A Novel Approach for Iris Recognition in Unconstrained Environment

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***Abstract*— Area of iris recognition for human identification is very growing in this industrial era. Today, almost in every field iris recognition systems have been installed for various purposes like attendance systems, human verification systems for security reasons and access control at premises. A great research has been done in this area for constrained environment. However those systems do not work efficiently for unconstrained environment. For unconstrained environment many constraints need to be kept in mind for proper and accurate functioning of the system. Unconstrained iris recognition plays a vital role in identification system for real life applications and thus a great amount of research is going on in this area. In this paper a novel approach for human identification in an unconstrained environment is given.**

***Index Terms*—Enhancement, Feature extraction, Iris segmentation, Localization and Normalization.**

I. Introduction

Iris is a unique flowery pattern for every individual which surrounds the pupil of the eye. It remains unique for the whole life and thus can be used for human identification which was first introduced by US patent [1]. This human identification system is much more accurate and reliable than earlier biometric systems being used for identification. It covers the various drawbacks of the various other existing biometric systems like fingerprints, retina scan, voice recognition etc. As human interaction is greatly required for the efficient functioning of these biometric systems but iris is externally visible part of the human eye and thus can be easily used for identification [1]. Moreover, iris has very high degrees of freedom and thus having less chances of similarity with any other iris pattern. Various algorithms were proposed for human identification based on iris patterns. Earlier research work recognized iris for images taken in ideal conditions only [2, 3]. For using iris as a widely available system for various security reasons and other access systems, it should work well in non-ideal conditions also. By non-ideal conditions we mean that no fixed lightening conditions are there when eye images are being captured. And thus iris recognition in unconstrained environment plays a very crucial rule in day to day life for security and identification purposes.

Various countries have also adopted iris as a unique human identification system for their citizens as iris scan cannot be forged by anyone. Human identification based on iris scan is almost foolproof and the most accurate than any other identification system. Iris recognition for unconstrained environment has wide applications in real time environment. As user cooperation is not required thus the person will not get to know where the image capturing device is located. So it is very difficult to forge with such a system. Various applications of such a system are given below:

- Security at borders and airports in various countries.
- Attendance system at various institutes and industries.
- Access to specified areas of any company to check unauthentic access.
- Access to premises like houses and research laboratories.

Iris recognition system works by acquiring the eye image of an individual and is stored in the iris image database for further identification. This iris image is processed by application of various procedures. Various types of existing noise like eyelashes, eyelids and specular reflections are removed. Iris template is created and then stored in the database for recognition. Various methods have been used by the people working in the field of iris recognition.

II. Related Work

Iris as an identification means was introduced in 1987 for the very first time. This patent provided theoretical measure for using iris as an identification system and provided it as most reliable system. But it did not provide any experimental or mathematical formulas as a proof of

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this for practical applications [1]. Earlier iris boundary was assumed to be circular but later on it was proved that iris do not have circular shape. In 1993 mathematical model for iris identification system was introduced by J. Daugman. He invented algorithms and designed a proper working model for iris identification system. His patent and work done in the field of iris recognition is regarded as a milestone for other researchers in this field. These algorithms work very efficiently for iris images taken in ideal conditions but failed to accurately recognize iris in non-ideal imaging conditions [2, 3]. Active contour model was used to locate various boundaries in the eye image. Active contours take the actual boundary of the object by enacting internal and external forces to get the accurate iris boundary regardless of its shape [4].

Various steps involved in iris recognition system are image acquisition, image preprocessing, iris localization, feature extraction and template matching [5, 6, 7, 8]. Acquisition is the process of acquiring eye images from various persons and stored in the iris image database. Figure 1 gives an overview of the working of iris recognition system. Image pre-processing is the process of processing eye image before iris segmentation stage so as to get an accurate iris pattern. Image preprocessing includes the iris localization after removal of pupil, eyelids, eyelashes, specular reflections and various types of noise existing in the image. Iris inner and outer boundaries are applied with Hough transform and edge detection operators to get accurate iris boundaries [5]. Iris is localized properly after applying various methods to get only the iris region for further processing and matching stages. Canny edge detection is applied to the image to get the accurate iris edge map [9]. Image is then normalized to get intensity distribution same throughout the whole image and create a fixed dimension iris block also called as template. Image is then enhanced in contrast to get a quality image for matching stage. Features are extracted from the enhanced image and then matched with the templates stored in the database. When any iris image appears which does not exist in the dataset the same procedure is applied on the image and its template is stored in the dataset. The matching stage includes the bit by bit matching of the image with every image in the dataset. Hamming distance measure is used for the process of template matching.

Iris segmentation is the most important step in the process of iris recognition and the way in which iris segmentation is performed makes the only difference. In the previous iris recognition methods for unconstrained environment [10], left and right eye are first distinguished based on the presence of amount of specular reflections and eyelash distribution. More specular reflections are there near the medial canthus but less specular reflections are there near the lateral canthus. Eyelash distribution also helps to distinguish the left and the right eye. As less number of eyelashes appear near the medial cantus and large number of eyelashes are there near the lateral canthus. Rough pupil center and radius is located and then iris radius and center is computed by circular edge detector.

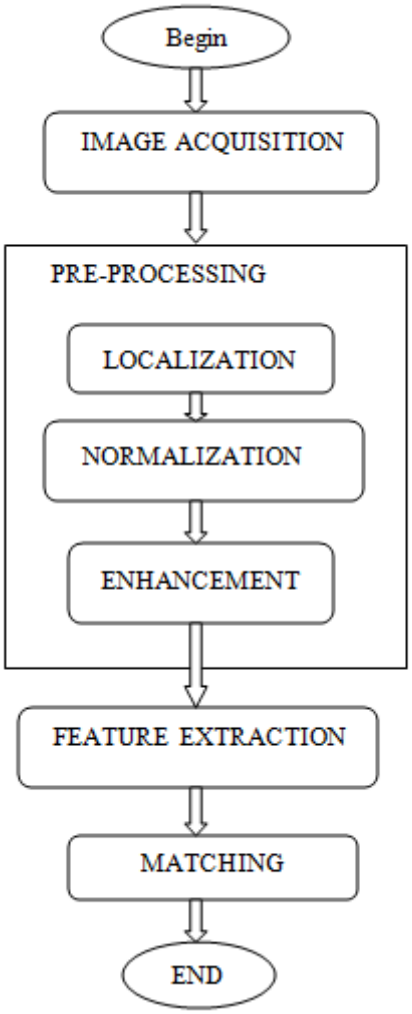

Fig. 1 Basic steps of iris recognition

Retinex filtering algorithm is applied on the image after differentiating left and right eye. It normalizes the illumination and enhances the distinctiveness of gray scale image. Iris is normalized and then iris region is converted into polar coordinates for measuring dissimilarity. Hamming distance measure is used to find the similarity index.

In another scheme [11], iris region is clustered before iris segmentation. In that, k-mean clustering algorithm is applied to the image and three clusters are formed based on their respective intensity values. First region is the region containing sclera and specular reflections with the higher intensity values. Second region is the region containing eyelashes, eyelids and iris with small intensity values. Third region is skin region having the intermediate intensity values between these two regions. As dark region of the eye is the main area of interest. After clusters are formed, image is morphologically treated to remove noise. Vertical canny edge detector and circular Hough transform are applied to the iris region of the image to get edges of the iris. Image is smoothed by the application of median filter. Canny edge detector and linear Hough transform is applied to remove the lower

eyelids. Pupil is detected using median filter. Extracted iris is then stored for further matching. Hamming distance measure is used for matching of iris patterns. The existing technique failed to detect the noisy iris images and more blurred images for further detection.

III. Proposed Scheme

In our proposed scheme, we have given a novel approach for the recognition of human iris for eye images taken in unconstrained environment means no constraints are applied on the imaging conditions like camera to eye distances and lightening conditions. Various techniques used at each step of the iris recognition are given

Retinex Algorithm [12] - Retinex algorithm is used to improve the brightness and sharpness of the image as it is an enhancement algorithm. It removes the illumination effects and provides a color constant image. It synthesizes the enhanced contrast by using non-linear spectral transform. Several new functions like use of various scales, color restoration and various other variants have been added to the original version of the algorithm. We are using Retinex Algorithm to enhance the image so that it may not affect further processing and matching technique.

Fuzzy C-mean Clustering- We are using Fuzzy C-mean clustering technique for making different clusters of the eye image. These clusters are formed based on the varying intensity values of the various eye parts. The part having higher intensity values belong to the one cluster and the one having lower values of intensity form a different cluster and the other one having the values of intensity in between these two intensity values. These clusters are formed by using Fuzzy methods and based on the membership function we define the exact cluster to which the part of the eye image belongs. Membership function defines the exact belongingness of the given eye part to a particular cluster. The use of Fuzzy-C mean clustering technique is batter then the previous K-mean clustering technique because k-mean clustering technique forms the clusters based on intensity values having full belongingness to the cluster or not. But using Fuzzy-C mean clustering, the part of the image is assigned with the degree of belongingness to the cluster which means that the up to what extent the part of the image belong to that particular cluster or to some other cluster. So based on this belongingness or membership function, Fuzzy-C mean clustering technique is better in performance and efficiency then the previously used K-mean clustering technique.

Canny Edge Detector [13] - Canny Edge detector is a very efficient edge detector.

It was used to detect iris edges and it established three main performance related criteria

i. Good detection: The algorithm should mark all real edges in the image which are possible.
ii. Good Segmentation: Edges in the real image should be as close as possible to the marked edges.
iii. Low multiplicity response to single edge and image should not create false edges.

Canny Edge Detection Process:

a. Smooth the image and eliminate noise.
b. Find the edge strength and define edge direction.
c. Non-Maximum Suppression.
d. Double thresholding and edge tracking the image using hysteresis.

It uses probability for finding errors. It has complex computations and false zero crossing. In our paper it is used to detect the boundaries of the iris. These iris edges are then treated with circular Hough transform to get iris boundaries exactly.

Morphological operations are then applied on the eye image to detect noise like eyelids and eyelashes with a particular structuring element.

Circular Hough Transform- It is used to create fine iris edges which were produced by Canny Edge detector.

In this, we will first apply the retinex filtering algorithm on the image to remove illumination, shadow and noise from the image to get a smooth image. After getting a smooth and enhanced image, we will apply the clustering technique to the eye image and form different clusters. The clustering technique we have adopted is Fuzzy C-mean clustering. Fuzzy C-mean clustering is the technique which introduces fuzziness to the eye image to be clustered and is thus a very efficient algorithm for making clusters accurately. We classify the eye image by using Fuzzy C-mean algorithm on the basis of intensity difference. Fine clusters are formed by using Fuzzy C-mean clustering technique. Image is then handled morphologically to remove the noise present in the image. Eyelashes and eyelids are removed very efficiently to get a very fine iris region for further processing of the iris image.

Vertical canny edge detector is applied to the image to get the iris area. Then on this area we apply circular Hough transform to get the iris boundary. Iris region is localized accurately regardless of its shape. The upper eyelids and the eyelashes are removed by using intensity difference between the eye and the skin region. Iris template is then created for every image in the dataset and stored in the database. When any eye image appears for the recognition then same procedure is applied to the eye image and its template is created. This template is then matched with the templates stored in the database. Hamming distance measure is used for matching the iris images. If a match occurs then it is announced as true eye image otherwise false eye.

IV. Software and Dataset

We will use MATLAB 8.0 with window7 operating system and core’2 duo processor. Various datasets containing eye images taken in unconstrained environment are available. These datasets contain thousands of eye images of various persons taken in varying imaging conditions. We are using UBIRIS v2 [14]

dataset having eye images of various persons from different countries. These persons belong to different age group. Also various eye images of the same person taken with varying camera to eye angle and varying imaging conditions.

V. Conclusion

This paper presents a scheme which is used to recognize human iris for the eye images taken in unconstrained environment rather than those taken in constrained environment. By unconstrained environment we mean that no constraints are applied on the lightening environment and for the person whose eye image is taken. This paper proposed a clustering based technique used at the initial stage of iris segmentation and thus enhanced the accuracy of iris segmentation stage. The clustering technique used here is Fuzzy C-mean clustering and this pre-processing step makes this method more efficient. Accurate edge maps are generated by using canny edge detector and circular Hough transform. UBIRIS iris database is used for performing experiments. This scheme is more accurate and computationally fast then the previous existing techniques.

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