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Iris segmentation and detection system.

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Abstract: This presents a human iris segmentation and recognition system in environment which is unconstrained, in which an effective method is proposed for localization of iris boundary. In this method, after pre-processing stage, circular Hough transform was utilized for localizing circular area of iris boundary. Also, through applying linear Hough transform, localization of boundaries between upper and lower eyelids is possible. Once we can segment an image, we take two images and perform the operations like normalization to identify whether the two eye images are same or not. The operations produce different templates of the two images which are used for feature matching and we will be able to distinguish whether the two images are same or unique.

Keywords: Iris, Hough transform, Localization, Normalization.

I. Introdution

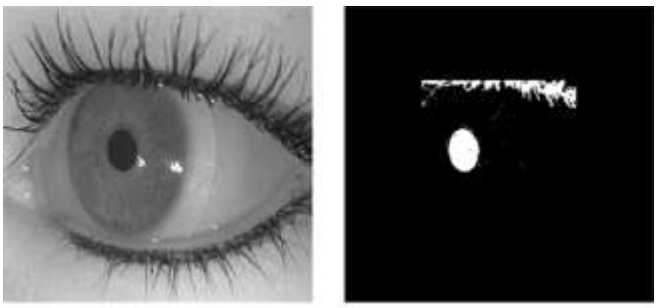
First, a segmentation algorithm is used, which would localize the iris region from an eye image and isolate eyelid, eyelash and reflection areas [1]. Automatic segmentation is achieved using the circular Hough transform for localizing the iris and pupil regions, and the linear Hough transform for localizing occluding eyelids. Thresholding is also employed for isolating eyelashes and reflections.

Second, the segmented iris region is normalized to eliminate dimensional inconsistencies between iris regions. This is achieved by implementing a version of Daugman's rubber sheet model, where the iris is modelled as a flexible rubber sheet, which is unwrapped into a rectangular block with constant polar dimensions [2].

Finally, features of the iris are encoded by convolving the normalized iris region with 1D Log-Gabor filters and phase quantizing the output to produce a bit-wise biometric template. The Hamming distance is chosen as a matching metric, which gives a measure of how many bits disagreed between two templates [3][4]. A failure of statistical independence between two templates would result in a match, that is, the two templates are deemed to have been generated from the same iris if the Hamming distance produced is lower than a set Hamming distance. The term Hamming distance is a measure of how many bits are same between the two-bit patterns.[5]

II. Image Binarization

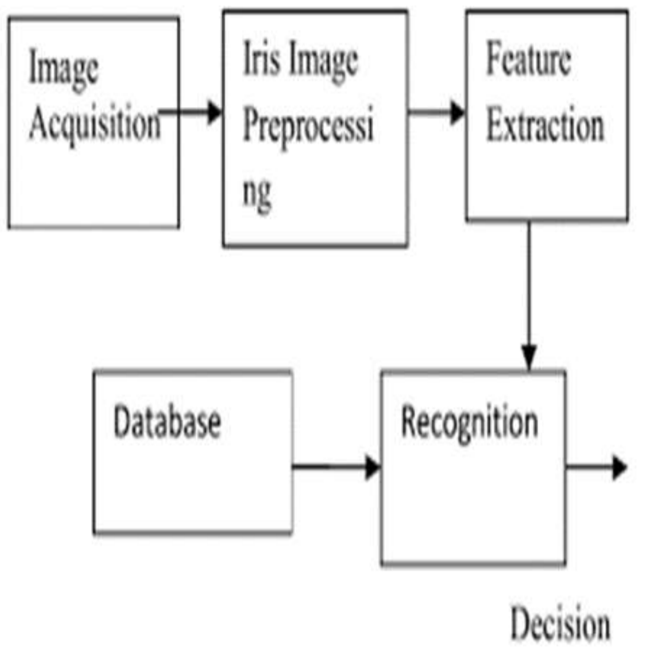
The input iris image is first binarized by a chosen threshold value. Since the intensity values of the pixels in the pupil area are small in the iris image and the area of the pupil is not large, 5 - 8% of the pixels with lowest intensity values are chosen and set to 1. Those pixels are assumed to include the pupil. There is usually glare in the pupil area, which sometimes makes the detection incorrect. The inner boundary is localized by thresholding the images and freeman's chain code, making the gray scale histogram of the image. By setting a threshold value T, we can change the original image into binary image B(x,y). If the gray values of pixel are bigger than T, set them as 0, on the contrary, set others to 1. Basically, thresholding is a technique by which we can separate the foreground and background of an image[6]. The resulting image is a binary image as shown in the figure below.



(a) (b)

[Fig. 1. Thresholding an input image of eye]

III. Block Diagram



[Fig. 2. Iris segmentation and recognition]

IV. Typical Iris Recognition System

3.4.1 Pre-processing: Pre-processing of the acquired iris image involves detection of specular reflections and this stage must remove these noise elements that can affect the feature extraction process. 2-D median filtering and in-painting is used here, if specular reflections in the image are present.

3.4.2 Segmentation: Two methods are proposed during this work as Geodesic Active Contours without edges and Canny edge detector method[10]. Also, segmentation performance is compared with the earlier reported work with Integro-Differential Operator and Hough transform.

3.4.3 Normalization: Iris segmentation is followed by a normalization to generate fixed dimension feature vectors further to be used for recognition by comparisons. The rubber sheet model proposed by Daugman maps each point in the (x, y) domain to a pair of polar coordinates (r, θ) [13]. This results in an image that has fixed size of unwrapped rectangular iris part.

3.4.4 Feature Encoding and Matching: For accurate recognition result, the most discriminating information present in an iris pattern must be extracted. Only the significant features of the iris must be encoded so that comparisons between irises can be made. To study the effects of iris segmentation on the iris recognition accuracy performance Log Gabor filters are used to extract the textural information (encoding) from the unwrapped iris. Further, the feature vectors are compared using a similarity measure for which matching algorithm is used.

V. Hough Transform

The Hough transform is a standard algorithm for computer vision that can be used to determine the parameters of simple geometric objects, such as lines and circles, which are present in an image [1]. The circular Hough transform can be used to deduce the radius and center coordinates of the pupil and iris regions of an eye. In first step, an edge map is generated by the calculation of the first derivatives of intensity values in an eye image and then thresholding the resultant image. From the edge map, we can cast votes in Hough space for the parameters of circles passing through each edge point. These parameters are known as Centre coordinates X and Y and the radius R, of the circle which will define any circle according to the equation (3.2),

$$X^2 + Y^2 - R^2 = 0 \qquad (3.2)$$

A maximum point present in the Hough space will point to the radius and center coordinates of the circle defined by the edge points. This involves first using canny edge detection which will generate an edge map. Gradients were also biased in the direction which is vertical for the outer iris/sclera boundary, as suggested by Wildes algorithm.

Algorithm for Hough transform (Masek method)

Segmentation:

Step 1: Set pupil radius = 28 and radius of iris =75 for CASIA database.

Step 2: Scale the image.

Step 3: Gaussian filtering.

Step 4: Edge map creation using canny edge detection.

Step 5: Circular Hough transform for limbic boundary detection

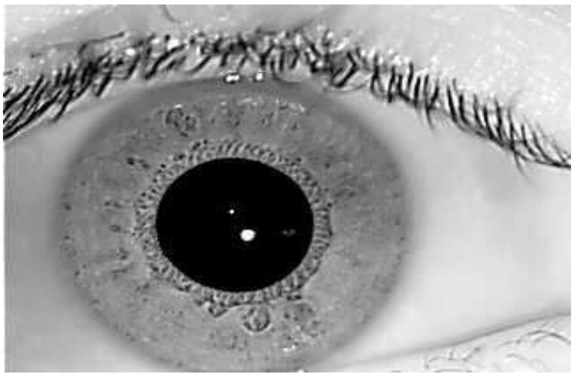
Step 6: We will use Circular Hough transform for boundary detection of pupil inside iris.

Step 7: Linear Hough transform for eyelid detection.

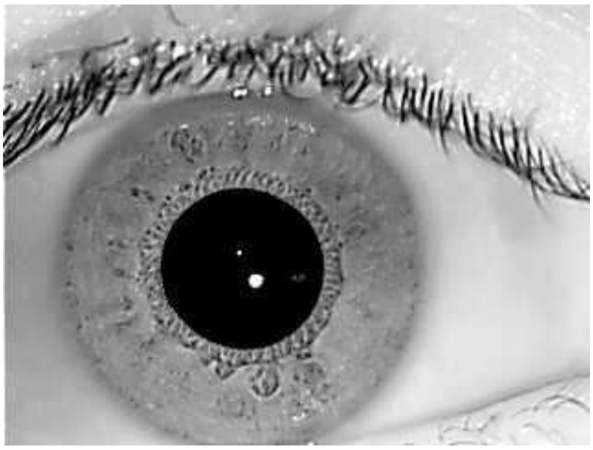
Step 8: Display the segmented image.

VI. Results

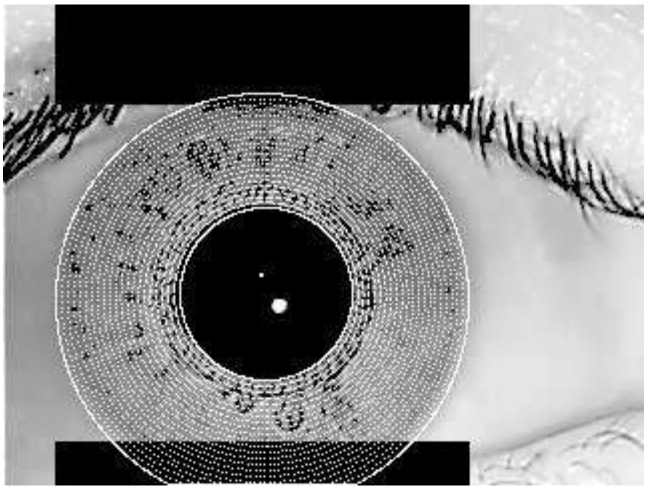
The results when we load two input images are:



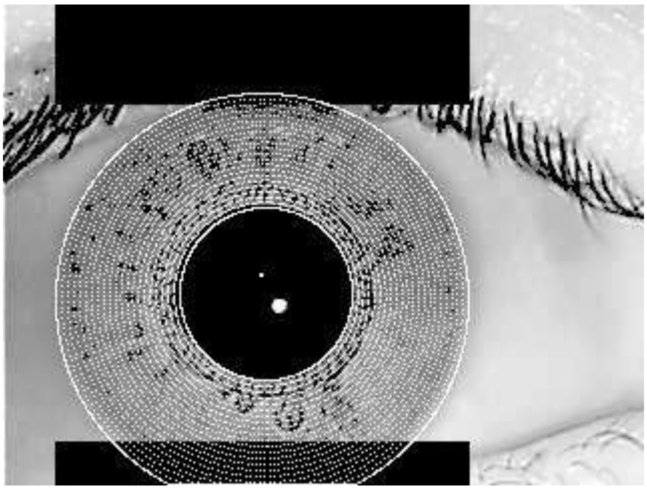
[Fig.3. Input image 1]



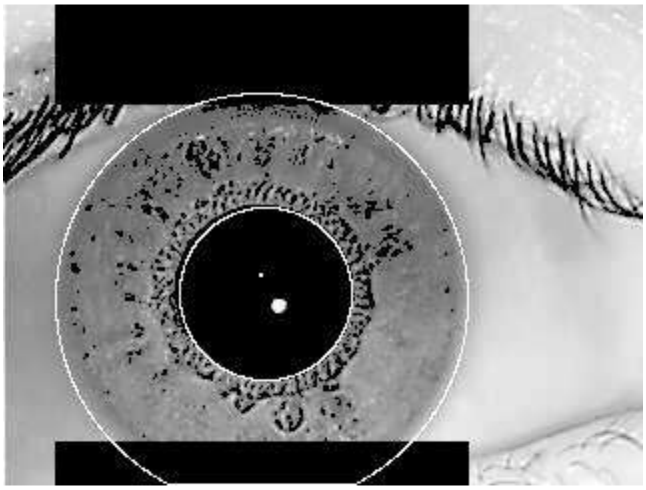
[Fig.4. Input image 2]



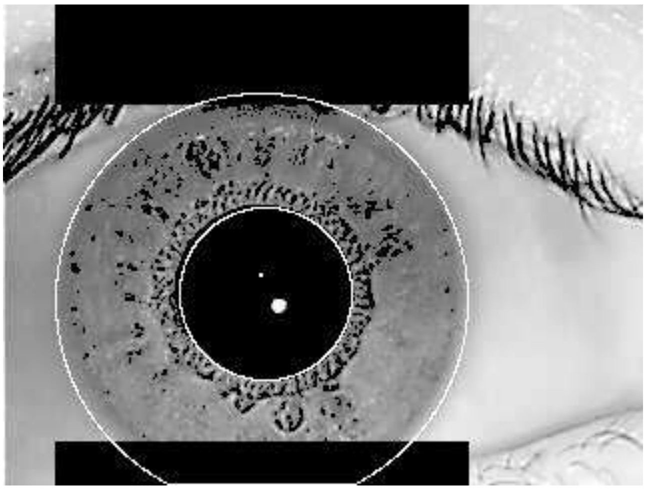
[Fig.5. Image 1 as a normalized image]



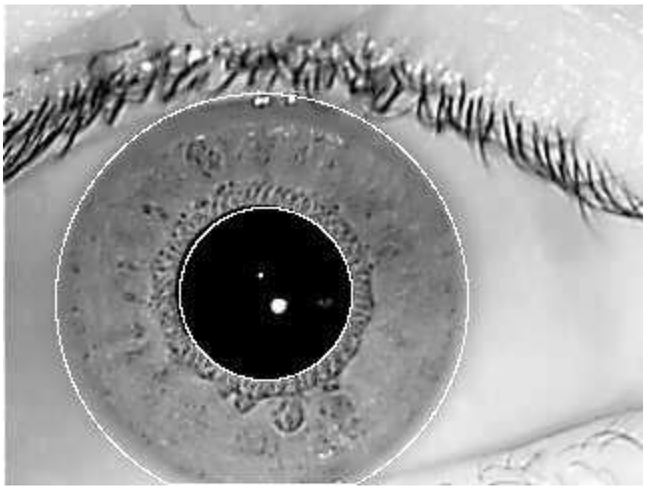
[Fig. 6. Image 2 as a normalized image]



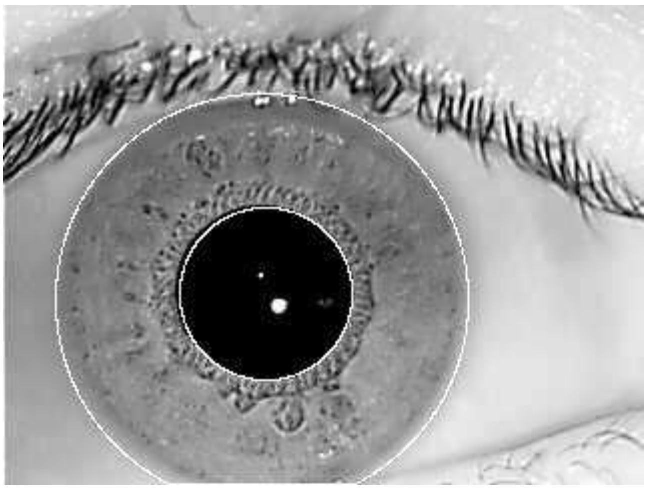
[Fig.7. Image 1 after noise removal]



[Fig.8. Image 2 after noise removal]



[Fig.9. Image 1 segmented]



[Fig.10. Image 2 segmented]

VII. Challenges in Iris Segmentation

Iris segmentation refers to the process of automatically detecting the pupillary (inner) and limbic (outer) boundaries of an iris in a given image. This process helps in extraction of features from the texture which is discriminative of the iris, while excluding the surrounding regions. Segmentation of an iris image is a classical image processing problem. Processing non-ideal iris images is a challenging task because of following reasons:

1. The iris is many a times covered with eyelids, eyelashes, shadows.
2. The iris is sometimes occupied by specular reflection.
3. The iris and the pupil are not perfect circles, and the shape varies depending from which angle image is taken.
4. Some of the other challenges of iris segmentation are defocusing, motion blur, poor contrast etc. These challenges are taken care by measuring the quality of input iris image and then continue with segmentation of the good quality image only.
5. The noise in images is of these types- the iris obstruction by eyelids or eyelashes, specular or lighting reflections, poor focused image, partial or out of iris image, motion blurred as belonging to the iris.

VIII. Conclusion

This paper presents an effective method to recognize iris boundaries by performing Hough transform. In this method, the boundaries were localized with high accuracy and with attention to the issue of low variations of illumination intensity in iris outer boundary compared with other sections was achieved a fine accuracy rate for this proposed method.

The results were examined on CASIA database images and they indicated the higher efficiency and high precision of the proposed method that are comparable with other existed methods of identity recognition by using iris part of the image. The results obtained were positive and the system successfully detected whether the two iris images are same or unique.

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