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# Performance of Image compression using Back-Propagation Neural Network

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**Abstract:** *The growth of data communication multimedia-based web applications has not only undergone the need for more efficient ways to data storage and digital communication technology. Image compression presented by JPEG, H.26x and MPEG standards uses new technology like algorithms of neural networks are developed to seek the future of image coding. Successful applications of neural network algorithms have now well established and other involvement of neural network in technology is appreciable. Most popular way to show the power of neural network for image compression follows the selection of multi layered network, training process and test vector.*

***Keywords:****Image compression, Neural networks, Multi layered network, Training process, Test vector, Image coding.*

## I. INTRODUCTION

In broad sense, data compression is an important and essential aspect for very large data storage and transmission application in fact it is the root for the advancements in the field of teleconferencing, video conferencing, video broadcasting, and internet revolutions in the present scenario. Thus, lots of efforts have been put in this field to improve the compression performance with the constraint of maintaining the quality of reconstructed data after decompression. This is really a challenge in front of the designers of compression systems

.

In the perspective of teleconferencing and video conferencing, the basic aim is to transfer the large size of images and videos along the low bandwidth communication channels because the size of bandwidth is very cost-effective. For these applications, the compression becomes very essential task.The term data compression refers to the process of reducing the amount of data required to represent a given quantity of information.In the perspective of Image, Image compression is the process which is intended to appropriately reduce the amount of data required to represent the original image without significant degradation (loss) of information contained by that image. If there is no degradation, it is known as lossless image compression otherwise lossy compression. As a matter of fact, every image compression method is lossy compression

.

In the field of image compression, the real challenge is to maintain the quality of reconstructed image after decompression process. The very fact is that whenever image is tried to be compressed, it loses some information. Thus this point must be kept in mind while designing the neural network for image compression applications. The Back-Propagation based Neural Network is implemented for achieving the image compression. This neural network is also tested on various image quality performance parameters [1]

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## II. COMPRESSION FUNDAMENTALS

Compressing an image is significantly different than compressing raw binary data. Of course, general purpose compression programs can be used to compress images, but the result is less than optimal. This is because images have certain statistical properties which can be exploited by encoders specifically designed for them. Also, some of the finer details in the image can be sacrificed for the sake of saving a little more bandwidth or storage space. This also means that lossy compression techniques can be used in this area

.

Lossless compression involves with compressing data which, when decompressed, will be an exact replica of the original data. This is the case when binary data such as executable, documents etc. are compressed. They need to be exactly reproduced when decompressed. On the other hand, images (and music too) need not be reproduced 'exactly'. An approximation of the original image is enough for most purposes, as long as the error between the original and the compressed image is tolerable.

The usual steps involved in compressing an image are;

1. Specifying the Rate (bits available) and Distortion (tolerable error) parameters for the target image.

 

2. Dividing the image data into various classes, based on their importance.
3. Dividing the available bit budget among these classes such that the distortion is a minimum.
4. Quantize each class separately using the bit allocation information derived in step 3.
5. Encode each class separately using an entropy coder and write to the file [3].

Reconstructing the image from the compressed data is usually a faster process than compression. The steps involved are;

1. Read in the quantized data from the file, using an entropy decoder.
2. DE quantize the data.
3. Rebuild the image

There are many other applications that benefit from data compression technology. Table 1 lists a representative set of such applications for image, video, and audio data, as well as a typical data rates of the corresponding compressed bits streams, typical data rates for uncompressed bit streams are also shown. Fig. 1 shows a generic compression system.

***Table 1: Application for image, video, and audio compression.***

| Application | Data Rate | |
|---|---|---|
| | Uncompressed | Compressed |
| **Voice**<br>8 ksamples/s, 8 bits/sample | 64 kbps | 2-4 kbps |
| **Slow-motion video (10 fps)**<br>Frame size 176X120, 8 bits/pixel | 5.07 Mbps | 8-16 kbps |
| **Audio conference**<br>8 ksamples/s, 8 bits/sample | 64 kbps | 16-64 kbps |
| **Video conference (15 fps)**<br>Frame size 352X240, 8 bits/pixel | 30.41 Mbps | 64-768 kbps |
| **Digital audio (stereo)**<br>44.1 ksamples/s, 16 bits/sample | 1.5 Mbps | 128 kbps-1.5 Mbps |
| **Video file transfer (15 fps)**<br>Frame size 352X240, 8 bits/pixel | 30.41 Mbps | 384 kbps |
| **Digital video on CD-ROM (30 fps)**<br>Frame size 352X240, 8 bits/pixel | 60.83 Mbps | 1.5-4 Mbps |
| **Broadcast video (30 fps)**<br>Frame size 720X480, 8 bits/pixel | 248.83 Mbps | 3-8 Mbps |

## III. BACK – PROPOGATION NEURAL NETWORK

Back-propagation in artificial neural networks is a mathematical technique for minimizing the discrepancy between a parameterized function and a set of pairs of inputs and "correct" outputs, where the overall function is partitioned into layers of vector functions. Each component of a layer is a weighted sum (or in some cases a product) of outputs from the previous layer, fed through some continuous scalar function. The "network" is regarded as the connections of outputs of one layer to inputs of the next. It is purely feed-forward -- there are no outputs from later layers that supply inputs of earlier layers. The back propagation algorithm adjusts the weights in the sums at each layer, in order to reduce the discrepancies between the network outputs before adjustment, and the desired values. The back-propagation algorithm to train the image is as follows;

1. Initialize the weights to small random values.
2. Select a training vector pair (input and the corresponding output) from the training set and present the input vector to the inputs of the network.
3. Calculate the actual outputs this is the forward phase.
4. According to the difference between actual and desired outputs (error). Adjust the weights Wo and Wh to reduce the difference this is the backward phase.
5. Repeat from step 2 for all training vectors.
6. Repeat from step 2 until the error is acceptably small.

 

Back Propagation learning algorithm. In the forward phase the hidden layer weight matrix h W is multiplied by the input vector X=(X1, X2, X3…….X n) to calculate the α.

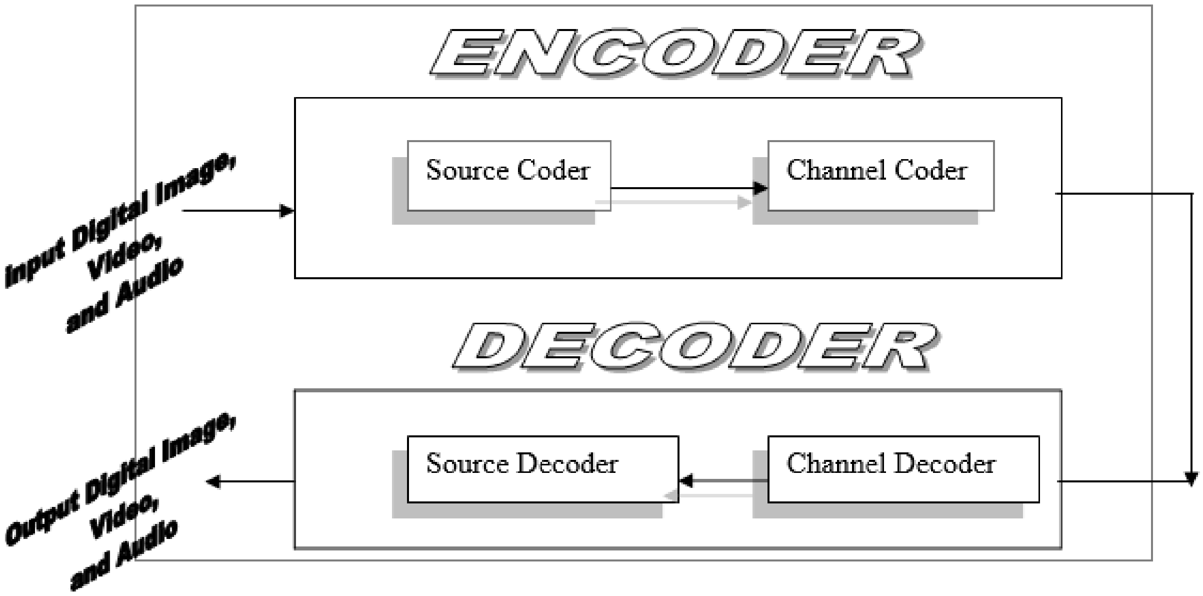


***Fig. 1: Generic compression system***

## IV. OBSERVATION

### *A. OBSERVATION 1:*

Image for compress/decompress: .\Bmp_Formats\leena.bmp
Image Size = 256 X 256
Image has been compressed. It took 1.125 seconds.
*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*
Peak Signal to Noise Ratio
=> PSNR= 25.7402 dB
Signal to Noise Ratio
=> SNR= 18.3529 dB
Normalized Mean Square Error
=> NMSE= 0.014612
The first-order estimate of the entropy of Original Image.
=> h1= 7.572
The first-order estimate of the entropy of Decompressed Image.
=> h2= 7.7784
Figure for Compressed and decompressed image for original image with error is given in below fig. 2 while the error histogram is attached as fig. 3.

### *B. OBSERVATION 2:*

Image for compress/decompress: .\Bmp_Formats\einstein.bmp
Image Size = 256 X 256
Image has been compressed. It took 1.109 seconds.
*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*
Peak Signal to Noise Ratio
=> PSNR= 26.1282 dB
Signal to Noise Ratio
=> SNR= 19.0987 dB
Normalized Mean Square Error
=> NMSE= 0.012306
The first-order estimate of the entropy of Original Image.
=> h1= 6.8841
The first-order estimate of the entropy of Decompressed Image.
=>h2= 7.3166
Figure for Compressed and decompressed image for original image with error is given in below fig. 4 while the error histogram is attached as fig. 5.

 

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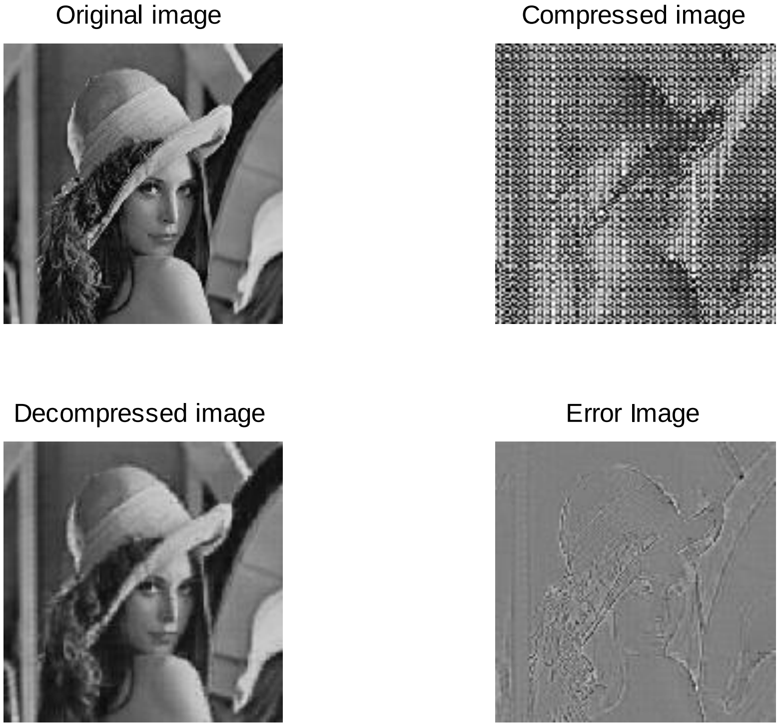


*Fig. 2: Compressed and decompressed image for original image with error*

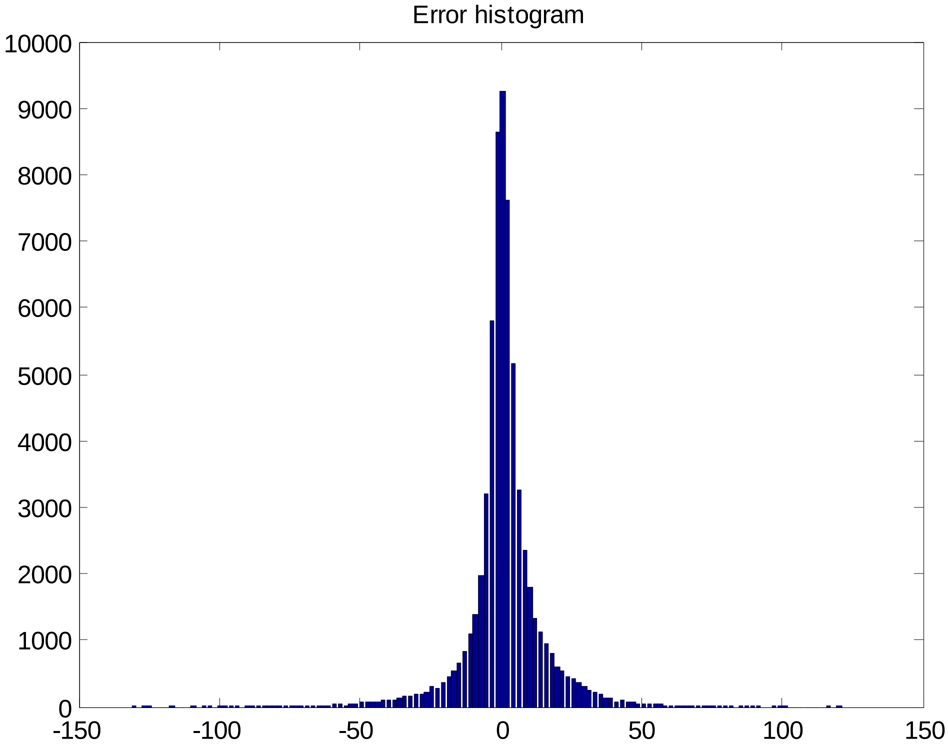


*Fig. 3: Error histogram*

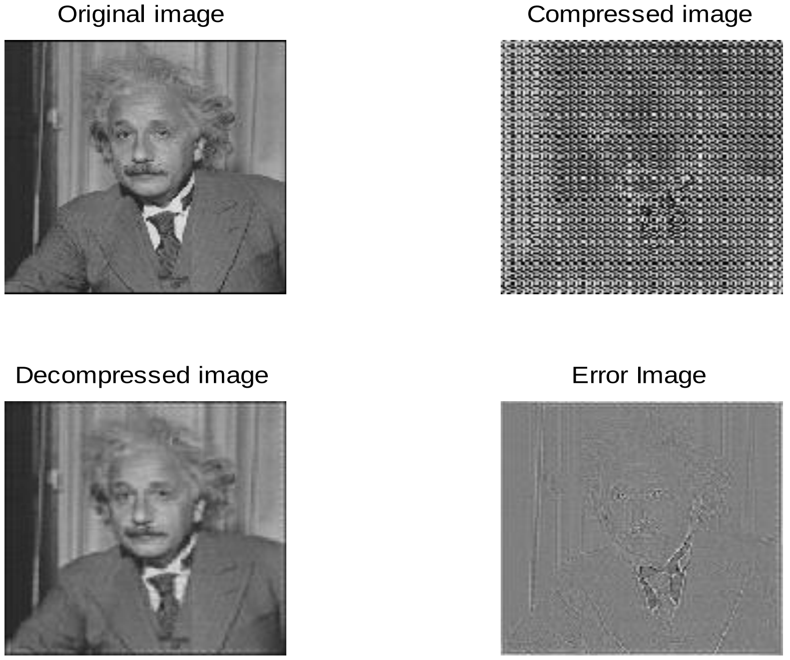


*Fig. 4: Compressed and decompressed image for original image with error*

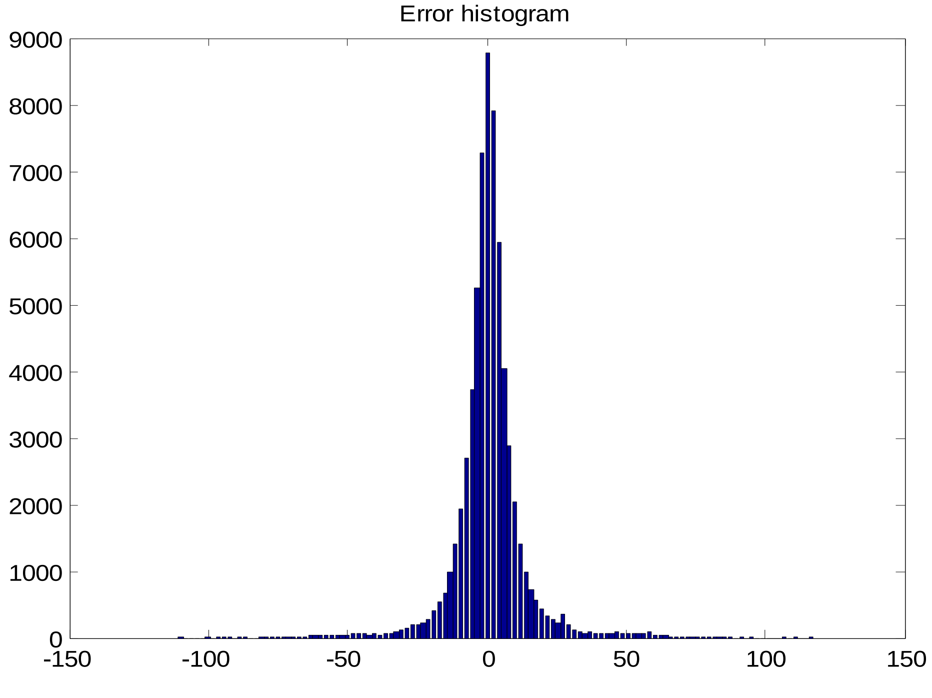


*Fig. 5: Error histogram*

*Table 2: Performance of Image compression using Back-Propagation Neural Network*

| Observation | Image Name | Image Size | Compression Time (Seconds) | Image Quality Parameters | | | | Entropy | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | PSNR (dB) | SNR (Db) | NMSE | Bit-Rate (bpp) | h1 | h2 |
| 1 | leena.bmp | 256×256 | 1.125 | 25.7402 | 18.3529 | 0.014612 | 0.625 | 7.572 | 7.7784 |
| 2 | einstein.bmp | 256×256 | 1.109 | 26.1282 | 19.0987 | 0.012306 | 0.625 | 6.8841 | 7.3166 |

 

## IV. CONCLUSION

In the present scenario data compression has become the fundamental requirement for transmission and storage purposes; in fact it is the back bone of data communication via internet facilities, multimedia communication, and teleconferencing. Data may be whether audio, video or image.The area of consideration is image compression and image coding, particularly for image transmission applications. Thus image compression using Back-Propagation Neural Network has been implemented and tested for still image coding. For achieving the compression, basic approach is that instead of transmitting the whole image, only the state vectors of hidden layer along with the weights associated with the output layer are proposed for transmission. This method is applicable to the problem of image compression and transmission over low bandwidth communication channels. Table 2 shows the performance of image compression system using Back-Propagation algorithm for compression and decompression of various images.

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