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Sparsity Inspired Selection and Recognition of Iris Images

1. *Dr K R Badhiti , Assistant Professor, Dept. of Computer Science,*
Adikavi Nannaya University, Rajahmundry, A.P, India
2. *Prof. T. Sudha, Dept. of. Computer Science, SPMVV, Tirupati*

***Abstract:**Today's computerized society requires high quality security for the citizens. Possessing pin or memorizing passwords may be lost or forgotten. Security is based using their morphological or behavioral traits which cannot be lost or forgotten. Thus Biometrics plays an important role in providing security to an authorized user and thus differentiating between an genuine person and an impostor. Though there are several biometric traits, this paper concentrates on Iris recognition since it is considered as the most reliable Biometric technology. Several other physiological biometric traits like face recognition, fingerprint, Hand geometry, retina and behavioral biometric traits like keystroke, signature and voice recognition have their own advantages and disadvantages. This paper explains various biometric technologies, their advantages and disadvantages and explains how Iris can be considered as the most reliable Biometric Technology. There are four stages in a typical personal identification system. They are Iris image acquisition, Iris Liveness detection, Iris image quality assessment and Iris Recognition. Iris Recognition includes Segmentation, Normalization, Feature Extraction and Matching. High Resolution cameras are used for image capturing, Iris liveness detection is explained basing on Red eye effect, Image quality assessment is done by noise removal using median filters. Hough transform is used to detect the iris and pupil boundaries in segmentation. In Normalization, Daugman's Rubber sheet model is used to transform the iris circular region to a rectangular region with a fixed size. The iris region is normalized from Cartesian coordinates to polar representation.1D Log gabor filters are used in feature extraction. Features are extracted from normalized iris image and the generated template is stored in a database. Hamming distance is used to compare iris templates in matching.*

***Keywords:** Liveness Detection, Median filters, 1D Log gabor filters, Hamming distance*

I. Introduction

Nowadays, the need for biometric authentication has become important. The process of identifying and authenticating the uniqueness of individuals based on morphological or behavioral traits is called Biometric Authentication. Biometrics are often used in a variety of fields where correct identification is imperative from computers to nuclear power plants, where different biometrics are used to control access to critical systems, as well as airlines, databases and other restricted sources. Airports are looking to biometrics access control technology to help address recent security breaches involving employees, which would help increase security for restricted areas. Fingerprints which are widely used may face problems like burns and bruises. Face changes over a period of time, even with the best algorithms face recognition has error rates of about 43 to 50%. Hand geometry is not distinctive enough to be used in large scale applications, hand written signatures can be forged. DNA is not unique among identical twins The iris is different for any two individuals even for identical twins. The iris is the pigmented elastic tissue that has adjustable circular opening in center of the eye. The accuracy of iris identification systems is proven to be much higher compared to all other biometric modalities. Iris identification will be explained in detail in the next section.

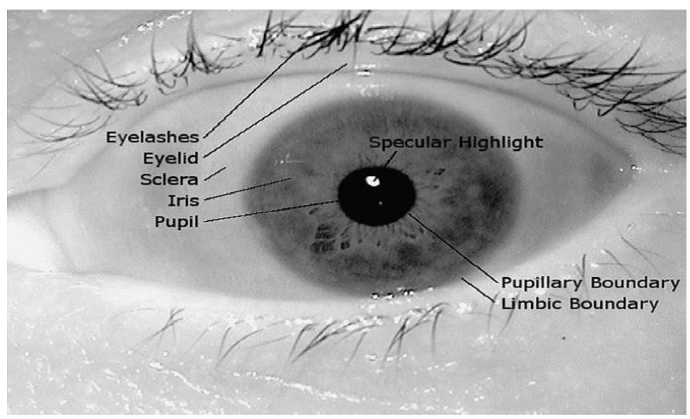

Figure 1: Structure of Iris

II. Implementation

In general, A typical iris identification system consists of four stages[3]:

2.1. Iris image Acquisition.

2.2. Iris liveness detection.

2.3. Iris image quality assessment.

2.4. Iris recognition.

2.1. Iris image Acquisition:

The first step of the iris identification system is image acquisition. This step is very complicated because the size and color of iris of every person is different. For example, recognition of iris images of poor quality, nonlinearly deformed iris images, iris images at a distance, moving iris images, and faked iris images all are open problems in iris recognition. As this technology is expensive and we need a video camera with NIR illumination for the infrastructure, most of the researchers go for some existing iris databases to implement Iris recognition. Examples of some existing iris databases are CASIA [15] and UBIRIS. In this system, UBIRIS database is used for iris images[5].

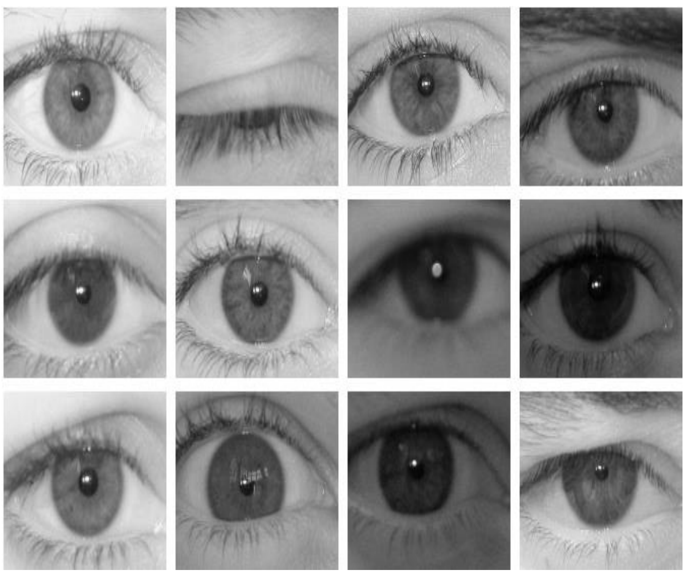

Figure 2: Sample images from UBIRIS database

2.2. Iris Liveness Detection:

Liveness Detection is an anti-spoofing strategy for fighting against impostors[2]. Iris liveness detection can be done using physiological and optical characteristics of human iris. Eye blink is a physiological activity of closing and opening eyelids which can be used for both face and iris liveness detection. Iris Liveness can be identified by Red eye effect, Pupil dilations[6]. Red eye effect is the common appearance of red pupils in color photographs of eyes. It occurs when we use a photographic flash very close to the camera lens in ambient low light. The Pupil is in the state of rhythmic contraction and dilation called hippus. Active illuminators are usually employed in iris cameras to cause significant pupil movements or constriction[7]. Usually, Pupil size increases in a dark environment and decreases in a bright environment. Each measurement registers the spontaneous pupil oscillations and its reaction after increasing the intensity of visible light.

2.3. Iris image quality Assessment

In Quality assessment, all the acquired images are not clear, suitable, and sharp enough for recognition. Iris region is occluded largely by eyelashes and eyelids, when the eye is partially opened. Image Quality can also be enhanced by preprocessing. Image preprocessing involves noise removal and identifying the portion occluded by eye lashes.

Noise will be removed by Median filters which is a non linear digital filtering technique. They replace the central gray value in an 20*20 window by the median of the sorted pixel values. Median filtering reduces noise without blurring edges and other sharp details[3].

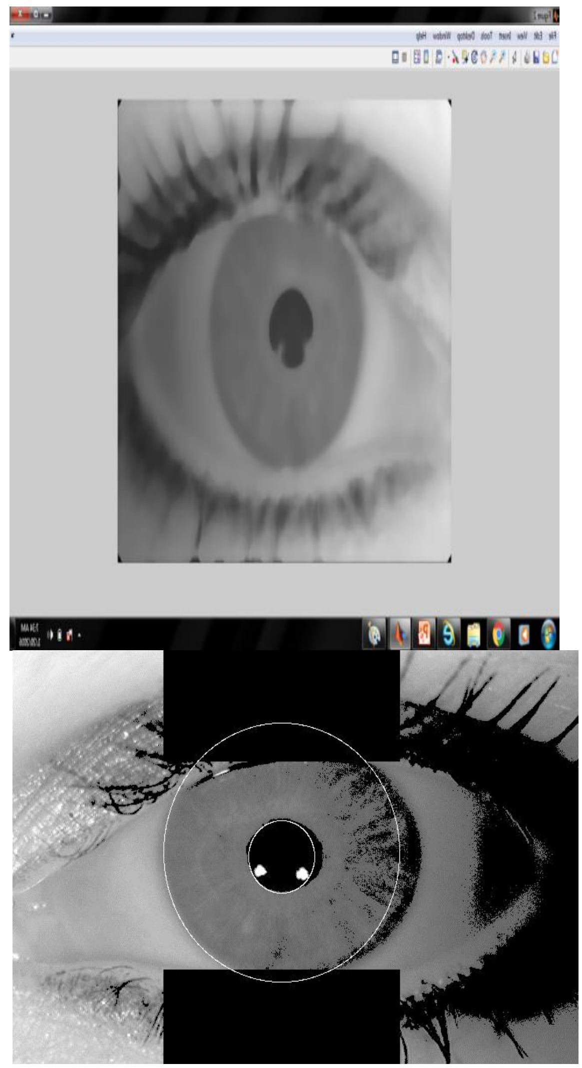

Figure 3: Results of a) Median filters b) After removing Noise.

2.4. Iris Recognition

Again Iris recognition includes four steps:

i. Segmentation (localization).
ii. Normalization.
iii. Feature Extraction.
iv. Matching.

Segmentation

Segmentation is also known as Localization. The first stage of iris recognition is to isolate the actual iris region in a digital eye image. Iris localization is the detection of the iris area between pupil and sclera[1]. Circular Hough transform is used to identify the radius and center of iris. The Hough transform for the iris/sclera boundary was performed and then Hough transform for the iris/pupil boundary was performed within the iris region, unless the whole eye region. After this process was complete, six parameters are stored, the radius, and center coordinates for both circles.

Normalization

Once the iris region is localized from an eye image, the next step is to transform the iris region so that it has fixed dimensions in order to allow comparisons [12]. Daugman's rubber sheet model was employed to unwrap the iris region to a rectangular block of texture. Since the pupil can be non-concentric, a remapping formula is necessary to rescale points depending on the angle around the circle. This is given by

$$r' = \sqrt{\alpha}\beta \pm \sqrt{\alpha\beta^2 - \alpha - r_I^{\,2}}$$

with

$$\alpha = o_x^2 + o_y^2$$

$$\beta = \cos\left(\pi - \arctan\left(\frac{o_y}{o_x}\right) - \theta\right)$$

where

o_x, o_y = Displacement of the center of the pupil relative to the center of the iris.

r' = Distance between the edge of the pupil and edge of the iris.

θ = Angle between edge of the pupil and edge of the iris(around the region).

r_I = Radius of the iris.

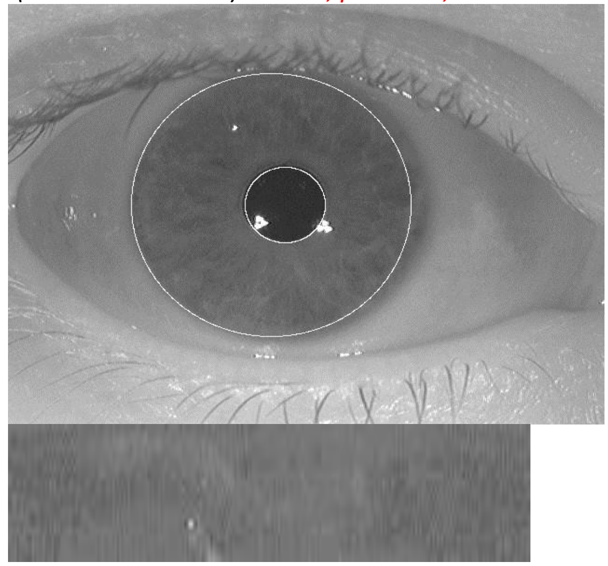

Figure 4: Results a) Segmentation b) Normalization

Feature Extraction:

Feature Extraction is a special kind of Dimensionality reduction and contains more information about the original image. It is the crucial stage of the whole iris recognition process for personal identification. Features are extracted using the normalized iris region. In order to provide accurate recognition of individuals, the most discriminating information present in iris have to be extracted. Only the significant features of the iris must be encoded so that comparisons between templates can be made. The iris contains important unique features, such as stripes, coronas, freckles etc. These features are collectively called as the texture of iris. These features are extracted using Gabor Wavelets. Feature encoding was done by convolving the normalized iris pattern with1D Log-Gabor wavelets. The rows of the 2D normalized pattern are used as the 1D signal, each row corresponds to a circular ring on the iris region. The encoding process delivers a bitwise template containing a number of bits of information.

01 00 00 10 11 11 01 01 00 10 10 11 11 01 01 00 10 10 11 01 01 01 01 01 00
10 10 01 11 00 01 11 10 11 10 10 00 10 01 10 00 11 01 10 11 00 01 01 11 10

Figure 4: Result of Feature Extraction

Matching:

Hamming distance was chosen as a metric for Matching, since bit-wise comparisons were needed. It will be calculated using only the bits generated from the true iris region. The Hamming distance formula is given as

$$HD = \frac{1}{N - \sum_{k=1}^{N} Xn_k (OR) Yn_k} \sum_{j=1}^{N} X_j (XOR) Y_j (AND) Xn'_j (AND) Yn'_j$$

where

Xj, Yj= two bit-wise templates to compare.

Xn_j Yn_j = Noise masks for Xj and Yj respectively.

N = Number of bits represented by each template.

If the hamming distance between two irises is less than the threshold, then they are from the same eye otherwise not.

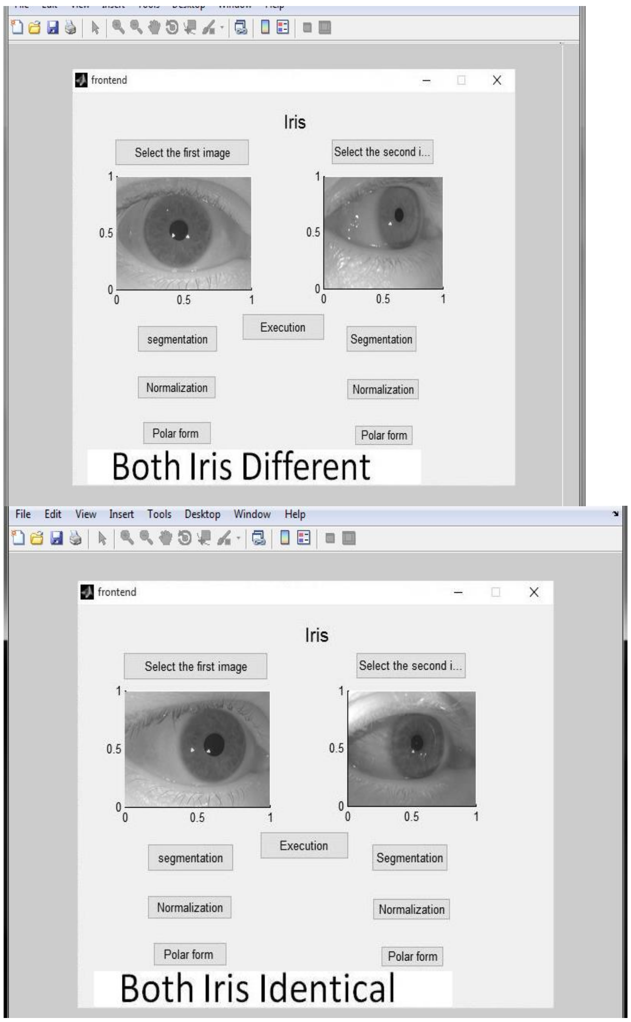

Figure 5: Result(s) of Matching

CONCLUSION:

Firstly, an automatic segmentation algorithm was used, which would localize the iris region from an eye. Next, the segmented iris region was normalized to eliminate dimensional inconsistencies by implementing a version of Daugman's rubber sheet model, where the iris is unwrapped into a rectangular block with constant polar dimensions. The Hamming distance was chosen as a matching metric, which gave a measure of how many bits disagreed between two templates. With the advancement of technology, more research work has to be done in the area of iris liveness detection and multimodal biometrics as it results in high accuracy and more reliability. Spoofing multi biometric traits of the same person may be difficult. Hence, it results in more accuracy and reliability.

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