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RESEARCH ARTICLE

A STUDY ON IRIS RECOGNITION SYSTEM

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Abstract— Iris recognition systems capture an image from an individual's eye. The iris in the image is then segmented and normalized for feature extraction process. The performance of iris recognition systems highly depends on segmentation and normalization. For instance, even an effective feature extraction method would not be able to obtain useful information from an iris image that is not segmented or normalized properly. This thesis is to enhance the performance of segmentation and normalization processes in iris recognition systems to increase the overall accuracy.

I. INTRODUCTION

Biometric technology deals with recognizing the identity of individuals based on their unique physical or behavioral characteristics. Physical characteristics such as finger- print, palm print, hand geometry and iris patterns or behavioral characteristics such as typing pattern and hand-written signature present unique information about a person and can be used in authentication applications.

II. IRIS RECOGNITION

Iris patterns are formed by combined layers of pigmented epithelial cells, muscles for controlling the pupil, stormed layer consisting of connective tissue, blood vessels and an anterior border. The physiological complexity of the organ results in the random patterns in iris, which are statistically unique and suitable for biometric measurements . In addition, iris patterns are stable over time and only minor changes happen to them throughout an individual's life . 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 over time, 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, 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. IriScan Inc. patents the core technology of the Daugman's system and several companies such as IBM, Iridian Technologies, IrisGuard Inc., Securimetrics Inc. and Panasonic are active in providing iris recognition products and services.

III. DAUGMAN' S IRIS RECOGNITION SYSTEM

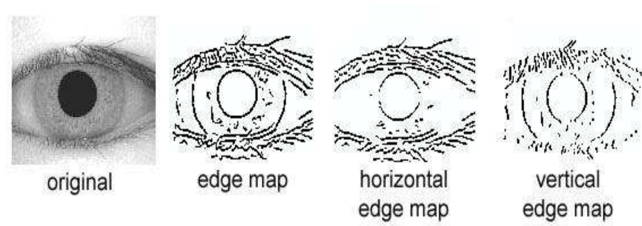
Properly detecting the inner and outer boundaries of iris texture is significantly important in all iris recognition systems. All the previous segmentation techniques model iris boundaries and the two eyelids with simple geometric models. Pupil and limbus are often modeled as circles and the two eyelids are modeled as parabolic arcs. However, according to our observation, circle cannot model pupil boundary effectively. Irregular boundary of pupil is the motivation to create an accurate pupil detection algorithm based on the concept of active contours. The contour model takes into consideration that an actual pupil boundary is a near-circular contour rather than a perfect circle. The objective of this work is to demonstrate that this method can effectively improve the recognition accuracy.

IV. ITERATIVE ALGORITHM

The next focus of this work is on iris normalization. Most normalization techniques are based on transforming iris into polar coordinates, known as unwrapping process. Pupil boundary and limbus boundary are generally two non-concentric contours. The non- concentric condition leads to different choices of reference points for transforming an iris into polar coordinates. Proper choice of reference point is very important where the radial and angular information would be defined with respect to this point.

V. HOUGH TRANSFORM

The Hough transform is a standard computer vision algorithm that can be used to determine the parameters of simple geometric objects, such as lines and circles, present in an image. The circular Hough transform can be employed to deduce the radius and centre coordinates of the pupil and iris regions.



Daugman's Integro-differential Operator

Daugman makes use of an integro-differential operator for locating the circular iris and pupil regions, and also the arcs of the upper and lower eyelids. 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 localization. Eyelids are localized in a similar manner, with the path of contour integration changed from circular to an arc. The integral-differential can be seen as a variation of the Hough transform, since it too makes use of first derivatives of the image and performs a search to find geometric parameters.

VI. OTHER SEGMENTATION METHODS

Other researchers use methods similar to the described segmentation methods. For instance, the iris localization proposed by Tisse et al. is a combination of the Integro- differential and the Hough transform. The Hough transform is used for a quick guess of the pupil center and then the Integro-differential is used to accurately locate pupil and limbus using a smaller search space.

Lim et al. localize pupil and limbus by providing an edge map of the intensity values of the image. The center of pupil is then chosen using a bisection method that passes perpendicular lines from every two points on the edge map. The center point is then obtained by voting the point that has the largest number of line crossovers. The pupil and limbus boundaries are then selected by increasing the radius of a virtual circle with the selected center point and choosing the two radii that have the maximum number of edge crosses by the virtual circle as the pupil and limbus radii.

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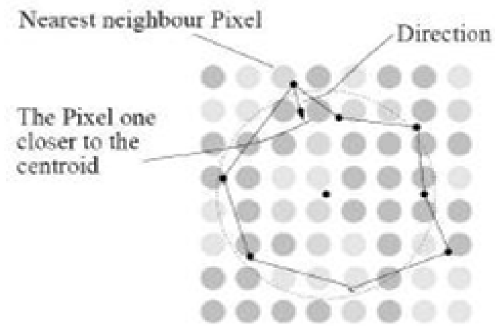
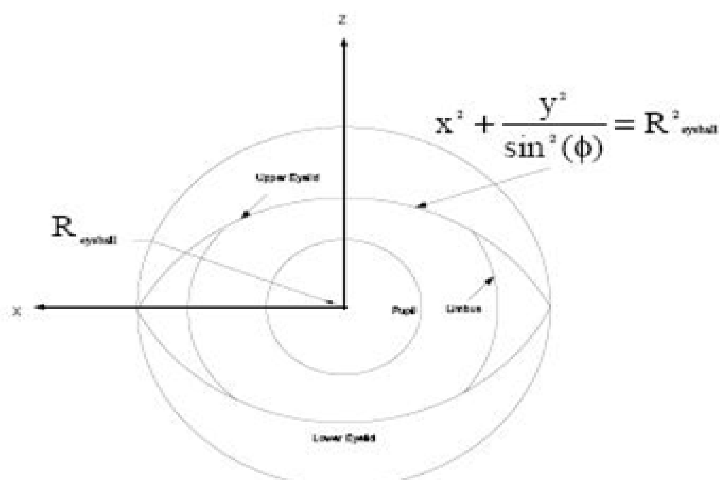


The external forces of the Discrete Circular Active Contour

Limbus and Eyelids Detection: Iterative Algorithm

An iterative algorithm is developed in order to accurately locate limbus and eyelids boundaries. The extraction method uses the Integro-diferential operator to detect the boundaries. The detection of an eyelid is based on the elliptic contours that are modeled by the spherical shape of an eyeball and the expected eyelid curve in different degrees of eye openness.



Eyelid curve model based on degree of eye openness: Front view.

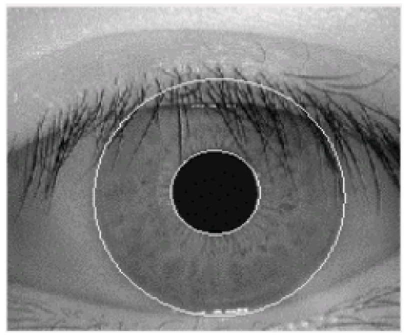
In the near-infrared images provided by the Institute of Automation, Chinese Academy of Sciences (CASIA), the limbus boundaries have insufficient contrast and global search techniques such as the Integro-differential operator are more suitable for the extraction process. However, even the global methods can result in false detection because of noises such as strong boundaries of upper and lower eyelids. The developed algorithm iteratively searches for iris and eyelids boundaries and excludes the detected eyelids areas for the next iteration. The process is designed with respect to the pupil center as the reference point and is performed by excluding the pixel values where the radius of limbus is larger than the radius of either upper or lower eyelids. This condition masks the areas where the iris is covered by the two eyelids and the process is repeated until the result of the search converges to a fixed center and radius for the limbus. Figure 3.4 illustrates the flowchart of the iterative algorithm.

Linearly-Guessed Reference Point Method

In addition to the center-based models based on limbus and pupil centers, the performance of a linearly-guessed center point is also examined. In this method, the reference point is obtained by a linear estimation using centers and radii of pupil and limbus. Illustrates the method for positioning the reference point. This method suggests that the unwrapping process should be performed by a point that the pupil center tends to reach when the pupil radius approaches to zero.

CURVE FITTING

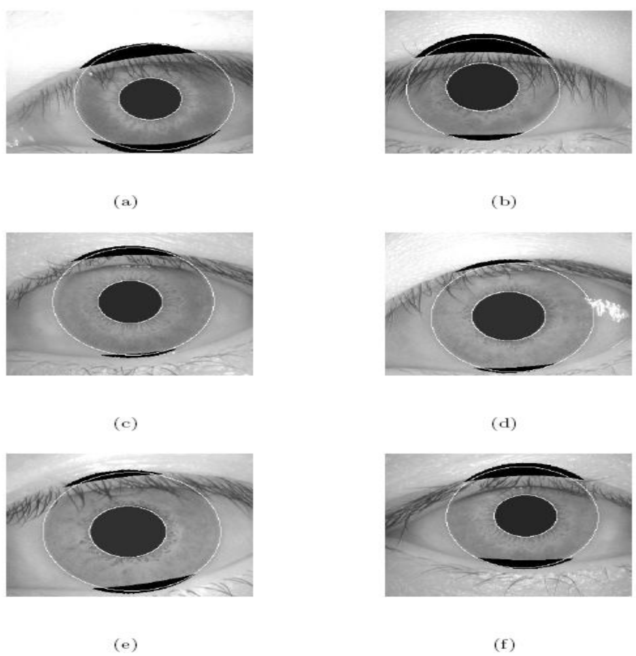
Finally, the precise iris center I (xi, yi) and radius Ri are obtained by fitting a circle to the outer boundary's points detected in the previous step. As a method for curve fitting, the least square method which minimizes the summed square of errors is applied in present study. Figure 3 shows the localized iris outer boundary.



Localized iris boundaries

VII. EYELIDS AND EYELASHES DETECTION

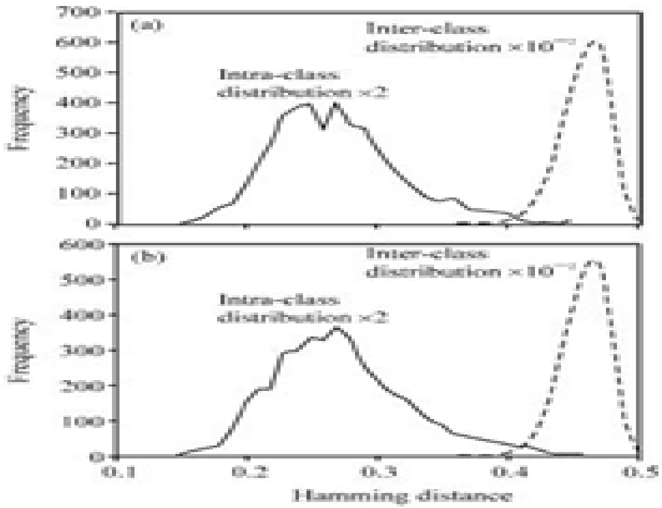
To localize the lower and upper eyelids, a Canny edge detector is applied to generate edge map, then a line is located using a linear Hough transform, since eyelids were modeled here as two horizontal lines. This approach is fast, since lines localization is performed within two relatively small iris portions, one for the lower eyelid and the other for the upper eyelid, also linear Hough transform requires less computation time.



(a)-(f) illustrate unsuccessful cases of eyelid detection due to the double eyelid condition. As it is shown in the images, some eyelids appear as two contours. However, the algorithm detects the contour with the higher edge contrast.

VIII. RESULTS

This system is implemented in Matlab (version 6.5) on a PC with P4 3 GHz processor and 512 M of DRAM. Iris images are obtained from CASIA V 1.0 iris image database (CASIA, 2003). It contains 108 classes and each class has seven iris images captured in two sessions.



Intra-class and inter-class Hamming distances (a) Using proposed method for iris localization and (b) Using Integrodifferential operator for iris localization

IX. CONCLUSION

In this study, a new iris localization algorithm was proposed. It localizes the iris inner boundary by using Daugman's integrodifferential operator after finding the approximate pupil center. For localizing the iris outer boundary, the algorithm adopts boundary points detection and curve fitting. First, a set of radial boundary points is detected by applying image integral projection along angular directions while localizing the integration area. Then a circle is fitted to these points by making use of least squares method. Eyelids and eyelashes are also detected. As in Daugman's iris recognition system, 2D Gabor filter is employed for extracting iris code for the normalized iris image. To evaluate iris localization results, an iris recognition system is implemented on CASIA V 1.0 with two different iris localization approaches, the proposed and Daugman's algorithms. Analysis of matching results indicates that the proposed algorithm gives better results.

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