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Iris Recognition System: A Survey

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***Abstract*— Iris recognition has been done by many researchers in last many decades. Iris recognition plays an important role to improve efficiency in biometric identification system due to its reliability in highly secured areas. Such as In Airports And Harbors, Access Control In Laboratories And Factories traditional issue is focused on full fingerprint images matching and face detection are used for identification of humans, but iris recognition system is more reliable and gives more accurate results for the identification. Iris recognition works on pattern recognition. The iris is an externally visible, yet protected organ whose unique epigenetic pattern remains stable throughout adult life. These characteristics make it very attractive for use as a biometric for identifying individuals. In iris recognition the signature of the new iris pattern is compared against the stored pattern after computing the signature of new iris pattern and identification is performed. This paper discusses different techniques used for Iris Recognition.**

***Index Terms*— Iris Detection, Bio-metric Identification, Segmentation, Pattern Recognition and Edge Detection**

I. INTRODUCTION

All these biometric identification technique, iris recognition is most prominent technique. Iris recognition systems [13] are gaining interest because it is stable over time. Iris scan has been developing an identification/verification system capable of positively identifying and verifying the identity of individuals. The unique patterns of the human iris, used for overcoming previous short comings. The iris indicates the color part of the human eye. It is a circular membrane of the former face of the ocular sphere. It is pierced with a black hole called the pupil which allows the light penetration to the retina. The iris is used to adapt this light quantity by papillary dilation or constriction. The iris is a combination of several elements. It is richest distinctive textures of the human. The pigment accretion can continue in the first postnatal years. The complex pattern of iris has many distinctive features such arching, zigzag collarets, ligaments, furrows, rings corona, ridges, crypts, freckles. This Iris stored an unique information in the form of objective mathematical representation, this will make a biometric template, it allows comparisons to be made between templates. A subject to be identified by Iris recognition system [12], then take a picture of eye and make a template of its iris region, then compared the template with other stored template in a database, when matching has been done if template is found it means subject is identified, or if no match is found and the subject remains unidentified.

Databases of enrolled templates are searched by matcher engines at speeds measured in the millions of templates per second per (single-core) CPU, and with infinitesimally small false match rates. Many millions of persons in several countries around the world have been enrolled in iris recognition systems, for convenience purposes such as passport-free automated border-crossings, and some national ID systems based on this technology are being deployed. A key advantage of iris recognition, besides its speed of matching and its extreme resistance to false matches is the stability of the iris as an internal, protected, yet externally visible organ of the eye. An iris-recognition algorithm first has to localize the inner and outer boundaries of the iris (pupil and limbus) in an image of an eye. Further subroutines detect and exclude eyelids, eyelashes, and specular reflections that often occlude parts of the iris. The set of pixels containing only the iris, normalized by a rubber-sheet model to compensate for pupil dilation or constriction, is then analyzed to extract a bit pattern encoding the information needed to compare two iris images. In the case of Daugman's algorithms, a Gabor wavelet transform is used. The result is a set of complex numbers that carry local amplitude and phase information about the iris pattern [10]. In Daugman's algorithms, most amplitude information is discarded, and the 2048 bits representing an iris pattern consist of phase information (complex sign bits of the Gabor wavelet projections). Discarding the amplitude information ensures that the template remains largely unaffected by changes in illumination or camera gain (contrast), and contributes to the long-term usability of the biometric template [1]. For identification (one-to-many template matching) or verification (one-to-one template matching), a template created by imaging an iris is compared to stored template(s) in a database. If the Hamming distance is below the decision threshold, a positive identification has effectively been made because of the statistical extreme improbability that two different persons could agree by chance ("collide") in so many bits, given the high entropy of iris templates.

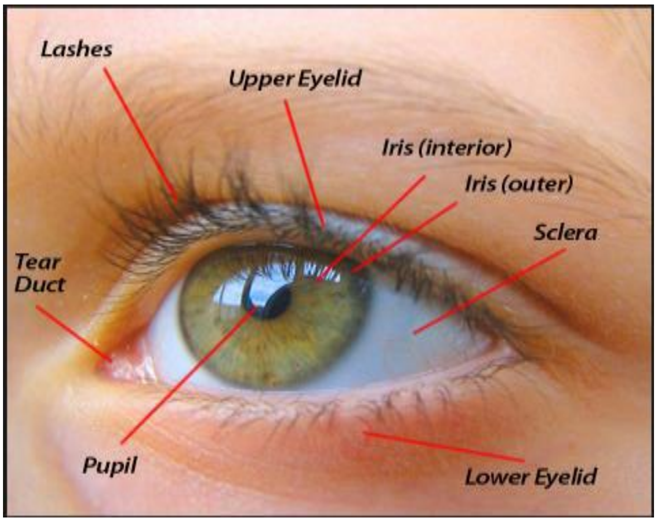

Figure 1: An Eye Anatomy

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II. GENERAL ARCHITECTURE

The problem was whether the algorithms involved could be executed in real time on a general-purpose microprocessor. In the process of recognition these question were resolved and a working model was presented by Daugman [13]. The Daugman's work divides in four main parts. Fig. 2 shows block diagram for a biometric system of iris recognition in unconstrained environments in which each block's function is briefly discussed as follows:

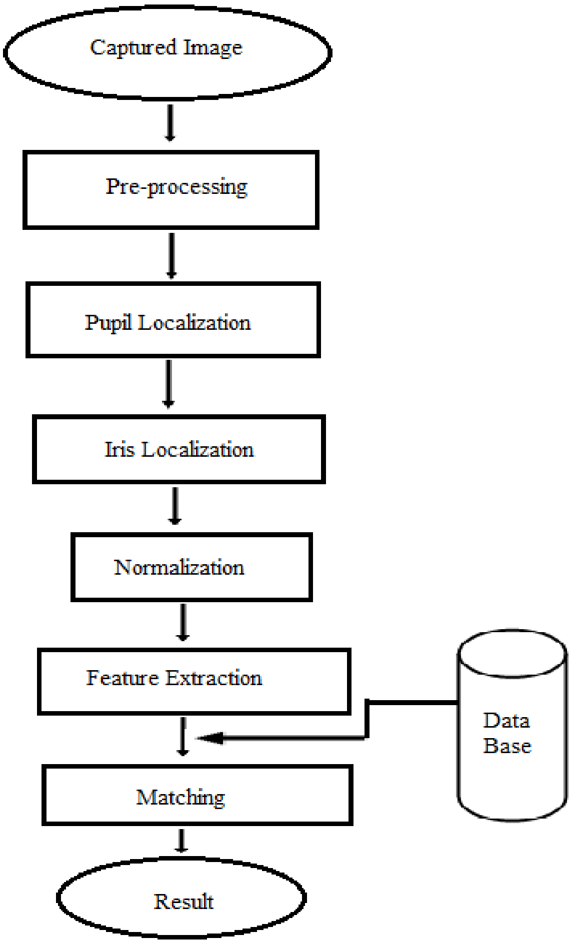

Figure 2: Iris Recognition System

SEGMENTATION

The first part of iris detection is to isolate or localize the actual iris region from the digital eye image. The iris region can be thought of as two circles, one circle forming the iris/sclera boundary and the other forming the iris/pupil boundary. Eyelids and eyelashes are also present which usually cover the upper and lower parts of the iris region. Specular reflections can also occur inside the iris region which may corrupt the iris pattern. So the technique used must be able to exclude these noises and localize the circular iris region.

The degree to which the segmentation applied succeeds will greatly depend on the data set being used. Images where specular reflection occurs can hamper the process of segmentation. If the eyelids and eyelashes cover too much of the iris region then the segmentation process may not result in a success. The segmentation process is very critical as data that has been localized incorrectly will result in very poor detection rates. To speed iris segmentation [9], the iris has been roughly localized by a simple combination of Gaussian filtering, canny edge detection and Hough transform.

where I(x, y) is the eye image, r is the radius to search for, $G\sigma(r)$ is a Gaussian smoothing function, and S is the contour of the circle given by r, x0, y0. The operator searches for the circular path where there is maximum change in pixel values, by varying the radius and centre x and y position of the circular contour. The operator is applied iteratively with the amount of smoothing progressively reduced in order to attain precise localize.

$$\max_{r,x_0,y_0} \left| G_{\sigma(r)} * \frac{\partial}{\partial r} \oint \frac{I(x,y)}{2\pi r} ds \right|$$

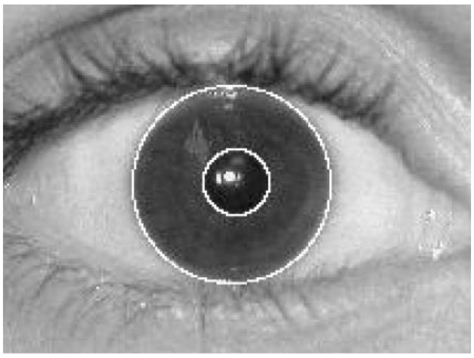

Figure 3: 1 localized image

Normalization

On having successfully segmented the eye image, the next step is to transform the iris region of the eye image so that it has fixed dimensions in order to allow the feature extraction process to compare two images. Dimensional inconsistencies may arise in eye images mainly due to dilation of the pupil which causes the stretching of the iris. Pupil dilation usually occurs due to varying levels of illumination falling on the eye. The other causes of inconsistency are, varying imaging distance, camera rotation, head tilt, and rotation of the eye within the socket. The normalization process [8] will produce iris regions having constant dimensions such that two images of the same iris taken at different conditions and time will have the same characteristics features at the same locations spatially.

Daugman's rubber sheet model: Daugman suggested normal Cartesian to polar transformation that maps each pixel in the iris area into a pair of polar coordinates (r,θ.). where r and θ are on the intervals [0,1] and [0,2π], this proposed method is known as Daugman's rubber sheet model. The unwrapping can be formulated as:

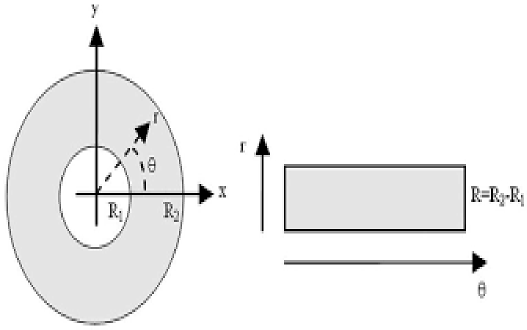

Figure 4: Daugman's Rubber Sheet Model

Feature Extraction

In our system, characteristic information from the iris is extracted by filtering the normalized iris region. This filtering is performed by convolution with a pair of Gabor filters. We also extract and store information about noise position in this stage. So, the iris code is formed by some characteristic information extracted from normalized iris filtered by convolution (a pair of resulting images) and a Boolean mask representing the position of noisy pixels [11].

A Gabor filter is a sine (or cosine) wave modulated by a Gaussian. This kind of filters optimally extracts information in space as well as in frequency domain. To extract iris features we designed two Gabor filters. First filter is a sine wave modulated by a Gaussian.

Second is the same as first but using a cosine wave. In these filters, the central frequency of the filter is specified by the sine (or cosine) wave frequency and bandwidth varies as Gaussian width does. At implementation level, each filter must be a matrix.

Iris Matching

Duagman's use hamming distance a matching metric developed by him, and calculation of the Hamming distance is taken only with bits that are generated from the actual iris region.

The matching algorithm consists of all the image processing steps that are carried out at the time of enrolling the encoded iris template in database. Once the bit encrypted bit pattern B' corresponding to binary image formed is extracted, it is tried to match with all stored encrypted bit patterns B using simple Boolean XOR operation [2]. The dissimilarity measure between any two iris bit patterns is computed using Hamming Distance (HD) which is given as,

$$HD=\frac{1}{N}\sum_{j=1}^{N} X_j (XOR)\, Y_j$$

Where, N is the total number of bits in each bit pattern. As HD is a fractional measure of dissimilarity with 0 representing a perfect match, a low normalized HD implies strong similarity of iris codes.

III. ADVANTAGES AND DISADVANTAGES

The iris of the eye has been described as the ideal part of the human body for biometric identification for several reasons:

1. It is an internal organ that is well protected against damage and wear by a highly transparent and sensitive membrane (the cornea). This distinguishes it from fingerprints, which can be difficult to recognize after years of certain types of manual labor.
2. The iris is mostly flat, and its geometric configuration is only controlled by two complementary muscles (the sphincter pupillae and dilator pupillae) that control the diameter of the pupil [14]. This makes the iris shape far more predictable than, for instance, that of the face.
3. The iris has a fine texture that—like fingerprints—is determined randomly during embryonic gestation. Like the fingerprint, it is very hard (if not impossible) to prove that the iris is unique. However, there are so many factors that go into the formation of these textures (the iris and fingerprints) that the chance of false matches for either is extremely low. Even genetically identical individuals have completely independent iris textures.
4. An iris scan is similar to taking a photograph and can be performed from about 10 cm to a few meters away. There is no need for the person being identified to touch any equipment that has recently been touched by a stranger, thereby eliminating an objection that has been raised in some cultures against fingerprint scanners, where a finger has to touch a surface, or retinal scanning, where the eye must be brought very close to an eyepiece (like looking into a microscope.

Many commercial iris scanners can be easily mislead by a high quality image of an iris or face in place of the ideal thing.

1. The scanners are often tough to adjust and can become bothersome for multiple people of different heights to use in succession.
2. The accuracy of scanners can be affected by changes in lighting.
3. Iris scanners are significantly more expensive than some other forms of biometrics, password or prox-card security systems.
4. Iris scanning is a relatively new technology and is incompatible with the very substantial investment that the law enforcement and immigration authorities of some countries have already made into fingerprint recognition.
5. Iris recognition is very difficult to perform at a distance larger than a few meters and if the person to be identified is not cooperating by holding the head still and looking into the camera.
6. As with other photographic biometric technologies, iris recognition is susceptible to poor image quality, with associated failure to enroll rates. As with other identification infrastructure (national residents databases, ID cards, Adhar cards etc.), civil rights activists have voiced concerns that iris-recognition technology might help governments to track individuals beyond their will.

IV. CONCLUSION

The iris recognition system that was developed proved to be a highly accurate and efficient system that can be used for biometric identification. Iris recognition is one of the most reliable methods available today in biometrics field. The accuracy achieved by the system was very good and can be increased by the use of more stable equipment and conditions in which the iris image is taken. The applications of the iris recognition system are innumerable and have already been deployed at a large number of places that require security or access control. In this review paper it has been shown how a person can be identified by a number of ways but instead of carrying bunk of keys or remembering things as passwords we can use us as living password, which is called biometric recognition technology it uses physical characteristics or habits of any person for identification. In biometrics a number of characteristics have been used in recognition technology as fingerprint, palm print, signature, face, iris recognition, thumb impression and so on but among these irises recognition is best technology for identification of a person.

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