LOSSLESS IMAGE COMPRESSION USING NEURAL NETWORK

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Abstract

In this paper, new multilayer perceptron's feed forward back propagation Neural Network (NN) technique using BFGS quasi newton , Levenberg -Marquardt (LM), Gradient descent back propagation with adaptive learning rate(GDA) Algorithms are being proposed with the project objective to develop a lossless image compression technique using NN and to design and implement image compression using Neural network to achieve maximum peak signal to noise ratio (PSNR), and low mean square error (MSE) and compression levels. This paper presents a NN based technique that may be applied to data compression and breaks down large images into smaller blocks (1x64) and eliminates redundant information. Finally, this technique uses a NN training functions like (trainbf, trainlm, traingda) and conversion of block codes to vector codes and vice versa. Results obtained with proposed techniques leads to better compression information. Finally, this technique uses a NN training functions like (trainbf, trainlm, traingda) and conversion of block codes to vector codes and vice versa. Results obtained with proposed techniques leads to better compression ratio at the same time preserving the image quality. The experimental result shows that the BFG quasi newton algorithm is best among the three proposed algorithm which provides better PSNR value and also reduces the MSE value.

Keywords— Neural network (NN), Multilayer perceptron's, peak signal to noise ratio (PSNR), mean square error (MSE)

Introduction

In communication, Image compression plays an important role. To remove redundancy from image, compression is required. There are mainly two types of image compression techniques lossy and lossless. The training through neural network is one of the methods in image compression to remove redundancy as it processes the data in parallel and with limited bandwidth and hence requires less time and therefore, it is superior over any other technique like cosine transform, wavelet etc. Based on neural network models, a learning approach has been developed and it consists of input layer, hidden layer and output layer [1]. In this project, different learning rule is employed to train multilayer neural network and the network is constructed from input layer, hidden layer, and output layer. In this project image should be subdivided into sub blocks and the pixels grey level values within the block will be reshaped into a column vector and input given to the neural network through the input layer [2-4]. Input pixels will be used as the target values, and therefore the MSE could be adjusted as needed.

Back-propagation Neural Network

The neural network structure is shown in figure. It consist of three layers input layer, output layer and hidden layer. Both of input layer and output layer are coupled to hidden layer. Compression of image is achieved by assigning the value of the number of neurons at the hidden layer which is less than that of neurons at both input and output layers.[3]

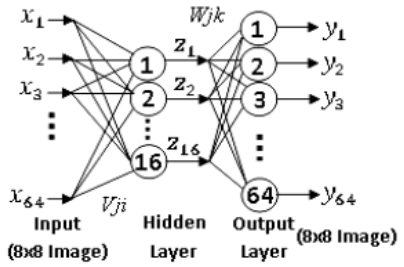


Fig 1

The above neural network could be either linear or nonlinear network according to the transfer function employed in the layers. Log-sigmoid function is one of the most common functions employed in different neural networks problems and its equation[4] is given as

$$f(x) = \frac{x}{1 + \exp(-x)}$$

In a feed forward neural network the output Zj of the jth neuron in the hidden layer is given as-

$$Z_j = f^1(\sum_1^N W_{ji} X_i + b_j)$$

And the output Y_k of the kth neuron in the output layer is given by

$$Y_k = f^2(\sum_1^M W_{kl} Z_l + b_k)$$

Function used for back propagation in matlab is

{newff(minmax(in31),[4,16],{'tansig','purelin'}

Mean square error is calculated as

MSE=(mean(mean(double(a11)-double(a61)))).

Peak signal to noise ratio is calculated as

PSNR=10*log (248*248/MSE).

There are various other parameters like goal setting (1e-5), mc=.2 and alpha=.8%

In this project, all training algorithms have been developed using MATLAB 2013a.

Tools and Methodology:

In this project a literature survey has been carried out to find and efficient multi-layered neural network [6]. MATLAB software along with its Neural Network and Image Processing toolbox will be used to implement the given technique. The MATLAB2013a software provides various easy to use and readily available built in functions for realizing Neural Network algorithms in quick time (Levenberg-Marquardt Algorithm, quasi newton method). An extensive study of this will be required as well.

Algorithm to be used Levenberg-Marquardt (LM) Algorithm, BFG quasi newton method, GDA algorithm

The usability and utility of the power of neural network for image compression lies on the following three important aspects:

(a) Selection of efficient multi layered network.
(b) Selection of training methods.
(c) Test vector.

The Approach:

Neuron:

The most basic element of the human brain is a specific type of cell, which provides with the abilities to remember, think, and apply previous experiences to our every action. These cells are known as neurons; each of these neurons can connect with up to 200000 other neurons. The power of the brain comes from the numbers of these basic components and the multiple connections between them.

The Artificial Neuron

The basic unit of neural networks, the artificial neurons, simulates the basic functions of natural neurons. Artificial neurons are much simpler than the biological neuron[7];

The figure below shows the basics of an artificial neuron.

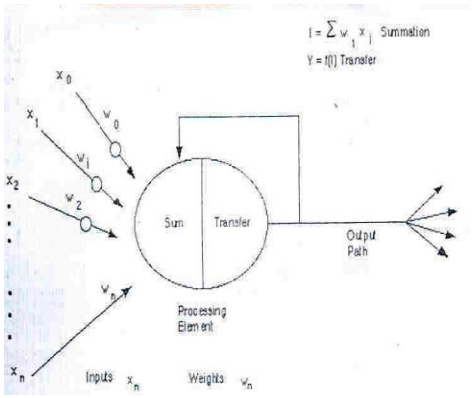


Fig 2

The various inputs to the network are represented by the mathematical symbol, x(n). Each of these inputs are multiplied by a connection weight, these weights are represented by w(n). In the simplest case, these products are simply summed, fed through a transfer function to generate a result and then output. Even though all artificial neural networks are constructed from this basic building block the fundamentals may vary in these building blocks and there are differences.

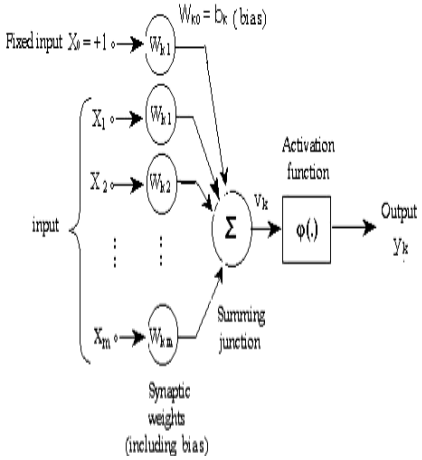


Fig 3

Design

The design goes through a period of trial and error in the decisions before coming up with a suitable neuron design. The design issues in neural networks are complex and are the major concerns of system developers.
Designing a neural network consists of:

- Arranging neurons in various layers.
- Deciding the type of connections among neurons for different layers, as well as among the neurons within a layer.
- Deciding the way a neuron receives input and produces output.
- Determining the strength of connection within the network by allowing the network learns the appropriate values of connection weights by using a training data set.

The process of designing a neural network is an iterative process.

Algorithm

Step1: Read the test image
Step2: Divide the 256x256 image into 8x8 blocks of pixels.
Step3: Check each block for the complexity level.
Step4: Initialize the neurons.
Step5: Target scanned vectors to each neuron on the input layer.
Step6: Depending on the weights and the logic involved, perform the operations (TRANSIG).
Step7: Pass them to the hidden layer.
Step8: Again, the same as in step6 (purlin).
Step9: Reassemble the outputs.

Experimental Results

In order to evaluate the performance of the proposed approach of image compression using LM, BFGs, GDA Algorithm . Standard image of baboon is considered from Matlab library. The work is implemented using MATLAB 2013a. The evaluation of the proposed approach in image compression is performed based on the following two factors, PSNR and MSE values.

Table1: PSNR and MSE values (LM algorithm) (a=.5,u=.4)

Epochs	PSNR(db)	MSE(db)
100	100.34	1.58
200	102.89	1.49
300	110.01	1.09
400	115.91	2.29
500	116.34	4.40
600	116.89	5.60
700	117.89	5.8
800	118.88	5.98
900	119.89	5.78
1000	123.88	7.68

Table 2: Table1: PSNR and MSE values (BFGs algorithm) (a=.5,u=.4)

Epochs	PSNR(db)	MSE(db)
100	134.3501	.0042
200	134.4522	.0479
300	134.9802	.0067
400	137.0125	.0141
500	136.8961	.0770
600	135.9871	.0851
700	138.6789	.0844
800	141.8790	.0834
900	144.0001	.0869
1000	146.7685	.1239

Table3: PSNR and MSE values (GDA algorithm) (a=.5, u=.4)

Epochs	PSNR(db)	MSE(db)
100	82.88	2.00
200	83.10	2.83
300	83.16	2.34
400	85.20	2.68
500	85.48	3.98
600	86.12	3.78
700	87.23	3.99
800	87.12	6.39
900	93.65	6.88
1000	95.89	6.99

PSNR(db) comparison values

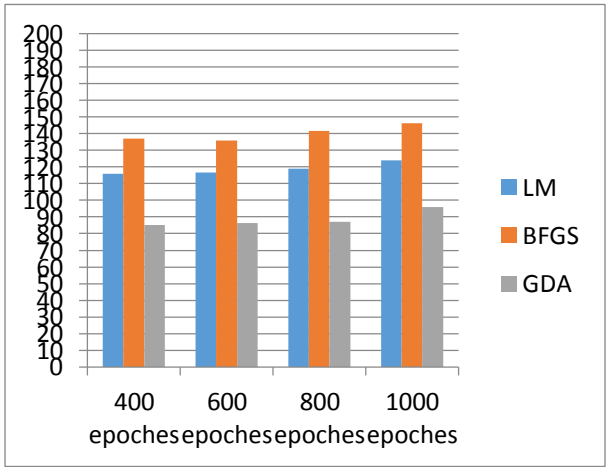


Fig 4

MSE(db) comparison values

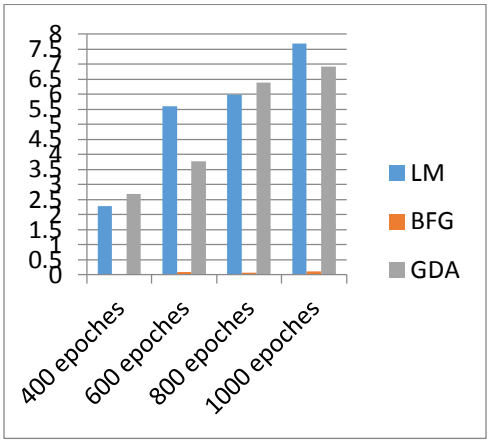


Fig 5

Neural network result using LM, BFGS, GDA Algorithms Result in MATLAB 2013a

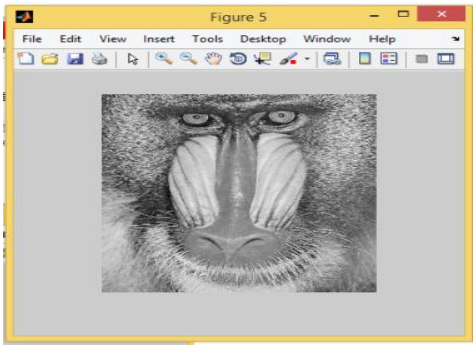


Fig (a)Original image(256 x 256)

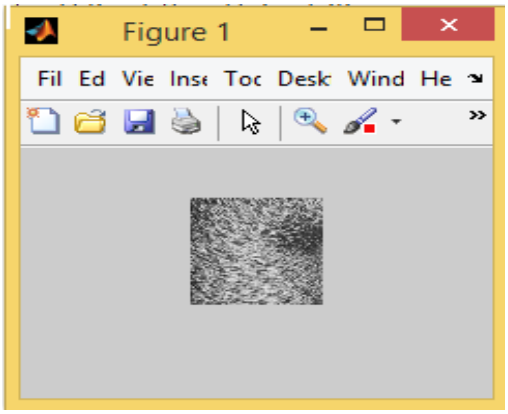


Fig (b)Trained image(8x8)

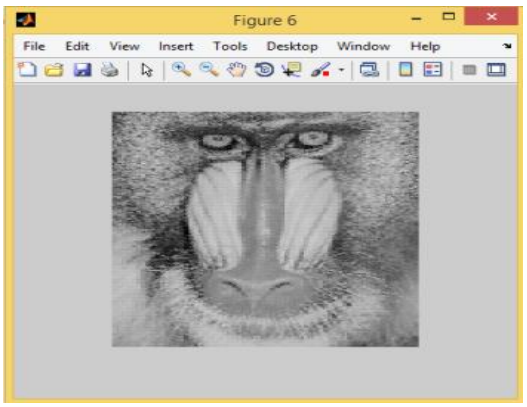


Fig © Compressed image

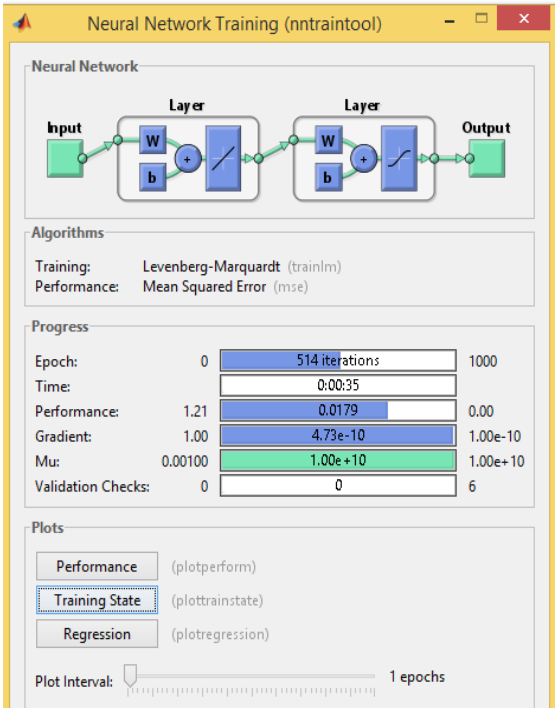
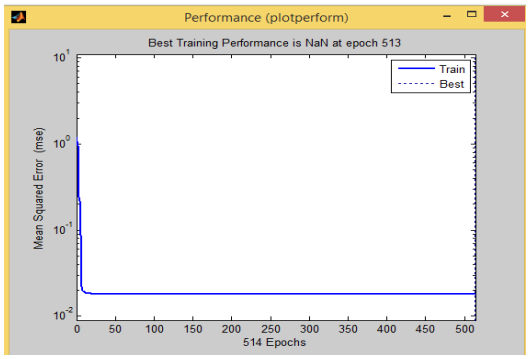


Fig (d)Trained neural network using LM algorithm



Fig(e) MSE performance curve for LM

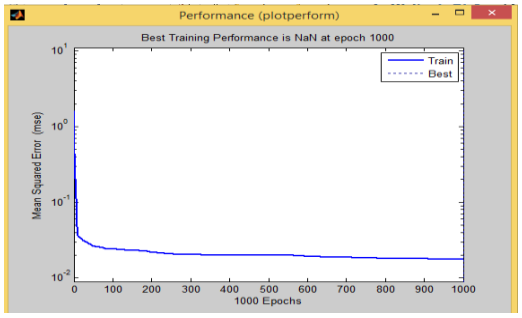


Fig (f) MSE performance curve for BFGS

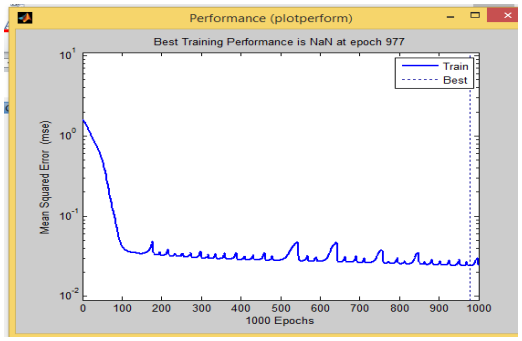


Fig (g)MSE performance curve for GDA

Conclusion

In this paper, neural network technique is proposed and trained using LM, BFGS, GDA algorithm for image compression. The neural network is trained with the small 8 × 8 blocks of image and tested. It is observed from the results that BFG algorithm is best among proposed image for parameters like MSE and PSNR. Using this method, a good quality of decompressed image is obtained. It has high PSNR and very less error. Thus, this method achieves high compression. In this technique the neural network is trying to determine the updated weights and biases in each step to minimize the systems errors.

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Biographies

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