Identify and Recognize Person Using Iris Biometric Security System

by

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requirements for the degree of Masters of Science (M.Sc)

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September 24, 2017

To my beloved parents

DECLARATION

I hereby declare that this project is based on the results found by myself. Materials of work found by other researcher are mentioned by reference. This project, neither in whole nor in a part, has been previously submitted for any degree.

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CERTIFICATE

This is to certify that the project entitled **Identify and Recognize Person Using Iris Biometric Security System** has been prepared and submitted by **Supriti Ghosh** in partial fulfillment of the requirement for the degree of Masters of Science in Information Technology on September 24, 2017.

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ABSTRACT

A biometric system provides distinct and automatic identification of an individual based on characteristics and unique features showed by individuals. This work will examine the developing automated iris recognition for personal identification in order to verify both uniqueness of the human iris and also its performance as a biometric based system. The iris recognition system consists of the iris acquisition system and iris authentication algorithm. This method will also able to localize the pupil region and circular iris, occluding eyelashes and eyelids, and reflections. The performance will be measured for stored database which is scored 0% each for False Reject Rate (FRR) and False Accept Rate (FAR). Consequently, iris recognition is shown to be a precise and reliable biometric technology.

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(a0, b0)	The potential center of the searched circular boundary
D	Radius
I(a,b)	Iris region
(a,b)	Cartesian coordinates
(d, $\propto$)	Conforming polar coordinates
(a_m, b_m)	Coordinates of the pupil
(a_i, b_i)	Iris boundaries
m(a,b)	Two-dimensional Gaussian function

LIST OF ABBREVIATIONS

FRR	False Reject Rate
FAR	False Accept Rate
DWT	Discrete Wavelet Transform
2DDWT	Two-Dimensional Discrete Wavelet Transform
GUI	Graphical User Interface
PCA	Principal Component Analysis
LSB	Least Significant Bit
KNN	k-nearest neighbor
SVM	Support Vector Machine

CHAPTER I

Introduction

1.1 Overview

A biometric system is fundamentally a pattern-recognition system that identifies a person based on a feature vector plagiaristic from a specific physiological or behavioral features that the person retains. A biometric system characteristically functions in one of two modes: verification and identification which is dependent on the application environment.

This work represent an improved identification based method to identify person using iris biometric security system and my contribution lies in five features:

- Image Acquisition is the first step of identify an image which must be acquired first in digital form that is appropriate for analysis.
- A simple preprocessing step where there is two algorithms: detection and segmentation, Cartesian to polar reference transform. In the detection and segmentation algorithm, there is three steps: iris detection, correct iris segmentation, locating iris. In iris detection, there is two types: automatic interlacing detection and correction, gazing-away eyes.
- Feature extraction is the third step of this work. Feature extraction step is most important step in the automatic iris recognition system which has the aptitude of extracting some unique characteristics from iris which help to produce an exact code for each individual.

- Pattern matching is the fourth step of the project. There is two steps in pattern matching: binary coding scheme, matching using hamming distance. Binary coding scheme represents the gained vector in a binary code and hamming distance represents the distance between input images and images in every class which are calculated and it uses two classifiers.
- Identification and verification is the last step of this work. It has two main goals of every security system founded on the desires of the atmosphere.

Figure 1.1 represents the step of identify the iris which is proposed in this work.

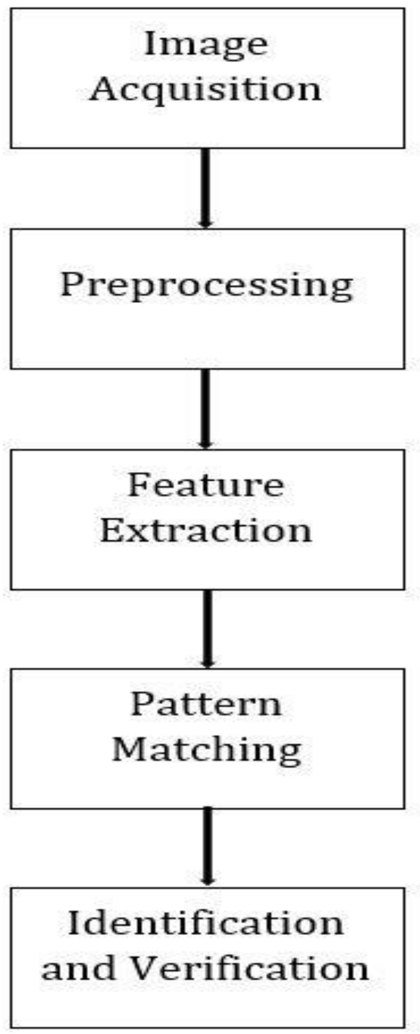


Figure 1.1: Procedure of the proposed system

1.2 Problem Statement

Now a day's security is an important feature in our everyday life whichever the classification of security plays vital role. The biometric person identification procedure based on the pattern of the humanoid iris which is well-matched to be functional to access control and carries solid e-security. Security structure having realized the assessment of biometrics for two rudimentary determinations: to verify or identify users. There is many types of biometric security system which can be approximated by preprocessing process. In this work, preprocessing system is based on the algorithm of detection and segmentation and Cartesian to polar reference transform.

1.3 Objectives

The principle objective of this work is to identify person using biometric security system in some pre-defined sense. Some objectives that are stated below:

- The key objective is to identify iris of person using biometric system to recognize person.
- To improve preprocessing method by algorithms for detection and segmentations and Cartesian to polar reference transform.
- To improve feature extraction method which can produce an exact code for individual.
- To improve pattern matching method by using binary coding scheme and matching using hamming distance.
- To determine hamming distance between input images and images in every class which are calculated and uses two classifiers.

1.4 Assumptions and Limitations

The proposed method is not work directly with color images, at first it needs to convert images in gray scale which limits our work. In case of linear binary pattern we need to identify classifier and the classifier will be the KMN classifier. But it is not possible to know the every classifier.

1.5 Comprehensive analysis with existing method

[1] This study considered on the preprocessing system for the algorithm of detection and segmentation and Cartesian to polar reference transform. [2] This study considered for only the wavelet decomposition which is used for feature extraction. [3] This study considered only using the Haar wavelet. In this study, Haar wavelet is used for iris identification systems on feature vector method. [4] This study considered on Daugman's mathematical algorithm for iris processing and Gabor filters to extract binary vectors.

In this study,

1. It represents the preprocessing system for the algorithm of detection and segmentation which is based on the iris detection, iris segmentation and locating iris.
2. In the method of feature extraction, here is a specific code for each individual. Gabor and wavelet transforms are naturally used for evaluating the human iris shapes and extracting features.

1.6 Project Outline

This study is arranged as section II contains related works or literature review. In section III, the proprocessing is discussed. Feature extraction is discussed on section IV. In section V, pattern matching is explained. Identification and verification is shown in section VI. In section VII, simulation results is discussed. Applications is discusses on section VIII. Challenges and future work is discussed on section IX. Finally, section X represents conclusion and discussions.

CHAPTER II

Literature Review

Several methods have been proposed in literatures to identify iris and to recognize person.

Vanaja Roselin.E Chirchi, Dr. LM. Waghmare and E. R. Chirchi [1] has proposed a method to recognize iris for person identification in security systems using the CASIA iris database which will also work for UBIRIS iris database which has images captured from distance and recognition when its performance evaluation is accurate. In this study, they considered on the preprocessing system for the algorithm of detection and segmentation and Cartesian to polar reference transform.

A. Poursaberi and B. N. Araabi [2] has proposed a half-eye wavelet based method and they used wavelet decomposition for feature extraction and the selected coefficients of 3-level decomposition with Daubechies 2 wavelet have been used as features and a mixed Hamming harmonic mean distance classifier was used for classification.

The optimal wavelet transform is determined by Sandipan P. Narote, Abhilasha S. Narote and Laxman M. Waghmare [3]. They used extracted features for matching. There, different wavelet transforms have been used by different researchers extract features using different coefficient such has horizontal, vertical, diagonal or combination of them. They used different basis wavelet for feature extraction.

Chirstel-Ioic Tisse, Lionel Martin, Lionel Torres and Michel Robert [4] has proposed a new iris recognition system that implements gradient decomposed Hough transform or integro-differential operators combination for iris localization and the analytic image concept to extract pertinent information from iris texture.

An efficient methodology for identification and verification for iris detection has been proposed by Khattab M. Ali Alheeti [5]. He proposed a method which is instigated on image capturing, enhancement, identification and different types of edge detection mechanisms.

Yong Zhu, Tieniu Tan and Yunhong Wang [6] has proposed a new system for identification based on iris patterns. They composed it using iris image acquisition, image preprocessing, feature extraction and classifier design. They proposed an algorithm for iris feature extraction which is based on texture analysis using multi-channel Gabor filtering and wavelet transform.

Kishori B. Jagtap and M. P. Satone [7] has proposed a method which converts the isolated iris using a wavelet transform into a standard domain where the common radial patterns of the human iris are concisely represented and it optimally selects, aligns and near-optimally compresses the most distinctive transform coefficients for each individual user.

CHAPTER III

Preprocessing

3.1 Image Acquisition

Image acquisition is an important and difficult stage of an iris recognition system. As iris is small in dimension and dark in color, it is challenging to procure good images for exploration using the standard camera and ordinary lighting. A camera can capture an image which is commence of an image and renewed into a convenient entity.

3.2 Iris Detection

Image preprocessing is that performance of enchanting an input image of an eye and splitting the iris from the contiguous noise and after that consequential in the output image. Such noise comprises the pupil, the cornea, the eyelids, the eyelashes, the eyebrows and the neighboring skin.

Irises are perceived even when the images have impediments, optical noise and different levels of enlightenment. Lighting reflections, eyelids and eyelashes impediments are reduced. Images with constricted eyelids or eyes that are looking away are also recognized using wavelet procedure.

Involuntary interlacing recognition and improvement: The improvement results in maximum feature of iris features patterns from moving iris images.

Gazing-away eyes: A gazing-away iris image is appropriately distinguished, segmented and altered as if it was observing straight into the camera.

3.3 Iris Segmentation

Iris segmentation is accomplished under these environments:

Perfect spheres fail: Normally eye procedures energetic shape reproductions that more specifically model the outlines of the eye as faultless circles do not model it is restrictions.

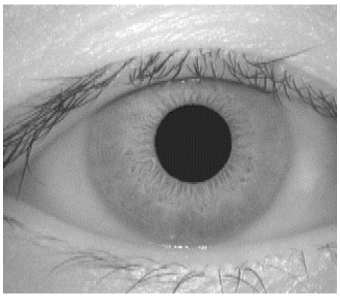
The midpoint of the iris inner and outer boundaries are dissimilar. The iris inner boundary and its midpoint are marked in green.

Iris boundaries are definitely not spheres and even not compressions and particularly in gazing-away iris images.

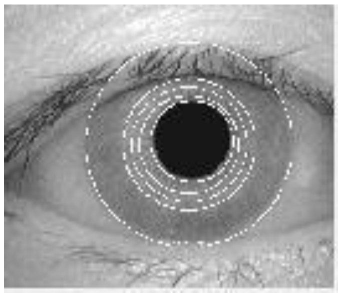
Iris boundaries appear to be perfect circles. The recognition quality can still be developed if boundaries are establish more specifically associated to perfect spherical white contours.

3.4 Iris Localization

Both the inner boundary and outer boundary of a characteristic iris can be reserved as spheres. But the two spheres are frequently not co-centric. Linked with the additional measure of the eye, the pupil is considerable darker. There is need to distinguish the inner boundary among the pupil and the iris by means of thresholding. The outer boundary of the iris is additional tough to detect because of the truncated contrast among the two edges of the boundary. After that there is need to detect the outer boundary by maximizing fluctuations of the perimeter-normalized sum of gray level principles beside the circle. The procedure is found to be efficient and effective (Figure 3.4.1).



(a)



(b)

Figure 3.4.1: (a) Original iris image (b) Image after iris localization

The first processing phase involves in localizing the inner and outer boundaries of the iris and second phase to normalize iris and third phase to develop the original image as in (Figure 3.4.2). The Daugman's structure, Integro differential operatives as in Eq. 3.4.1 is used to perceive the center and diameter of iris and pupil correspondingly.

$$\max(d, a0, b0) = \{\frac{\partial}{\partial r}\int_0^{2r} I(d * \cos \propto \ +a0, d * \sin \propto \ +b0)\} \qquad (3.4.1)$$

where (a0, b0) denotes the potential center of the searched circular boundary and d is its radius.

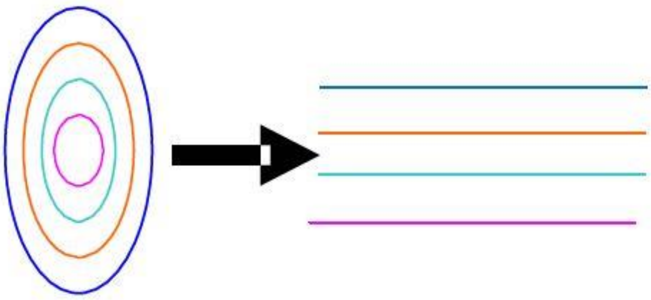


Figure 3.4.2: Polar transformation [8]

3.5 Cartesian to polar orientation transform

Cartesian to polar orientation transform recommended by Daugman authorizes corresponding rectangular representation of the sector of awareness as in Figure 3.4.2 which remaps every pixel in the pair of polar co-ordinates (d, ∝) where d and ∝ are on interval [0,1] and [0,d] correspondingly. The unpacking in formulated as in Eq. 3.5.1 [8].

$$I\left(a(d,\propto), b(d,\propto)\right) \rightarrow I\ (d,\propto) \tag{3.5.1}$$

Such that

$$a(d,\propto) = (1-d)a_m(\propto) + \mathrm{d}a_i(\propto) \tag{3.5.2}$$

$$b(d,\propto) = (1-d)b_m(\propto) + \mathrm{d}b_i(\propto) \tag{3.5.3}$$

Where I(a,b), (a,b), (d, ∝), (a_m, b_m), (a_i, b_i) are the iris region, Cartesian coordinates, conforming polar coordinates, coordinates of the pupil and iris boundaries along the ∝ direction, correspondingly.

CHAPTER IV

Feature Extraction

The greatest significant step in insentient iris recognition is the capability of removing some distinctive features from iris which support to produce an unambiguous code for each individual. Gabor and wavelet transforms are characteristically used for considering the human iris outlines and extracting features from them.

Algorithm for feature extraction:

Step 01: Apply 2DDWT with Haar up to five-level decomposition.

Step 02: Consuming 4^{th} level, 5^{th} level decomposition particulars construct the feature vector.

Step 03: Binaries the particulars receiving from step no. 3.

Step 04: Store these feature vectors.

The features of the iris are positioned founded on the polar coordinate structure, Gabor's multifaceted two-dimensional pass band filters, which agreement the best spatial-frequency determination in the two-dimensional instance [13], are proposed by J. Daugman to extract textural material of iris images. As a consequence of the filtering at dissimilar frequencies and particular positions in the polar organize system, a set of complex standards are calculated by convolution. The sign of both the real and imaginary parts of the quadrature image predictions from these unambiguous regions of the iris accomplishes a phase quantization of the local texture signal. The time mandatory for computing one complete iris code, once an iris has been positioned within the image, is about 100 ms. It is significant to note that, because of radial associations between dissimilar iris patterns, it happens a enslavement within bits extracted in iris codes. The study of the quantity of degrees of independence indicates in the Daugman's organization a reduction of the information measurements of the iris code by a factor of 4.05 from 2048 bits to about 506 bits.

4.1 Gabor Filtering

The multi-channel Gabor filtering technique is inspired by the psychophysical findings that the processing of pictorial information in the human visual cortex involves a set of parallel and quasi-independent mechanisms or cortical channels which can be modeled by band pass filters.

A simple computational model for the cortical channels in modeled by a pair of Gabor filters $p_c(a, b; e, \propto)$ and $p_f(a, b; e, \propto)$. The two Gabor filters are of opposite symmetry and are given by

$$p_c(a, b) = m\ (a, b). \cos[\ 2\pi e(xcos \propto\ + \mathrm{y}\sin \propto)] \tag{4.1.1}$$

$$p_f(a, b) = m\ (a, b). \sin[\ 2\pi e(xcos \propto\ + \mathrm{y}\sin \propto)] \tag{4.1.2}$$

Where m(a,b) is a two-dimensional Gaussian function, f and ∝ are the central frequency and orientation which define the location of the channel in the frequency plane. Commonly used frequencies are of power 2. The central frequencies used in this paper are 2, 4, 8, 16, 32 and 64 cycles/degree.

For each central frequency f, filtering is performed at ∝=0°, 45°, 90° and 135°. This leads to a lot of 24 output images from which the iris features are extracted. These features are the mean and the standard deviation of each output image. Therefore, 48 features per input image are calculated. Testing was performed by using all 48 features or its various subsets.

4.2 Two-dimensional wavelet transform

Wavelet transform is a good scale analysis tool and has been used for texture discrimination. A two-dimensional wavelet transform can be treated as two separate one-dimensional wavelet transforms. After applying wavelet transform on an original image, a set of sub images are obtained at different resolution levels. The mean and variance of each wavelet transform. The information at the finer resolution level is strongly affected by noise. In order to reduce this effect on the extracted features, only five low resolution levels, excluding the coarsest level are used. For each resolution level, means and standard deviations are extracted as features. This makes the 26 extracted features robust in a noisy environment.

CHAPTER V

Pattern Matching

5.1 Binary Coding Structure

It is very significant to characterize the acquired vector in a binary code as it is easier to treasure the modification between two binary code mechanisms than among two number vectors. In circumstance Boolean vectors are constantly easier to compare and to influence. In order to code the feature vector first pragmatic some of its characteristics. Currently establish that all the vectors that have to be acquired have a maximum assessment that is less than 0. If "A" is the feature vector of an image than the subsequent quantization structure transforms it to its corresponding code word.

- If $A(i) \geq 0$ then $A(i) = 1$
- If $A(i) < 0$ then $A(i) = 0$

The subsequent phase is to associate two code words to discovery out that they characterize same person or not.

5.2 Matching using Hamming Distance

The Hamming distance (DDs) among input image and images in both class are premeditated, then the two dissimilar classifiers are being applied as follows:

1. In the principal classifier, the minimum Hamming distance among input iris code and codes of every class is calculated.
2. In the subsequent classifier, the harmonic mean of the p Hamming distance that have been verified yet is allocated to the class in Eq. 5.2.1.

$$\text{MM} = \frac{length\ (code)}{\sum_{i=1}^{length(code)}(1/code(i)} \tag{5.2.1}$$

Steps for equivalent using hamming distance:

Step 01: Associate feature vector of database images by feature vector of interrogation image.

Step 02: Compute the hamming distance for every database feature vector.

Step 03: Find out the minimum hamming distance.

The iris codes in the database are used to discovery out which iris codes originate from the same eye. Hamming distance is selected because of its speed in calculating dissimilarity between binary codes. Hamming distance two Boolean is as shown in Eq. 5.2.2.

$$DD = \frac{1}{N}\sum_{i-1}^{N} \qquad A_I \oplus B_I \tag{5.2.2}$$

When N is the quantity of bits in the feature vector, A_I is the ith feature of the established iris and B_I is the ith feature of the iris pattern. If two bit shapes are absolutely autonomous such as iris templates produced from different irises, the hamming distance the two shapes will be close to 1. If two arrangements are consequential from the identical iris, the Hamming distance among them will be close to 0, since they are extremely correlated and the bits must agree between the two iris codes.

The maximum Hamming distance that occurs among two irises belonging to the same person is 0.32. Thus, when associating two iris images, their matching binary feature vectors are distributed to a function accountable of scheming the Hamming distance among the two. The assessment of whether these two images belong to the same person depends upon the subsequent result:

1. If DD <= 0.32 agree that it is identical person
2. It DD > 0.32 agree that it is different person indications the iris code matching person

CHAPTER VI

Identification and Verification

Identification and verification methods are two main goals of every security system founded on the requirements of the environmental. In the confirmation stage, the organization checks if the user data that was entered is accurate or not but in the documentation stage, the arrangement attempts to determine who the issue is deprived of any input information. After that, verification is a one-to-one exploration but identification is a one-to-many assessment.

CHAPTER VII

Simulation Results

In this work, the GUI displays all the phases for iris analysis like pupil detection and noise removal. The GUI shows iris recognition system in Figure 7.1. Iris localization gives result in popup window which is shown in Figure 7.3. The consequences for feature extraction are displayed in Figure 7.4 on command window of MATLAB. From matching pushbutton process of verifier side of the classification starts. Using image matching pushbutton image to verify is browsed after that for classification. To display the result of classification text is provided which is shown in command window of MATLAB.

Figure 7.1: Iris Recognition System

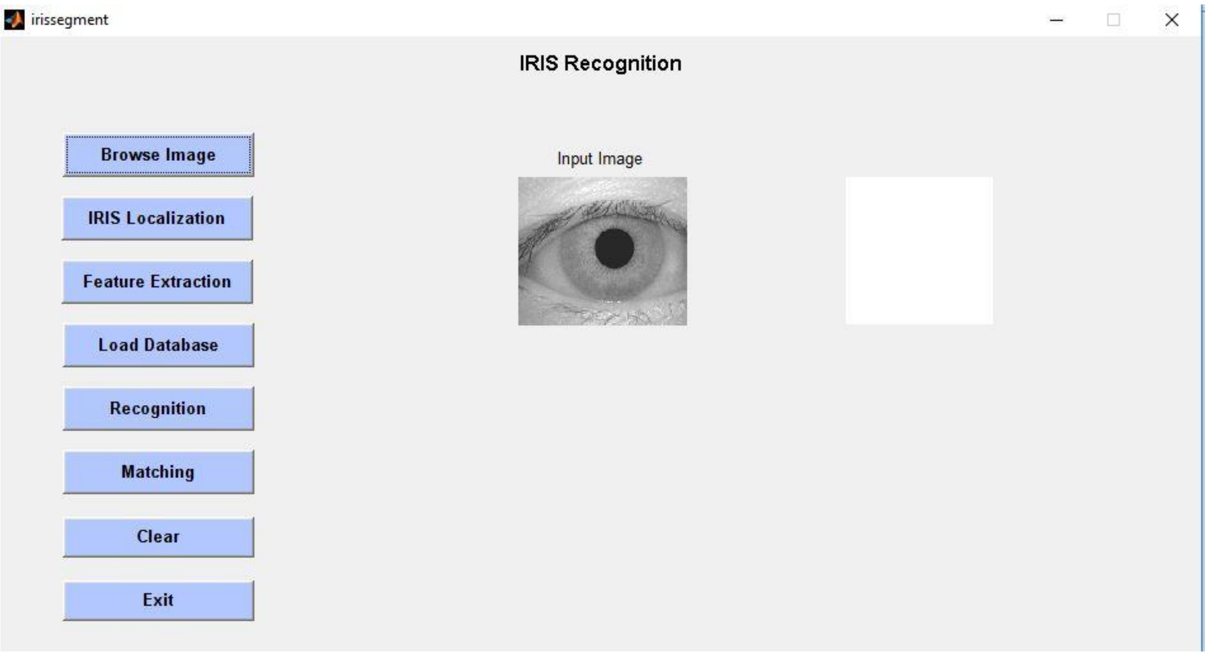


Figure 7.2: Iris Recognition System (after browsing image)

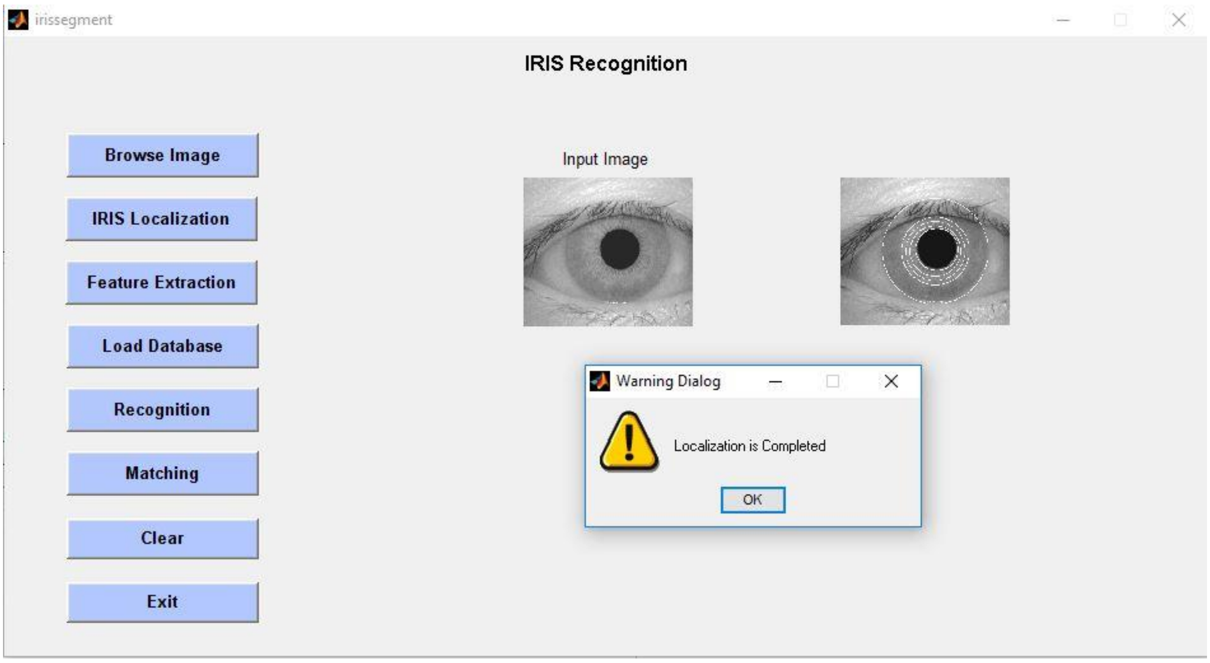


Figure 7.3: Iris Recognition System (after iris localization)

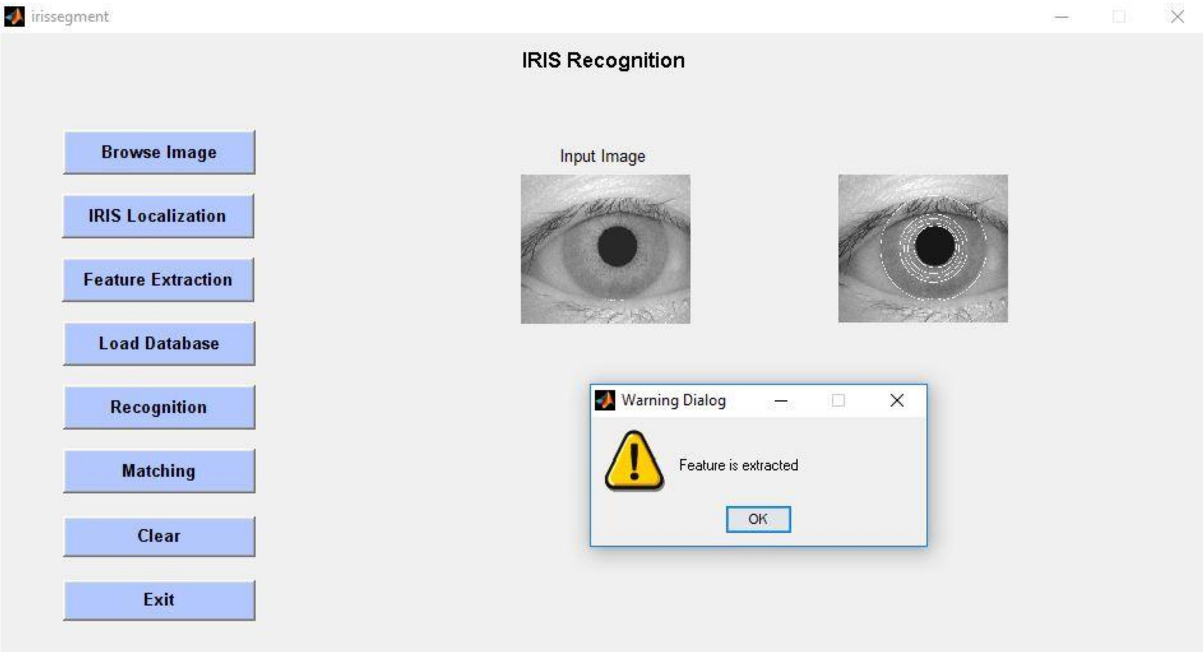


Figure 7.4: Iris Recognition System (after feature extraction)

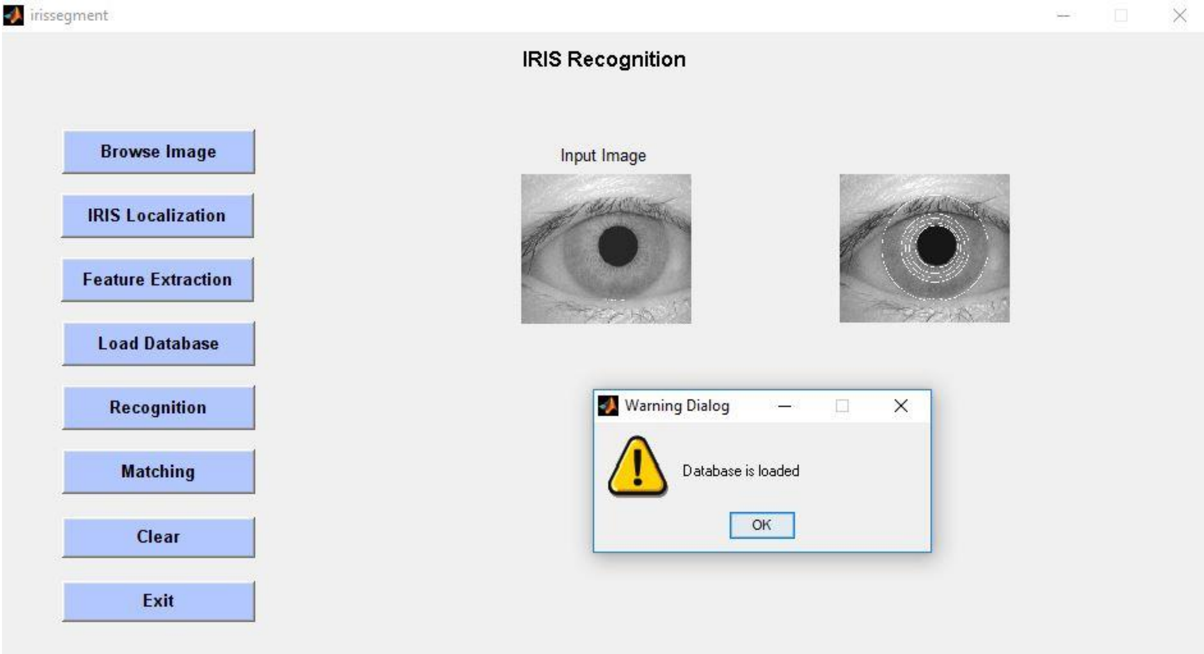


Figure 7.5: Iris Recognition System (after database is loaded)

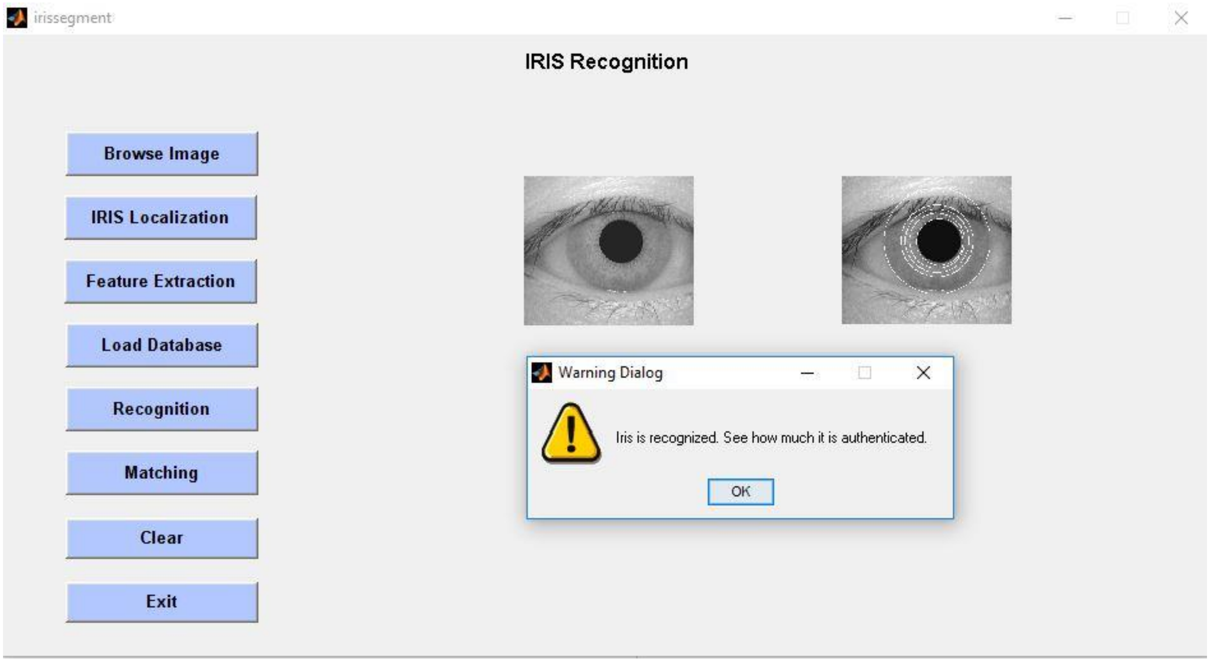


Figure 7.6: Iris Recognition System (after iris is recognized)

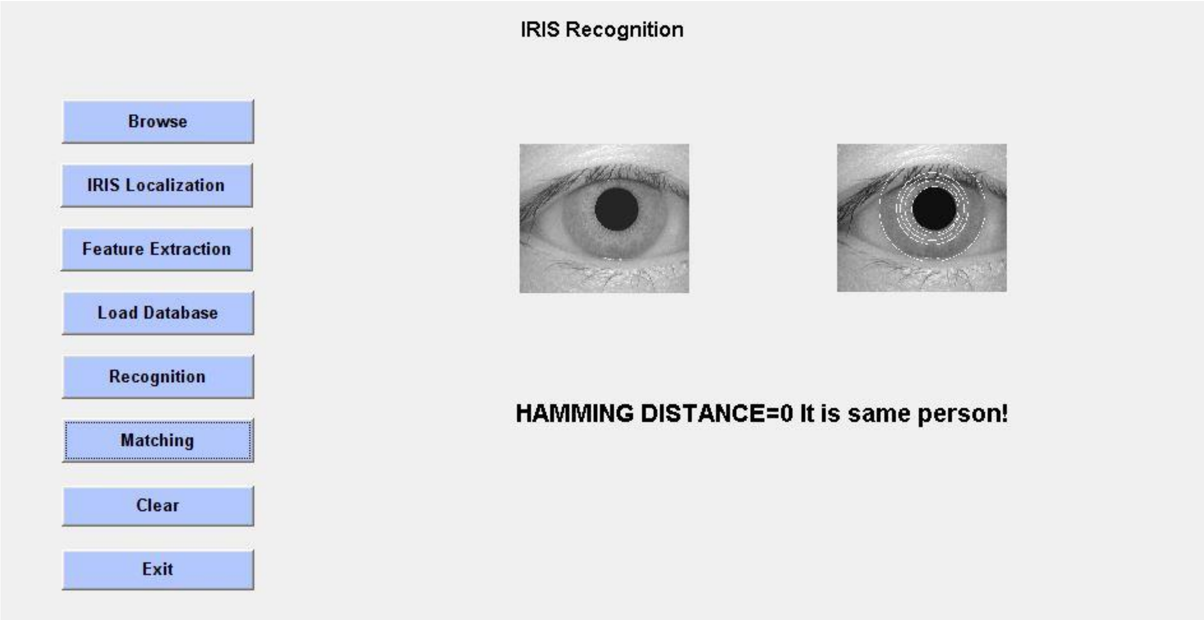


Figure 7.7: Iris Recognition System (matching of iris image)

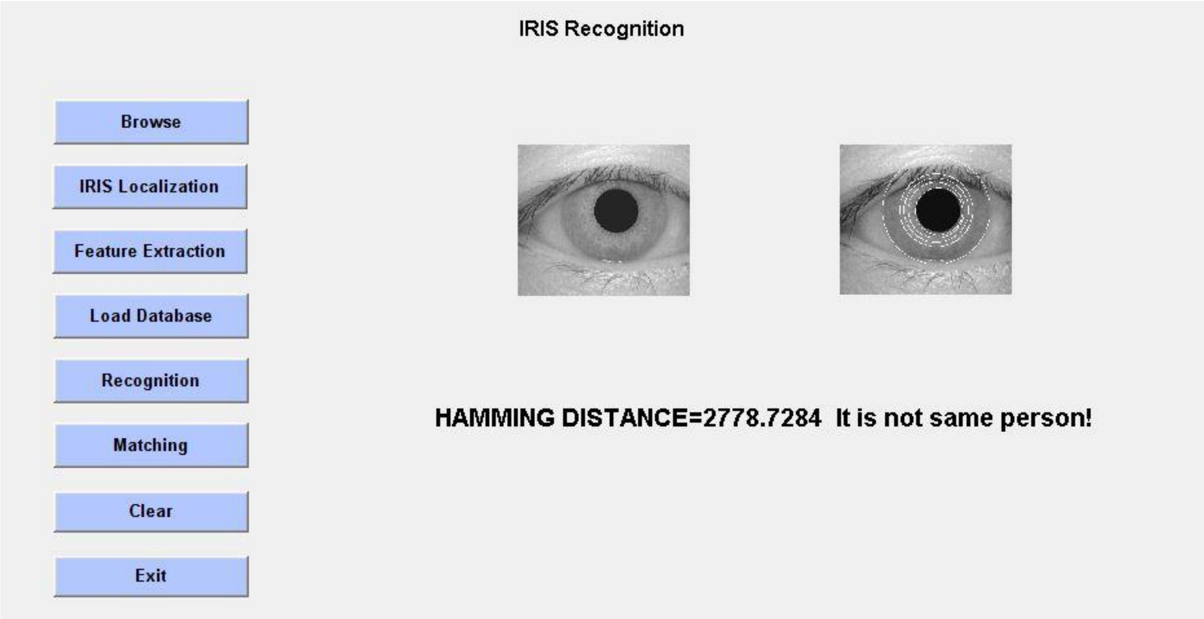


Figure 7.8: Iris Recognition System (matching of iris image)

CHAPTER VIII

Applications

Access mechanism is presently the principal concentration of iris id's commerce as it is extensively organized in both public and private divisions everywhere the world which is providing state-of-the-art access mechanism to administrations appreciating human and physical possessions. One zone in which iris id is gaining considerable thoughtfulness and acceptance for iris access is in data center access mechanism. The repositories of material concerning business encompass a company's most appreciated advantage which is information accumulated over time at considerable expense. Iris recognition system is finding its technique into the education segment which is not objective for security but for additional applications as well. It is being recycled in daycare and schools to constrain access and establish the uniqueness of the school organizations as well as parents or additional adults who come to school to preference up particular children.

CHAPTER IX

Challenges and Future Work

9.1 Challenges

1. **Security:** Multiple providers as well as many organizations will take part in this system. Different parties will interact with different resource puddle. Therefore, a proper security mechanism is a challenge to maintain data persistence, integrity, confidentiality and availability.

2. **Data management:** A lot of structured and non-structured data will generate continuously in this recognition system. Database should be replicated to different locations and geographical distances for higher reliability and better access. All data should be error free because it matters a lot to the users of it. In spite of any hardware or software failure data should be persistence constantly.

3. **Usability:** Always the users and connecting devices are increasing. So the system should be able to scale itself to the requirements so that no failure is occurred in case of traffic. Moreover, there may open the new GUI window to be added to the system for better service.

4. **Maintainability:** A large scale system development is not finished. Unlike a single organization system, this is difficult to maintain different parts and mechanisms. This resources and services must be designed for reliability and quick maintenance. To provide error free service to lot of people and different organizations, perfect testing models should be developed for reducing maintenance time.

9.2 Future Work

In future, this method will be incorporated with the principal component analysis (PCA) and least significant bit (LSB) algorithm is used to entrench the user information into the iris image and then for verification of the user two classifier will be used such as k-nearest neighbor (KNN) and support vector machine (SVM). The exactitude of the coordination can be improved by using these genetic algorithms. The effectiveness of the iris biometric technique can be abundant developed if used in combination with additional biometrics.

CHAPTER X

Conclusion and Discussions

The proposed exertion is to enhance the algorithm for efficient person identification for each additional area of applications by cumulative FRR more than 0.33% as the eye procedure consequences with FRR 0.32% and FAR 0.001%. Wavelets iris recognition procedure is appropriate for dependable, reckless and protected person identification. Wavelet, Gabor filter and the assortment of hamming distance for Haar wavelet is a smaller amount i.e., 0.2866 to 0.51111, for robust and fast equivalent for healthcare procedure for persistent identification. Proposed algorithm focus on the algorithm for rapid and accurate iris identification even if the images are obstruct additional procedure will also concentration on robust iris acknowledgement, even through gazing-away eyes or contracted eyelids which resolves all the safety interrelated difficulties.

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