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Iris Recognition System using PCA

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ABSTRACT - Iris recognition or iris scanning is the process of using visible and near-infrared light to take a high-contrast photograph of a person's iris. It is a form of biometric technology in the same category as face recognition and fingerprinting. The iris recognition system consists of an automatic segmentation system that is based on the Hough transform and is able to localize the circular iris and pupil region. The extracted iris region was then normalized into a rectangular block with constant dimensions to account for imaging inconsistencies. Data from 1D Log-Gabor filters was extracted and quantized to four levels. Finally, PCA is used to encode the unique pattern of the iris into a bit-wise biometric template. And finally, iris recognition is employed for classification of iris templates, and two templates were found to match if a test of statistical independence was failed. Therefore, iris recognition is shown to be a reliable and accurate biometric technology**.** Using PCA we have achieved 95% of accuracy with high speed. Execution time is 0.082 sec respectively towards identification of the person will indicates the performance of the system.

Key Words: Biometric, Hough transform, Iris recognition, Log-Filter, PCA, Template,

I. INTRODUCTION

Iris scanning raises significant civil liberties and privacy concerns. It may be possible to scan irises from a distance or even on the move, which means that data could be collected surreptitiously, without individuals' knowledge, let alone consent [1]. There are security concerns as well: if a database of biometric information is stolen or compromised, it is not possible to get a new set of eyes like one would get a reissued credit card number. And iris biometrics are often collected and stored by third-party vendors, which greatly expands this security problem [2-3].

Iris scanning measures the unique patterns in irises, the colored circles in people's eyes. Biometric iris recognition scanners work by illuminating the iris with invisible infrared light to pick up unique patterns that are not visible to the naked eye. Iris scanners detect and exclude eyelashes, eyelids, and specular reflections that typically block parts of the iris. The result is a set of pixels containing only the iris. Next, the pattern of the eye's lines and colors are analyzed to extract a bit pattern that encodes the information in the iris [4-5]. This bit pattern is digitized and compared to stored templates in a database for verification (one-to-one template matching) or identification (one-to-many template matching) [6].

Iris scanning cameras may be mounted on a wall or other fixed location, or they may be handheld and portable. Researchers at Carnegie Mellon University are developing long-range scanners that could even be used to capture images surreptitiously from up to 40-feet away. Human iris is taken as one of the Biometric elements. The iris is a thin circular diaphragm, which lies between the cornea and the lens of the human eye. A front-on view of the iris is shown in Fig (1) [7].

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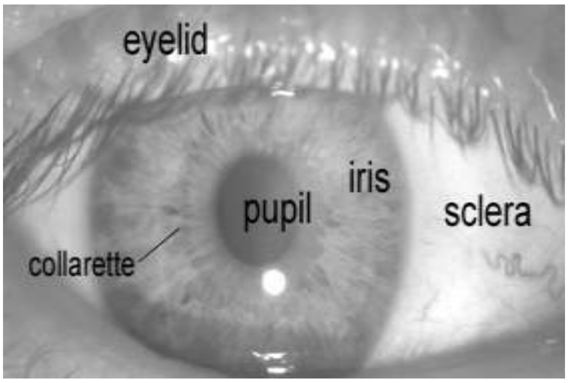

Fig. 1 Human Eye

In pattern recognition problems, the key issue is the relation between inter-class and intra-class variability: objects can be reliably classified only if the variability among different instances of a given class is less than the variability between different classes. So as an alternative we propose to use biometrics (iris recognition) system to identify an individual. The main objective of our application is to identify an individual with high efficiency and accuracy by analyzing the random patterns visible within the iris of an eye.

II. LITERATURE REVIEW

Biometric research has gotten a lot of focus in recent years, thanks to a rise in security concerns. People and governments have been encouraged by the rising homicide rate to act and be more vigilant in counterterrorism efforts [9]. Individuals must also secure their working environments, residences, personal items, and assets, among other things. Many fingerprinting approaches have been created and are still being enhanced, with the most successful being used in police and military applications on a routine basis. Several state-of-the-art approaches are used in biometric procedures [10-12]. In the current context, iris recognition is regarded as the most powerful approach for security authentication. Sensor technology advancements and rising biometric demand are propelling a booming biometric sector to develop new technologies. Many different technologies for identification systems are being developed as commercial incentives emerge, each with its own set of strengths and shortcomings as well as a possible specialist sector.

Chun-Wei Tan and Kumar [13] have developed a novel method for the extraction of the feature from the iris region. Here, they have approached a hybrid model using Linear discriminant and wavelet transformation. The developed algorithms are mainly used get the normalized iris. The characteristics are classified using the Euclidean distance (ED) classifier. 1200 iris images have been used by authors for the experiment on each category of dataset like CASIA_V-1 and CASIA_V-2. At the end authors have proposed theory's effectiveness is computed by the Equal Error Rate (EER). According to the authors their approach had a high level of accuracy.

Alice Nithya. A. And Lakshmi, C [14] Using chain coding and a zigzag collarette area, we attempted to improve the iris detection model. Here, authors have been concentrated on a zigzag collarette section to gather only the most essential aspects of the eyeball. The Gabor wavelet (GW) approach is used to feature extraction from iris scans, which are ultimately identified using the Support vector machine (SVM) approach. Authors have tested on the CASIA database version 2 (with 1000 images). According to the survey, authors conclude that their method will have a high success rate than the existing methods.

III. METHODOLOGY

Iris recognition is a highly effective and efficient identification technology which is regarded as a reliable and tremendously accurate biometric system. Iris is the annular portion between the dark pupil and the white sclera which provides many interlacing minute characteristics. Iris has a rich uniqueness of differences in anatomical texture information which is essentially stable over a person's life. The personal identification systems are non-invasive to their users based on iris recognition system. A simple Iris recognition system is as shown in figure 2. Iris recognition system consists of four stages such as iris acquisition, segmentation, normalization, feature extraction and matching which leading to a decision. In iris recognition system, accuracy is most considerable one. Because accuracy of iris recognition system depends on reduce the false acceptance rate and increase the false rejection rate.

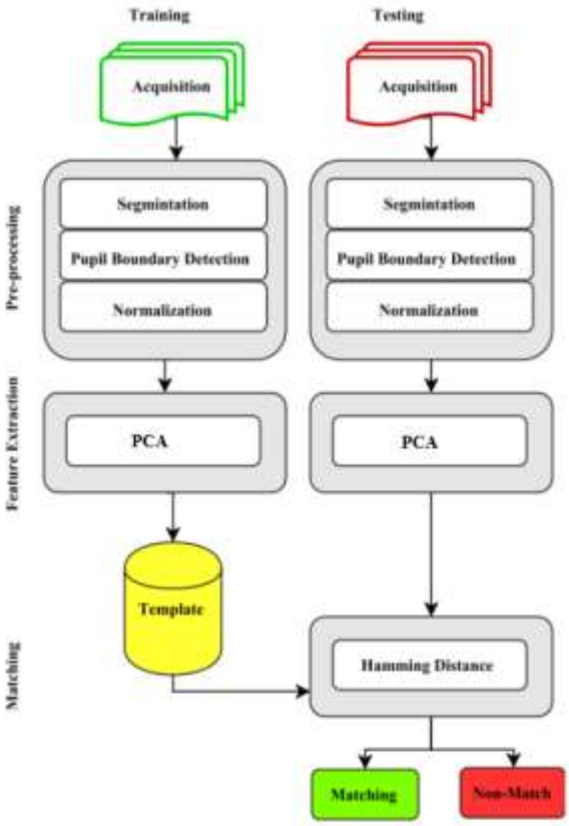

Fig. 2 Iris recognition system

3.1 Iris Image Acquisition:

The acquisition stage obtains the images of an eye. The optical system parameters, such as magnification and field of view, were optimally designed through the first-order optics The working distance is set to 3m in our system with pupil diameter 86mm and CCD irradiance 0.3mW/cm, after this iris image will be captured and stored in the database.

3.2 Segmentation/Localization

The Iris is located in between the pupil and sclera. The darker part of the eye is pupil. Iris localization technique is located and isolates the iris region. The spatial extent in the eye image segments the iris by isolating it from other structures such as the sclera, pupil, eyelid, and eyelashes.

3.3 Normalization

After locating the iris, the locating iris image cannot carry on the code immediately and firstly should carry on the calibration. The angular resolution, which determines how many sample points selected around the iris circumference. Along any given rays the radial resolution, which specifies how many points sampled between the pupil and limbic boundaries. When generating the iris code, then average neighbouring rows to create a smaller image is used.

3.4 Feature Encoding

From the pre-processing step, with the normalized iris image proper iris features can be extracted. In the feature encoding process, the template is generated which also need a corresponding match metric gives a measure of similarity between two iris templates. During the feature extraction step the uniqueness of the characteristics extracted that will determine the reliability of the recognition. A set of features will be assigned to each iris pattern obtained which allows the computation of a similarity measure between two iris patterns.

3.5 Matching Algorithm and Decision

All the feature extraction algorithms presented before give as a result a sequence of numbers or a pattern and it give no information about their relationship with the templates stored in the database. After generating the iris code of the image, need to compare this template and see if any matching occurs as in figure 3.

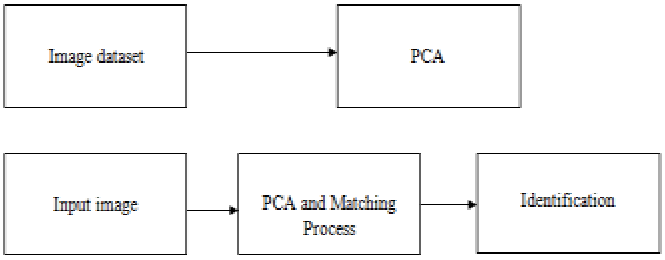

Fig. 3 System Architecture

IV. MATERIALS AND METHODS

The following steps are carried out to detect match or mismatch condition of the iris concerned to the specific person.

Step 1: standardization

The aim of this step is to standardize the range of the continuous initial variables so that each one of them contributes equally to the analysis. Mathematically, this can be done by subtracting the mean and dividing by the standard deviation for each value of each variable.

Step 2: covariance matrix computation

The covariance matrix is a p × p symmetric matrix (where p is the number of dimensions) that has as entries the covariances associated with all possible pairs of the initial variables. For example, for a 3-dimensional data set with 3 variables x, y, and z, the covariance matrix is a 3×3 matrix of this from:

$$\begin{bmatrix} Cov(x,x) & Cov(x,y) & Cov(x,z) \\ Cov(y,x) & Cov(y,y) & Cov(y,z) \\ Cov(z,x) & Cov(z,y) & Cov(z,z) \end{bmatrix}$$

Step 3: Compute the eigenvectors and eigen values of the covariance matrix to identify the principal components

Eigenvectors and Eigen values are the linear algebra concepts that we need to compute from the covariance matrix to determine the principal components of the data. Principal components are new variables that are constructed as linear combinations or mixtures of the initial variables.

Step 4: Feature vector

In this step, what we do is, to choose whether to keep all these components or discard those of lesser significance (of low Eigen values), and form with the remaining ones a matrix of vectors that we call Feature vector.

Step 5: Recast the data along the principal component's axes

In this step, which is the last one, the aim is to use the feature vector formed using the eigenvectors of the covariance matrix, to reorient the data from the original axes to the ones represented by the principal components (hence the name Principal Components Analysis). This can be done by multiplying the transpose of the original data set by the transpose of the feature vector as in equation (1).

Final Data Set= Feature Vector^T $_*$ Standard data set^T (1)

Step 6: Matching using Hamming Distance:

In this work hamming distance approach is used to compare the input and the template by using Hamming Distance formula which given by Equation (2)

$$\text{HD} = \frac{1}{N}\sum_{J=1}^{N} C_A(j) \oplus C_B(i) \qquad \textbf{(2)}$$

Where CA and CB are the coefficients of two iris images, N is the size of the feature vector, Ex-OR is the Boolean operator that gives a binary 1 if the bits at the position j in CA, CB are different and 0 if they are similar.

V. RESULT AND ANALYSIS

5.1 Pre-processing

The acquired image always contains not only the "useful" parts (IRIS) but also some parts (e.g., eyelid, pupil & reflection) which are not useful for our work. Under some conditions, the brightness is not uniformly distributed. A typical iris recognition system developed using MATLAB is as shown in figure 4

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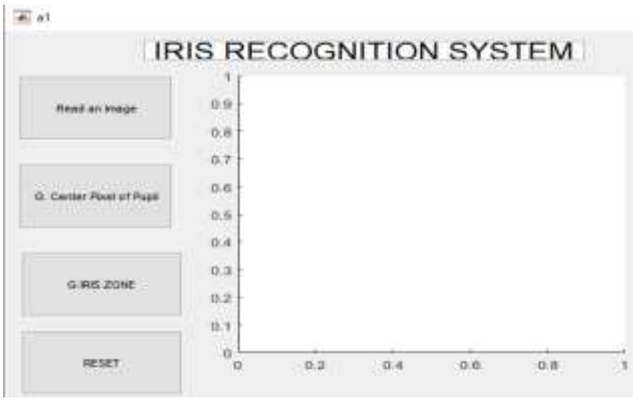

Fig. 4 Iris recognition System

Problem was in determining the pupil boundary the maximum change should occur at the edge between the very dark pupil and the iris, which is relatively darker than the bright spots of the illumination as a solution to this problem, modification to the integro differential operator is proposed to ignore all circles if any pixel on this circle has a value higher than a certain threshold. This threshold is determined to be 200 for the gray-scale image. The integro-differential can be seen as a variation of the Hough transform, since it too makes use of first derivatives of the image and performs a search to find geometric parameters. Since it works with raw derivative information, it does not suffer from the thresholding problems of the Hough transform. Figure 5 and 6 indicates the detection of the pupil and selection of iris zone from our proposed method.

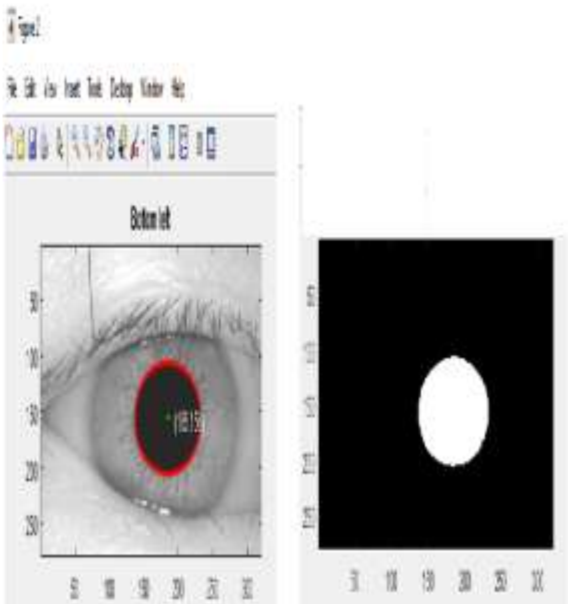
Fig. 5 pupil detection

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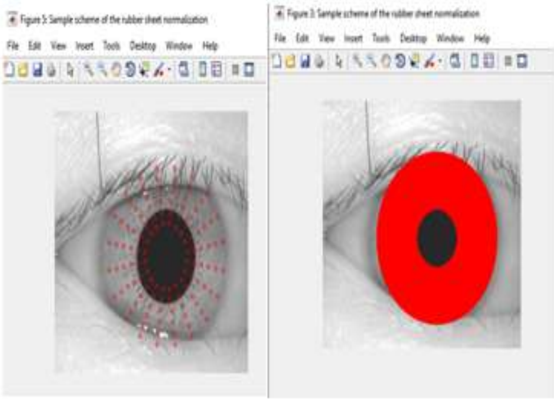


Fig. 6 Iris zone detection

5.2 Sample Data point after applying PCA

Feature extraction is a key process where the two-dimensional image is converted to a set of mathematical parameters. The iris contains important unique features, such as stripes, freckles, coronas, etc. These features are collectively referred to as the texture of the iris. These features were extracted using PCA algorithms. PCA reduces the dimension of input data. The reduced data is shown below

[-0.8844335 0.66498715 -0.16804463 0.6301673 -0.16804463 0.06301674 -0.1890502 -0.08402231 -0.00754888 -0.01050279 0.13128486 -0.6511729 -0.33608925 -0.05776534 -0.6511729 -0.12603347 -0.20480438 -0.00525139 -0.22055857 -0.13916194 -0.25206694 -0.2678211 0.17329602 0.26650825 -0.03150837 0.14178765 -0.33608925 0.0945251 0.08402231 0.0945251 0.11553068 0.07877091 0.14703904 0.26256973 -0.12603347 0.1969273 0.04201116 0.02100558 -0.09977649 -0.22055857].

We have applied PCA to extract the iris feature. For an input image obtained feature using PCA is as shown in figure 7.

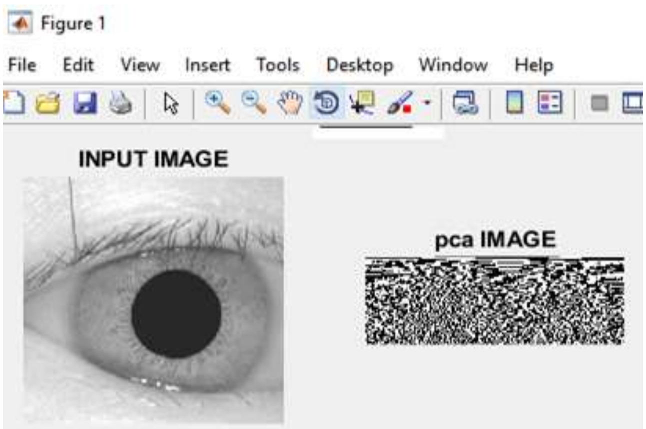


Fig. 7 Feature Extraction using PCA

To create iris code feature extracted image is divide into vertically blocks. Finally, we can obtain binary Iris Code for Verification which is indicated in figure 8.

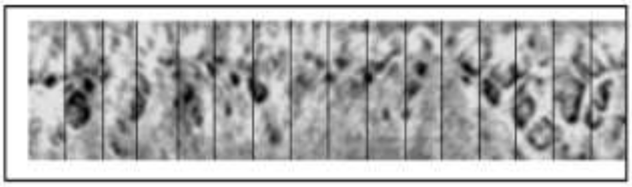
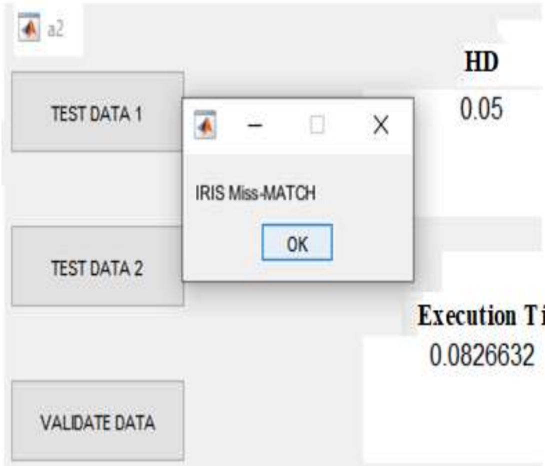


Fig. 8 Iris Code Generation

5.3 Prediction

Provide the image of eye to the developed system as an input. The system predicts the identity of the person by displaying his name. Some of the examples of prediction are given below. Using iris code template, we can develop iris recognition system as in figure 9.

CASE-1 Iris Miss-Match Condition



CASE-2 Iris Match Condition

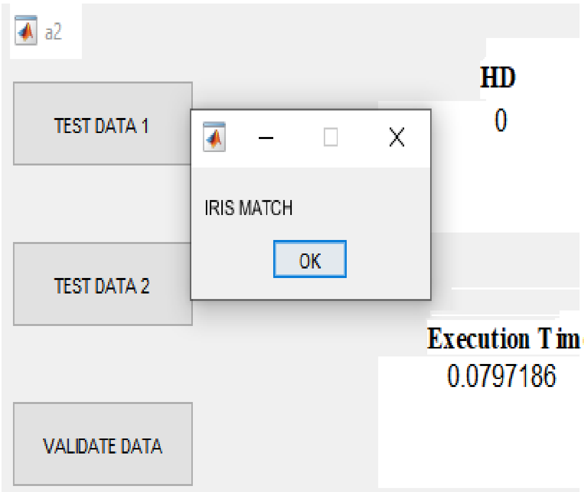


Fig. 9 Iris Matching System

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VI. CONCLUSIONS

Iris recognition technology is durable, quantifiable, recordable, and reliable. It thus fulfils the basic tenets of an ideal biometric system. The stored biometric template can be used for a person's whole life as iris patterns are not susceptible to change, remaining stable for long periods of time. In case high security requirement in any kind of application(s) one can select multimodal biometric kind of approach. Using PCA we have achieved 95% of accuracy with high speed. Execution time is 0.082 sec towards identification of the person will indicates the performance of the system. In future Iris scanners can be used to protect high value locations by denying access to unwarranted visitors.

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