iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 5 **Issue:** IX **Month of publication:** September 2017

DOI: http://doi.org/10.22214/ijraset.2017.9163

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor:6.887
Volume 5 Issue IX, September 2017- Available at www.ijraset.com

Full Resolution Image Compression with Deep Neural Networks

Sarabjot Singh Grewal[1], Er. Beant Kaur[2]
[1,2]Department Of Electronics and Communication Punjabi University Patiala

Abstract: Image compression became prevalent for every image and graphic that we want to send over the internet. It is because a significant amount of bandwidth and space decrease using the image compression techniques. It reduces both time and bandwidth cost and leads to fast and efficient sharing of images and other information. Neural networks have been researching rapidly for image processing. In this research, we presented image compression and error correction control using deep neural networks. First, Deep Neural Network (DNN) is implemented for image compression. We applied the algorithm on four different sizes of images including 512*512, 256*256, 128*128 and 64*64. The result of DNN implementation shows better quality of the decompressed images along with less computational capacity. The proposed algorithm is effective in accomplishing better error-correction and reducing the storage requirements.
Keywords: image compression, deep neural networks, compression ratio, means square error, resolution.

I. INTRODUCTION

Image compression is a form of data compression which is applied to the digital images to reduce its size and the storage sufficiency. Image compression technology helps to compress the size of the image which is very helpful for the maintenance and storage of the thing or an image. Many images which we see on the internet are to be uploaded with the help of image compression. Image compression helps the person to upload the picture quickly on the web and use less space because it reduces the size of the images and reduces the image pixels also. The image compression does not compress the physical size of the images it just compresses the data so that it is easily uploaded to the web. [13]
In simple words, image compression is all about reducing the size of images and different graphics in bytes without degrading the quality. After the image compression process, the image quality must be at an acceptable level. With the minimization of the size of the image, a number of images can be stored in a specific memory space. Along with this, it also helps to minimize the time required for graphics to upload on the internet or download from different websites and web pages [3].

A. Flow of Image Compression

Image compression is performed using image compression coding. It is all about storing the bit-stream of an image into a compact file and displaying the decoded image at the monitor exactly as it was displayed with the original size. The figure shows the complete description of the image compression process. At first, an original image is provided to the encoder, which is converted into a bitstream and sent to the decoder. On the decoder side, it is decoded in the form of an image. As the total data quantity at the decoder side is less than the encoder side, the image can be called compressed image [7].

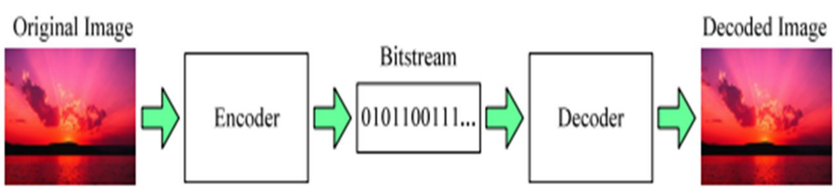


Fig. 1 Flow of Image compression

II. TECHNIQUES OF IMAGE COMPRESSION

Various image compression methods have been developed over the past two decades. All these compression methods can be broadly classified into two categories including lossy or lossless image compression. A high compression ratio of approximately 50:1 can be accomplished using the lossy image compression. It is because a certain level of degradation in the image quality is allowed in the lossy image compression techniques. But it is not able to recover the original data completely. Second techniques are the lossless compression in which possibly there is no degradation in the image quality [11]. It can completely recover the original data of the

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor:6.887
Volume 5 Issue IX, September 2017- Available at www.ijraset.com

image. But the compression ratio is only 2:1. In the case of lossless image compression. Below is the complete description of both type of image compression method

A. Lossy Image Compression

Most of the lossy image compression techniques comprise three steps as shown in the image below. In the first stage of the lossy image compression technique, the interpixel redundancy is eliminated to ensure efficient packing of the information. After that, in the quantization stage, psycho-visual redundancy is removed to represent the information as few bits as possible [21]. At last, more compression is accomplished by encoding the image from the coding redundancy.

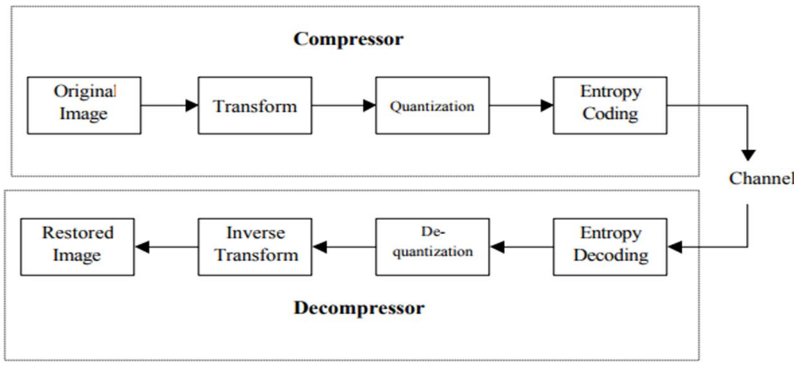


Fig. 2 Lossy Image Compression Method

Lossy image compression is divided into various types [9]

1) *Transformation Coding:* It is used to change the pixel of the current or present images so that it can be stored easily and anywhere [33].
2) *Vector Quantization*: This technique is used to develop a fixed vector in the image to reduce the pixels present in the image.
3) *Fractal Coding*: It is used to decompose the image into different segments by using the technique of standard image processing. It is used for color separation, and edge detection.
4) *Block Truncation Coding*: In this technique, the image is divided into blocks and many other segments to reconstruct the values in the image.

B. Lossless Image Compression

Unlike lossy image compression, it is a two-step algorithm. In the first step, the original image is transformed to any other format to reduce the interpixel redundancy. In the second step, coding redundancy is removed using an entropy encoder. At the decoder side, a lossless decompress perform the inverse process and retrieve the original information without degrading the quality [12].

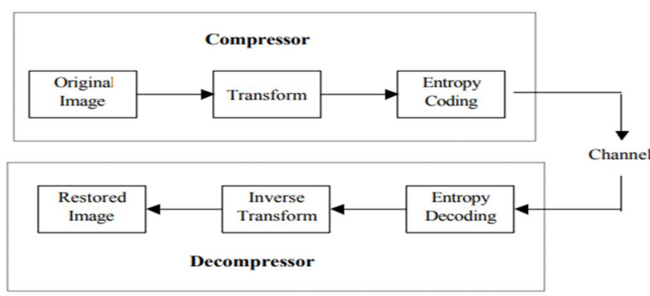


Fig. 3 Lossless Image Compression Method

In lossless image compression, there is no loss of information. If the necessary image is decompressed, then it can be converted to original image easily [7].

III. NEURAL NETWORKS

A neural network is an association computational framework. The computational system that a programmer write is procedural, a program begins at the initial line of code, executes it, and moves ahead to the following instructions in a linear approach [14].

Whereas, a neural network does not follow a linear approach. However, data is processed on the whole, in parallel all through a network of nodes. Neural networks are commonly maintained in layers. These layers are comprised of various interconnected nodes that include an actuation function. Patterns are displayed to the network using the input layer that transfers to at least one hidden layer, the place where the real processing is done using a system of weighted connections [2].

Neural networks also are known as Artificial Neural Networks (ANNs) are organized in layers. Different layers are made of a large number of interconnected nodes which comprise "activation function." The input layer accepts different patterns that communicate to hidden layers. Weighted connections perform the actual processing. At last, the hidden layers provide output to the output layers. The complete functioning is deliberated in the image given below:

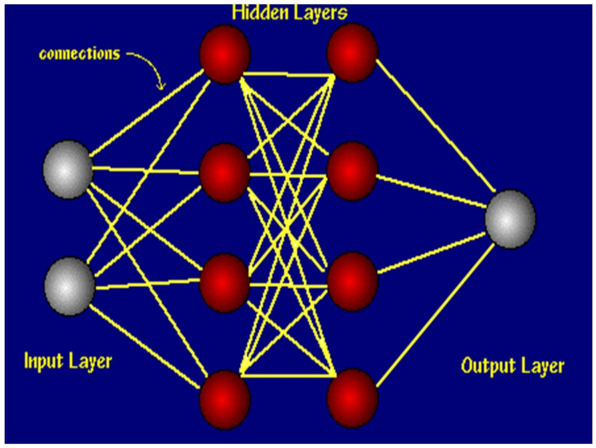


Fig. 4 Multilayer neural network

Neural networks are general approximations, and they function best if the system has a high resilience to error. But, they function extremely well for

capturing connections or finding regularities inside a group of patterns;

where the number of variables, volume or diversity of the information is exceptionally large;

The connections between variables are ambiguously known; or,

The connections are hard to represent sufficiently with conventional methodologies.

IV. ADVANTAGES OF NEURAL NETWORKS

There are numerous advantages of using artificial neural networks. The most prevalent benefits are explained below:

A. Organic Learning

Neural networks have the ability to learn organically. It means the output obtained from the neural networks are not limited by the inputs provided to them by the system. ANNs have the capability to generalize their inputs which are highly necessary for the pattern recognition and robotics systems [13].

B. Fault Tolerance

Neural networks have the capability for high fault tolerance. They can easily route missing servers or data and nodes that cannot communicate while scaling across multiple servers or multiple machines [35].

C. Other Benefits

1) Deep learning became possible through the artificial neural networks. We were not good in speech recognition, machine learning, etc. without deep learning.
2) Based on the strength of the internal data and the nature of the application, it is possible to expect a network to train well. It applies to all the problems where nonlinear or dynamic relationships are present [9, 37].
3) Neural networks provide a better and analytical solution to all the conventional techniques. As the conventional techniques are limited by several strict assumptions of linearity, normality and variable independence. On the other hand, neural networks can capture several relationships, and thus allow modeling any phenomenon in a relatively easy way.
4) It is a non-parametric model. On the other hand, statistical methods are parametric models that make the higher background of statistic as an essential [39].

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor:6.887
Volume 5 Issue IX, September 2017- Available at www.ijraset.com

V. LIMITATIONS OF NEURAL NETWORKS

There are several limitations of neural networks as well. Below are the most prevalent limitations of the neural networks:

1) Considering the backpropagational neural network, we can say that these are simply a "black boxes." Once the neural network starts to train the data, there is no other rule for the users. The user provides it input and gets the output. But there is no understanding what is happening in the hidden layers.
2) Sometimes backpropagational networks are slower to train as compared to another different type of networks.

VI. DEEP NEURAL NETWORK

Deep neural network (DNNs) is the type of artificial neural networks (ANNs) which have numerous hidden layers among input layers and output layers. Figure 2 shows the structure of DNN used for image compression. The architecture of DNN comprises of one input layer, one output layer, and several hidden layers. Input and output layers are totally interconnected with all hidden layers having the same number of neurons. To perform image compression using DNN, a number of neurons can be designed from hidden layers less than a number of neurons from input layer and an output layer. When a lot of input neurons is inserted into a smaller amount of hidden layer neurons, the process of compression started. The decompressor reconstructs the compressed image to the neurons from output layer. The overall process of DNN network for image compression use original image as an input to compress it as a compressor and decompressor gives image similar to the original image at the output layer [1]

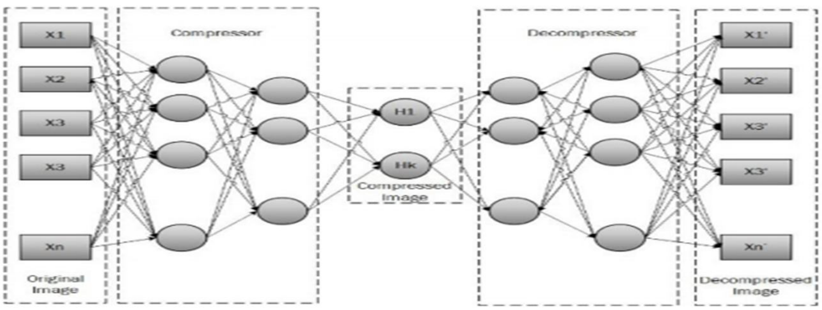


Fig. 2 Deep neural network structure [1]

A. *Image Compression using Neural Network*

Neural Networks are the type of multiprocessor computer system with high degree of interconnection, and simple processing elements. Image compression plays an important role in the quality of the images. [4] The neural network plays an important role to remove the redundancy in the image. It helps to create all the effects in the image which is parallel to each other with limited bandwidth. It requires less time and is superior from all other techniques. Neural network divides the images into subdivision parts, i.e., into the blocks and pixels can be shown in a gray level values within the block, and the input will be given to the neural network through this system. This technique can help to find out the efficient multi-layered neural networks [5].

With the advancement of different multimedia service in computer and media transmission applications, for example, digital broadcasting, teleconferencing, and video technology; hence there is need of Image compression. With the developing demand for better use of bandwidth, efficient image compression techniques have risen as an essential component for image transmission and storage. Image Processing with Neural network is very helpful in the world of multimedia where the images are transmitted to over a network, but one problem occurs while transmitting the images because of its size as the pixel size of the image is very large, and it takes much time and space to transfer. By using the neural network with the lossless image compression, it does not lose the information of the image, and it remains the same whether we converted the image into the original form. The backpropagation neural network technique is best from all other techniques to improve the quality of the picture. From the literature review performed in this paper, it can be seen that training of back propagation neural network is better than other techniques [11].

VII. LITERATURE REVIEW

Watkins & Sayeh (2016) proposed a deep neural network (DNN) for Image compression. The proposed system was designed for the fault-tolerance transmission system and image compression. The LM algorithm was used to implement the DNN for image compression. The implementation results proved that the DNN gives reconstructed images with better quality as well as require less computational energy as compared to other techniques such as DCT coding, SPHIT, DCT threshold coding, and Gaussian pyramid.

The research also investigated error correction rate of the channel and resulted shown that the proposed network gives best error-correction feature using Hamming and Repeat-Accumulate coding, by sending binary images over a noisy channel [1].

Chhikara, S. & Sachdeva, R. (2016) developed image compression algorithm based on the neural network to get good and better level of the compression which obtained firstly in a neural network by modeling in the MATLAB. In this research, different techniques were used in image processing with a neural network which decreased the data which are required to represent a digital image. The neural network can learn from the example which makes them powerful and flexible. And for the color image compression, an algorithm of wavelet image compression is developed [3].

Patel, B. & Agrawal, S. (2013) evaluated the different image compression techniques using the artificial neural network. This research proposed an Image processing algorithm based on back propagation neural network combined with the Levenberg-marquardt algorithm. For this purpose, the image was first divided into blocks, and one neural network was selected for each block based on their complexity values. This proposed algorithm was combined with training algorithm to improve the performance and decrease the convergence time. The peak signal to noise ratio and compression ratio were calculated for image compression. The proposed model also provided the low distortion and high compression of the image **[6].**

Niras, A., Ojha, G. & Sachan, S. (2015) analyzed novice perspective for compression of the image using the architecture of the neural network. The research proposed an Image compression using neural network because original image occupies large space on the network or to transfer over the internet. So, this research developed a technique to reduce the size of an image on disk and make it easier to transfer over the network. Various algorithms were evaluated and tested to find the best approach to them. Different training algorithm was applied, and their results were compared with other performance parameters such as Regression plots, MSE, PSNR, etc. This technique was used for image denoising, segmentation [7].

Dattatherya, S. Chalam, V., Singh, M. K. (2012) presented an approach to a neural network for the security, authentication, and compression of the image. The research proposed a method to protect the data from unauthorized access by using different properties like one to one mapping, universal approximation which is associated with the neural network. To obtain protection and fixed compression ratio, the direct compression method is used which describe that single image on a neural network can generalize by decompression and compression of an image using optimal weight. The research proposed the concept to achieve protection, authentication, and compression together on a neural network by one to one mapping, one-way property and learning which are very efficient in the performance, cost effectiveness and simplicity [8].

Tapase, R. (2016) proposed a Bipolar Coding Technique, Principal Component Analysis (PCA) and LM approach for image compression. The research also used the Levenberg-Marquardt (LM) algorithm and compared this algorithm with bipolar PCA to identify the powerful image compression technique. The results of PCA algorithm were based on the accuracy of the threshold value of eigenvalue. However, the outcomes of PCA algorithm were not satisfactory. The results showed that Bipolar and LM techniques are the best approaches as compared to PCA technique for Image processing and image compression applications. The study proves that the Bipolar Coding technique and LM technique can be used where the data is highly nonlinear [9].

VIII. PRESENT WORK

A. Artificial Neural Network

An ANN stands for the Artificial Neural network; it is also known as information paradigm because neural network is like the brain which is full of neurons and is made of different layers. It is mainly used for processing information. This network has three types of layers. They are Input Layer, Hidden Layer, and the Output Layer. The primary function of the input layer is to receive the incoming information from the external surroundings. The output of this layer is further given to the Hidden Layer. The Hidden Layer, which is also known as an Intermediate layer. They consist of neurons which perform the function of extracting the data from the particular process. The hidden layer is used to conduct all the internal processes. The output of this layer is passed on to the Output layer. The output layer is at the end of the neural network. It is made up of neurons; its function is to process the data coming from the hidden layer. It shall consist of a vast number of neurons or elements which are interconnected working on the same problem for getting a solution. In the ANN, there is no limit of internal layers. In the overall process, each layer is a function which takes same variables and then transforms them to another variable.

B. Implementation

The method of the Image Compression and Decompression is proposed with the help of train neural network algorithm in MATLAB. For this, the two-layered feed-forward neural network was considered and implemented using the Levenberg Marquardt Algorithm. It consists of multiple hidden layers which are used to encode or decode an image. The neural network trains the image

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor:6.887
Volume 5 Issue IX, September 2017- Available at www.ijraset.com

until the minimum possible MSE value is reached. There are two hidden layers of the neural network model, one consisting of 6 layers and other of 16 layers. The main steps of the algorithm are as follows:

1) Read the input image of the desired size.
2) Conversion of the image to grayscale (if it is not in the grayscale format) was done.
3) Removal of extra noise from the picture was done with the help of a median filter.
4) The primary step is to divide the image into blocks. The image was split into R x C blocks of pixels. After this, each block is scanned to form the vector.
5) Neural Network was Initialized after the Blocks to pixels division was completed. For the neural network, the Levenberg Marquardt Algorithm was implemented. LM is one of the most widely used algorithms. It is the variation of Newton's method which was designed to minimize the functions that are sums of squares of other nonlinear functions. This algorithm is very well suitable for the neural network training. In this training, the Performance Index is considered as the Mean Squared Error (MSE).
6) Now, with the help of Block to matrix function, all the matrix were arranged column wise. The overall network was developed using the four neurons in the first layer and sixteen neurons in the second tier. The first layer uses the function called as 'tangent sigmoid function' and 'linear function' was employed in the second tier. The training goal was set to 1e-005 with 100 Epochs.
7) After this, the various plots of training modules were analyzed like the plot of Training state data, Regression plot and the Performance plot.
8) The different calculations were done for MSE, PSNR and CR values.

IX. RESULTS

The work is done for four different sizes of the image.

*A. Output for Image Size (512*512)*

Fig 6. Original Image of size (512*512)

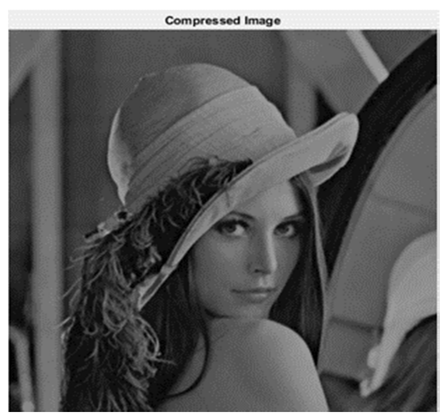


Fig. 7. Compressed Image of size (512*512)

*B. Output for Image size (256*256)*

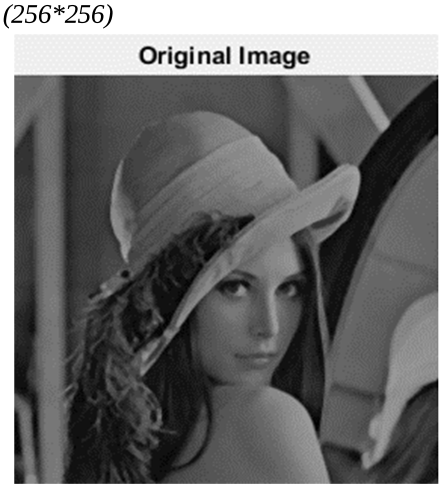


Fig 8. Original Image of size (256* 256)

Fig 9. Compressed Image of size (256* 256)

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor:6.887
Volume 5 Issue IX, September 2017- Available at www.ijraset.com

*C. Output for Image size (128*128)*

Fig 10. Original Image of size (128* 128

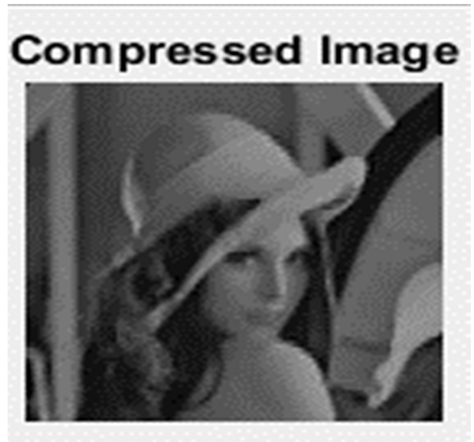


Fig 11. Compressed Image of size (128* 128)

*D. Output for Image Size (64*64)*

Fig 12. Original Image of size (64*64)

Fig 13. Compressed Image of size (64*64

E. Final Resultant Table

Table 1 Final Resultant Table

Image Size	Compression ratio Value	PSNR	MSE	SNR
64*64	1.11	30.32	20.32	25.45
128*128	1.32	32.42	14.1	27.13
256*256	1.51	37.89	8.32	32.52
512*512	1.64	38.8807	3.56	33.17

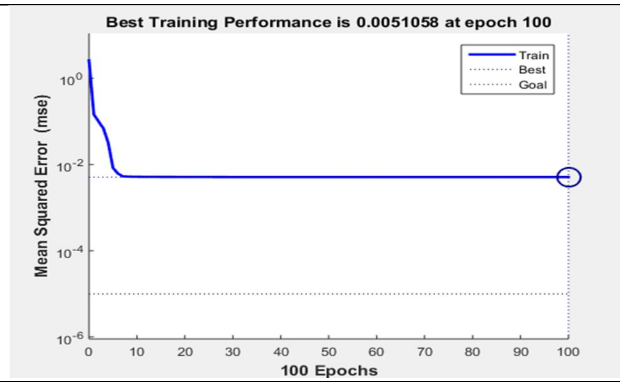
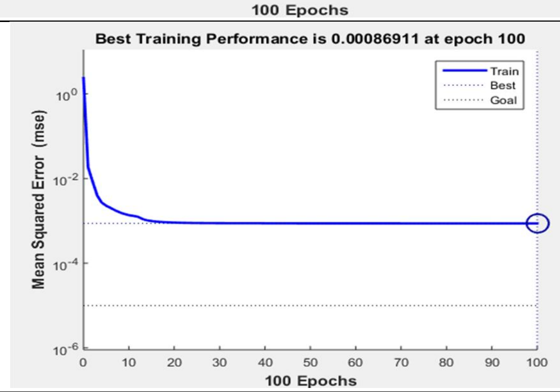
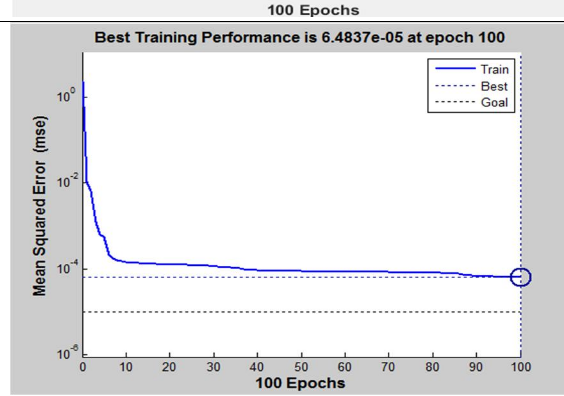
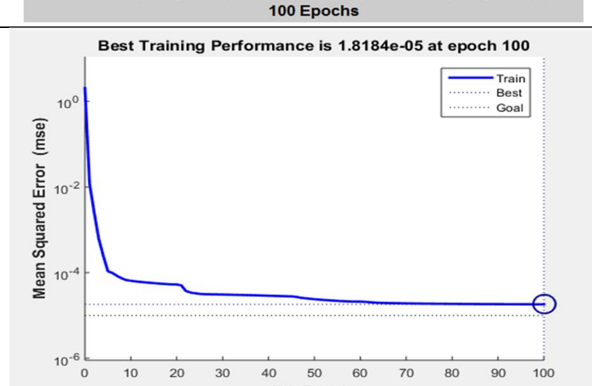
F. Resultant Performance Plots

The below shown are the Performance plots for all the size of images. The performance scheme is also known as Mean Squared Error (MSE) plot. MSE is defined as the cumulative squared error between the compressed and the original Image. As the size of image increases, the MSE value goes on decreasing. The lower value of the MSE indicates the lesser amount of error. Mathematically MSE is defined as below

$$MSE = \frac{1}{M*N}\sum_{i=0}^{M}\sum_{j=0}^{N}[X(i,j) - Y(i,j)]^2$$

where X(i,j) is the original Image, and the Y (i,j) is the decompressed image.

Table 2performance Plot

<table>
<tr><th>Image Size</th><th>Performance Plot</th></tr>
<tr><td>64*64</td><td>
</td></tr>
<tr><td>128*128</td><td>
</td></tr>
<tr><td>256*256</td><td>
</td></tr>
<tr><td>512*512</td><td>
</td></tr>
</table>

G. Comparing our Results with the Previous Work in the same Field (1)

In our task, the methodology was implemented on all the size of the image like (64*64), (128*128), (256*256) and (512*512). But in their work, they have chosen the particular size image as (512*512). MSE stands for Mean Squared Error, and the lower MSE value depicts that there is less error in our method. The method which is used for the comparison is the Deep Neural network. The comparison table of the output values for (256*256) size of the image is represented as below:

Table 3 Output Values For (256*256) Size Of Image

Image Size	Compression ratio Value (Our Implementation)	Compression ratio Value (Their work)	MSE VALUES (Our Implementation)	MSE VALUES (Their work)
256*256	1.51	4:1	8.32	15.46

In their work, for all the compression ratios, the MSE lies between 15 and 45 for Lena Image. But in our improved work, for all the compression ratios, the MSE lies between 3 and 20.

X. CONCLUSION

Presently, a vast amount of information including data, images, audio, video, and graphics is stored and transmitted digitally all around the world. Image compression techniques are used to reduce the bandwidth cost and storage capacity of the channel to provide fast and efficient delivery of images and graphics over the internet. In this research, we presented image compression using deep neural networks for increasing storage capacity and error correction. DNN algorithm was implemented on four sizes of the image including (64*64), (128*128), (256*256) and (512*512). The result of our study shows less MSE (Mean Square Error) and improved compression ratio compared to the previous study.

REFERENCES

[1] Y. Z. Watkins and M. R. Sayeh, "Image Data Compression and Noisy Channel Error Correction Using Deep Neural Network," Procedia Computer Science, vol. 95, pp. 145–152, 2016.

[2] R. Dony, and S. Haykin, "Neural Network Approaches to Image Compression."Proceedings of the IEEE, Vol. 83, No. 2, February 1995.

[3] S. Chhikara, and R. Sachdeva, "Image Compression Using Neural Networks." Imperial Journal of Interdisciplinary Research (IJIR), Vol. 2, no. 7, 2016.

[4] A. Oord, N. Kalchbrenner, and K. Kavukcuoglu, "Pixel Recurrent Neural Networks," Proceedings of the 33rd International Conference on Machine Learning, vol. 48, 2014.

[5] B. Anjana, and R. Shreeja"Image Compression: An Artificial Neural Network Approach."International Journal of Computational Engineering Research (ijceronline.com), Vol. 2, no..8, 2012.

[6] B.K. Patel, and S. Agrawal, "Image Compression Techniques Using Artificial Neural Network." International Journal of Advanced Research in Computer Engineering & Technology (IJARCET), Vol. 2, no.10, October 2013.

[7] A. Niras, G. Ojha, and S. Sachan, "Lossless Image Compression Using Neural Network." International Journal of Emerging Technology and Advanced Engineering, Vol. 5, no. 6, June 2015.

[8] S. Dattatherya, V. Chalam, and M.K. Singh, "Unified Approach with Neural Network for Authentication, Security, and Compression of Image." International Journal of Image Processing (IJIP), Vol.6, no.1, 2012.

[9] R. Tapase, "Neural network-based image compression," International Research Journal of Engineering and Technology (IRJET), vol.3, no.7, pp. 479-482, 2016.

[10] V. H. Gaidhane, V. Singh, Y. V. Hote, and M. Kumar, "New Approaches for Image Compression Using Neural Network," Journal of Intelligent Learning Systems and Applications, vol. 03, no. 04, pp. 220–229, 2011.

[11] S.R. Kumar, and N. Rani, "Analysis of Wavelet-Based Compression Technique to Compress Images Using Neural Network." International Journal of Technical Research (IJTR), vol. 2, no. 1, pp.36-41, 2013.

[12] N. Senthilkumaran and J. Suguna, "Neural Network Technique for Lossless Image Compression Using X-Ray Images," International Journal of Computer and Electrical Engineering, pp. 170-175, 2011.

[13] M. Egmont-Petersen, D. De Ridder, and H. Handels, "Image processing with neural networks—a review." Pattern Recognition, Vol. 35, no.10, pp. 2279-2301, 2002.

[14] N. Johnston, D. Vincent, D. Minnen, M. Covell, S. Singh, T. Chinen, and G.Toderici, "Improved Lossy Image Compression with Priming and Spatially Adaptive Bit Rates for Recurrent Networks." arXiv preprint arXiv: 1703.10114, 2017.

[15] G. Toderici, D. Vincent, N. Johnston, S. J. Hwang, D. Minnen, J. Shor, and M. Covell, "Full Resolution Image Compression with Recurrent Neural Networks." arXiv preprint arXiv: 1608.05148, 2016

[16] C. Hillar, R. Mehta, and K. Koepsell, "A Hopfield recurrent neural network trained on natural images performs state-of-the-art image compression." 2014 IEEE International Conference on Image Processing (ICIP), 2014.

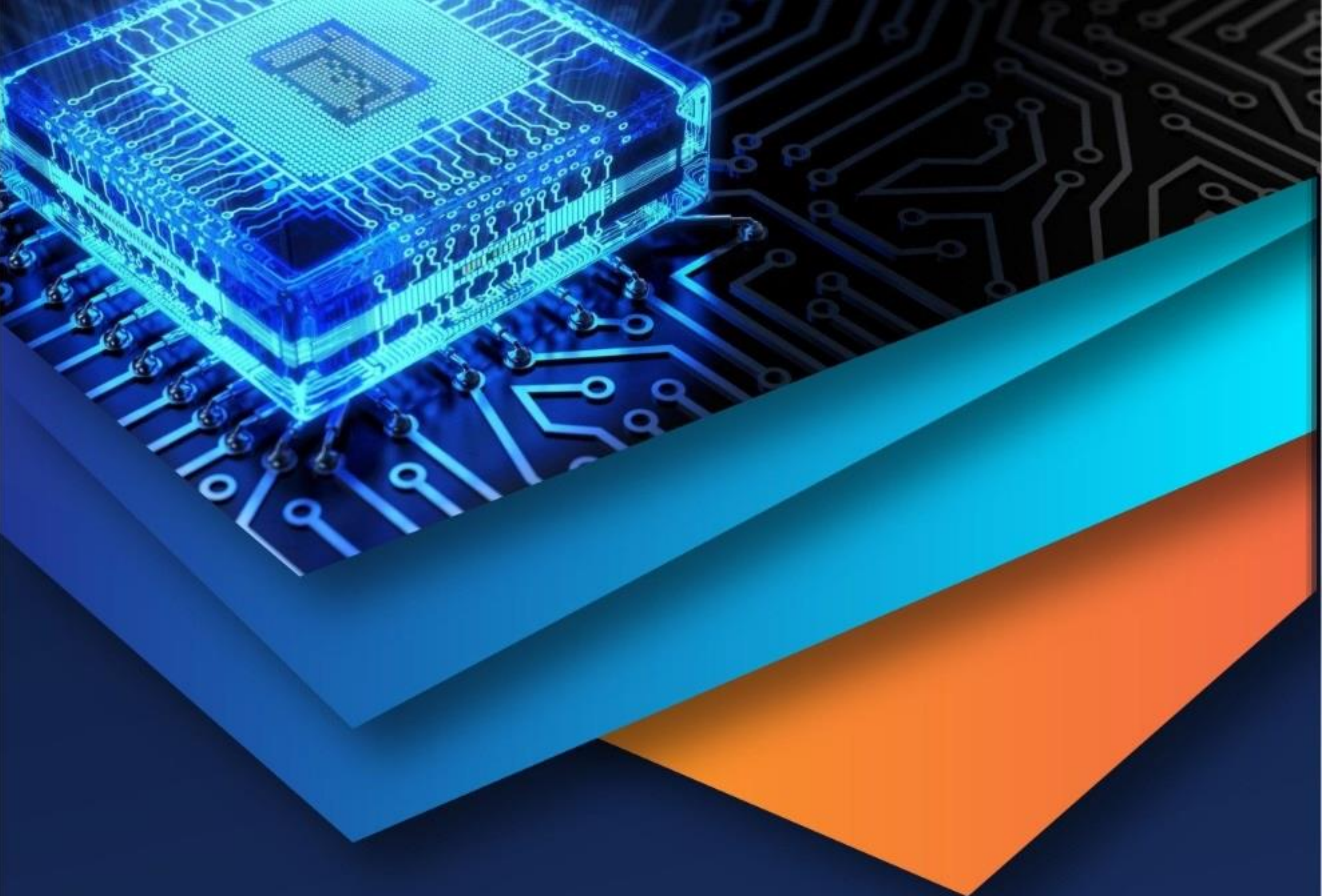
[17] W. Tan, C. Chan, H. Aguirre and K. Tanaka, "Fuzzy qualitative deep compression network," Neurocomputing, vol. 251, pp. 1-15, 2017.

[18] Y. Li, J. Hu, X. Zhao, W. Xie and J. Li, "Hyperspectral image super-resolution using the deep convolutional neural network," Neurocomputing, vol. 266, pp. 29-41, 2017.

[19] J. Wang, Z. Fang, N. Lang, H. Yuan, M. Su and P. Baldi, "A multi-resolution approach for spinal metastasis detection using deep Siamese neural networks," Computers in Biology and Medicine, vol. 84, pp. 137-146, 2017.

[20] W. Liu, Z. Wang, X. Liu, N. Zeng, Y. Liu and F. Alsaadi, "A survey of deep neural network architectures and their applications," Neurocomputing, vol. 234, pp. 11-26, 2017.

[21] Y. Lv, M. Yu, G. Jiang, F. Shao, Z. Peng and F. Chen, "No-reference Stereoscopic Image Quality Assessment Using Binocular Self-similarity and Deep Neural Network," Signal Processing: Image Communication, vol. 47, pp. 346-357, 2016.
[22] Y. Li, L. Po, X. Xu, L. Feng, F. Yuan, C. Cheung and K. Cheung, "No-reference image quality assessment with shearlet transform and deep neural networks," Neurocomputing, vol. 154, pp. 94-109, 2015.
[23] R. DiBiano and S. Mukhopadhyay, "Automated diagnostics for manufacturing machinery based on well-regularized deep neural networks," Integration, the VLSI Journal, vol. 58, pp. 303-310, 2017.
[24] H. Kandi, D. Mishra, and S. R. S. Gorthi, “Exploring the learning capabilities of convolutional neural networks for robust image watermarking,” Computers & Security, vol. 65, pp. 247–268, 2017.
[25] W. Zhang, C. Qu, L. Ma, J. Guan, and R. Huang, “Learning structure of stereoscopic image for no-reference quality assessment with the convolutional neural network,” Pattern Recognition, vol. 59, pp. 176–187, 2016.
[26] K. Noda, H. Arie, Y. Suga, and T. Ogata, “Multimodal integration learning of robot behavior using deep neural networks,” Robotics and Autonomous Systems, vol. 62, no. 6, pp. 721–736, 2014.
[27] S. Mori, “Deep architecture neural network-based real-time image processing for image-guided radiotherapy,” Physica Medica, 2017.
[28] A. J. Hussain, D. Al-Jumeily, N. Radi, and P. Lisboa, “Hybrid Neural Network Predictive-Wavelet Image Compression System,” Neurocomputing, vol. 151, pp. 975–984, 2015.
[29] R. V. Sharan and T. J. Moir, “Robust acoustic event classification using deep neural networks,” Information Sciences, vol. 396, pp. 24–32, 2017.
[30] J. Arevalo, F. A. González, R. Ramos-Pollán, J. L. Oliveira, and M. A. G. Lopez, “Representation learning for mammography mass lesion classification with convolutional neural networks,” Computer Methods and Programs in Biomedicine, vol. 127, pp. 248–257, 2016.
[31] M. H. Baig and L. Torresani, “Multiple hypothesis colorizations and its application to image compression,” Computer Vision and Image Understanding, 2017.
[32] Y. Zhang, E. Zhang, and W. Chen, “Deep neural network for halftone image classification based on sparse autoencoder,” Engineering Applications of Artificial Intelligence, vol. 50, pp. 245–255, 2016.
[33] K. Sun, S. Lee, and P. Wu, “Neural network approaches to fractal image compression and decompression,” Neurocomputing, vol. 41, no. 1-4, pp. 91–107, 2001.
[34] T. Mikołajczyk, K. Nowicki, A. Kłodowski, and D. Pimenov, “Neural network approach for automatic image analysis of cutting-edge wear,” Mechanical Systems and Signal Processing, vol. 88, pp. 100–110, 2017.
[35] B. Arunapriya and D. K. Devi, “Image compression using single layer linear neural networks,” Procedia Computer Science, vol. 2, pp. 345–352, 2010.
[36] A. Meyer-Bäse, K. Jancke, A. Wismüller, S. Foo, and T. Martinetz, “Medical image compression using topology-preserving neural networks,” Engineering Applications of Artificial Intelligence, vol. 18, no. 4, pp. 383–392, 2005.
[37] Z. C. B. C. Dokur, “A unified framework for image compression and segmentation by using an incremental neural network,” Expert Systems with Applications, vol. 34, no. 1, pp. 611–619, 2008.
[38] G. M. Lakshmi, “Implementation of image compression using Fractal Image Compression and neural networks for MRI images,” International Conference on Information Science (ICIS), 2016.
[39] G. Kumar, and P.K. Bhatia, “Empirical analysis of image compression using wavelets, discrete cosine transform, and neural network.” In Computing for Sustainable Global Development (INDIACom), 2016 3rd International Conference on, pp. 3862-3866, 2016
[40] S. Sahami and M. Shayesteh, “Bi-level image compression technique using neural networks,” IET Image Processing, vol. 6, no. 5, p. 496, 2012.
[41] S. A. Alshehri, “Neural network technique for image compression,” IET Image Processing, vol. 10, no. 3, pp. 222–226, Jan. 2016.
[42] Y. Al-Nabhani, H. A. Jalab, A. Wahid, and R. M. Noor, “Robust watermarking algorithm for digital images using discrete wavelet and probabilistic neural network,” Journal of King Saud University - Computer and Information Sciences, vol. 27, no. 4, pp. 393–401, 2015.



10.22214/IJRASET

INDEX COPERNICUS
45.98

ISRA JIF
IMPACT FACTOR:
7.129

TOGETHER WE REACH THE GOAL
IMPACT FACTOR:
7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY