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A Survey: Various Segmentation Approaches to Iris Recognition

Nidhi Manchanda, Oves Khan, Rishita Rehlan and Jyotika Pruthi

Department of Computer Science and Engineering
ITM University, Gurgaon.

Abstract

Biometrics refers to the authentication of an individual's identity based on his physical or behavioral traits. The iris, one of the biometrics stands out among other biometric techniques because of its unique features like stability and accuracy, segmentation of iris has its own major applications in the field of surveillance, forensics as well as in security purposes. The performance of the iris recognition systems depends heavily on segmentation and normalization techniques. A review of various segmentation approaches used in iris recognition is done in this paper.

1. Introduction

In the recent years, dire improvements have been accomplished in the areas like iris recognition, automated iris segmentation, edge detection, boundary detection etc. 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 as well as feature extraction and encoding. Image acquisition is a module which involves the capturing of iris images with the help of sensors. Pre-processing module provides the determination of the boundary of iris within the eye image, and then extracts the iris portion from the image in order to facilitate its processing. It involves the stages like iris segmentation, iris normalization, image enhancement etc. Edge detection systems like boundary as well as the edge detection have been provided with much advancement but optimal accuracy has not been achieved yet. Thus, there is a strong need to develop a new segmentation approach that is more reliable as well as robust.. Approaches like Integrodifferential operator [1], Hough transform [2] constitute a

major part in the iris recognition techniques. Many other iris recognition as well as the iris segmentation approaches [3, 4, 5, 6, 7, 8] have been introduced.

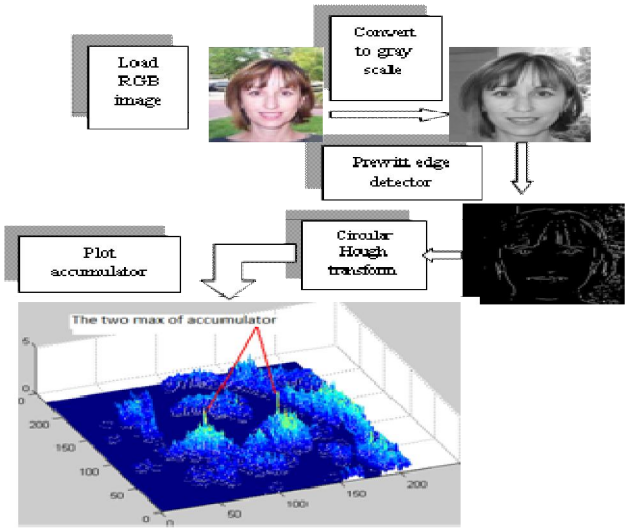
2. Techniques Used for Iris Segmentations

2.1 Integrodifferential operator

This approach [1] is resembled as one of the most cited approaches in the survey of iris recognition. .Daugman used an integrodifferential operator for segmenting the iris. It finds both inner and the outer boundaries of the iris region. The outer as well as the inner boundaries are referred to as limbic and pupil boundaries. The parameters such as the center and radius of the circular boundaries are being searched in the three dimensional parametric space in order to maximize the evaluation functions involved in the model. This algorithm achieves high performance in iris recognition. It is having a drawback that, it suffers from heavy computation.

2.2 Hough Transform

The Hough Transform is an algorithm presented by Paul Hough in 1962 for the detection of features of a particular shape like lines or circles in digitalized images. The classic Hough Transform is a standard algorithm for line and circle detection. It can be applied to many computer vision problems as most images contain feature boundaries which can be described by regular curves. The main advantage of the Hough transform technique is that it is tolerant to gaps in feature boundary descriptions and is relatively unaffected by image noise, unlike edge detectors.



The edge detection has been performed through the gradient-based Canny edge detector, which is followed by the circular Hough transform [2], which is used for iris localization. The advantage of this method is that it provides segmentation accuracy up

to an extent. The drawback of this approach is that, it does not provide any attention to eyelid localization (EL), reflections, eyelashes, and shadows which is more important in the iris segmentation.

2.3 Masek Method

Masek introduced an open iris recognition system for the verification of human iris uniqueness and also its performance as the biometrics. The iris recognition system consists of an automated segmentation system, which localize the iris region from an eye image and also isolate the eyelid, eyelash as well as the reflection regions. This Automatic segmentation was achieved through the utilization of the circular Hough transform in order to localize the iris as well as the pupil regions, and the linear Hough transform has been used for localizing the eyelid occlusion. Thresholding has been employed for isolating the eyelashes as well as the reflections. Now, the segmented iris region has got normalized in order to eliminate the dimensional inconsistencies between the iris regions. This was achieved by applying a version of Daugman's rubber sheet model, in which the iris is modeled as a flexible rubber sheet, which is unpacked into a rectangular block with constant polar dimensions. Ultimately, the iris features were encoded by convolving the normalized iris region with the 1D Log-Gabor filters and phase quantizing the output to produce a bit-wise biometric template. The drawback of this approach is that the iris segmentation is not that much accurate and also the speed of the system is low.

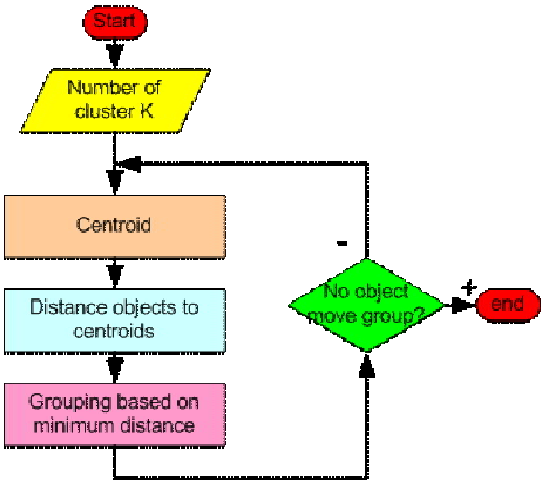
2.4 Fuzzy clustering algorithm

A new iris segmentation approach, which has a robust performance in the attendance of heterogeneous as well as noisy images, has been developed in this. The process starts with the image-feature extraction where three discrete i.e., (x, y) which corresponds to the pixel position, and z which corresponds to its intensity values has got extracted for each and every image pixel, which is followed by the application of a clustering algorithm which is the fuzzy K-means algorithm[4]. The main advantage of this method is that, it provides a better segmentation for non cooperative iris recognition. The major drawback in this method is that thorough (extensive) search is needed in order to recognize the circle parameters of both the pupil as well as the iris boundaries.

2.5 Pulling and Pushing (PP) Method

A perfect (accurate) as well as a rapid iris segmentation algorithm for iris biometrics has been developed in this. There are mainly five major contributions in this. Firstly, a novel reflection removal method has been developed in order to exclude the specularities involved in the input images, also an Adaboost-cascade iris detector has been used in order to detect the iris in them and also to exclude the non iris image parts before further processing such that redundant computations can be avoided. In addition to this, a rough iris center has been extracted in the iris images. Second contribution is

that, beginning from the rough iris center, a novel puling and pushing (PP) [5] procedure has been developed in order to accurately localize the circular iris boundaries. The PP method directly finds the shortest path to the valid parameters. Third is that, a cubic smoothing spline has been adopted in order to deal with the noncircular iris boundaries. Fourth contribution is that, an efficient method for the localization of the eyelids has been developed.. The advantage of PP method is the accuracy and speed. The drawback of this method is that the occurrence of the segmentation error.



2.6 Eight-neighbor connection based clustering

An efficient as well as robust algorithm for noisy iris image segmentation in the background of non cooperative and less-cooperative iris recognition has been developed in this. The major contributions involved in this are as follows. Firstly, a novel region growing scheme known as the eight-neighbor connection based clustering [6] has been proposed in order to cluster the whole iris image into different parts. Then, genuine iris region has been extracted with the aid of several semantic priors, and also the non-iris regions such as eyelashes, eyebrow, glass frame, hair, etc are identified and also excluded as well, which intensely reduces the possibility of mis localizations occurring on the non-iris regions. Secondly, an integrodifferential constellation has been introduced inorder to accelerate the traditional integrodifferential operator, and then, enhance its global convergence ability for pupillary as well as the limbic boundary localization. Thirdly, a 1-D horizontal rank filter as well as an eyelid curvature model has been adopted in order to tackle the eyelashes as well as the shape irregularity, during eyelid localization. Finally, the eyelash as well as the shadow occlusions has been detected with the aid of learned prediction model which is based on the intensity statistics between different iris regions. All these techniques acquire segmentation accuracy in many areas such as

boundary detection, iris detection, pupil and limbic boundary detection etc. But none of these papers provide a solution for attaining overall segmentation accuracy.

Table I: Tabular Comparison.

NAME	**APPROACH**	**PERFORMANCE**	**DISADVANTAGES**
High confidence visual recognition of persons by a test of statistical independence	Integrodifferential operator	Very high performance in iris recognition	Computational time is very high
Iris Recognition: An emerging biometric technology	Hough transform	Segmentation accuracy achieved up to an extent	Does not provide attention to EL as well as reflections etc
Recognition of Human Iris Patterns for Biometric Identification	Liber Masek's encoding algorithm	Localization of circular iris region as well as eyelids, eyelashes and also the reflections occurs	Speed of the system is low
Iris segmentation methodology for non cooperative recognition	Fuzzy clustering algorithm	Better segmentation for non co- operative iris recognition	Thorough search is needed to recognize the circle parameters of both pupil and iris boundaries
Toward Accurate and Fast Iris Segmentation for Iris Biometrics	Pushing and pulling (PP) method	Possess accuracy and speed	Occurrence of segmentation error
Efficient and robust segmentation of noisy iris images for non cooperative iris recognition	Eight-neighbor connection based clustering	iris segmentation accuracy has been attained to an extent	segmentation of noisy iris images should be improved

3. Conclusion

This paper presents a literature survey on the various segmentation techniques involved in iris recognition. There are various techniques that can be used for this purpose. Overall segmentation accuracy of all these techniques has been analyzed. Higher the segmentation rate, thus higher is its performance. The unified framework

[7] has the highest segmentation rate and also has highest performance. Integrodifferential operator has high performance in iris recognition.

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