# Image Compression and Decompression Using Artificial Neural Network

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***Abstract:*** **Digital image require 3MB of storage and 2 minutes for transmission, utilizing a high speed, ISDN line. If the image is compressed, the storage requirement is reduced to 300KB and the transmission time drop to less than 6seconds. Digital image compression compresses and reduce the size of image and also perform decompression decompress and regenerate the original image from the compressed image. Two methods are used for compression one is lossless compression and lossy compression. Lossless compression techniques produce image with no loss in the quality of the image. Lossy compression techniques are one which produces a minor loss of quality to the output image. Digital image compression helps in saving a lot of memory space and hence is extensively used for compression of photographs, medical imaging, art work, map, etc. image reduced in size by digital image compression can be sent, upload or download in much lesser time and thus it make sharing of image lot easier. Researchers use artificial neural network as an image compression approach are adaptive learning, fault tolerance and optimized approximations. A survey about different image compression and decompression has been done. From that observation recently used artificial neural network is multilayer feed forward network due to its efficiency.**

***Keywords*** **– artificial neural network (ann), image compression, image decompression.**

## I. INTRODUCTION

Image Compression has became the most recent emerging trend throughout the world. In a distributed environment large image files remains a major bottleneck within systems. The compression is important techniques of the solutions available for creating file sizes of manageable and transmittable dimensions. The easiest way to reduce the size of image files is to reduce the size of the image itself. By shirking the size of the image, fewer pixels need to be stored and consequently the file will take less time to load. The advantages of image compression over the internet are reduction in time of web page loading and uploading and also lesser storage space in terms of bandwidth. Image compression is essential where image need to be transmitted or stored efficiently and quickly.

Artificial neural network are simplified model of biological neuron system. A neural network is highly interconnected network with large number of processing element called as neuron. Recently artificial neural network [2] provides possible solution to problems and for application in many fields where high computation rates are required [4]. Artificial neural networks are massively parallel adaptive networks 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 [5].

A feed-forward neural network contains the forward paths. In feed-forward neuron system each layer receiving input from the previous layer and submitting to net layer. Weights of direct feedback paths, from a neuron to itself, are zero. Weights from a neuron to a neuron in a previous layer are also zero. Weights of direct feedback paths, from a neuron to itself, are zero. Weights from a neuron to a neuron in a previous layer are also zero.

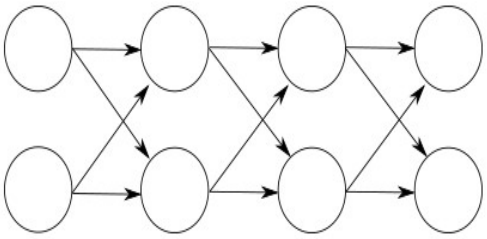


Fig1. Feed-forward networks with four hidden layers

## II. PROCEDURES

In image compression image division in blocks is done to reduce size of the image for that purpose size of image we are taking for image processing is reduced in 3*3or 4*4 or 16*16 matrix so that it is divided in n number of matrices which helps in generating gray scale matrix. If size of matrix in which we are dividing image is larger than we are losing more pixels from the image. Gray scale matrix is another matrix which is generated by the combination of neurons collected by the divided matrix operation which is reduced sized compression image matrix which is centroids of the divided small sized matrices. When decompression of image process starts it revolves around the concept of threshold in image

processing which helps neurons to identify the foreground, background, edge of image which helps to recognize all the parts of original image. In decompression process all neurons will help to allocate other points in image which are completing image after decompression of the image.

## III. METHODOLOGIES

Image compression coding is to store the image into bit-stream as compact as possible and to display the decoded image in the monitor as exact as possible. The image compression and decompression algorithms are used. Artificial neural networks are massively parallel adaptive networks 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.

### *3.1Compression*

Image processing is very useful for image compression and day to day improvement in the image compression. Image processing is the manipulation, analysis, storage of image and display graphical image. The main objective of image compression is to reduce storage capacity of the image and the transmission time. There are two types of image compression Lossy and Lossless. Lossy compression is a data compression method which losses some data from original data and which result is smaller size of the image. Lossless compression is a data compression method there are no loss of compressed data that allows smaller file size but also decompressed and back to the original size and qualities. In that image is JPG and PNG format. To compress the image we follow next process. We start from the first pixel of the image and select other eight adjacent pixels. In that there is square matrix is formed as shown in fig 1. How matrix is formed. To form such sets of square matrix we first check whether m and n are divisible by 3.In that case there is m and n are not divisible by 3 then zero padding is done. This padding may lead to some error which will be removed when original image is acquired back after decompression.

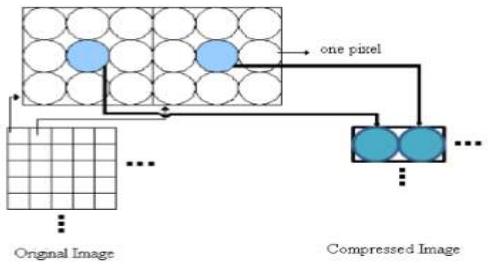



Fig.2 Image Representation

Consider Image in a matrix form which is size of (1024, 1024). The starting pixel is at position (1,1). It compress by the described method. We first check whether1024 is divisible by 3.If it is not we padding that means pad the image by 2 rows and 2 columns. The squares are formed starting from the first pixel. The centre pixels in Figure 3 are selected and stored in an matrix.

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 176 | 178 | 178 | 177 | 176 | 175 | 184 | 192 | 191 | 186 |
| 2 | 181 | 176 | 172 | 173 | 176 | 176 | 185 | 193 | 192 | 185 |
| 3 | 186 | 172 | 166 | 170 | 178 | 177 | 185 | 190 | 191 | 184 |
| 4 | 184 | 173 | 168 | 172 | 179 | 178 | 185 | 191 | 188 | 183 |
| 5 | 179 | 177 | 177 | 177 | 178 | 179 | 182 | 185 | 184 | 182 |
| 6 | 180 | 183 | 185 | 181 | 175 | 172 | 175 | 180 | 182 | 182 |
| 7 | 190 | 188 | 186 | 180 | 174 | 165 | 167 | 176 | 180 | 181 |
| 8 | 188 | 186 | 183 | 180 | 177 | 173 | 174 | 176 | 175 | 172 |
| 9 | 180 | 180 | 182 | 182 | 181 | 181 | 182 | 181 | 175 | 169 |
| 10 | 174 | 177 | 180 | 182 | 182 | 183 | 185 | 186 | 183 | 177 |

Fig.3 Image in matrix form

In Figure 3 As can be seen in Figure 3pixel values at position (2,2) ,(5,2) ,(8,2) becomes pixel values at position (1,1),(1,2),(2,1) respectively .In Figure 2 Similarly the whole image is compressed.

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 176 | 176 | 193 | 184 | 183 | 178 | 183 | 178 | 184 | 199 |
| 2 | 177 | 178 | 185 | 184 | 181 | 180 | 167 | 178 | 183 | 179 |
| 3 | 186 | 177 | 176 | 171 | 181 | 181 | 173 | 173 | 187 | 182 |
| 4 | 176 | 181 | 188 | 180 | 167 | 177 | 182 | 178 | 184 | 177 |
| 5 | 172 | 175 | 180 | 174 | 168 | 187 | 182 | 180 | 179 | 178 |
| 6 | 172 | 174 | 192 | 176 | 175 | 175 | 184 | 176 | 180 | 183 |
| 7 | 167 | 171 | 175 | 168 | 175 | 185 | 164 | 191 | 176 | 178 |
| 8 | 182 | 160 | 170 | 176 | 181 | 174 | 178 | 170 | 169 | 176 |
| 9 | 173 | 168 | 167 | 169 | 174 | 165 | 171 | 169 | 170 | 177 |
| 10 | 188 | 168 | 179 | 178 | 176 | 175 | 184 | 178 | 181 | 173 |

Fig.4 Compressed Matrix

### *3.2 Decompression*

In this method we are going to use the application of second order interpolation over the compressed image. The pixel of image has two values. The first value is position of that pixel in that image that is (x, y) and second value is gray value at that position of that pixel that is G[3]. The n th pixel which is at the position (xp,yq) and gray value Gn can be plotted on coordinate system .As shown in figure 5, we plot the xp or yq depending on x or y direction we are going and on G axis we plot the gray values.

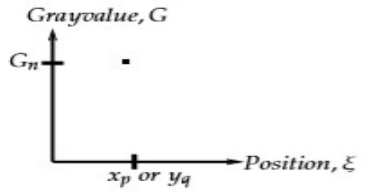



Fig 5: pixel representation on coordinate system

In this decompression method, we consider image as a matrix of size (m′, n′) and start from (1, 1). To achieve the decompression we follow the following steps [3]:

1. The first pixel P1 at position (1, 1) from compressed image is acquired.
2. Consider, we are moving in x direction we acquire the next pixels P2 and P3 at position (1,2) and (1,3) from compressed image.
3. Then we obtain gray values G1, G2, G3 for pixels P1, P2, P3 respectively.
4. As mentioned in compression method, the two pixels were originally present between two adjacent pixels of compressed image. Interpolate the two pixels between P1, P2 and P2,P3 respectively as follows:

- As shown in fig 5, P1 is at position (1, G1) and P2 is at position ((1+3), G2) on the coordinate system. Similarly P3 at position ((1+6), G3).
- The second order curve passing through these three points is
  $18G = (G1 - 2G2 + G3)\,\xi 2 + (-11G1 + 16G2 - 5G3)\,\xi + 28G1 - 14G2 + 4G3$ …… (1)
- Using equation (1) we calculate the values of interpolated pixels, as IP1, IP2, IP3 and IP4 at position 2, 3, 5 and 6 respectively on ξ-axis. And IG1, IG2, IG3 and IG4 are calculated gray values of interpolated pixels IP1, IP2, IP3 and IP4 respectively.
- Then we are going to store the gray values G1, IG1, IG2, G2, IG3, IG4 in new matrix at corresponding positions i.e., at (1,1), (1,2), (1,3), (1,4), (1,5), (1,6) and (1,7).

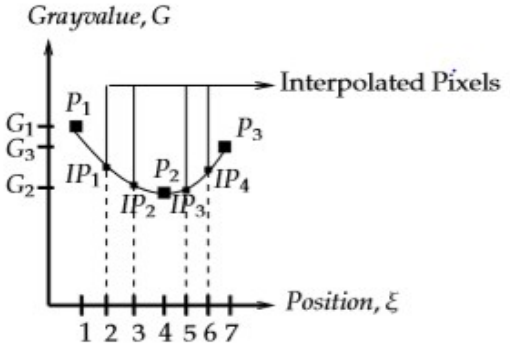



Fig 6: Derived Curve

5. Then we acquire all pixels in x direction, Repeat steps 3 to 5 until whole image is decompressed in x direction.

6 .When images are decompressed completely in both directions, and then render the reconstructed image.

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 176 | 174 | 174 | 176 | 180 | 185 | 193 | 184 | 184 |
| 2 | 177 | 177 | 177 | 178 | 180 | 182 | 185 | 184 | 183 |
| 3 | 186 | 182 | 179 | 177 | 176 | 175 | 176 | 171 | 175 |
| 4 | 176 | 177 | 179 | 181 | 183 | 185 | 188 | 180 | 173 |
| 5 | 172 | 173 | 174 | 175 | 176 | 178 | 180 | 174 | 169 |
| 6 | 172 | 171 | 172 | 174 | 178 | 184 | 192 | 176 | 176 |
| 7 | 167 | 168 | 170 | 171 | 172 | 174 | 175 | 168 | 170 |
| 8 | 182 | 171 | 164 | 160 | 160 | 163 | 170 | 176 | 179 |
| 9 | 173 | 171 | 169 | 168 | 167 | 167 | 167 | 169 | 172 |

Fig 7: Decompressed matrix

## IV. EXPERIMENTAL RESULTS

The proposed method is evaluated using some different type of images. The following sub-sections take on the various as-

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 176 | 174 | 174 | 176 | 180 | 185 | 193 | 184 | 184 |
| 2 | 175 | 175 | 175 | 177 | 180 | 185 | 190 | 185 | 184 |
| 3 | 176 | 175 | 176 | 178 | 180 | 183 | 188 | 185 | 184 |
| 4 | 177 | 177 | 177 | 178 | 180 | 182 | 185 | 184 | 183 |
| 5 | 179 | 178 | 178 | 178 | 179 | 180 | 182 | 181 | 181 |
| 6 | 182 | 180 | 178 | 178 | 177 | 178 | 179 | 177 | 179 |
| 7 | 186 | 182 | 179 | 177 | 176 | 175 | 176 | 171 | 175 |
| 8 | 176 | 177 | 179 | 181 | 183 | 185 | 188 | 180 | 173 |
| 9 | 174 | 176 | 177 | 178 | 180 | 182 | 183 | 177 | 171 |

Figure 8: Final Decompressed Matrix

Figure 9: Complete Original Image

For each image the method is compared to well known lossy JPEG compression format.

### *4.1 Compression Ratios*

The size of Figure 9 is 581 K*B*. Various compression ratios are applied to it. Figure 11(a) depicts the cropped part of the original image. Figure 11(b), (c), show this part of the decompressed images with compression ratios of 4:1, 9:1, 16:1 and 25:1 respectively [3]. This shows that our method gives tolerable quality of decompressed image till a compression ratio of 25:1 for image of this dimension. After that the image starts blurring to an unacceptable extent. The Table 1 shows variation in the compression ratio with

variation in the size of image. As can be observed, image size is directly proportional to compression ratio.

*4.2 Experimental Analysis*

For thoroughness of our comparison various types of gray scale images were used as test images. Two of them are shown in Figure 12. Figure 12(a) is used as it is natural image with varying textures.

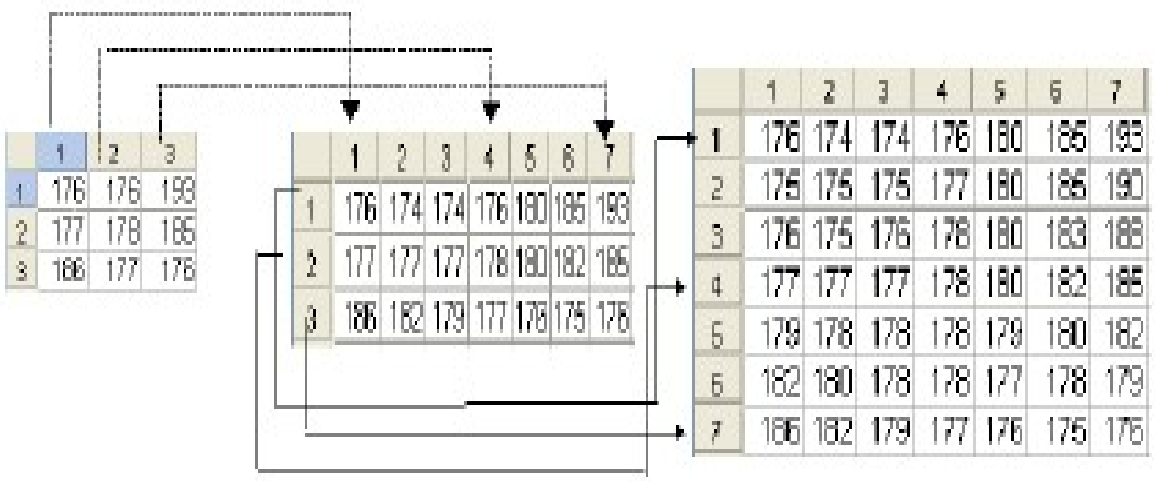
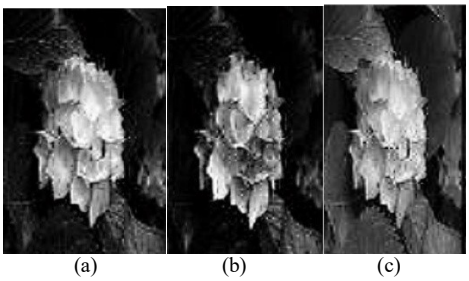



Figure 10: Compressed To Decompressed

| Image size | Recommended Compression Ration |
|---|---|
| 1KB-700KB | 4:1 |
| 700KB-5.5MB | 9:1 |
| 5.5MB-9.5MB | 16:1 |
| 9.5MB-14.5MB | 25:1 |
| >14.5MB | 36:1 |

Compression ratio = (Original Size/Compressed Size) : 1

Table 1: Recommended Compression for Various File Size



(a) (b) (c)

Figure 11: Comparison Of Decompressed Images Obtained Using Non-linear Interpolation. For Different Compression Ratios (a) Part Of Original Image (b)4:1 (c)9:1(d)16:1 (e)25:1 images are of size 1.1 *MB* and 343.1*MB* respectively. Figure 13 depicts the result of decompressing by our interpolation. As can be noticed the reconstructed images are almost the same and there is no perceptible loss of data and the compression is as high as 89% of the original image. Table 2 illustrates how our method fares with respect to JPEG. As can be seen, when the image size is large then our algorithm provides better compression then lossy JPEG. But for small images, to maintain the quality of decompressed image and so that minute details are not lost, our method compresses less.

*Compressed and Decompression of image*

(a)Image1(original size 55.3KB)

(a)Image1(Decompressed size 20.7KB)

Figure 12: Original Images and Decompressed Image

(b)Image2(original size 31.6KB)

(b)Image2 (Decompressed size 17.2KB

Figure 13: Original Images and Decompressed Image

| Name of Image | Original Size | Compression Ratio(original size/compressed size) | Compressed image size | Decompressed image size |
|---|---|---|---|---|
| Image1 | 55.3KB | 15 | 3.80KB | 20.7KB |
| Image2 | 31.6KB | 9 | 3.35KB | 17.2KB |
| Fig 8 Image | 581KB | 81 | 7.15KB | 40.3KB |

Table2.Compression Ratio with decompressed size of Original image with JPEG format

## V. CONCLUSION

Image compression is done by Feed-forward neural networks. It is simplest form of Artificial Neural Network. Feed-forward neural net contains only forward paths. In a feed-forward system each layer receiving the input from previous layer and forward output to net layer. There is no any feedback. In Feed-forward neural network signal from one layer are not transmitted to a previous layer, it forward signal to next layer. Feed-forward network is used due to its efficiency. The compression algorithm reduces the original image size in very simple manner and also compression ratio generating depending on it original size and compressed size of image. It also maintains the quality of decompression image.

The decompression it takes the compressed image and based on Interpolation algorithm image decompressed. Further on, the compression algorithms apply on multiple images.

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