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Neural Network in Image Compression

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Abstract- *Computer images are extremely data intensive and hence require large amounts of memory for storage. As a result, the transmission of an image from one machine to another can be very time consuming. By using data compression techniques, it is possible to remove some of the redundant information contained in images, requiring less storage space and less time to transmit. Neural network can be used for the purpose of image compression. It is apparent that neural network derives its computing power through, first its massively parallel distribution structure and second, its ability to learn and therefore generalize. Generalization refers to the neural network producing reasonable outputs for inputs not encountered during training(learning).These two information processing capabilities make it possible for neural network to solve complex problem that are currently intractable.*

Keywords- *Image compression, Image compression techniques, back propagation neural network and performance parameters PSNR, NMSE,BPP.*

I. INTRODUCTION

The term data compression refers to the process of reducing the amount of data required to represent a given quantity of information. A clear distinction must be made between data and information. In fact data are the means by which information is conveyed. Various amounts of data may be used to represent the same amount of information. For example, if two individual use a different number of words to tell the same basic story, two different versions the story are created, and at least one includes nonessential data. That is it contains data either provide no relevant information or simply restate that which is already known. It is thus said to contain data redundancy.

Data redundancy is a central issue in digital image compression. If N_1 and N_2 denote the number of information carrying units in two data sets that represents the same information, the relative data redundancy R_d of the first data set N_1 can be defined as

$$R_d = 1 - \frac{1}{C_R} \qquad [1.1]$$

Where C_R is the compression ratio

$$C_R = N_1 / N_2 \qquad [1.2]$$

A practical compression ratio such as 10 (10:1) means that the first data set has 10 information carrying units for every one unit in the second or compressed data set.

There are three basic types of redundancies.

1. Coding redundancy
2. Inter pixel redundancy
3. Psychovisual redundancy

Types of Neural Networks:

Richard Lippman in 1987 tutorial article in ASSP magezine "An introduction to computing to neural network" has discussed several neural network models. Hopfield Network and Multilayer Perceptron were the most common.

Multilayer perceptron (MLP):

The capabilities to the single layer perceptron are limited to linear decision boundaries and simple logic functions. However, by cascading perceptrons in layers, we can implement complex decision boundaries and arbitrary Boolean expressions. Perceptrons in the network are called neurons or nodes and differs from Rosenbelt perceptron in the activation function used. The output of this layer feed into each of the second layered perceptron and so an. Often nodes are fully connected between layers i.e. every node in first layer is connected to every node in next layer. Refer figure 1.10 the multiple nodes in the output layer typically corresponds to multiple classes for the multiclass pattern recognition problem.

Capability of MLP:

The capabilities of MLP can be viewed from three different perspectives. The first has to do with its ability to implement Boolean logic function, the second with its ability to partition the pattern space for pattern classification problem and third with its ability to implement the only vanishingly small fraction of number of logic function of 'n' variables. By cascading perceptions together in layers however, arbitrary logic function can be implemented.

MLP Limitations:

The MLP is capable of approximating arbitrary nonlinear mappings and given a set of examples, the back propagation algorithm can be called upon to learn the mapping at example points. However, there are number of practical concerns. The first is matter of choosing the network size. The second is the time complexity of learning. Finally the ability of the network to generalize. i.e. its ability to produce accurate results on new samples outside the training set.

Generalization:

Generalization is the measure of how well the network performs on the actual problem once training is complete. Evaluating the performance of the network on new data outside the training set. It is influenced by the three parameters; the number of data samples, the complexity of the problem and the network size.

Problem definition:

Image data compression deals with representing an image information with smaller number of bits/pixel at the same time it preserves the level of intelligibility required for the given application.

The problem selected is to compress the monochrome images of 128 × 128 by using different architectures of the neural networks such as 16-4-16, 32-8-32, 32-4-32, 16-6-16, 16-8-16 with the compression ratio 2 bits/pixel, 2 bits/pixel, 1bit/pixel, 3 bits/pixel, 4bits/pixel respectively. It is also needed to select the proper values of learning rate (η) & momentum (α) to train the neural network using back propagation algorithm. It is also required to compare the original images with reconstructed images by considering the PSNR of the same.

The back propagation network:

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For many years there was no theoretically sound algorithm for training multilayer artificial neural networks. The invention of the back propagation has played a large part in the resurgence of interest in artificial neural networks. Back propagation is the systematic method for training multiplayer artificial neural networks. Despite its limitations, because of strong mathematical foundation, back propagation has dramatically extended the range of problems to which artificial neural networks can be applied.

The multilayer network:

Sr.	Architecture	α	η	Compression
1	16-4-16	0.6	0.05	2 bits/pixel
2	32-8-32	0.8	0.02	2 bits/pixel
3	32-4-32	0.5	0.05	1 bits/pixel
4	16-6-16	0.5	0.05	3 bits/pixel
5	16-8-16	0.56	0.045	4 bits/pixel

The elementary back propagation is a three layer (perceptron) artificial neural network with feed forward connections from input layer perceptions to the hidden layer perceptions and feed forward connections from hidden layer perceptrons to the output layer perceptrons. Thus there are no feedback connections and no connections that bypass one layer to go directly to a later layer. It is possible to have several hidden layers fig. shows a three layer Back propagation network.

W_{22}

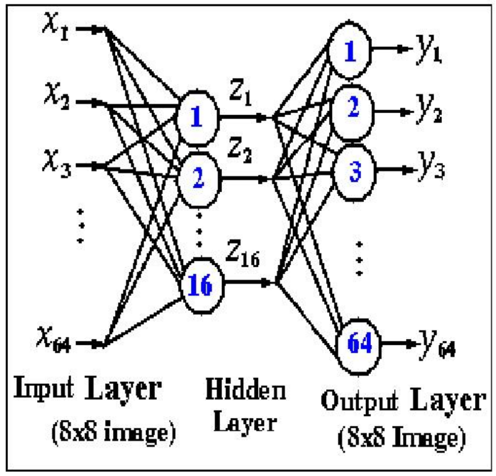

Figure Three Layer Back Propagation Neural Network

II. Selection of Training & Test Data

Training data required to train the neural network can be taken from any image randomly or in a sequential pixel way. Here the standard LEN.128 image is used is as a training image & that to in sequential pixel manner. Pattern so far considered for training the network are 100 (1600 pixels from image of 128 x 128) This can be counted as the major difficulty to select the training pattern & hence proper matching of training data with the network selected is quite a typical work based on trail & error basis. If the training pattern pixels have a very less intensity variations then this will results to reduce the quality of reconstructed image.

III. Results

The training time acquired increases with the increase in network size & it also depends upon two main factors.

i) Learning rate 'alpha'. (α)

ii) Momentum constant 'eta' (η)

For higher compression rate we have use the architecture 32-4-32 which compression of 1bit/pixel at expense image quality. For lower compression rate we have used the architecture 16-8-16 which given the compression of 4 bits/pixel which gives best quality reconstructed.

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IV. Important Terms

a) RMSE (Root mean Square Error):

$$RMSE = \sqrt{\frac{1}{M \times N}\sum_{i=0}^{M}\sum_{j=0}^{N}\left(f(i,j) - f'(i,j)\right)^2}$$

b) SNR (Signal to Noise Ration)

$$SNR = 20\log_{10}\sqrt{\frac{\frac{1}{M \times N}\sum_{i=0}^{M}\sum_{j=o}^{N}\left(f(i,j)\right)^2}{RMSE}}$$

c) PSNR (Peak Signal to Noise Ration)

$$PSNR = 20\log_{10}\frac{2^n - 1}{RMSE}$$

where n is the number of bits per pixel of the image.

d) BPP (Bits Per Pixel)

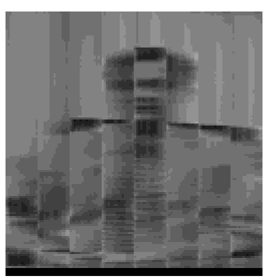
BPP = Total No. of bits required to represent compressed image/ (M*N)

RMSE, SNR, PSNR are used to assess the fidelity (quality) of the reconstructed image

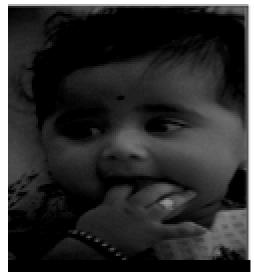
*V. **Original and Decompressed Images***

<u>Network 16-4-16</u>

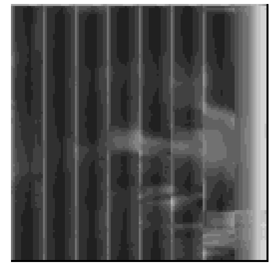
Original Image



Reconstructed Image (PSNR: 10.04 db)

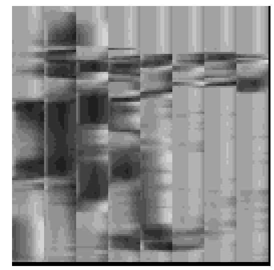


Original Image



Reconstructed Image (PSNR: 10.69 db)

Original Image



Reconstructed Image (PSNR: 07.81db)

<u>Network 16-8-16</u>

Original Image

Reconstructed Image (PSNR: 22.75db)

Original Image

Reconstructed Image

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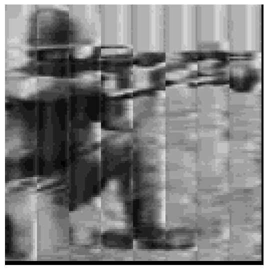
(PSNR: 31.47db)



Original Image Reconstructed Image (PSNR: 31.47db)

VI. CONCLUSION

In image compression technique convergence time also play main role for quality of image and the back propagation is very popular for image compression technique The need for effective data compression is evident in almost all applications where storage and transmission of digital images are involved. Neural networks offer the potential for providing a novel solution to the problem of compression by its ability to generate an internal data representation. Multilayer feed forward network is used due to its efficiency.

REFERENCES

1] S. S. Panda, M.S.R.S Prasad, MNM Prasad, Ch. SKVR Naidu Dept. of Computer Science & Engg., Regency Institute of Technology, Yanam "Image Compression Using Back propagation Neural Network" International Journal of Engineering Science & Advanced Technology Jan – Feb- 2012.

[2] Venkata Rama Prasad Vadella, Kurupati Rama "Artificial Neural Network for Compression of Digital Images" International Journal of Reviews in Computing 2010.

[3] Bhavna Pancholi, Reena Shah, Mitul Modi *"Tutorial* review on existing image compression techniques" International Journal Of Engineering And Computer Science *ISSN: 2319-7242* Volume 3 Issue 8 August, 2014 .[4] Anjana B, Mrs Shreeja R "Image Compression: An Artificial Neural Network Approach" International Journal of Computational Engineering and Research (ijceronline.com) ISSN 2250-3005 Vol. 2 Issue.8, December 2012.

[5] Rajashree Tapase "Neural network based image compression" International Research Journal of Engineering and Technology (IRJET) Volume: 03 Issue: 07 ISO 9001:2008 Certified Journal ISSN: 2395 -0056, July-2016.

[6] Vilas H. Gaidhane, Vijander Singh, Yogesh V. Hote, Mahendra Kumar "New Approaches for Image Compression Using Neural Network" Journal of Intelligent Learning Systems and Applications, Volume 3, November 2011.

[7] Birendra kumar Patel, Suyash Agrawal "Image Compression Techniques Using Artificial Neural Network" International Journal of Advanced Research in Computer Engineering & Technology (IJARCET) ISSN: 2278 – 1323Volume 2, Issue10, October 2013.

[8] S. Anna Durai, and E. Anna Saro "Image Compression with Back-Propagation Neural Network using Cumulative Distribution Function" World Academy of Science, Engineering and Technology 1July 2006.

[9] Pachara V Rao, Suhas MadhusudanA, Nachiketh S.S., Kusuma Keerthi " Image Compression Using Artificial Neural Network" Second International Conference on Machine Learning and Computing, 2010.

[10] Yousuf A Latif Al-Bastaki "GIS Image Compression and Restoration: A Neural Network Approach" Information and Technology Journal-5 ISSN 1812-5638, 2006

[11] Liying Ma and K. Khorasani "Application of Adaptive Constructive Neural Networks to Image

Compression" IEEE Transaction on Neural Network Volume 13, No.5, September 2002.

[12] M.A. Wahdan, A.Z. Badr, Tamer Mustafa "An Efficient Image Compression Technique using variable Quadtree Resolution and Neural Networks" 16th National Radio Science Conference , NRSC-99, Cairo, Egypt, 1999.

[13] G. Qui, T.J. Terell, M.R. Varley "Improved Image Compression using Back propagation Networks" IEEE 1994, 0-8186-5845-2/94.

[14]"Introduction to Neural Network Using MATLAB 6.0" by Dr. S.N.Sivanandam, Dr. S Sumathi, Dr. S N Deepa, Mc Graw Hill Education 2014.