Person Recognition Using Multimodal Biometrics

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Abstract—Unimodal biometric systems often face significant limitations due to sensitivity to noise, interclass variability, data quality, no universality, and other factors. To improve the performance of individual matchers in such situations may not prove to be highly effective. Multibiometric systems seek to alleviate some of these problems by providing multiple pieces of evidence of the same identity. These systems help achieve an increase in performance accuracy that may not be possible using a single-biometric indicator. A system that uses various biometric features to establish the identity of the person can be used in order to improve the security aspects. The developed multimodal biometric system possesses a number of unique qualities, starting from utilizing principal component analysis algorithm in the MATLAB for individual matchers (face and ear) identity authentication. The results indicate that fusion of individual modalities can improve the overall performance of the biometric system.

Keywords-- Ear recognition, Eigenfaces, Eigenears, Face recognition, Fusion Biometrics, Face and Ear, Face Ear Fusion, Human recognition, High security biometrics system, PCA algorithms.

I. INTRODUCTION

Biometrics is the science of establishing identity of an individual based on the physical, chemical or behavioral attributes of the person. The relevance of biometrics in modern society has been reinforced by the need for large-scale identity management systems whose functionality relies on the accurate determination of an individual’s identity in the context of several different applications. Examples of these applications include sharing networking computer resources, granting access to nuclear facilities, performing remote financial transactions or boarding a commercial flight.

The various biometric features which include Finger prints, Ear, Face, Hand Geometry, vein pattern, voice, Keystroke Pattern, Signature, iris, palm print, gait etc. out of which Face and Ear Biometric features will be used in this project. The False Acceptance Rate (FAR) and the False Reject Rate (FRR) of the proposed system is also quite small compared to the systems present at this stage; which eventually increases the Genuine Acceptance Rate (GAR) of the system.

Fig 1 Biometric Parameters of a person
However, ears have played a significant role in forensic science for many years, especially in the United States, where an ear classification system based on manual measurements was developed by Iannarelli, and has been in use for more than 40 years. Several reasons account for this trend: first, ear recognition does not suffer from some problems associated with other non contact biometrics, such as face recognition; second, it is the most promising candidate for combination with the face in the context of multi-pose face recognition; and third, the ear can be used for human recognition in surveillance videos where the face may be occluded completely or in part. Even though, current ear detection and recognition systems have reached a certain level of maturity, their success is limited to controlled indoor conditions. In addition to variation in illumination, other open research problems include hair occlusion; ear print forensics; ear symmetry; ear classification; and ear individuality.

During recognition only the images falling in same group as test image, will be loaded as image vectors in covariance matrix of PCA for comparison. This method can also improve the accuracy of face recognition. PCA is used for identification and pattern recognition. It allows expressing the data showing the distinction between their similarities and their differences. Since the problem of pattern recognition can become increasingly difficult, in particular when the data (images) are of very great dimensions.

As multimodal biometrics is used, the accuracy level of the recognition increases. The work on the face and ear biometrics will be on score level. With the development of computer technology, people attach importance to the information security. In order to meet demands of information age, the said attempt is being made.

II. BACKGROUND

The method employed in the said project is with the help of Principal Component Analysis algorithm. The database formed for the said task is stored as the training part which has been sorted according to the person i.e. every person’s images are maintained in separate folders so as to make the recognition process easier. The approaches are analyzed in terms of the facial representations they used. Eigenface is one of the most thoroughly investigated approaches to face recognition. It is also known as Karhunen-Loève expansion, eigenpicture, eigenvector and principal component. Some references used principal component analysis to efficiently represent pictures of faces. In mathematical terms, eigenfaces are the principal components of the distribution of faces, or the eigenvectors of the covariance matrix of the set of face images. The eigenvectors are ordered to represent different amounts of the variation, respectively, among the faces.

Each face can be represented exactly by a linear combination of the eigenfaces. It can also be approximated using only the “best” eigenvectors with the largest eigenvalues.

III. EIGENFACES TECHNIQUE

Principal Component Analysis (PCA, also known as “Eigenfaces”), is one of the most known global face recognition algorithm. The main idea is to de correlate data in order to highlight differences and similarities by finding the principal directions (i.e., the eigenvectors) of the covariance matrix of a multidimensional data. For our experiments, we use several datasets. Each Gallery Set contains train subjects and test subjects. For testing our system, we use some face images from test subjects like same persons of the train Set but with changes in facial expressions.

Training the PCA: From a theoretical point of view, a face image can be seen as a vector is a huge dimensional space, concatenating the columns. We research with normalized face images that we pre processed. For example of a normalized face and ear image which used in our system show Fig. 1. We write new code with MATLAB to combined face and ear recognition in one algorithm using PCA and GUI for facilitate used database for training and test image of face and ear which used. The first step is to train the PCA using the Training Set, in order to generalize the ability of our system and generate eigenvectors. We compute the mean image of training data:

$$\Psi_{mean} = \frac{1}{M} \sum_{i=1}^{M} \Gamma_{i}$$

Then each training image is mean-subtracted:

$$\phi_i = \Gamma_i - \Psi_{mean} \text{ for } i = 1, 2, ..., M$$

This set of very large vectors is then subject to principal component analysis, which seeks a set of M ortho normal vectors, $U_n$, which best describes the distribution of the data. The kth vector, $U_k$, is chosen such that:

$$\lambda_k = \frac{1}{M} \sum_{i=1}^{M} (U_i \phi_n)^2$$

The vectors $U_k$ and scalars $\lambda_k$ are the eigenvectors and eigenvalues, respectively, of the Covariance Matrix (CM):

$$C = \frac{1}{M} \sum_{i=1}^{M} (\phi_i \phi_i^T) = AA^T$$
Fig 2 An example of a normalized face and ear image used in our system

The mean image \( \Psi \) of the gallery set is computed. Each mean-subtracted gallery image, \( \Phi_i = \Gamma_i - \Psi \), \( i = 1 \ldots M \) is then projected onto the “Face Space” spanned by the \( M' \) eigenvectors deriving from the training set. This step leads to:

\[
\mathbf{a}_k = U [\mathbf{\Phi}_i] \quad k = 1 \ldots M'
\]

This describes a set of point-by-point image multiplication and summations. The weight from the vectors:

\[
\mathbf{\Omega} = [\mathbf{a}_1, \mathbf{a}_2, \ldots, \mathbf{a}_k]
\]

That describes the contribution of each eigenface or eigenear in representing the input face or ear image treating the eigenfaces or eigenears as a basis set of face or ear images. Calculating a Euclidean distance is the simplest way to classify the new face or ear class as follows:

\[
d_k = \| \mathbf{\Omega} - \mathbf{\Omega}_k \|
\]

Where, \( \mathbf{\Omega}_k \) is a vector describing the kth face or ear class. A face is classified as belonging to class \( k \) when the minimum \( d_k \) is in the defined threshold limit of \( \varepsilon_k \). Otherwise, the new face or ear is defined as ‘unknown’. The unknown face or ear can be used for developing further database. PCA computes the basis of a space which is represented by its training vectors. These basis vectors, actually eigenvectors, computed by PCA are in the direction of the largest variance of the training vectors. As it has been said earlier, we call them eigenfaces. Each eigenface can be viewed a feature. When a particular face is projected onto the face space, its vector into the face space describes the importance of each of those features in the face. The face is expressed in the face space by its eigenface coefficients (or weights). We can handle a large input vector, facial image, only by taking its small weight vector in the face space. This means that we can reconstruct the original face with some error, since the dimensionality of the image space is much larger than that of face space. In this study, let’s consider face identification only. Each face in the training set is transformed into the face space and its components are stored in memory. The face space has to be populated with these known faces. An input face is given to the system and then it is projected onto the face space.

The system computes its Euclidian distance from all the stored faces. By studying all the literature listed above we came to the decision of using multimodal biometrics in our project for the sake of identification / verification using the PCA algorithm.

**Aim Of the Project:** Person Recognition Using Multimodal Biometrics.

### IV. BLOCK DIAGRAM

![Block Diagram of Person Recognition Using Multimodal Biometrics](image)

The first defect is easily avoided since the first eigenface is a good face filter which can test whether each image is highly correlated with itself. The images with a low correlation shall be rejected. This is clear in Fig. 2 shows a representation of the operations followed in the proposed method which written in our project with MATLAB.

The screenshots of the designed system are shown in below figure.

![PCA Based Person Recognition](image)

**Fig 4. System Overview of the Person Recognition Using Multimodal Biometrics.**
Computation of the score for Score level Fusion:

The score for every person is calculated using the Euclidean distance of the test as well as the matching image. The euclidean distance is of both the images is added together and is divided by two for averaging of the same. The generated score of person is displayed as the score of the person which is unique in each case.

V. ALGORITHM OF PCA

- Get the image data in matrix form.
- Calculate the mean.
- Subtracting the mean of the data from each data element.
- Calculate the covariance matrix.
- Calculate the eigenvectors and the eigenvalues of the covariance matrix.
- Choosing components and forming vectors.
- Deriving the new data set.

VI. FLOW CHART

![Flow chart of person recognition using multimode biometrics](image)

VII. RESULTS

The results observed for the said project with the help of PCA algorithm for person recognition involves multiple parameters such as FAR, FRR, GAR. The results also depend on the background continuity for the photographs taken to some extent. While performing the said project it was assumed that the camera will be fixed at a single position giving the same background for the training as well as the test images and hence helping improve the accuracy of the system.

False Acceptance Rate is observed in event of the person is allowed the access even when not matching in the records. FAR calculated for the said project is 4%.

False Rejection Rate is observed in event of denying the access to the particular person even when he holds the matching records with database. FRR calculated for this system is 12%.

VI. FLOW CHART

![Flow chart of person recognition using multimode biometrics](image)

Genuine Acceptance Rate of the system is nothing but the rate of allowing the access to right persons. GAR can be given as:

\[ \text{GAR} = 1 - \text{FRR} \]

It comes to the 88% when calculated with the formula; giving the extensive accuracy to the system.

<table>
<thead>
<tr>
<th></th>
<th>Face</th>
<th>Ear</th>
<th>Fusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>FAR</td>
<td>18%</td>
<td>16%</td>
<td>4%</td>
</tr>
<tr>
<td>FRR</td>
<td>24%</td>
<td>16%</td>
<td>12%</td>
</tr>
<tr>
<td>GAR</td>
<td>76%</td>
<td>84%</td>
<td>88%</td>
</tr>
</tbody>
</table>

VIII. CONCLUSION

In the study of this multimodal biometric recognition system, it exploits two modalities namely face and ear recognition. With this recognition approach, the accuracy of 88% is obtained. Currently, we are working to enhance the recognition rate under controlled environment so that it can be applied to various applications including forensics and surveillance applications.

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REFERENCES