Novel fast and Efficient Face Recognition Technique

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1. Introduction To Biometrics

Biometrics includes the study of methods for uniquely recognizing humans based upon one or more intrinsic physical or behavioral traits such as eye iris, voice tones, palm print, face outline. Biometric Technologies fill the role of analyzing and measuring unique biological properties in order to produce unique identifications which is then digitalized and stored.

Biometrics can be divided into two main classes:

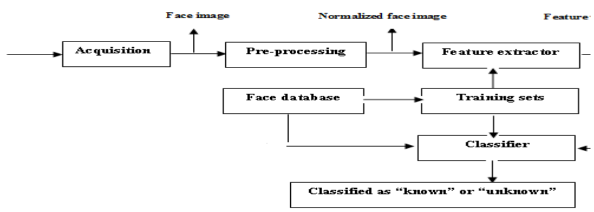


Fig. 1: Outline of a typical face recognition system

Face Recognition:- Face detection is concerned with finding whether or not there are any faces in a given image and, if present, return the image location and content of each face. This is the first step of any fully automatic system that analyzes the information contained in faces (e.g., identity, gender, expression, age, race and pose). While earlier work dealt mainly with upright frontal faces, several systems have been developed that are able to detect faces fairly accurately with in-plane or out-of-plane rotations in real time. Although a face detection module is typically designed to deal with single images, its performance can be further improved if video stream is available. The advances of computing technology have facilitated the development of real-time vision modules that interact with humans in recent years. Examples abound, particularly in biometrics and human computer interaction as the information contained in faces needs to be analyzed for systems to react accordingly. For biometric systems that use faces as non-intrusive input modules, it is imperative to locate faces in a scene before any recognition algorithm can be applied. An intelligent vision based user interface should be able to tell the attention focus of the user (i.e., where the user is looking at) in order to respond accordingly. To detect facial features accurately for applications such as digital cosmetics, faces need to be located and registered first to facilitate further processing. It is evident that face detection plays an important and critical role for the success of any face processing systems. The face detection problem is challenging as it needs to account for all possible appearance variation caused by change in illumination, facial features, occlusions, etc. In addition, it has to detect faces that appear at different scale, pose, with in plane rotations. In spite of all these difficulties, tremendous progress has been made in the last decade and many systems have shown impressive real-time performance. The recent advances of these algorithms have also made significant contributions in detecting other objects such as humans/pedestrians, and cars.

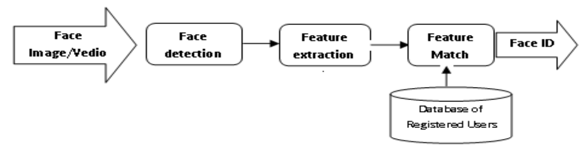


Fig. 2: Traditional Face Recognition Process

How is facial recognition technology currently being used?

Unlike other biometric systems, facial recognition can be used for general surveillance, usually in combination with public video cameras. There have been three such uses of face-recognition in the U.S. so far. The first is in airports, where they have been proposed - and in a few cases adopted - in the wake of the terrorist attacks of September 11.

How well does facial recognition work?

Computers can do increasingly amazing things, but they are not magic. If human beings often can't identify the subject of a photograph, why should computers be able to do it any more reliably? The human brain is highly adapted for recognizing faces - infants, for example, remember faces better than other patterns, and prefer to look at them over other patterns. A study by the government's National Institute of Standards and Technology (NIST), for example, found false-negative rates for face-recognition verification of 43 percent using photos of subjects taken just 18 months earlier, for example. And those photos were taken in perfect conditions, significant because facial recognition software is terrible at handling changes in lighting or camera angle or images with busy backgrounds. The NIST study also found that a change of 45 degrees in the camera angle rendered the software useless. The technology works best under tightly controlled conditions, when the subject is starting directly into the camera under bright lights - although another study by the Department of Defense found high error rates even in those ideal conditions. Grainy, dated video surveillance photographs of the type likely to be on file for suspected terrorists would be of very little use.

Face recognition scenarios can be classified into two types,

(a) Face verification/authentication, (b) Face identification/recognition.

Framework

In most cases, a face recognition algorithm can be divided into the following functional modules: **a face image detector** finds the locations of human faces from a normal picture against simple or complex background, and a **face recognizer** determines who this person is. Both the face detector and the face recognizer follow the same framework; they both have a **feature extractor** that transforms the pixels of the facial image into a useful vector representation, and a **pattern recognizer** that searches the database to find the best match to the incoming face image. The difference between the two is the following; in the face detection scenario, the pattern recognizer categorizes he incoming feature vector to one of the two image classes: "face" images and "non-face images.

Variations in Facial Images

Face recognition is one of the most difficult problems in the research area of image recognition. A human face is not only a 3-D object; it is also a non-rigid body. Moreover, facial images are often taken under natural environment. That is, the image background could be very complex and the illumination condition could be drastic. Figure 2 is an example of an image with a complex background.

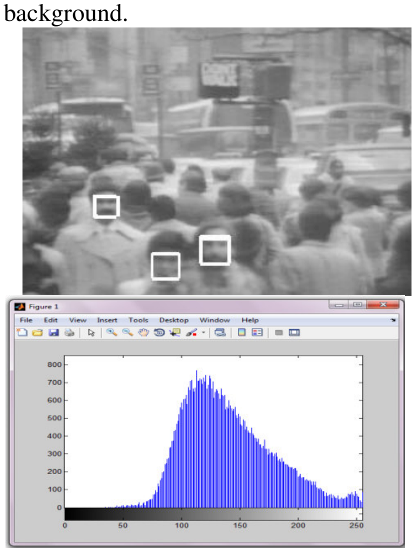


Fig. 3: The face detector found three faces from a complex background and Histogram

2. Background and Related Work

Much of the work in computer recognition of faces has focused on detecting individual features such as the eyes, nose, mouth, and head outline, and defining a face model by the position, size, and relationships among these features. Such approaches have proven difficult to extend to multiple views and have often been quite fragile, requiring a good initial guess to quide them. Research in human strategies of face recognition, moreover, has shown that individual features and their immediate relationships comprise an insufficient representation to account for the performance of adult human face identification [17]. Nonetheless, this approach to face recognition remains the most popular one in the computer vision literature. Bledsoe [18, 19] was the first to attempt semi-automated face recognition with a hybrid human-computer system that classified faces on the basis of fiducial marks entered on photographs by hand. Parameters for the classification were normalized distances and ratios among points such as eye corners, mouth corners, nose tip, and chin point. Later work at Bell Labs developed a vector of up to 21 features, and recognized faces using standard pattern classification techniques.

3. Proposed Work

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. The classification or description scheme usually uses one of the following approaches: statistical (or decision theoretic), syntactic (or structural). Many face recognition techniques have been studied; one of the most recently used techniques is the appearance-based method. In general, a face image of size n x m pixels is represented as a vector in an n x 1 dimensional space. This leads one to consider methods of dimensionality reduction that allows one to represent the data in a lower dimensional space. Take the following typical cases: a face recognition system based on n x m gray scale images which, by row concatenation, can be transformed into n dimensional real vectors. In practice, one could have images of m = n = 256, or 65536-dimensional vectors used as the classification system, the number would be exceedingly large memory for the entire training database. Therefore dimensionality reduction is essential. In practical situations, when n is prohibitively large, one is often forced to use linear techniques. Consequently, projective maps have been the subject of considerable investigation. **Eigenface method is the most popular linear techniques for face recognition.** Eigenface applies Principal Component Analysis (PCA) to project the data points along the directions of maximal variances. Eigenface method is unsupervised, ability to learn and later recognize new faces. There is another popular technique, Linear Discriminant Analysis (LDA) which is a supervised algorithm and this approach projects the face images along the directions optimal for discrimination. But the eigenface is better because it provides for the ability to learn and later recognize new faces in an unsupervised manner. KNN classifier is best suited for classifying persons based on their images due to its lesser execution time and better accuracy than other commonly used methods which include Hidden Markov Model and kernel method. Although methods like SVM and Ada boost Algorithm are proved to be more accurate than KNN classifier, KNN classifier has a faster execution time and is dominant than SVM in sparse datasets.

The Proposed Algorithm: Novel Face Recognition Algorithm:

The Proposed Algorithm

Step 1: - Separate the skin regions from the non skin regions.
Step 2: - Create the chroma chart of the image of skin regions.
Step 3:- The input RGB image is converted into YCbCr color space. The Cb and Cr part are then extracted separately using the equations given below:
$r = R/(R+G+B)$
$b = B/(R+G+B)$
Step 4:- From the Gaussian fitted skin color model of the input, the likelihood of skin is computed using the equation.
$\text{Likelihood}=P(r, b) =\exp [-0.5(x-m)T\ C-1(x-m)]$
Where $x=(r, b)\ T$
m =mean of x.
C=Co-variance of x.
Step 5:- The grayscale image of the figure is then obtained, highlighting the skin regions. Using adaptive threshold, skin regions are highlighted effectively.
Step 6: - Then segment the gray scale image.
Step 7: - By using compression algorithm compress the resulting image for reducing storage capacity.
Step 8:- The face is then located from the skin like segments by finding the number of holes in the skin regions using the following equations
$E = Cc – H$
E: is the Euler number
Cc: The number of connected components
H: The number of holes in a region.
$H = 1 – E$
Step 9:- The template face is then resized according to the height and width of the region computed and also oriented accordingly.
Step 10: - The PFC (Profile Fourier Coefficients) is obtained by taking Fourier transform of the detected face region. This detected face image is used for recognition.
Step 11: - The Eigenface method is used for face recognition.
Step 12: -Then applies Principal Component Analysis (PCA) to project the data points along the directions of maximal variances.
Step 13: - Perform the classification in the image space by nearest neighbor classification algorithm. Under this scheme an image in the test set is recognized by assigning to it the label of the closest point in the learning set, where distance are measured in image space.

The detected features are reduced in dimension using any dimensionality reduction technique and classified using a KNN classifier. The images of faces do not change radically when projected into face space, while the projection of non-face images changes radically. The background can significantly affect the recognition performance, because Eigenface analysis does not distinguish the face from the rest of image. The luminance and chrominance part is removed of the RGB image is which is given as input and thus overcoming the above mentioned problem.

ular linear technique for face recognition. Eigenface applies Principal Component Analysis (PCA) to project the data points along the directions of maximal variances.

4. Implementation

MATLAB ***Interface:*** Various software packages are available for writing programs for a windows based operating system but must not constrain themselves to a graphical user interface alone. The software package chosen for this thesis had to have the capability to develop a graphical user interface

(GUI), strong mathematical library, neural network and data analysis libraries, image analysis capability and well proven in the academic field. As this thesis will form the basis of a complete fingerprint identification system, the software had to enable easy integration of the algorithms developed in this thesis to future expansion of this thesis with a neural network or similar verification algorithm. MATLAB also has a very strong matrix based computational engine and is used extensively within the research field due to its stability, performance and large libraries which already implement many functions saving development time.

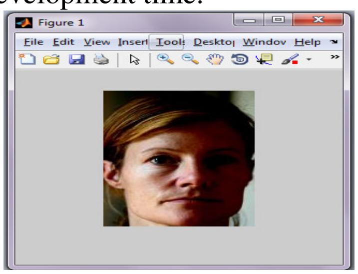


Fig. 4: Original Image

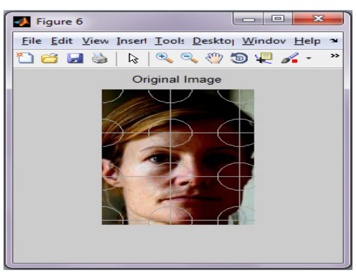


Fig. 5: Finding the holes from the Face Image

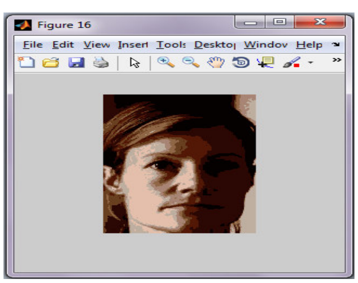


Fig. 6: Resulting Image

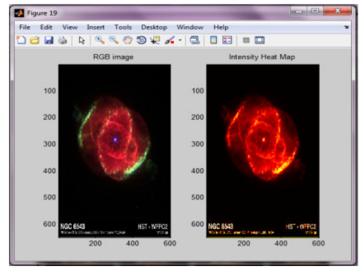


Fig. 7: Intensity Heat Map

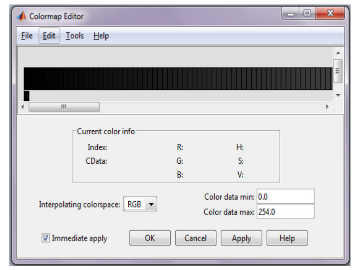


Fig. 8: Color map

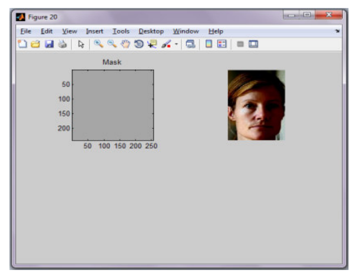
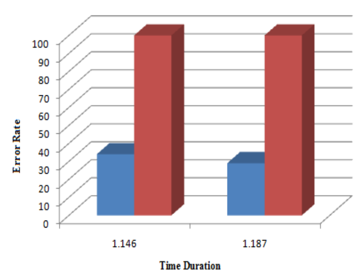
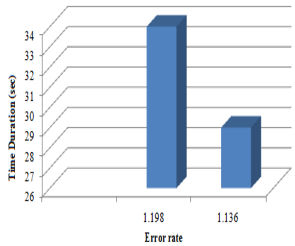


Fig. 9: Resulting Image

Comparison to the Previous Recognition Method





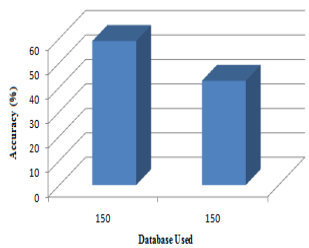


Fig. 10: Error Rate Vs Time Duration Fig. 11: Error Rate Vs Time Duration Fig. 12: Accuracy Vs Database

Accuracy Chart

	Database Used	Accuracy (%)
Previous method	150	42.63 %
Proposed method	150	58.91 %

Comparison= proposed method / previous method
= 58.91/42.63
= 1.38

After the calculation I found that the proposed face recognition method is 1.38 times bettre than the previos method.

5. Conclusion

The proposed **"Fast and Efficient Face Recognition Algorithm: (FE-FRA) Algorithm"** localizes the face from the given input image using the skin color detection method where the skin regions are segmented and face is located using template matching. The detected face image is projected using Eigen face analysis and classified using the K nearest neighborhood (KNN) classifier. This algorithm is efficient as it can be integrated with the output from multi-modal sensors and thus can be used as part of multi-sensor data fusion. **The proposed scheme is faster with lower error rate than the previous scheme.** After Implementation of the proposed algorithm, the Results give the details that the **Proposed Algorithm is 1.38 times accurate** than the previous scheme.

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