A Comparative Analysis of Face Recognition Algorithms

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Abstract: **As in the environment importance of security is increasing. So for organization identification and authentication is also important. The face recognition methods have become a key technology in various areas: access control in buildings; access control for computer in general or for ATMs in particular day-to-day affairs like withdrawing money from bank account or dealing with the post office; or in the prominent field of criminal investigation. Such requirement for reliable personal identification in computerized access control has resulted in an increased in biometrics and in the main field the face recognition. Face recognition is a biometric method of identifying a person based on a photograph of his face. The quality of the computer recognition system is dependent on the quality of the image and mathematical algorithms used to convert a picture into numbers. Important factors for the image quality are light, background, and position of the head. There are different kinds of algorithms for the face recognition. The different algorithms for the face recognition differ in their behaviours, but the analysis follows the same steps. The first step is image acquisition; once the image is captured, a head is identified. In some cases, before the feature extraction, it might be necessary to normalize the image, and then begins feature extraction using one of the algorithms. For any given computer vision problem, there are numerous algorithms designed to solve it. The design of each algorithm is based on a set of decisions and assumptions. These algorithms are able to recognise the face from small and large database. These algorithms have different features and are 2-D or 3-D based. These algorithms are divided in different categories based on the approach used for the face recognition. Also different types of databases are available for face recognition like FERET, Asian and Korean etc.**

Keywords: **Face Recognition, biometric, FERET**

I. INTRODUCTION

Face recognition systems have been grabbing high attention from commercial market point of view and is fast growing, challenging and interesting area in real-time applications. The problem of machine recognition of human faces continues to attract researchers from disciplines such as image processing, pattern recognition, neural networks, computer vision, computer graphics, computer art and psychology. Face recognition is a process of identifying or verifying a person from an image and comparing the selected features from the image with a given database.

II. FACE RECOGNITION

Facial recognition is a biometric method of identifying a person based on a photograph of their face. Biometric methods use biological traits to identify people. Biometric methods have been under development since the late 1980s. In the 1990s the first commercial systems appeared in the market.

Biometric identification is the technique of automatically identifying or verifying an individual by a physical characteristic or personal trait [19]. The term "automatically" means the biometric identification system must identify or verify a human characteristic or trait without the intervention of user [Fig 1]. The key element of biometric technology is the ability to identify a human being and enforce security.

III. FACE RECOGNITION ALGORITHMS

Although we have different algorithms for the face recognition and these all differ in their working methods but the analysis follows the same steps. The first step is image acquisition; once the image is captured, a head is identified. In some cases, before the feature extraction, it might be necessary to normalize the image, and then begins feature extraction using one of the algorithms [19]. For any given computer vision problem, there are numerous algorithms designed to solve it. The design of each algorithm is based on a set of decisions and assumptions. Because of these decisions and assumptions, it may not be appropriate to apply a particular test to an algorithm.

The most common methods used are eigenfaces, which are based on principal component analysis (PCA) to extract face features. The analysis can be very accurate, as many features can be extracted and all of the image data is analyzed together; no information is discarded. Another common method of creating templates is using neural networks. Despite continuous improvements, none of the current algorithms is 100% correct. The best

verification rates are about 90% correct. At the same time, the majority of systems claim 1% false accepts rates. The most common reasons for the failures are: sensitivity of some methods to lighting, facial expressions, hairstyles, hair color, and facial hair.

The face is one of the most useful keys to identifying a person. Thus far many algorithms have been developed for automatic face recognition, namely PCA (Principal Component Analysis), LDA (Linear Discriminant Analysis), KPCA (Kernel PCA), SVM (Support Vector Machine), LFA (Local Feature Analysis), NN (Neural Network). Some of them have demonstrated excellent results. But there are still many technical limitations coming from the variety of illumination, expression, pose and accessory. Understanding the limitations of the current face recognition technology is a key to developing successful face recognition systems [7].

The feature-based approach has the advantage over the image-based approach that it requires less data input but suffers from the incompleteness of features and difficulty of automatic feature detection. By carefully choosing the region of interest (ROI) and possibly appropriate transformations, the image-based approaches can give more reliable results than the feature-based approach. In the simplest version of image-based approaches, faces are represented as a 2D array of intensity values and recognition is normally based on direct correlation comparisons between the input face and all other faces in the database [5].

The line-based is a type of image-based approaches. It does not use any detailed biometric knowledge of the human face. These techniques use either the pixel-based bi-dimensional array representation of the entire face image or a set of transformed images or template sub-images of facial features as the image representation. An image-based metric such as correlation is then used to match the resulting image with the set of model images [5].

Most of the earliest and current methods of face recognition are 2-dimensional (2-D). They use a flat image of a face. However, 3-D methods are also being developed and some are already available commercially. The main difference in 3-D analysis is the use of the shape of the face, thus adding information to a final template. The first step in a 3-D analysis is generation of a virtual mesh reflecting a person's facial shape [10]. It can be done by using a near-infrared light to scan a person's face and repeating the process a couple of times. The nodal points are located on the mesh, generating thousands of reference points rather than 20–30 used by 2-D methods. It makes the 3-D methods more accurate, but is more expensive. As a result, 2-D methods are the most commonly used. An extension of facial recognition, 3-D methods are using computer graphics to reconstruct faces from skulls. This allows identification of people from skulls if all other methods of identification fail. In the past facial reconstruction was done manually by a forensic artist.

IV. NEED OF FACE RECOGNITION

Within today's environment of increasing importance of security and organization identification and authentication the face recognition methods have become a key technology in various areas: access control in buildings; access control for computer in general or for ATMs in particular day-to-day affairs like withdrawing money from bank account or dealing with the post office; or in the prominent field of criminal investigation [15]. Such requirement for reliable personal identification in computerized access control has resulted in an increased in biometrics and in the main field the face recognition.

The Interactive Face Recognition is beneficial in the areas of: Law Enforcement, Airport Security, Access Control, Driver's Licenses & Passports, Homeland Defence, Customs & Immigration and Scene Analysis [17]. The following detail explains each of these topics:

i. Law Enforcement: Today's law enforcement agencies are looking for innovative technologies to help them stay one step ahead of the world's ever-advancing terrorists.
ii. Airport Security: The Interactive Face Recognition device can enhance security efforts already underway at most airports and other major transportation hubs (seaports, train stations, etc.). This includes the identification of known terrorists before they get onto an airplane or enter into a secure location.
iii. Access Control: The Interactive Face Recognition device can enhance security efforts considerably. Biometric identification ensures that a person is who they claim to be, eliminating any worry of someone using illicitly obtained keys or access cards.
iv. Driver's Licenses & Passports: The Interactive Face Recognition device can leverage the existing identification infrastructure. This includes, using existing photo databases and the existing enrolment technology (e.g. cameras and capture stations); and integrate with terrorist watch lists, including regional, national, and international "most-wanted" databases [17].
v. Homeland Defence: The Interactive Face Recognition device can help in the war on terrorism, enhancing security efforts. This includes scanning passengers at ports of entry; integrating with CCTV cameras for "out-of-the-ordinary" surveillance of buildings and facilities; and more.
vi. Customs & Immigration: New laws require advanced submission of manifests from planes and ships arriving from abroad; this should enable the system to assist in identification of individuals who should, and should not be there.

V. DATA COLLECTION

The data collection task begins after a problem is defined and the research design is chalked out. There are two types of data i.e. primary and secondary. The primary data are that which are collected afresh and for the first

time. The secondary data are the data that are already available, which have already been collected and analyse by someone else. The secondary data may either be published or unpublished data. There are different sources available for secondary data. When it is to decide that what method of data collection can be used, it is chosen from these primary and secondary data.

VI. DIFFERENT APPROACHES

Faces are defined as "the front part of human head, including the chin mouth, nose, cheeks, eyes and usually the forehead" by Webster's dictionary. It would be very difficult to describe a face using simple shapes or patterns, which creates the challenge for computer to recognize a face automatically. Detection and recognition of faces in images is important in various applications such as in intelligent human computer interaction, person identification or verification by face, classification of photograph, and so on.

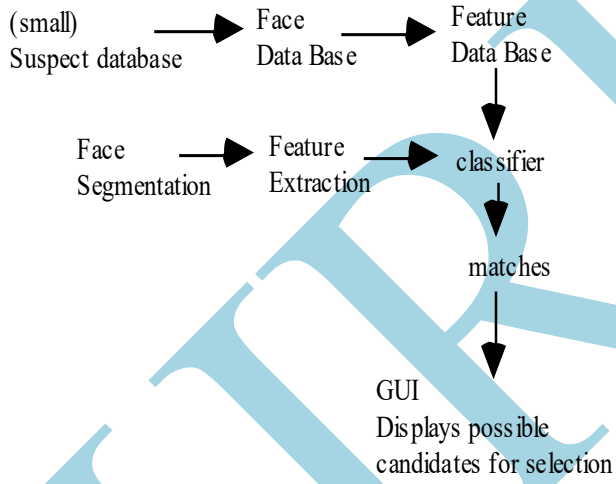

Fig 1: Face identification System

VII. PRINCIPAL COMPONENT ANALYSIS (PCA)

Principal Component analysis (PCA) technique is, by Kirby and Sirivich in 1988. PCA approach is then used to reduce the dimensions of the data by means of data compression basic and reveals the most effective low dimensional structure of facial patterns. This reduction in dimensions removes information that is not useful and precisely decomposes the face structure into orthogonal (uncorrelated) components known as eigenfaces. Each face image may be represented as a weighted sum (feature vector) of the eigenfaces, which are stored in a 1D array. A probe image is compared against a gallery image by measuring the distance between their respective feature vectors.

VIII. FISHERFACES

The well-known Fisherface method takes a two-stage "PCA+LDA" strategy. That is, it first performs the principal component analysis (PCA) to reduce the feature dimension of facial image, and then perform the linear discrimination analysis (LDA) to extract discriminative features. The two-dimensional (2D) discrimination analysis now becomes an interesting technique in face recognition, since it can extract discriminative feature faster than the one-dimensional (1D) discrimination analysis. Yang et al. present a 2D PCA method which significantly reduces the feature extraction time than PCA. Liu et al. develop an Image LDA method to extract 2D discriminative feature, which employs the Fisher criterion. However, existing 2D methods generally use more discriminative features and take longer to test than 1D method. 2D PCA in particular cannot make full use of the Fisher discriminant criterion. Image LDA also has drawbacks in that it cannot perform 2D principal component analysis and discards components with poor discriminative capabilities. In addition, existing 2D methods cannot provide an automatic strategy to choose 2D principal components or discriminant vectors. How to rapidly extract efficient discriminative feature is a research emphasis for face recognition.

When the expressions of the face are taken into account, then the face recognition rate is less than the algorithm of Garborjet. This algorithm is also able to find out the 90% resembling faces present in the database related to the target face for recognition. This algorithm is sensitive to the position of the face, if there is change in the position then the recognition rate is affected.

IX. CONCLUSION

It is concludes that the Eigenfaces algorithms would work better in the 2-d environment and the computational work is also less to do. But when the user has to recognise face in 3-d environment then the Fisherfaces algorithms are better to use. These algorithms provide good results when the users take into account the expressions of the face during the recognition of the face. As the study carried out tells that 3D methods are better for face recognition but, they are complex in computational form.

These algorithms try to help the users, the police, forensic scientists, governments, private companies, the military, and casinos etc. The police use facial recognition for identification of criminals. Companies use it for securing access to restricted areas. Casinos use facial recognition to eliminate cheaters and dishonest money counters. The National Centre for Missing and Exploited Children uses the technique to find missing children on the internet. The use of facial recognition is important in law enforcement, as the facial verification performed by a forensic scientist can help to convict criminals.

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