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IMAGE COMPRESSION AND FACE RECOGNITION TECHNIQUES: A REVIEW

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ABSTRACT
This paper presents a brief review of techniques of two specific areas of digital image processing. One is image compression and other is face recognition. Image compression deals with the problem of reducing the amount of data required to represent a digital image. Image compression techniques are the most concerned topics in today's technological developments. Image compression reduces the data from the image in either lossless or lossy way. This study presents overview of image compression techniques. Face is the index of mind. It is a complex multidimensional structure and needs a good computing technique for recognition. Face recognition is a necessity of the modern age as the need for identification of individual has increased with the globalization of the world. Personal authentication through face has been under research since last two decades. The performance of the face recognition system has been enhanced using various algorithms. This paper provides an overview of different face recognition approaches.

KEYWORDS: Image compression, Lossless and Lossy compression, Face Recognition, Face recognition techniques

1. INTRODUCTION
Compression refers to reducing the quantity of data used to represent a file, image or video content without excessively reducing the quality of the original data. Image compression is the application of data compression on digital images. The main purpose of image compression is to reduce the redundancy and irrelevancy present in the image, so that it can be stored and transferred efficiently. The compressed image is represented by less number of bits compared to original. Hence, the required storage size will be reduced, consequently maximum images can be stored and it can be transferred in faster way to save the time, transmission bandwidth [3].
In 1960s First face recognition algorithms were introduced in which geometric features were used for detection of face and recognition of a person. Face recognition is a necessity of the modern age as the need for identification of individual has increased with the globalization of the world. Personal authentication through face has been under research since last two decades [5]. A facial recognition methodology is a way to automatically verify person by matching his digital image with the database of images. Nowadays the security of person, information or assets is becoming more difficult and important. The crimes like credit card misuse and computer hacking or security breach in organizations are increasing day by day [5]. Facial Recognition is rapidly becoming area of interest [11].

2. IMAGE COMPRESSION
The objective of image compression is to reduce irrelevance and redundancy of the image data in order to be able to store or transmit data in an efficient form. Compression is achieved by the removal of one or more of three basic data redundancies [2].

- Coding redundancy, which is present when less than optimal (i.e. the smallest length) code words are used.
- Interpixel redundancy, which results from correlations between the pixels of an image.
- Psycho visual redundancy, which is due to data that is ignored by the human visual system (i.e. visually non-essential information).

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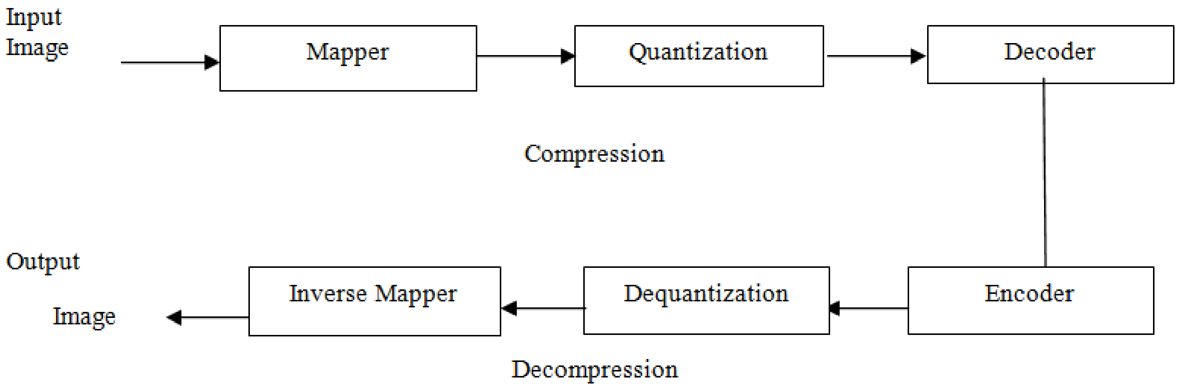

Fig.2.1. Image Compression and Decompression

First, the image is taken from the image dataset. The mapper converts the input image into inter pixel coefficients. Transformation for the mapper may be DCT, wavelet or Curvelet transform. Each has its own advantages and disadvantages. Second stage is the quantizer which simply reduces the number of bits needed to store the transformed coefficients. It is many to one mapping in which larger values are quantized into smaller value. It is a lossy process and it is the main source of compression in an encoder. Quantization reduced the number of bits so it results some kind of information loss. Quantizer can be scalar or vector quantization. An entropy encoder compressed the quantized values and improves the compression. The reverse Process Decoder, Dequantizer and inverse mapper is obtained to reconstruct the image and it is called decompression [3].

Compression Techniques:

Digital image is basically array of various pixel values. In the digital image Pixels of neighborhood are correlated and so that these pixels contain redundant bits. By using the compression algorithms redundant bits are removed from the image so that size image size is reduced and the image is compressed [3]. There are Two types of compression algorithm: Lossless and Lossy.

***A. Lossless Compression*:** In the lossless compression, the compressed image is totally replica of the original input image, there is not any amount of loss present in the image [3].

a. Run Length Encoding: Run-length encoding (RLE) is one of the simplest forms of data compression methods. The principle of RLE is to exploit the repeating values in a source. This repeating string of characters is called a run [7]. Run length coding replaces data by a (length, value) duo, where “value” is the recurring value and “length” is the quantity of repetitions [1]. It is a method that allows data compression for information in which pixels are repeated constantly. It is based on the fact that the repeated pixel can be substituted by a number indicating how many times the pixel is repeated and the pixel itself. RLE is used in fax machines [7].

b. Entropy encoding: Entropy encoding is a lossless data compression scheme that is independent of the specific characteristics of the medium. One of the main types of entropy coding creates and assigns a unique prefix-free code to each unique symbol that occurs in the input. These entropy encoders then compress data by replacing each fixed-length input symbol with the corresponding variable length prefix-free output codeword [4]. The length of each codeword is approximately proportional to the negative logarithm of the probability. Therefore, the most common symbols use the shortest codes [3]. There are usually many repeating characters in a file, these repeated symbols noted down and instead of repeating them at every pixel, positions of these pixels are recorded and they are all noted to have the same symbol. Thus, there is no loss of information so called non-lossy coding [2].

c. Predictive Coding: Lossless predictive coding predicts the value of each pixel by using the value of its neighboring pixels. Therefore, every pixel encoded with a prediction error rather than its original value. These errors are much smaller compared with original value so that fewer bits are required to store them [2]. Predictive Coding Technique constitute another example of exploration of interpixel redundancy, in which the basic idea to encode only the new information in each pixel. This new information is usually defined as the difference between the actual and the predicted value of the pixel. The predictor’s output is rounded to the nearest integer and compared with the actual pixel value: the difference between the two- called prediction error. This error can

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be encoded by a Variable Length Coding (VLC). The distinctive feature of this method lies in the paradigm used to describe the images. The images are modeled as non-causal random fields [3].

B. Lossy Compression: In lossy compression the compressed image is not same as the input image, there is some amount of loss is present in the image [3].

a. Transform encoding: Transform coding is a type of data compression for "natural" data like audio signals or photographic images. The transformation is typically lossy, resulting in a lower quality copy of the original input. In transform coding, knowledge of the application is used to choose information to discard, thereby lowering its bandwidth. The remaining information can then be compressed via a variety of methods. When the output is decoded, the result may not be identical to the original input, but is expected to be close enough for the purpose of the application [3].

b. Vector Quantization: Vector quantization (VQ) is a classical quantization technique from signal processing which allows the modeling of probability density functions by the distribution of prototype vectors. It was originally used for image compression. It works by dividing a large set of points (vectors) into groups having approximately the same number of points closest to them. The density matching property of vector quantization is powerful, especially for identifying the density of large and high-dimensioned data. Since data points are represented by the index of their closest centroid, commonly occurring data have low error, and rare data high error. This is why VQ is suitable for lossy data compression. It can also be used for lossy data correction and density estimation [4].

c. Fractal Coding: In Fractal Coding decompose the image into segments by using standard image processing techniques such as edge detection, color separation, and spectrum and texture analysis. Then each segment is looked up in a library of fractals. The library contains codes called iterated function system (IFS) codes, which are compact sets of numbers. Using a systematic procedure, a set of codes for a given image are determined, such that when the IFS codes are applied to a suitable set of image blocks yield an image that is a very close approximation of the original [3].

C. Evaluation of Compressed Image [1]:
To calculate the quality of the image there are different parameters, normally used are Peak Signal to Noise Ratio and Mean Squared Error. In this section, different parameters are discussed.

The MSE is the cumulative squared error among the actual and the compressed image is calculated by:

$$\text{MSE} = \frac{1}{MN} \sum_{i=1}^{M} \sum_{j=1}^{N} (x(i,j) - y(i,j))^2$$

The PSNR is a measure of the peak error between the actual and the compressed image is measured by:

$$\text{PSNR(dB)} = 10 \ \log_{10}\left(\frac{255^2}{MSE}\right)$$

where i (x, y) is the actual image, z (x, y) is the approximated version (which is actually the decompressed image) and M, N are the dimensions of the images. An inferior value for MSE means lesser error, and as seen from the inverse relation between the MSE and PSNR, this translates to a soaring value of PSNR.

The compression ratio is defined as follows: Cr= N1/N2 , where N1 is the data of the actual image and N2 is the data of compressed image.

D. Benefits OF Image Compression [8]:
There are the following advantages of image compression:
a. Size reduction: The size reduction is most significant benefit of the image compression. It takes up less space on the hard drive and retains the same physical size, unless edit the image's physical size in an image editor. The file size reduction with the help of internet, to create image rich sites without using much bandwidth or storage space.
b. Data Loss: Some common files like JPEG, which an image shrinks in the size of compression, will discard some of the photo's data permanently. So, compress the images to ensure that decompressed back up before starting. Otherwise lose the high quality of the original decompressed image permanently.

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c. Slow Devices: Various electronics devices may load large compressed image slowly. For example, CD devices can only read data at a specific rate and cannot display large images in real time. Also, doe some webhost that transfer data slowly compressed images remain necessary for a fully functional website. Image compression allow for the faster loading of data on slower devices.

3. FACE RECOGNITION

A facial recognition methodology is a way to automatically verify person by matching his digital image with the database of images [5]. There are three operations involved in Face Recognition: a. Face Detection b. Features Extraction c. Face Recognition

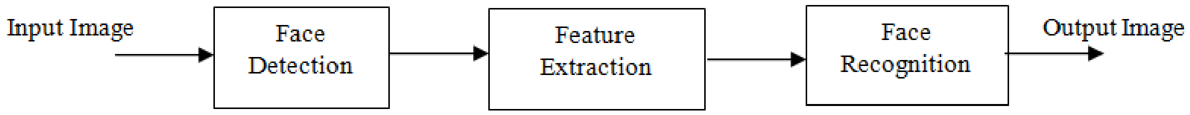

Fig. 3.1. The basic flowchart of a face recognition

A. Face Recognition Techniques:

Image based face recognition approaches can be classified as under:

a. Geometric Approach: Face geometry was the first historical way to recognize people. There are lot of geometric features based on the points. These geometric features may be generated by segments, perimeters and areas of some figures formed by the points. Geometric features include Lip thickness, Nose profile, eyes separation etc. The approach is automatic point location, which may cause problem to bad quality images [10]. The geometric feature based approaches are the earliest approaches to face recognition and detection. In these systems, the significant facial features are detected and the distances among them as well as other geometric characteristic are combined in a feature vector that is used to represent the face. To recognize a face, first the feature vector of the test image and of the image in the database is obtained. Second, a similarity measure between these vectors, most often a minimum distance criterion, is used to determine the identity of the face [6].

b. Template Matching Method: A simple version of template matching is that a test image represented as a two-dimensional array of intensity values is compared using a suitable metric, such as the Euclidean distance, with a single template representing the whole face. There are several other more sophisticated versions of template matching on face recognition. One can use more than one face template from different viewpoints to represent an individual's face. A face from a single viewpoint can also be represented by a set of multiple distinctive smaller templates. In 1993, Bruneli and Poggio automatically selected a set of four features templates, i.e., the eyes, nose, mouth, and the whole face, for all the available faces. They compared the performance of their geometrical matching algorithm and template matching algorithm on the same database of faces which contains 188 images of 47 individuals. One drawback of template matching is its computational complexity [9].

c. Principal Components Analysis: PCA was invented in 1901 by Karl Pearson, it was later independently developed and named by Harold Hotelling in the 1930's.PCA is a technique pioneered by Kirby and Sirovich in 1988, it is commonly referred to as the use of Eigen face [10]. PCA technique is used to reduce the dimension of the data by means of data compression basics and reveals the most effective low dimensional structure of the facial patterns. The reduction in the dimension will remove the information that is not useful and it will decompose the face structure into orthogonal component known as Eigen face and each of the Eigen face are represented as the weighted sum of the Eigen face, which are stored in 1D array. Then the probe image is compared with the gallery image by measuring the distance between their respective feature vectors. Basically, in PCA technique requires the full-frontal face which is to be presented each time otherwise the image will result in poor performance [10]. A detailed (and more theoretical) description of PCA can be found in [11]:

Step 1: Prepare the data: The faces constituting the training set (Γ_i) should be prepared for processing.

Step 2: Subtract the mean: Average matrix Ψ should be calculated, then subtracted from the original faces (Γ_i) and the result stored in the variable ϕ_i :

$$\Psi = \frac{1}{M} \sum_{n-1}^{M} \Gamma_n \qquad \text{(i)}$$

$$\Phi_i = \Gamma_i - \Psi \qquad \text{(ii)}$$

Step 3: Calculate the covariance matrix: In step three, the covariance matrix C is calculated according to:

$$C = \frac{1}{M} \sum_{n-1}^{M} \Phi_n - \Phi_n^{\;T} \qquad \text{(iii)}$$

Step 4: Calculate the eigenvectors and eigenvalues of the co-variance matrix: The eigenvectors (eigenfaces) μ_i and the corresponding eigenvalues $\lambda_i$should be calculated. The eigenfaces must be normalized so that they are unit vectors, i.e. length 1. The description of the exact algorithm for determination of eigenvalues and eigenvectors is eliminating, as it belongs to the standard arsenal of most math programming libraries.

Step 5: Select the principal components From M eigenvectors (eigenfaces) μ_i , only M^0 should be chosen, which have the highest eigenvalues. The higher the eigenvalue, the more characteristic features of a face does the particular eigenvector describe. Eigenfaces with low eigenvalues can be omit-ted, as they explain only a small part of characteristic features of the faces. After M^0 eigenfaces μ_i are determined, the" training" phase of the algorithm is finished.

d. Linear Discriminant Analysis: LDA is a classification method originally developed in 1936 by R.A. Fisher [10]. So, LDA also called as Fisher's Discriminant Analysis. This is another dimensionality reduction technique [11]. In this technique data are linearly projected among the regions in such a way that each region can easily be separable [5]. The drawback of this method is it cannot perform well in face verification. LDA is an enhancement to PCA and factor analysis constructs a discriminant subspace that minimizes the scatter between images of same class and maximizes the scatter between different class images. LDA does not perform very well due to the testing simples are from persons not in the training set and also when markedly different samples of trained classes are presented, samples are presented from different background. Therefore, later LDA is overcome from these drawbacks [10].

e. Discrete Cosine Transform (DCT): The basic idea is to use the discrete cosine transform (DCT) as a means of feature extraction for later face classification. Classification is based on a simple Euclidean distance measure. When we apply the DCT for feature extraction from the N*N image then we get a 2D coefficient matrix in this matrix high frequency components are located at the top left corner of the matrix and the low frequency component are located at the bottom right corner of the matrix.
the DCT Equation:

$$F(u,v) = \alpha(u)\,\alpha(v) \sum_{x=0}^{N-1} \sum_{y=0}^{M-1} \cos\left[\frac{\pi u}{2N}(2x+1)\right] \cos\left[\frac{\pi v}{2M}(2y+1)\right] f(x,y)$$

$$\alpha(u)\,\alpha(v) = \left\{ \begin{matrix} \sqrt{\frac{1}{N}} & for\ u,\ v \neq 0 \\ \sqrt{\frac{2}{N}} & for\ u,\ v = 0 \end{matrix} \right\}$$

And for the coefficient selection static coefficient selection approach is used in this approach zigzag scanning is used as shown in figure 3 below.

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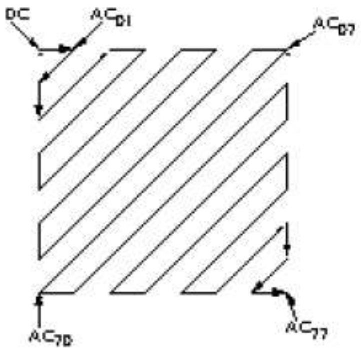

Fig 3. Zigzag Scanning for Obtaining DCT Coefficients for Feature Vector

Euclidean Classifier:
Euclidean classifier is used to find the best match between the train and test images. It is calculated as shown in Eq.

$$D = \sqrt{\sum_{i=1}^{N}(p_i - q_i)^2}$$

p_i and q_i are the coordinates of p and q in the N dimensional space, corresponding to the train and test images. Minimum distance thus corresponds to maximum correlation.

***B. Benefits of Face Recognition** [11]:*

a. *No More Time Fraud:* Due to face, biometric systems in your Industry or organization is that you won't have to worry about time fraud. A person can be identified or rejected in a matter of seconds. It will be impossible for buddy punching to occur, since everyone must have their face scanned to clock in.
b. *Better Security:* You'll also enjoy better security with a facial biometrics system. Not only can you track employees, but any visitors can be added to the system and tracked throughout the area too. Anyone that is not in the system will not be given access.
c. *Automated System:* Many companies like the fact that biometric imaging systems are automated. You won't have to worry about having someone there to monitor the system.
d. *Easy Integration:* Biometric facial systems are also easy to integrate into your company. Usually they will work with existing software that you have in place.
e. *High Success Rate:* Facial biometrics technology today has a high success rate, especially with the emergence of 3d face recognition. It is extremely difficult to fool the system, so you can feel secure knowing that your system will be successful at tracking time and attendance while providing better security.
f. *User Friendly Systems:* Biometrics Systems is easy to install and after that, we can do job quickly, reliably and uniformly. We need only a minimum amount of training to get the system operational and there is no need for expensive password administrators.
g. *Convenience:* It's considered to be a convenient security solution because you don't have to remember passwords, or carry extra badges, documents, or ID cards. People forget passwords and ID cards are lost, which can be a huge headache with traditional security methods

4. CONCLUSION

Although the image compression is a trade of between compression ratio and peak signal to noise ratio, better and efficient compression-decompression algorithm is yet a demanding in the field. Though extensive research has been taking place in this area, keeping in view the ever-increasing need for low bit rate compression methods, scope exists for new methods as well as evolving more efficient algorithms in the existing methods. The review makes clear that, the field will continue to interest researchers in the days to come. This paper constitutes the idea of image compression, numerous technologies, used within the photo compression. All the

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image compression techniques are useful in their related areas and every day new compression techniques are developing which gives better compression ratio. Based or different technology, the quality of image can be measured by various important parameters like compression ratio, MSE, PSNR. two types of techniques can be used for compression. In lossless techniques image quality is maintained as original after decompression but not too much compression ratio can be achieved. But in case of lossy techniques compression ratio can be achieved more than lossless but at the cost of image quality. This paper discusses the different approaches which have been employed in automatic face recognition. In the geometrical based methods, the geometrical features are selected and the significant facial features are detected. The research will be focused to develop the computational model for face recognition that will be fast, simple and accurate in different environment. Face detection is a necessary first-step in face recognition systems, with the purpose of localizing and extracting the face region from the background Face recognition is a challenging problem in the field of image analysis and computer vision that has received a great deal of attention over the last few years because of its many applications in various domains. The review makes clear that, the field will continue to interest researchers in the days to come.

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