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# Iris Recognition for Personal Identification System

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***Abstract:*** ***Biometric is a secure identification system to check for identity and helps prevent unauthorized access. It provides an automated way for identification and verification with the help of one's physiological and behavioral characteristics. It also provides an advantage over the basic method of password and PIN protected systems that are vulnerable to being lost or stolen, as it is more stable and secure. Various biometric systems are developed based on different physical characteristics like the face, voice, fingerprint, iris, etc. Among all these, iris recognition is found to be a more reliable and secured authentication system. Iris recognition is a technique to identify an individual based on the unique patterns present in the eye. These patterns differ even in identical twins. Due to the uniqueness in this pattern, iris recognition is considered to be more stable. This paper proposes a basic iris recognition system using Integro-differential operator and Log Gabor analysis. Iris templates are created from the input image and are used to compare during the verification process. This system provides an easy way to authenticate and access for the admin to verify the person given the iris image.***

***Keywords: Biometric, authentication, iris recognition, segmentation, feature encoding.***

## I. INTRODUCTION

As digital technology is increasing widely across the world, an issue with protecting the confidential data and securing access to the systems comes into the picture. Earlier methods of password and PIN are no longer secure as they can be easily spoofed. To overcome this issue, biometric systems are developed which provides an easy and convenient way to authenticate a person in a secured way. This technique uses the unique traits of an individual like fingerprints, voice, facial features, and so on. Iris recognition is one such biometric system that offers more stability and accuracy compared to other identification systems. Iris recognition is a method that uses unique patterns in the eye to verify the person's identity. Iris is segmented from the eye image and different algorithms are applied to the iris image to extract unique patterns. These patterns are then encoded in binary form creating templates. Templates can be used as a matching feature to verify the person. Iris recognition technology is being used in various sectors like Banking and financial services for KYC work or to identify its clients and employees, Health care services where the patient is identified using iris image to know his medical history and treatment planning. Iris technique can even be considered as a form of National ID, where the citizens are identified accurately and also it prevents any duplicate registration. The iris is a thin, circular structure in the eye that surrounds the pupil. The iris feature differs for each individual and remains unchanged throughout the lifetime of a person. This unique character of iris makes it more stable for the recognition system. The random patterns of iris are analyzed to recognize the individual. Basic steps that are followed during the recognition process include:

*A.* Image Acquisition: a process of retrieving eye image.
*B.* Segmentation: locating the iris boundary and pupil boundary in the image.
*C.* Normalization: converting segmented iris to a fixed dimension.
*D.* Feature extraction: creating an iris code in the form of a template.
*E.* Matching: comparison of iris templates.

The image is captured using a high-quality CCD camera or an iris scanner under a luminous condition. In this work, iris images are taken from the CASIA dataset. Segmentation is performed on the image to locate the iris region and feature encoding is done to study the patterns of iris. The system is trained with the iris images during the registration of a person. Identification is done based on the registered iris images which compare the stored templates with the new iris code. The authentication is done faster once the iris has been registered. It provides a convenient way to provide access to authorized users.
In this paper, we propose an idea for improving the segmentation process using an Integro-differential operator. The segmented iris is tested to verify if the segmentation is performed correctly, if not the iris is rejected for further steps. Log Gabor filter is used for feature encoding, which converts the iris image to binary values. Matching is done by calculating the hamming distance of the iris code. During registration, the designed GUI is used to collect the details of the person with the iris image. The generated templates are stored in the folder for later the verification process. The person is identified when his iris is matched with the stored template.

## II. PROPOSED SYSTEM

An iris biometric system is designed which can verify the identity of a person using the iris patterns. Input iris images are taken from the CASIA dataset, which is used for the verification process. Statistical texture features in the iris are studied for feature extraction. Log Gabor filter is used to analyze the image for a particular frequency, which can be used as a pattern for encoding. The designed system allows the admin to add a new iris image and train the system for verification. The system design is shown in Fig.1.

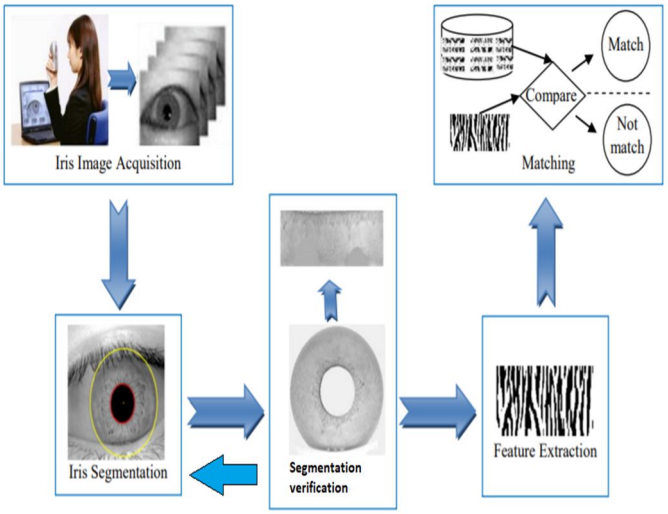


Fig.1 System Architecture

The different steps in the system design are:

1) *Iris Image Acquisition:* It's the method of capturing the eye image from the source. In this work, iris images are taken from the dataset. CASIA dataset contains 2655 iris images, among which 200 images are used in this work.
2) *Iris Segmentation:* In this process, the iris region is located along with pupil boundary. Segmentation is done using an Integro-differential operator. Iris and pupil boundaries are divided and normalization is performed. In normalization, pixels of iris are converted to a standardized dimension. The cartesian form of iris image is converted to polar form during normalization. As a result, a rectangular-shaped iris image is obtained.
3) *Segmentation verifIcation:* The segmented iris is verified to check if the segmentation process is done accurately or not. Texture features are analyzed and compared with the threshold value to check the accuracy of segmentation. If the iris is not segmented correctly, then the segmentation procedure is repeated until it locates the iris boundary accurately.
4) *Feature Extraction:* In this process, the unique patterns are observed in the iris image. Features like some particular frequency, intensities in an image are studied. The observed values are then converted to binary code called iris templates. Along with the template, a noise mask is generated. This mask contains the corrupted bits in the template.
5) *Matching:* Templates along with the mask are used to calculate the Hamming distance. The template is mapped with the iris image and is stored in the database. When a new image is given, the hamming distance is calculated for the new iris code and is compared with the stored one. In case of the same person, Hamming distance will result in 0, else it results in different values.

### A. Algorithms

1) *Integro-differential operator:*

It is applied to locate the iris boundary in the eye image. This algorithm can be considered as a circular edge detector for locating the iris boundary and pupil boundary. It is given by the following equation:

$$\max_{(r,x_0,y_0)} \left| G_\sigma(r) * \frac{\partial}{\partial r} \oint_{r,x_0,y_0} \frac{I(x,y)}{2\pi r} ds \right| \quad \text{- - - eqn (1)}$$

Where I (x, y) denotes the iris image,
r represents radius,
(x0, y0) is the center coordinate,
The symbol * denotes convolution,
G(r) acts as a Gaussian filter for smoothing of the image.
Initially, the min and max value of the radius is fixed, then the iris is searched to locate its center. This is done by line integrating and differentiating along with the image domain. A blurred image is obtained by a Gaussian filter. The maximum value of the blurred image is determined to locate the iris center. The operator is then applied again across this roughly located center by varying the radius and other parameters to locate the pupil region. As a result, iris inner and outer boundaries are detected.

2) *Log-Gabor filter:* The unique patterns are extracted as features using this filter. It helps in coding the image by viewing on a logarithmic frequency scale. It is given as:

$$G(f) = \exp \{- [\log (f / f_0) ]^2 / 2[\log (\sigma / f_0)]^2\} \quad \text{- - - eqn (2)}$$

Where $f_0$ denotes center frequency,
$\sigma$ represents the bandwidth of the filter
The encoding of features is done by convolution of normalized iris patterns with log-Gabor filter. The 2D normalized iris pattern is broken into ID signals. These signals are used in the convolution of Gabor filter. Each row in the 1D signal represents a circular ring of the iris images. After encoding, 2bit quantization is performed to generate the template of a particular length. These templates are stored for matching purposes.

3) *Hamming distance:* For matching the stored templates, a hamming distance is calculated. It represents the unique bits in the iris code. Hamming distance is calculated by performing XOR operation on the two-iris code to detect the similarity between them. If both the iris codes are the same, then the hamming distance will result is 0. It is given as:

$$HD = \frac{\|(I_1 \otimes I_2) \cap M_1 \cap M_2\|}{\|M_1 \cap M_2\|} \quad \text{---eqn (3)}$$

Where $I_1$and $I_2$ represents the iris code
$M_1$ and $M_2$ are the mask value
The symbol $\otimes$ denotes XOR operator
The XOR operation results in 0 for similar iris. For a given new image, its template value is compared with the hamming distance value of all the stored templates. A minimum Hamming distance value is considered for matching and verifying the iris.

## III. IMPLEMENTATION

The iris image is taken as input from an iris scanner or any dataset. The Graphical User Interface (GUI) is designed using a QT designer. The designed user interface provides an easy and effective communication for the admin to perform the recognition process. Python is used as a programming language for implementation work. An individual is identified by comparing it with the matching template. In case of matching, the system returns with a person name and ID. If there is no match, it displays a message showing not found. The GUI of the project is shown in Fig.2.


Fig.2 Login page

*A. Training*

Admin can log in to the system to perform the recognition process. Iris images of different people are obtained and stored in a file. During the registration process, these images are used to train the model. Admin can provide the person name while training the iris image. A unique ID is generated for each individual during the training process. Templates are generated for the iris code, which is stored in the folder. Fig.3 shows the registration process, where the image is selected from the folder to train the system.


Fig.3 Registration process

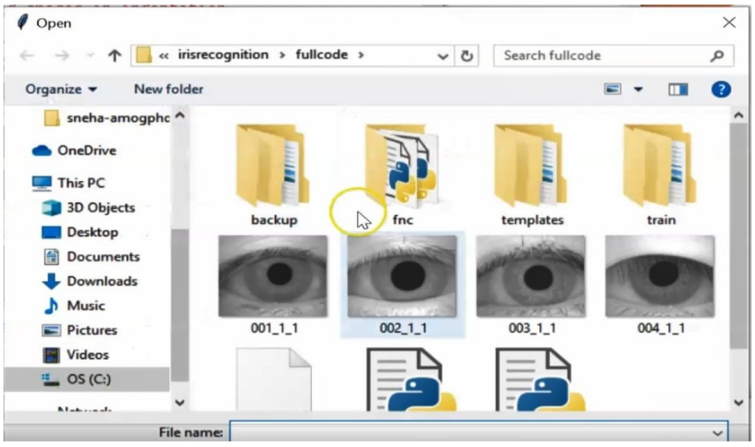


Fig.4 Selection of iris image

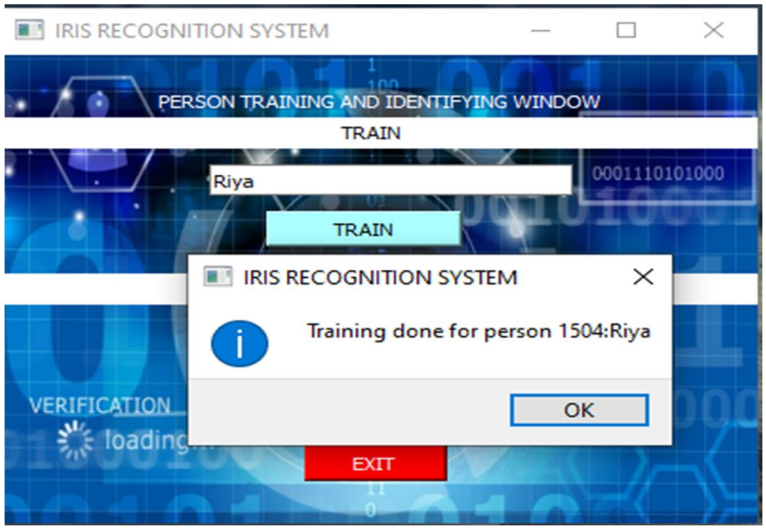


Fig.5 Completion of training

*B. Classification*

To verify the person, the iris image is taken and uploaded for classification. Iris code is generated for the given image as a template. This template is then compared with the stored templates and the minimum distance is considered as a matching factor. The system identifies the person if there is a match found, if not the iris has to be registered in the system. Fig.6 shows the classification process to verify the person. It includes the same procedure as training, i.e., selection of iris image Fig.4, generating the iris code for comparison.

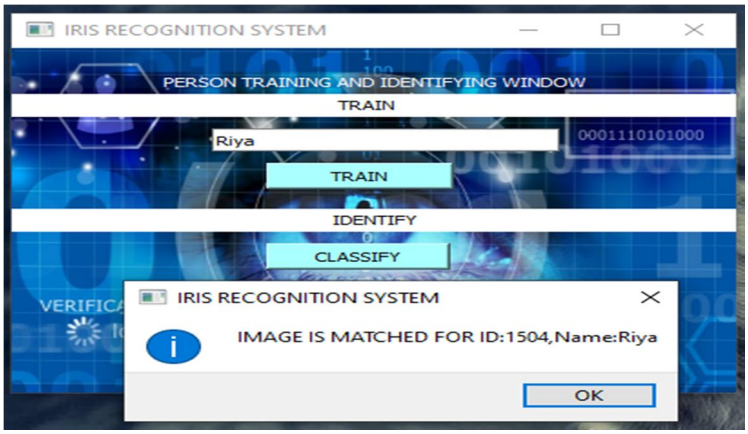


Fig.6: Result of classification

*C. Deletion*

The designed system provides an option for the admin to delete iris images. The registered iris images are selected which needs to be deleted and entire information regarding the person is deleted from the system. Fig.7 shows the deletion process. The Image is selected from the folder Fig.4 and is removed.


Fig.7 Deletion process


Fig.8 Iris image deleted

## IV. RESULTS

The designed system performance is measured by calculating the accuracy of the segmented iris image. The total number of correctly matched images are considered to calculate the accuracy of the system. It is given as,

Acc = matched *100.0 / Total trained images - - - eqn (4)

Amongst the total trained images, the accurately classified images are calculated. Depending on the number of correctly classified, accuracy is estimated. The designed model is trained for nearly 250 images, and the accuracy is obtained to be 97%. As the number of trained images increases, the accuracy seems to vary due to the similarities in the features. It has limitations over the person wearing glasses. In that case, iris is not clearly segmented which results in false identification.

## V. CONCLUSION

The main focus of our work is to propose a simple biometric system using iris as a characteristic feature. This work also helps in improving the segmentation process by verifying the segmented iris image. The proposed biometric system is a standalone app, which can be used only by the admin. The experiment results show the accuracy of just 250 images. Further work could be aiming towards designing a system that can identify a person even with the glasses on and improving the accuracy by testing on a larger dataset.

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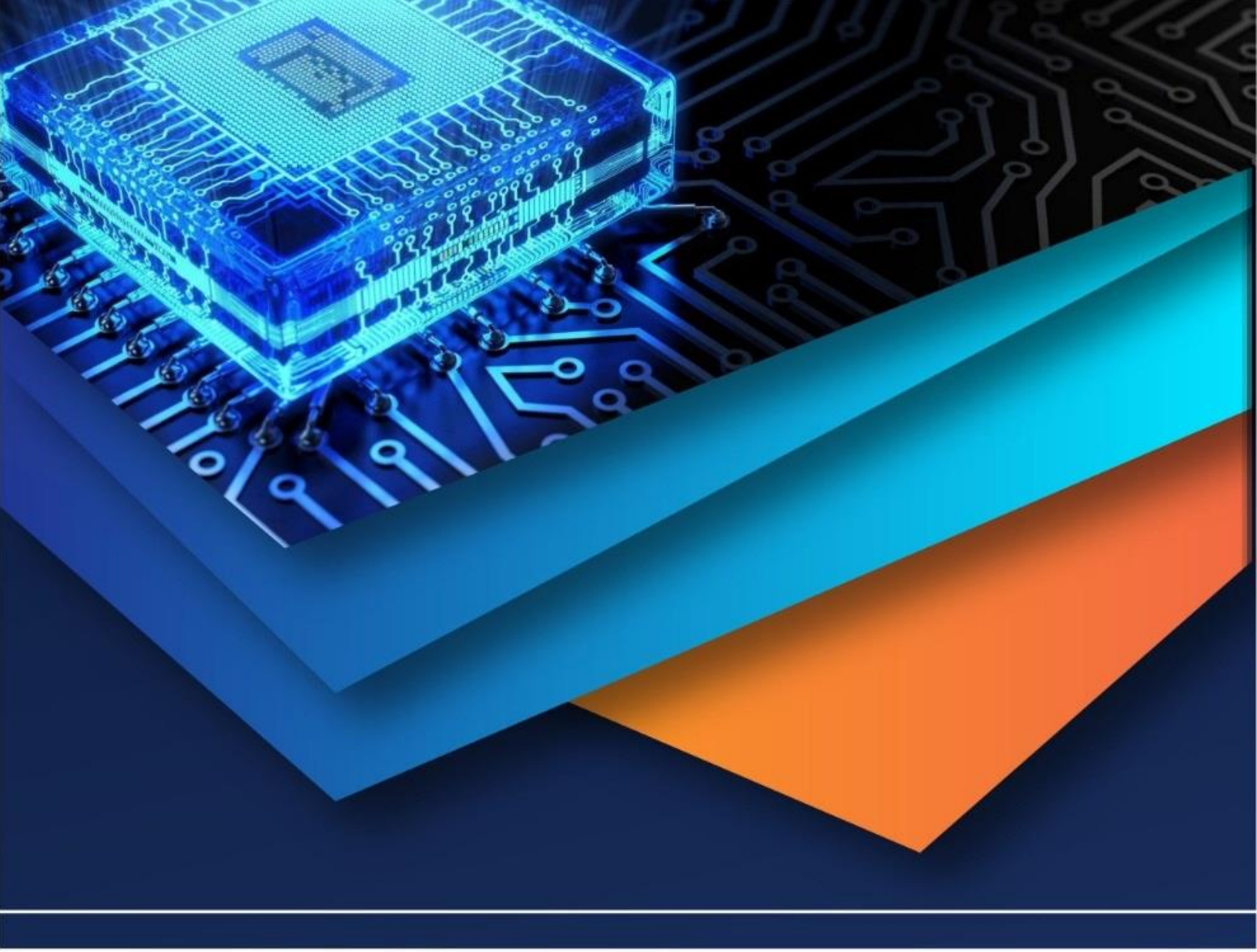

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