly interconnected network of a large number of processing elements called neurons in an architecture inspired by the brain. Artificial neural networks are massively parallel adaptive networks of simple nonlinear computing elements called neurons which are intended to abstract and model some of the functionality of the human nervous system in an attempt to partially capture some of its computational strengths. A neural network can be viewed as comprising eight components which are neurons, activation state vector, signal function, pattern of connectivity, activity aggregation rule, activation rule, learning rule and environment.

Recently, artificial neural networks [1] are increasing being examined and considered as possible solutions to problems and for application in many fields where high computation rates are required [2]. Many People have proposed several kinds of image compression methods [3]. Using artificial neural network (ANN) technique with various ways [4, 5, 6, 7]. A detail survey of about how ANN can be applied for compression purpose is reported in [8, 9]. Broadly, two different categories for improving the compression methods and performance have been

suggested. Firstly, develop the existence method of compression by use of ANN technology so that improvement in the design of existing method can be achieved. Secondly, apply neural network to develop the compression scheme itself, so that new methods can be developed and further research and possibilities can be explored for future. The typical image compression methods are based on BPNN techniques. The Back propagation Neural Network (BPNN) is the most widely used multi layer feed forward ANN. The BPNN consists of three or more fully interconnected layers of neurons. The BP training can be applied to any multilayer NN that uses differentiable activation function and supervised training.

The BPNN has the simplest architecture of ANN that has been developed for image compression but its drawback is very slow convergence. Mapping the gray levels of the image pixels and their neighbors in such a way that the difference in gray levels of the neighbors with the pixel is minimized and then the CR and network convergence can be improved. They achieved this by estimating a Cumulative Distribution Function (CDF) for the image. They used CDF to map the image pixels, then, the BPNN yields high CR and converges quickly. In BPNN for image compression and developed algorithm based on improved BP. The blocks of original image are classified into three classes: background blocks, object blocks and edge blocks, considering the features of intensity change and visual discrimination Finally, an adaptive method based on BPNN for image compression/decompression based on complexity level of the image by dividing image into blocks, computing the complexity of each block and then selecting one network for each block according to its complexity value. They used three complexity measure methods such as: entropy, activity and pattern-based to determine the level of complexity in image blocks.

This paper is organized as follows. In section II we discuss Methodology (Image compression using ANN) III Describes the Neural network models. IV Describes the multi-layer perception neural network and its approach that is directly developed for image compression. In section V describe the Process steps for compression. VI explains the experimental results of our implementation are discussed and finally in section VII we conclude this research and give a summary on it.

1.2 Image Processing:

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. 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.

2. Artificial Neural Network (ANN):

The Soft Computing book by S. N. Shivanandam gives the detail information about ANN. Artificial neural networks are massively parallel adaptive networks of simple nonlinear computing elements called neurons which are intended to abstract and model some of the functionality of the human nervous system in an attempt to partially capture some of its computational strengths. A neural network can be viewed as comprising eight components which are neurons, activation state vector, signal function, pattern of connectivity, activity aggregation rule, activation rule, learning rule and environment.

ANN has the special functionalities like, adaptability, self learning capability. The ANN requires inputs with real type and the sigmoid function of each ANN neuron requires the input data to be in the range [0-1].

2.1 Training the ANN:

The input image is split up into blocks or vectors of 4×4, 8 ×8 or 16×16 pixels. These vectors are used as inputs to the network. The network is provide by the expected (or the desired) output, and it is trained so that the coupling weights, {wij}, scale the input vector of N -dimension into a narrow channel of Y -dimension (Y < N) at the hidden layer and produce the optimum output value which makes the quadratic error between output and the desired one minimum. In fact this part represents the learning phase, where the network will learn how to perform the task. In this process of leering a training algorithm is used to update network weights by comparing the result that was obtained and the results that was expected. It then uses this information to systematically modify the weight throughout the network till it finds the optimum weights matrix.

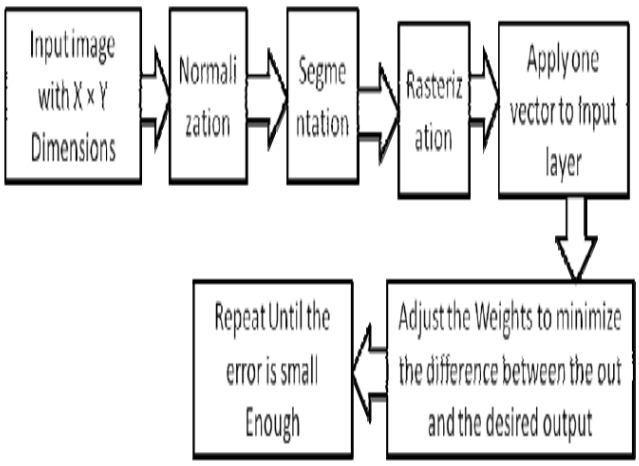

Fig.-1 Block diagram of ANN

3. Image Compression:

The information about Image Compression is referred from IEEE paper on "Image Compression and Reconstruction Using Artificial Neural Network" published by K. Siva Nagi Reddy, Dr. B. R.Vikram, L. Koteswara Rao, B. Sudheer Reddy.

Image compression techniques aim to remove the redundancy present in data in a way, which makes image reconstruction possible. Image compression continues to be an important subject in many areas such as communication, data storage, computation etc.

In order to achieve useful compression various algorithms were developed in past. A compression algorithm has a corresponding decompression algorithm that, given the compressed file, reproduces the original file. There have been many types of compression algorithms developed. These algorithms fall into two broad types, 1) Loss less algorithms, and 2) Lossy algorithms. A lossless algorithm reproduces the original exactly. Whereas, a lossy algorithm, as its name implies, loses some data. Data loss may be unacceptable in many applications.

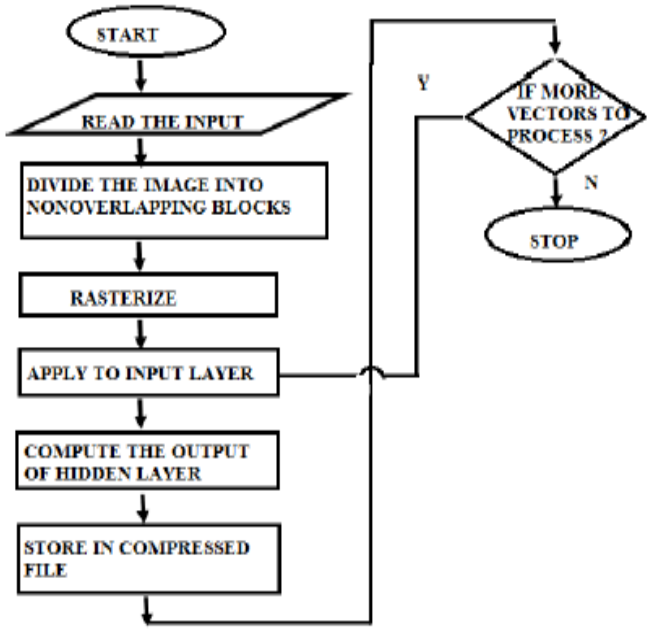

Chart-1 Image Compression

4. Image Decompression:

To decompress the image; first the compressed image is renormalized then applies it to the output of the hidden layer and get the one vector of the hidden layer output is normalized then it rasterization to represent the reconstruct the image.

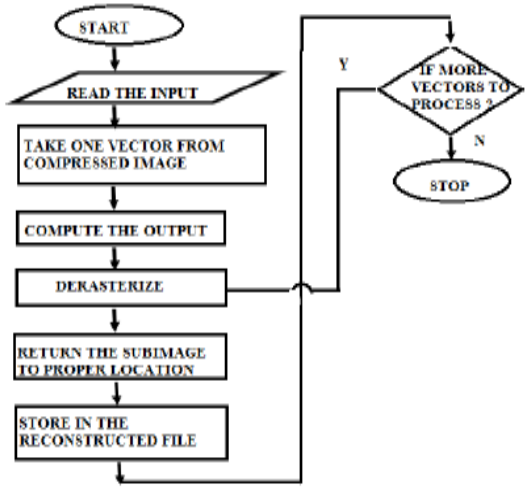

Chart-2 Image Decompression

5. CONCLUSIONS:

In this project the use of Multi -Layer Perception Neural Networks for image compression is reviewed. Since acceptable result is not resulted by compression with one network, a new approach is used by changing the Training algorithm of the network with modified LM Method. The proposed technique is used for image compression. The algorithm is tested on varieties of benchmark images. Simulation results for standard test images with different sizes are presented. These results are compared with L-M method. Several performance measures are used to test the reconstructed image quality.

According to the experimental results, the proposed technique with modified L-M method outperformed the existing method. It can be inferred from experimental results as shown in Table 1, 2 and 3 that the proposed method performed well and results higher compression ratio. Besides higher compression ratio it also preserves the quality of the image. It can be concluded that the integration of classical with soft computing based image compression enables a new way for achieving higher compression ratio.

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