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AN OVERVIEW OF PCA AND JPEG IMAGE COMPRESSION SCHEME

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ABSTRACT

*Image compression is the method of reducing the quantity of data required to represent an image and this technique is the most useful and commercial technology in the modern Internet and Digital Image Processing. In this paper, some of techniques such as PCA, JPEG, and Image compression are discussed. PCA is a Mathematical tool, which growths the efficiency . It may come as afeature that it can be used as a mutual approach in Image Compression. In this paper PCA and JPEG compression are applied to the image and various parameters like PSNR and MSE is calculated for both of the compression technique. The Mean Square Error (**MSE**) and the Peak Signal to Noise Ratio (**PSNR**) are the two error parameter used to compare image compression quality. In the paper some lossless technique such as Huffman run length coding some lossy techniques such as block truncation, fractal transform sub-band coding are discussed.*

Keywords: Image Compression, PCA, JPEG, DCT, PSNR ,MSE

I. INTRODUCTION

Image compression is the method of converting data file into smaller compact files for increasing efficiency of storage and transmission. Image compression is the key area for the fast growth of Information Technology. We can't imagine the digital world without compression. The main objective of compression of image is to reduce redundancy and irrelevance of theimage in order to store and transmit data in an effective way. Compression is an option that when naturally select when faced with problems of high cost. Image processing are of two types Digital and Analog image Processing. Most commonly used image processing is Digital Image Processing. In Image processing there is one exact area through which size of data will be reduced which we call Image Compression. Image Compression is elaborated as the technique through which minimizing the size in bytes without degrading the quality of image.Image compression is very beneficial in reduction in size of data. Images can be compressed so that more and more amount of data and images can be store in the hard disk.it helps to minimize the consumption of expensive resource like hard disk of data in the compressed image .Compression is accomplished by the removal of three types of basic data redundancy techniques 1. Coding Redundancy 2. Interpixel Redundancy 3 Psychovisual Redundancy. **Coding redundancy**suggests a way to compress image by changing a letter, symbol by allocation a short codes or variable lengthcodes**.Inter-pixel redundancy** is that which effects from the connection between the two or more pixels of an image**.Psychovisual redundancy**originates due to data which is unnoticed by the human visual system

II. IMAGE COMPRESSION CONCEPTS

Image Compression is characterized mainly into two: 1. Lossless Compression Method. 2.LossyCompression Method.

Lossless Compression Method Lossless Compression is a processwhere no loss of information involved. Original data is easily recovered from the compressed dataTypes of Lossless Compression Methods are as follows:

1. Run Length Coding: It is one of the simplest data compression procedures which are established on the principle that the run of characters is exchanged with the number of the same character and a single character.

2. Huffman Coding: It is most popular techniqueestablished on the concept of a variable length code should use as the shortest code words for the most likely symbols and the longest code words for the smallest likely symbols.

3. LZW Coding: LZW stands forLempel–Ziv–Welch.It is the foremost method for general purpose data compression due to its simplicity and flexibility. LZW to compress text, executable code, and similar data files to about one-half their original size and uses some Mat lab codes like GIF,TIFF

4. Area Coding: Area coding is a method or improved form of run length coding. In the algorithms of area coding try to find out rectangular regions with the same characteristics.

Lossy Compression Method: Lossy Compression is compression algorithms in which after compression original data is always damaged. TypesofLossy Compression Methods are as follows:

1. Transformation Coding: DCT is a type of transforms which are used in shifting the pixels of the original image into frequency domain quantities. There are several properties in this type of coefficients. One is the compaction property. This is the basis for realizing the compression.

2. Vector Quantization: This is the technique which can develop a dictionary of Fixed- size vectors called code vectors. An image is distributed into non-overlapping blocks and then for each value dictionary is obtained as well as index is produced for the dictionary which is used as the encoding for an input original image.

3. Fractal Coding: Fractal coding is the idea of decomposition of an image into segments by using standard methods of image processing like colour separation, edge detection and texture analysis. Each segment is stored in a library of fractals.

4. Block TruncationCoding: In this process, firstly the image is separated and then organize a block of pixels and find a threshold and restore values for each block then a bitmap of the block is resulting and all those pixels got exchanged which have the value greater than or equal to the threshold value by 1or 0.

5. Sub band Coding: The image examined as to create the components which contain frequencies of well-defined blocks and sub bands. The image examined as to create the components which contain frequencies of well-defined blocks.

III. PRINCIPLE COMPONENT ANALYSIS (PCA)

PCA is process which is used for mainly minimize the no of variables or dimensions in Image compression. In PCA, every image in the training samples is characterized as a linear combination of weighted eigenvectors called Eigen faces. These eigenvectors are determined from covariance matrix of training samples. We use PCA

with “Eigen face” method because of itssimplicity, speed and learning capability. These particular features are called Eigen faces in the facial recognition area out of original image data these characteristics can be take out with the help of mathematical tool called Principal Component Analysis (PCA). Principalcomponentanalysis (PCA) is a Mathematical method which reduced the large no of variables into few variables .PCA is also known as the KARHUNEN-LOEVE Transform (KLT, called after Kari Karhunen & Michel Loeve) or the HOTELLING Transform. Its commonobjectives are Data reduction and Interpretation

IV. JPEG (TRANSFORM COMPRESSION)

One of the best examples of transform compression is embodied in the popular JPEG standard of image encoding. JPEG stands for Joint Photographers Experts Group We will describe the operation of JPEG to explain how lossy compression works.Transform compression is based on a simple statementwhen the signal is delivered through the Fourier (or other) transform, the resultant data values will no longer be identical in their information carrying roles. Advantages and disadvantages of image compression: 1 File reduction which is very beneficial for Internet and multimedia usage without using much bandwidth or storage space. 2. Image compression permits for the faster loading of data on slower devices such as Cameras; Computer CDs etc. 3.Overall execution time is reduced. 4. Since few bits are transmitted, the probability of transmission errors also reduced. 5. Security is provided to save from hacking. 6. Since lossy compression reduces file by permanently eliminating certain information so when the file is decompressed only a portion of the original information is remaining.

V. DISCRETE COSINE TRANSFORMS (DCT)

The DCT works by splitting images into parts of differing frequencies. During a step called quantization, where part of compression trulyoccurs, the lessmajor frequencies are discarded, hence the use of the term”lossy.” Then, only the most important frequencies that remain are used retrieve the image in the decompression process. Asa result, reconstructed images contain some distortion; but as we shall soon see, these levels of distortion can be adjusted during the compression stage. The following is a general overview of the JPEG process.

l. The image is broken into 8x8 blocks of pixels.

2. Working from left to right, top to bottom, the DCT is useful to each block.

3. Each block is compressed through quantization.

4. The array of compressed blocks that constitute the image is stored in a drastically reduced amount of space.

5. When desired, the image is reconstructed through decompression, a process that uses the Inverse Discrete Cosine Transform (IDCT).

This equation represents the basic equation of DCT

$$F(u) = (\frac{2}{N}) \sum_{i=0}^{\frac{i}{2}N-1} \underset{\frac{}{}}{A}(i) \cos[\pi . u/2 . N(2i+1]$$

Equation :-Basic Equation Of DCT

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PSNR AND MSE:-The Mean Square Error (MSE) and the Peak Signal to Noise Ratio (PSNR) are the two error components used to compare image compression quality. The MSE represents the cumulative squared error between the compressed and the original image, whereas PSNR represents a measure of the peak error.

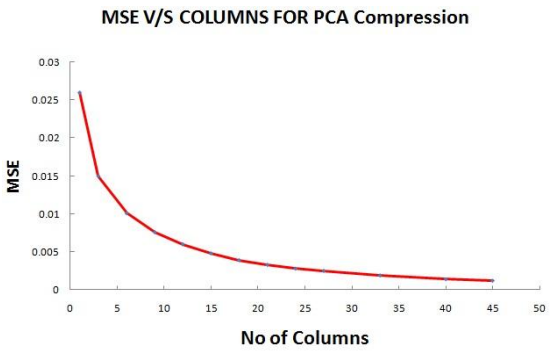
$$PSNR = 10.\log_{10}\left(\frac{MAX_1^2}{MSE}\right)$$

$$= 20.\log_{10}\frac{(MAX)}{\sqrt{MSE}}$$

$$= 20.\log_{10}(MAX) - 10.\log_{10}(MSE)$$

PSNR is most commonly used to measure the quality of reconstruction of lossycompression .The signal in this case is the original data, and the noise is the error introduced by compression. When comparing compression codecs, PSNR is an *approximation* to human perception of reconstruction quality.Although a higher PSNR generally indicates that the reconstruction is of higher quality, in some cases it may not. One has to be extremely careful with the range of validity of this metric

VI. EXPERIMENTAL RESULT



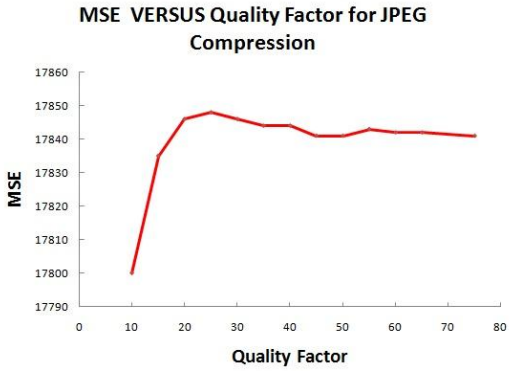
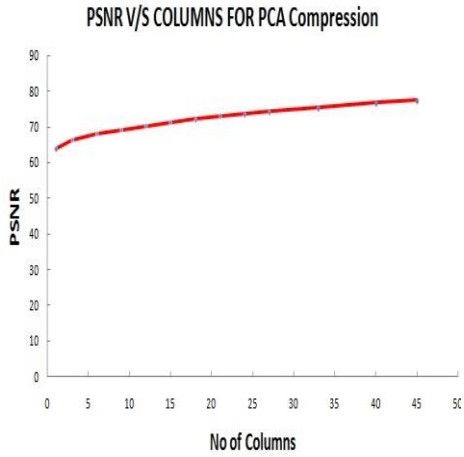


Figure 1 Mse V/S Columns For Pca Compression **Figure 2 Mse V/S Quality Factor For Jpeg Compression**



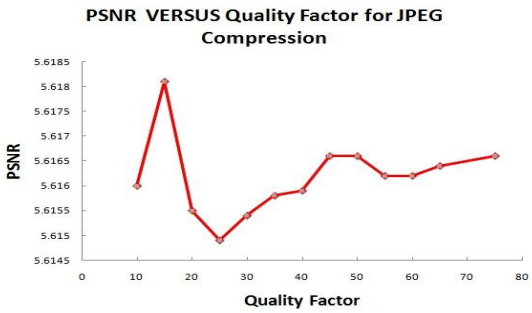


Figure 3 Psnr V/S Columns For Pca Compression **Figure 4 Psnr V/S Quality Factor For Jpeg Compression**

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Figure 5 Original Image For Pca Compression *Figure 6 Image Compressed By Pca :No Of Columns =20*

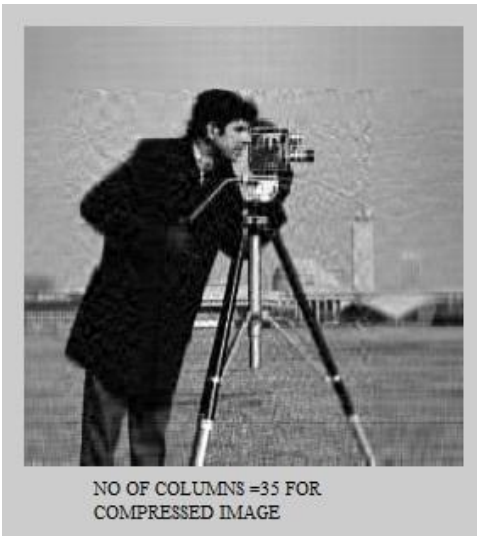

Figure 7image Compressed By Pca :No Of Columns =35

Figure 8 Image Compressed By Jpeg :Quality Factor=3o

Figure 9 Original Image For Jpeg Compression Figure 10image Compressed By Jpeg :Quality Factor=15

VII. RESULT AND DISCUSSION

In this paper PCA dimensionality reduction is applied to the image compression and parameters like PSNR and MSE has been calculated. The PCA compression has been compared with the commonly used compression technique i.eJPEG.In PCA it was found that as the number of columns taken for the compression in PCA increases the perceptual quality of image increase. However the size of image also increases. It was found that MSE also decreases with increased number of column vector and PSNR of the image also increases with increase in number of column vector. In case of JPEG image it was noticed that the image perceptual quality improves as the quality factor increases. In JPEG PSNR and MSE was calculated against Quality factor. The PSNR and MSE does not follow any noticeable trend. There is unpredictable graph of PSNR and MSE with respect to Quality factor.

VIII CONCLUSION

In this paper we implemented image compression using PCA and JPEG .The parameter MSE and PSNR was calculated for PCA and JPEG. The PCA uses dimensionality reduction for compression .PCA extracts major variation in the data sets while removing other insignificant components and JPEG uses Discrete Cosine Transform for image compression. The MSE and PSNR of PCA compression found a noticeable trend however for JPEG the trend is unpredictable when compared against quality factor.

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