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Segmentation and Normalization of Human Iris as Biometrics Identifier

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Abstract:
The iris recognition is a kind of the biometrics technologies based on the physiological characteristics of individual, compared with the trait recognition based on the fingerprint, palm-print, appearance and echo etc, the iris has some advantages such as individuality, permanence, high detection rate, and non-infringing etc. Iris recognition is an automatic method of identifying persons that uses geometric model detection techniques on images of the iris in person's eyes. The performance of the iris recognition systems depends on segmentation and normalization techniques. In this paper, we are discussing the various techniques they are Daugman's algorithm technique, multi-scale extraction technique and Gabor technique.

Keywords: Daugman's Algorithm, Gabor filter, Iris Recognition, Iris segmentation, Multi-scale Edge Detection

I. INTRODUCTION

Iris recognition is a biometric recognition technology that utilizes the pattern recognition techniques based on the high quality images of iris. Typical iris recognition system consists of mainly three modules. They are image acquisition, preprocessing stage and edge detection. Image acquisition is a module which involves the capturing of iris images with the help of sensors. Pre-processing section provides the resolve of the boundary of iris within the eye representation, and then extracts the iris section from the image in order to facilitate its processing. It involves the stages like iris segmentation, iris normalization, image development etc. Edge detection systems like boundary as well as the edge detection have been provided with much advancement but optimal accuracy. Thus, there is a strong need to develop a new segmentation approach that is more reliable as well as robust.The image acquisition deals with capturing sequence of iris images from the subject using cameras and sensors. An image acquisition consists of illumination, position and physical capture system. Preprocessing involves various steps such as iris detection, pupil and iris boundary detection, eyelid detection and removal and normalization. Iris detection differentiates subject from a photograph, a video playback, a flute eye or additional artifacts. It is possible that biometric features are forged and illegally used. Edge detection identifies the most prominent features for categorization. Some of the features are x-y coordinates, radius, shape and size of the novice, intensity values, direction of the pupil ellipse and ratio between average intensity of two pupils. The features are encoded to a format suitable for recognition.

II. BACKGROUND THEORY

Iris patterns are formed by combined layers of pigmented epithelial cells, muscles for con-trolling the pupil, stomal layer consisting of connective tissue, blood vessels and an anterior border layer [1] [8]. The physiological complexity of the organ results in the random patterns in iris, which are statistically unique and suitable for the biometric measurements [7]. In addition, iris patterns are stable over time and only minor changes happen to them throughout an individual's life [3]. It is also an internal organ, located behind the cornea and aqueous humor, and well protected from the external environment. The characteristics such as being protected from the environment and having more reliable stability overtime, compared to other popular biometrics, have well justified the ongoing research and investments on iris recognition by various researchers and industries around the world. For instance, the developed algorithm by Daugman [7], which is known as the state-of-the-art in the field of iris recognition, has initiated huge investments on the technology for more than a decade. The history of iris recognition goes back to mid 19th-century when the French physician, Alphonse Bertillon, studied the use of eye color as an identifier [2]. However, it is believed that the main idea of using iris patterns for identification, the way we know it today, was first introduced by an eye surgeon, Frank Burch, in 1936 [6]. In 1987, two ophthalmologists, Flom and Safir, patented this idea [3] and proposed it to Daugman, a professor at Harvard University, to study the possibility of developing an iris recognition algorithm. After a few years of scientific experiments, Daugman proposed and developed a high confidence iris recognition system and published the results in 1993 [7]. The proposed system then evolved and achieved better performance in time.

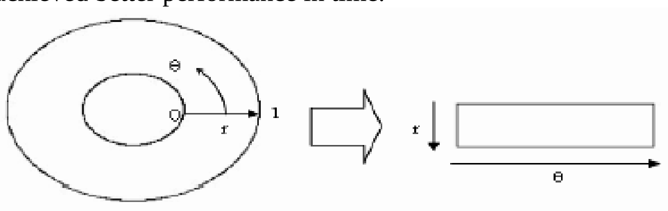

Figure.1. Daugman's rubber sheet model shows how a circular shape (iris) can be normalized into definite (rectangular) template of iris patterns [4].

The overall performance of an iris recognition system relies on the performance of its subsystems. The qualities of the image acquisition, segmentation, normalization and feature encoding, altogether, define the performance of the system. The main objective of the study is to provide an automated segmentation and normalization system based on Daugman's rubber-sheet model using Hough Circles and Canny edge detection techniques on iris images to create a highly accurate pre - requisite for matching algorithms in order to build an efficient and reliable iris recognition system and to test it on CASIA database.

III.METHODOLOGY

It is the process of acquiring high definition iris images either from iris scanner or pre-collected images. These images should clearly show the entire eye especially iris and novice part. Then main steps are followed.

Segmentation: A technique is required to isolate and exclude the artifacts as well as locating the spherical iris section. The inner and the outer margins of the iris are calculated. This operation improves the contrast between each eye regions which potentially will facilitate the segmentation task.

Normalization: Iris of different people may be captured in dissimilar size, for the same individual also size may differ because of the variation in illumination and further factors. The normalization method will make iris region, which have the same unvarying proportions, so that two photographs of the same iris under dissimilar situation will have Characteristic features at the same spatial location.

Feature extraction: The significant features of the iris must be encoded so that comparisons between templates can be ended. Most iris detection systems make utilize of a band pass decomposition of the iris image to create a biometric template. Iris provides abundant consistency in sequence. A characteristic vector is created which consists of the ordered sequence of features extracted from the various representations of the iris images.

Matching of an Image: To authenticate via identification (one-to-many pattern matching) or verification (one to- one pattern matching), a pattern created by imaging the iris is compared to a stored value template in a database. If the Hamming distance is below the assessment threshold, a positive detection has effectively been completed e.g. a hamming distance of 0 would result in a perfect contest.
The techniques used for iris recognition are explained as under:

A) Daugmans Algorithm Method: Daugman's algorithm is based on applying an integro-differential operator to find the iris and novice shape. Iris detection begins with finding an iris in an image, demarcating its inner and outer boundaries at the pupil and sclera, detecting the upper and lower eyelid boundaries if they occlude, and detecting and excluding any superimposed eyelashes or reflections initiation the cornea. This process could collectively be called segmentation. The algorithm is done twice, first to get the iris contour then to get the pupil contour. The illumination inside the pupil is a perfect circle with very high intensity level. Therefore, we have a problem of sticking to the illumination as the maximum rise circle. So a minimum pupil radius must be set. Another issue here is 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 lighting. Hence, while scanning the picture individual should take care that a very bright spot value could deceive the operator and can result in a maximum gradient. This simply means failure to localize the pupil. The integro-differential operator is proposed to ignore all circles if any pixel on this circle has a value higher than a certain threshold. For instance, if the threshold is determined to be 200 for the grayscale representation it will ensure that only the intense spots values usually higher than 245 will be cancelled. The iris outer boundary localization, the proposed method selects two search regions to detect upper and lower eyelids. The upper and lower search regions are labeled. The pupil centre, iris inner and outer boundaries are used as reference to select the two search regions. The search regions are confined within the inner and outer boundaries of the iris. The width of the two search regions is same with diameter of the pupil.

B) Multi-scale Edge Detection Technique: The edge separates two different regions, an edge point is a point where the local intensity of the image varies rapidly more rapidly than in the neighbor points which are close from the edge: such a point could therefore be characterized as a local maximum of the gradient of the image intensity. The problem is that such a characterization is to be applied to differentiable images. Multi-scale edge detection can be formalized through a wavelet transform. The resolution of an image is directly related to the appropriate scale for edge detection. High resolution and a small scale will result in noisy and discontinuous edges; low resolution and a large scale will result in undetected edges. The scale controls the significance of edges. Edges of higher significance are more likely to be preserved by the wavelet transform across the scales. Edges of lower significance are more likely to disappear when the scale increases. The method of multi-scale edge detection is used to find the edges. This wavelet is non sub sampled wavelet decomposition and essentially implements the discretized gradient of the image at different scales. To detect the iris and pupil boundaries an edge map has been detected first by using a multi-scale edge detection. Eyelids and eyelashes are isolated from the detected iris image by considering them as noise because they degrade the performance of the system. The eyelids are isolated by first fitting a line to the upper and lower eyelid using the linear Hough transform. A horizontal line is then drawn which intersects with the first line at the iris edge that is closest to the pupil. A second horizontal line allows the maximum isolation of eyelid regions. A multi-scale edge detection is then used to create the edge map and only the horizontal gradient information is taken. If the greatest in the Hough freedom is lesser than a set threshold, then no procession is fixed, since this corresponds to the eyelids. Also, the lines are restricted to lie exterior to the pupil region and interior to the iris region.

Gabor Technique: The human iris is located between the pupil and the sclera, has a complex pattern determined by the chaotic morphogenetic processes during emergent improvement. The iris model is unique to each person and to each eye, and is essentially stable during an entire duration. In addition, an iris image is characteristically captured using anon-contact imaging apparatus, of great significance in realistic applications. These reasons make iris detection a strong technique for personal identification. Gabor filters to the iris image for extracting phase features, known as the Iris Code. Using an 2D wavelet transform at various resolution levels of concentric circles on the iris image. They characterize the consistency of the iris with a zero-crossing representation. The bank of spatial filters, with kernels that are suitable for iris recognition to represent the local texture features of the iris. The only work in literature that makes use of boosting for iris recognition is. Instead of Gabor phasors, ordinal measures are used for iris representation. There are however too many parameters that need tuning when using ordinal measures, and to construct and optimal classifier is a difficult problem. The authors suggest the use of similarity oriented boosting. Iris is a muscle within the eye size of the pupil, calculating the amount of illumination that enters the eye. It is the colored Portion of the eye. The iris is the most unique identifier on the human body. Iris is a muscle within the eye size of the Pupil, calculating the quantity of light that enter the eye. It is the highlighted segment of the eye. The iris is the most unique identifier on the human body. Iris recognition has become the major recognition technology since it is the most reliable form of biometrics. Iris pattern are single and constant, still over a long phase of time. Additionally, iris canning and detection systems are very user-friendly. During recognition the scanned iris is on a smart card. Biometric identification utilizes physiological and behavioral characteristics to authenticate a people uniqueness. Some common physical individuality that may be Iris recognition is the Process of recognizing a person by analyzing that random pattern of automated method of iris recognition is relatively young. The used for identification include fingerprints, palm prints, dispense geometry, retinal patterns and iris patterns. Behavioral individuality include name, quality pattern and keystroke dynamics.

Recognition Process Stages:

A) Image acquisition: This step is one of the most important and deciding factors for obtaining a good effect. A good and clear representation eliminates the method of noise removal and also helps in avoiding errors in calculation. In this case, computational errors are avoided due to absence of reflection, and because the images have been taken from close proximity. These images were taken solely for the purpose of iris recognition software research and performance. Infra-red light was used for informative the eye, and hence they do not involve any specular reflections. Several parts of the calculation involve removal of errors due to reflections in the image.

B) Image Pre-Processing: Due to computational ease, the image was scaled down by 60%. The image was filtered using Gaussian filter, which blur the picture and reduces effect due to noise. The quantity of smoothening is decided by the standard deviation. The gradient image is along the boundary of circles of rising radii. From the probability of all circles, the utmost sum is intended and is used to find the circle centers and radii.

C) Iris Localization:
The part of the eye carrying information is only the iris component. It is the deception between the sclera and the pupil. Hence the next step is sorting out the iris component from the eye image. The iris inner and outer limitations are located by finding the edge image using the Canny edge detector. The thresholding for the eye image is performed in a vertical track only, so that the power due to the eyelids can be concentrated. This reduces the pixels on the round edge, but with the use of Hough transform, successful localization of the edge can be obtained even with the absence of few pixels.

IV.RESULTS

The results obtained from segmentation and normalization process are discussed in this section along with the implementation of a new Graphical User Interface in MATLAB.

A. Output 1: the user-interface designed in MATLAB
The designed user interface for Iris Image Segmentation and Normalization in MATLAB is shown in Fig.2.

B. Output 2: the original input image
The original input image is shown in Fig.3. The image is selected by clicking in the "**Select Image**" button on the GUI and the output is shown as under.

Output 3: the detection of pupil and iris boundary
The output image after detection of Pupil and Iris boundary of the selected original input image for Iris Image Segmentation and Normalization in MATLAB. This is done by using hough circles. The detected boundaries are shown using circles of white borders in the Fig. 4.

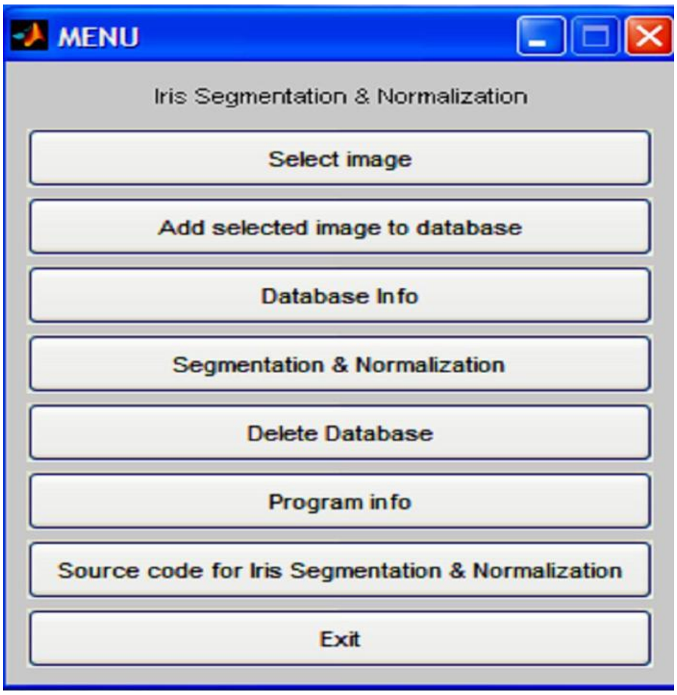

Figure .2. Matlab user-interface for iris segmentation and normalization.

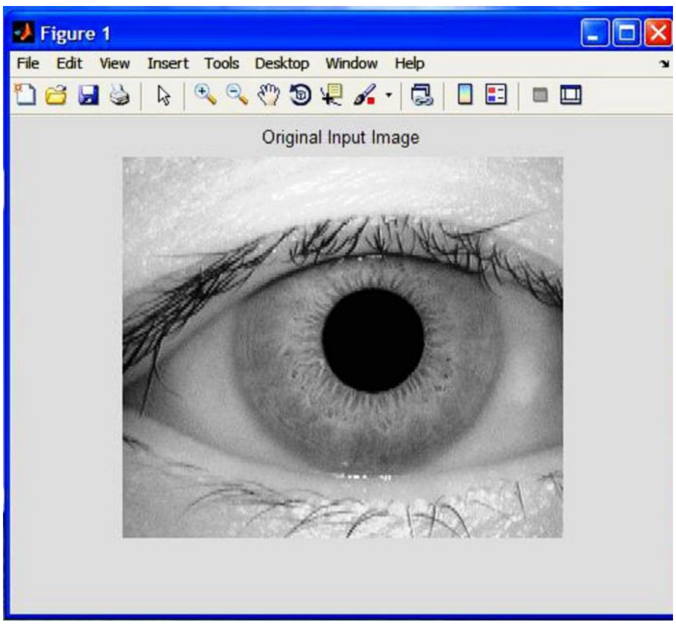

Figure .3. The input iris image to be processed.

Output 4: the edge detection of eyelids and iris

The output image edge detection of the selected original input image for Iris Image Segmentation and Normalization in MATLAB (Fig, 5). This is application of canny edge detection.

Output 5: top and bottom eyelid segmentation

The output segmented image after detection of Pupil and Iris boundary with top and bottom eyelid detection. This function is important as it removes the intruding eyelids over the detected iris region of interest and makes it possible to dissociate this unwanted artifacts from the effective area required for normalization and feature encoding, thus generating a good iris template pattern for matching. The eyelid detection is shown in the Fig. 6.

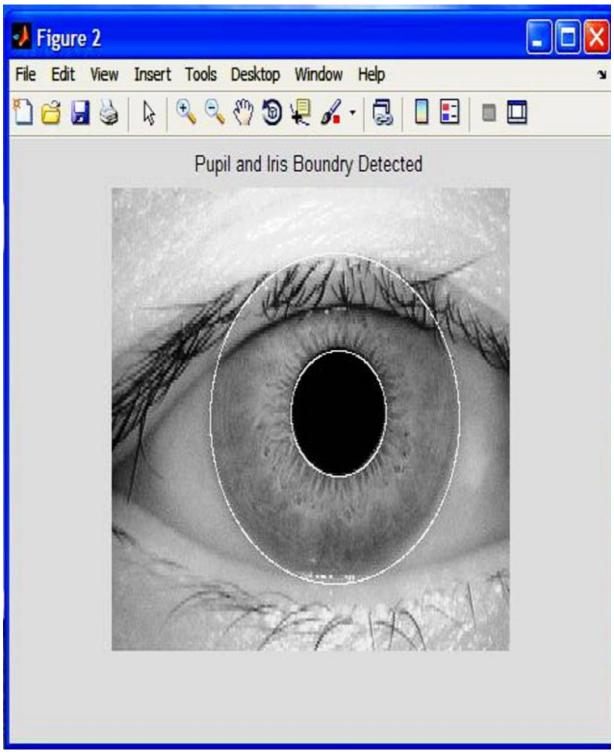

Figure .4. Boundaries of iris and pupil of the eye detected.

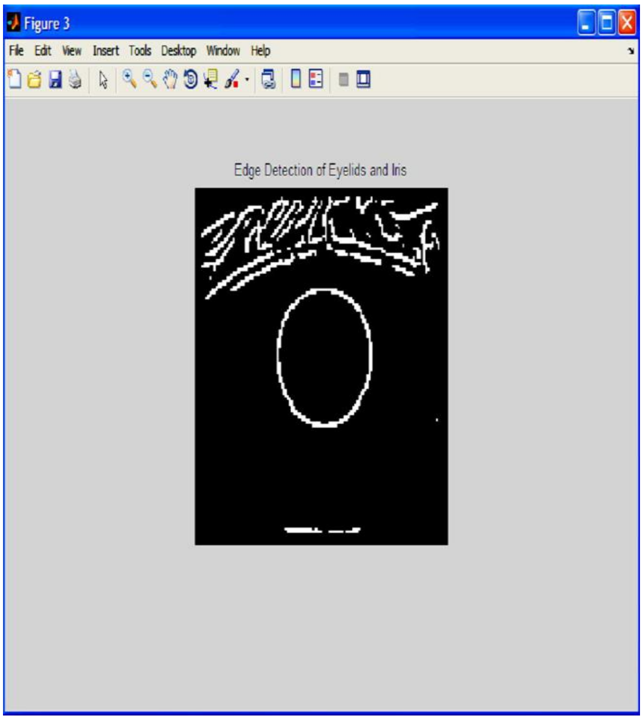

Figure.5. Edge detection

Output 6: the normalized iris image

The output normalized image (Fig. 7) after detection of Pupil and Iris boundary along with top and bottom eyelid detection and elimination for Iris Image Segmentation and Normalization in MATLAB. The function used here is normaliris.

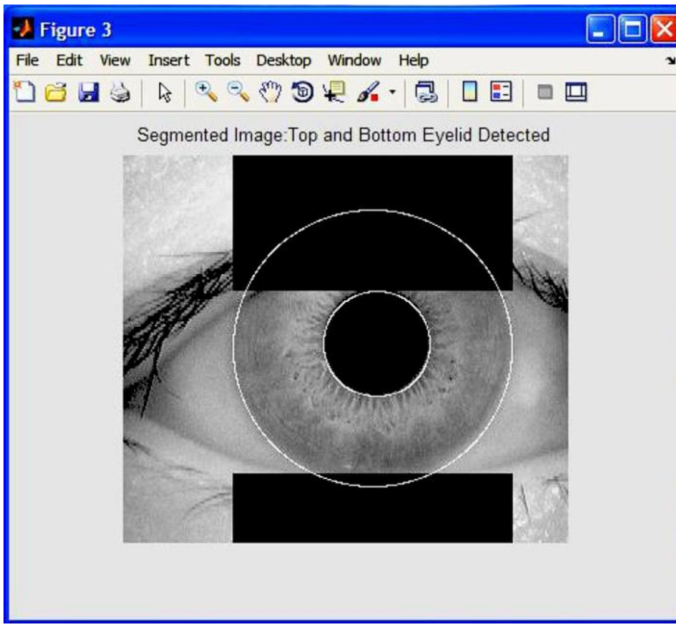

Figure. 6. Segmentation of top and bottom eyelid

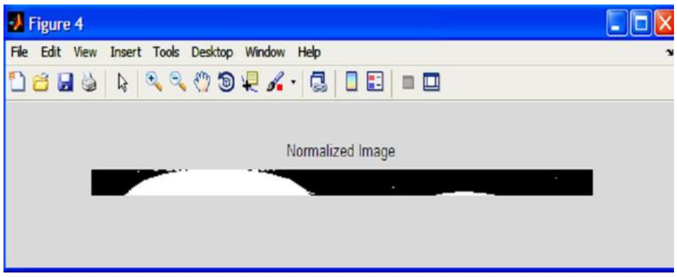

Figure. 7. Normalized iris patterns

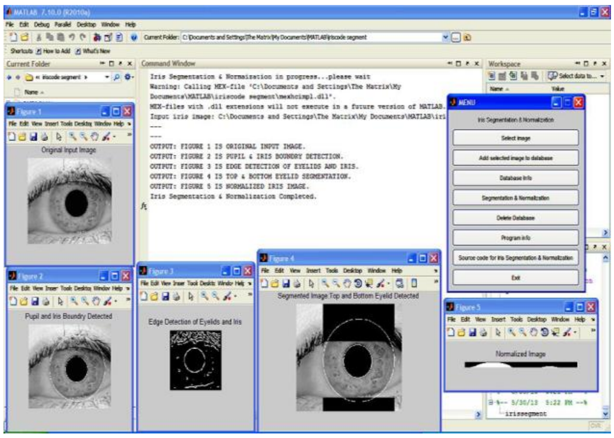

Figure. 8. Final matlab output window

Output 7: the final MATLAB output window

The final MATLAB output window with all the final iris image segmentation and normalization results is shown in Fig. 8.

V. CONCLUSION

This paper presents a survey on various techniques involved in iris recognition. The physiological characteristics are relatively unique to an individual. An approach to reliable visual recognition of persons is achieved by iris patterns. The other approaches are based on discrete cosine transforms, spot recognition and parametric template methods. The results obtained in implementation has presented an Iris segmentation and normalization system, which was tested using CASIA database of gray scale eye images in order to verify the claimed performance of iris recognition technology and application of MATLAB in Digital Image Processing.The future work in real applications utilization to support generation of compact iris codes for mobile phones and PDAs. In this research, an effort has been made to present an insight of different irisrecognition methods. The survey of the techniques provides a platform for the developmentof the novel techniques in this area as future work.

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