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Face Recognition Techniques - A Review

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***Abstract**: Human faces are major identity mark. Face recognition is the active research area in real time applications. Face detection has many applications in biometrics, video surveillance , robotics, control of man-machines, photography, and image indexing. Many face recognition techniques are developed to recognize human features. In this paper the study and methodology of PCA (Principal Component Analysis), CoC (Coefficient **of** Correlation) , SSIM (Structural SIMilarity Index Metrics), DWT (Discrete Wavelet Transform**)** face recognition techniques is provided.*

I. Introduction

TFace recognition is the process of identifications of the person by their facial images. this technique make it possible to use the facial images of the person to authenticate him into a secure system, for criminal identifications for passport verification etc. we can recognize a familiar individual under varying angles or viewpoints, scaling differences, different backgrounds do not affect our ability to recognize faces and we can even recognize individuals with just a fraction of their faces visible or even after several years have. Furthermore, we are able to recognize the faces of several thousand individuals whom we have met during our lifetime.

The face is our primary focus of attention in social intercourse, playing a major role in conveying identity and emotion. Although the ability to infer intelligence or character from facial appearance is suspect, the human ability to recognize faces is remarkable. We can recognize thousands of human faces learned throughout our lifetime and identify familiar faces at a glance even after years of separation. [7] This skill is quite robust, despite large changes in the visual stimulus due to viewing conditions, expression, aging, and distractions such as glasses or change in hairstyle or facial hair.

A complete pattern recognition system consists of:

i) A Sensor that gathers the observations to be classified or described,
ii) A feature extraction mechanism that computes numeric or symbolic information from the observations,
iii) A Classification or description scheme that does the actual job of classifying or describing observations, based on the extracted features.

A face recognition system usually has a sequential configuration of processing steps: face detection, pre-processing, feature detection, feature extraction and classification. Early research of facial expression recognition needs the help of markers for facial feature point detection. The first important factor in facial recognition systems is its ability to differentiate between the background and the face. . The goal is to find a person within a large database of faces (e.g. in a police database). These systems typically return a list of the most likely people in the database. Often only one image is available per person. It is usually not necessary for recognition to be done in real-time.

Changes in viewing conditions or rotations of faces bring difficulties to a face recognition system. There are two types of face rotations that must be considered here: first one is the rotation of human face images in the image-plane and the second one is the rotation of faces out of the image plane (in-depth rotation). In the first case, face images can be easily normalized by detecting several landmarks in the face and then applying some basic transformations, while in the second case such normalization is impossible since some parts of faces may be occluded. [8]

Face Recognition is a term that includes several sub-problems. There are different classifications of these problems in this work. In order to build a system capable of automatically capturing facial feature positions in a face scene, the first step is to detect and extract the human face from the background image. The input of a face recognition system is always an image. The output is an identification or verification of the subject or subjects that appear in the image or video. Some approaches define a face recognition system as a three step process. From this point of view, the Face Detection and Feature Extraction phases could run simultaneously. [17]

1.1 Applications of Face Recognition

There are number of application of face recognition in different areas. Some of them are mentioned below**.**

Information security : Access security (OS, data bases) data privacy (e.g. medical records) User authentication (trading, on line banking)Secure access authentication (restricted facilities)Permission based systems Access log or audit trails.

Access management : Secure access authentication (restricted facilities) permission based systems Access log or audit trails .

Biometrics : Person identification (national IDs, passports ,voter registrations, driver licenses) Automated identity verification (border controls).

Law Enforcement : Suspect identification Suspect tracking (investigation) Forensic Reconstruction of faces from remains.

Personal security : Home video surveillance systems.

Entertainment : Leisure Home video game systems Photo camera applications.

II. Face Recognition Techniques

2.1 Principal Component Analysis (PCA)

The earliest descriptions of PCA appear to be proposed by Karl Pearson in 1901[1] and Hotelling in 1933[2]. Rao in 1964 provided a large number of new ideas concerning uses, interpretations and extensions of PCA [3]. Apart from being used basically as a dimensionality reduction tool, PCA is now widely used for feature extraction, data compression and pre-processing for image or pattern recognition. In the context of face image recognition problem, Kirby and Sirovich [4], [8] showed that KLT (Karhunen-Loève Transform)-based (or PCA-based) dimensionality reduction can be used efficiently to represent face images by projecting face images onto low-dimensional linear subspace that is computed using the KLT. Starting with an ensemble of original face images, they calculated a best coordinate system for image compression, where each coordinate is actually an image that they termed an "eigenpicture". Later on, Turk and Pentland utilized this idea and implemented a very successful face image recognition system using PCA [9]. After these pioneering works, PCA is widely accepted in face image recognition studies and became a standard procedure for dimensionality reduction. PCA is a statistical method under the broad title of factor analysis. The purpose of PCA is to reduce the large dimensionality of the image space (observed variables) to the smaller intrinsic dimensionality of feature space (independent variables), which are needed to describe the image data economically. PCA algorithm extracts orthonormal linear projections, called eigenvectors that maximize the scatter of all projected samples. It enables one to represent an image as linear combination of orthonormal vectors, called eigen pictures. [9].

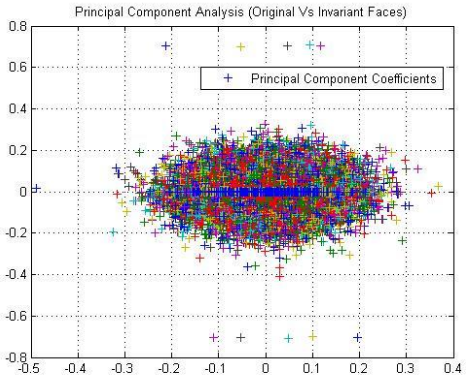

Fig. 1. Principal component analysis (original Vs invarient faces)

2.2 Coefficient of Correlation (CoC)

Correlation is a method for establishing the degree of probability that a linear relationship exists between two measured quantities. In 1895, Karl Pearson defined the Pearson product-moment correlation

coefficient, r. Pearson's coefficient of correlation, r, was the first formal correlation measure and is widely used in statistical analysis, pattern recognition and image processing. The correlation coefficient has the value r =1 if the two images are absolutely identical, r= 0 if they are completely uncorrelated and r= -1 if they are completely anti-correlated. The Pearson product-moment CoC is a dimensionless index, which is invariant to linear transformations of either variable [5]. It condenses the comparison of two (often large) 2-D images down to a single scalar, r . It is computationally intensive. This limits its usefulness for image registration.

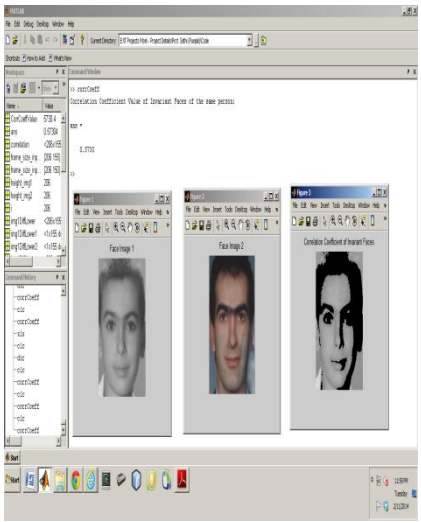

Fig. 2 . (Correlation coefficient value of invariant faces of the same person)

2.3 Structural SIMilarity Index Metrics (SSIM)

It is observed that natural image signals are highly structured i.e., the image signal samples exhibit strong dependencies amongst themselves, especially when they are spatially proximate. These dependencies carry important information about the structure of the objects in the visual scene [15]. SSIM is full-reference image quality assessment methods; the quality of a test image is evaluated by comparing it with a reference image that is assumed to have perfect quality [10]. The goal of image quality assessment research is to design methods that quantify the strength of the perceptual similarity (or difference) between the test and the reference images. So, this SSIM values can be used to measure the similarity between the structure of test image and stored database training images for recognizing the images.

Fig. 3 . (SSIM map of face image)

2.4 Discrete Wavelet Transform (DWT)

Jean Morlet in 1982 introduced the idea of the wavelet transform and provided a new mathematical tool for seismic wave analysis [20]. The wavelet transform concentrates the energy of the image signals into a small number of wavelet coefficients. It has good time-frequency localization property . The fundamental idea behind wavelets is to analyze signal according to scale. . Wavelet transform decomposes a signal into a set of basic functions. These basic functions are obtained from a "mother wavelet" by translation and dilation [20].

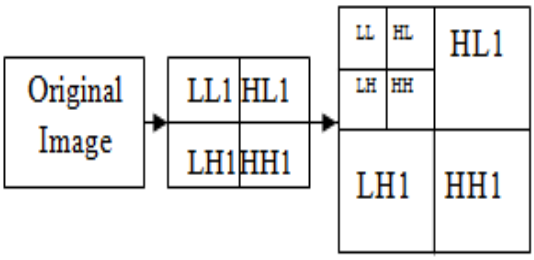

Figure 1: Process of decomposing an image [9] the symbols L and H used in Figure 1 refer to low-pass and high-pass filter respectively. LL represents the approximation sub-band & LH, HL and HH are the detail sub-bands. LL is the low frequency sub-band of the original image as it corresponds to the low-frequency components in both vertical and horizontal directions of the original image and it contributes to the global description of an image. The sub band LL will be the most stable sub band, so we can use it as the feature representation of an image . Horizontal coefficients (LH) correspond to the low-frequency component in the horizontal direction and high-frequency component in the vertical direction. Therefore, it is a combination of high and low-frequency component. Similar interpretation applies to HL and HH [17]. Wavelets are powerful statistical tool which can be used for a wide range of applications, such as signal processing, data compression, smoothing and image denoisingand, fingerprint verification.

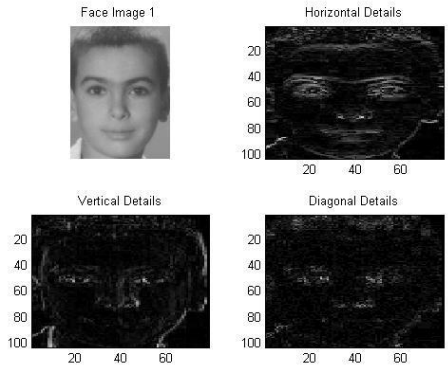

Fig. 4. (Discrete wavelet transforms of a face image) Click on the appropriate topic under the Special Sections link.

III. Conclusion

This paper has attempted to review a significant number of papers to cover the study and methodology of various face recognition techniques. Present study reveals that using hybrid methods of soft computing such as ANN, SVM and Gabor filters may yield better performance in face detection accuracy. The list of references is providing more detailed understanding of approaches described is enlisted.

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