An Effective Feature Set Exploration Of Iris Using High Dimensional Density Estimation

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Abstract

Iris Recognition has become one of the most important biometric mechanisms of all time, because of their unique patterns, which helps in finding the individual. When comparing to other traditional methods in biometric system, Iris Recognition ranks first, because of its high performance in identifying. In real-time Iris Recognition, Iris Localization is very important step for Iris Recognition. So, the Iris Masks plays an important role in iris recognition. So, we use Learning- Based algorithms to estimate accurate Iris Masks from Iris Images, which propose to use Figueiredo and Jain's Gaussian Mixture Models (FJ-GMMs) to model the underlying probabilistic distributions of both valid and invalid regions on iris images. Then instead of using polar coordinates in normalization, we go for Non-Polar coordinate system, which preserves and enhances the geometric structure of an original iris image and is suitable for multi-scale geometric analysis. Then, we employ the normalized energy components as elements of the feature vector and use Support Vector Machine (SVM) to classify the features. In feature extraction instead of Gabor filter banks we adopt Improved Circular Symmetric Filter Bank (ICSFB) to implement multi-scale decomposition. This Learning-based algorithm is implemented in the UBIRIS dataset to achieve high performance result.

Index terms - Figueiredo and Jain's Gaussian Mixture Model(FJ-GMMs), Non-polar coordinate system, Support Vector Machine(SVM), Improved Circular Symmetric Filter Bank(ICSFB).

1. Introduction -

Biometric Identification provides security and authentication to individuals which are an alternate and better option than traditional authentication methods used. Personal identification has become a trend in present day and in future. Compared to other biometric mechanisms, Iris Patterns is ranked top because the structure of the Iris is constant from age 1 till death. And a person's left and right eyes have a difference between them. Mostly all Iris Recognition systems contains four main stages, they are acquisition, segmentation, normalize, and recognition. From all the cases of Iris Recognition systems, we can see that Iris is normalized from Cartesian coordinate to Polar coordinate. But in this paper, to give it a twist, we go for a novel approach by applying Non-Polar coordinate in normalization phase. Where the Non-Polar coordinates help the segmented Iris in circular shape itself, and it helps to recognize and match the patterns in one's eye. Advantages of using this Non-Polar coordinates is that, we do not need to worry about the rotational position of the eye and its external occlusion that occurs while capturing the image. In all transformation that happens in Iris Recognition the person concentrate on normalizing the image into polar coordinates.

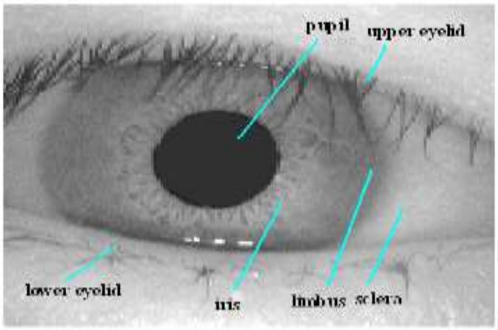


Fig. 1. Image of an Eye.

But in our paper, we concentrate on creating a Iris Mask, which helps recognition to perform higher level and attain high accuracy. Iris Masks has a great impact. If the main focus relies on the power of the matching algorithm and the feature extraction rather than the Iris Mask creation then the best feature extraction and recognition algorithms even cannot compensate for such flaws. The goal of this mask is to indicate which part in the iris map is truly iris texture and which part is noise. So this, accurate iris masks, combined with good features and effective recognition schemes, make the iris recognition systems more successful.

2. Previous Works –

Daugman's work is one of the earliest in iris recognition [1]. Ma et al. proposed a full framework for an iris recognition system [2]. Ma [2] proposed a new system using Circular Symmetric Filter for characterization and an improved Nearest Feature Line method for matching. Wildes et al. [3] proposed another iris recognition system that decomposes the iris image into multiresolution pyramid layers using the wavelet transform. Boles [4] characterized the texture of the iris based on zero crossings of wavelet transform. Amir Azizi [5] proposed a feature extraction method based on contourlet transform. In [6] and [7], different research groups were trying optimizing Gabor filters for the purpose of unsupervised texture recognition. Gabor filters are also used in biometrics applications. In colour iris recognition systems, the segmentation requires a significant computational effort [8], as a correct localization of the iris is vital for further stages of the biometric system. In a classical iris recognition system, the near infrared illumination implies a series of user constraints: the subject has to be in the field of view of the near infrared illumination and has to look for a few seconds at the acquisition device [9]. All used the most common database which is easier to work is the CASIA dataset[10].

3. Proposed Work –

Previously, all works related to Iris Mask generation has some limitations. The parameter tuning of the Rule-Based approach is so important for the performance of the Iris Mask generation. And so the Rule-Based approach is very sensitive to the environmental setting for any specific database. Many Iris Masks generated are not accurate enough for Iris Recognition. So, to overcome the short-comings of these previous methods, we go for a Novel-Based approach. We propose a novel method for automatic iris mask generation and it has to be flexible for all possible sizes of Iris Images. This Novel method is called as Learning-Based approach, which has been introduced to achieve the goal of generating the accurate Iris Masks.

The aim of our paper is to correctly locate the Iris boundaries, i.e., both Pupil boundary and Limbus boundary form the Iris Image. It means finding the position of the centre and radius of the pupil and limbus to estimate the Iris Regions and to extract the Iris Masks during Iris Segmentation. This Iris Segmentation is done by Canny edge detector by applying the binary threshold image to separate the pupil and limbus from the image. We adopt a novel non-polar coordinate normalization strategy as iris preprocessing method. It preserves and enhances the geometric structure of an original iris image and is suitable for multi-scale geometric analysis. Then Iris Mask is formed using the Non- Polar coordinates. Later, the extracted iris inner and outer boundary is in-painted for feature extraction purpose. In feature extraction, we adopt improved circular symmetric filter bank (ICSFB)[11].

4. Image Pre-Processing –

The process of capturing the Iris Image is called as Enrolment. There are several devices for enrolment process such as Iris Sensor, DSLR camera and Mobile Iris camera. The Iris Image intensity depends on how the Iris captured whether using in-door device or outdoor device. In iris recognition system, iris region is the part between pupil and sclerotic, the aim of iris boundary localization is to locate the boundary of iris/pupil and the boundary of iris/sclerotic. Both inter boundary and outer boundary of iris are alike circles, so many iris localization methods are to locate iris boundaries using circle detector. Fast boundaries localization based on prior pupil centre position estimation can improve iris boundary localization real-time, the main idea of this algorithm is: firstly, pupil centre coarse localization, secondly, edge detection based on canny operation; thirdly, iris inter boundary localization in a small image block selected; fourthly, edge extraction based on local grey gradient extreme value; finally, outer boundary localization in image block selected based Hough transform.

Pupil and Limbus coarse localization -

In eye image, there are obvious lower grey levels in pupil regions than other parts as shown in Fig.2. Firstly, a binary threshold can be selected based on Histogram adopting p-tail method. Usually, iris image is captured in a distance, so pupil size is limited to a range in eye image, we can select threshold depend on the set rate of pupil pixels number to whole image pixels in histogram. Faculas can be seen in eye image as shown in Fig.2, these interferences must be removed, or they will affect iris boundary localization.

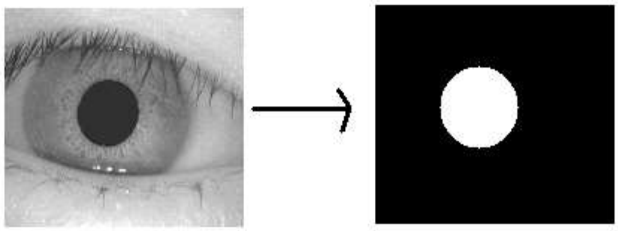


Fig. 2. Pupil detection using binarization

Iris boundary localization algorithm is as follows:

Step 1. Pupil centre coarse localization;
Step 2. Select a small image block and extract edge information based on canny operator;
Step 3. Pupil boundary localization based on Hough transform;
Step 4. Select a small image block and extract edge information based on line's grey gradient extreme value;
Step 5. Iris outer boundary localization based on Hough transforms.

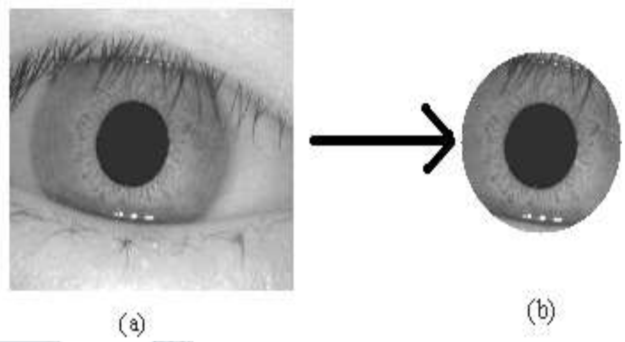


Fig. 3. (a) Eye Image, (b) Extracted Iris part along with pupil.

Due to improve localization speed and localization accuracy, taking the advantage of the grey information, we decrease the number of edge points and parameter range down to a small range to locate iris boundary.

5. Image Normalization -

In our iris recognition system, we adopt a novel non-polar coordinate normalization strategy as iris preprocessing method. It preserves and enhances the geometric structure of an original iris image and is suitable for multi-scale geometric analysis. We design the multi-resolution analysis framework according to the texture distribution of normalized iris images. We calculate the parameters of circles by voting through each edge point in the Hough space. Finally, we obtain the inside and outside circles of iris region. This non-polar coordinate normalization preserves the geometric structure and directional information of the original iris image.

Then, we go for the in-painting method called, Region-Filling Algorithm. First, a user selects a target region, Ω, to be removed and filled. The source region, Φ, may be defined as the entire image minus the target region $(\Phi = I ¡ \Omega)$, as a dilated band around the target region, or it may be manually specified by the user.

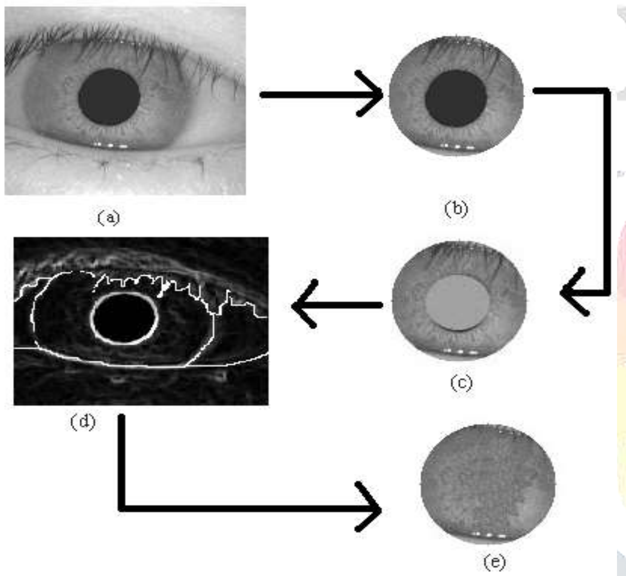


Fig. 4. (a) Eye Image, (b) Extracted Iris part along with pupil, (c) Inner & outer Iris part, (d) Iris Map, (e) In-painted Iris.

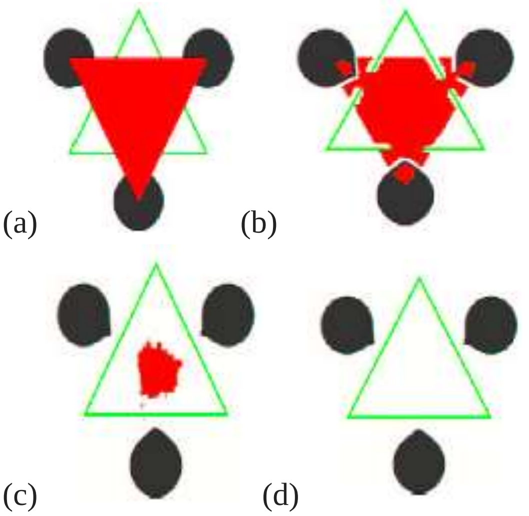


Fig. 5. (a),(b),(c),(d) shows how the region filling algorithm works.

Next, as with all exemplar-based texture synthesis, the size of the template window must be specified. Once these parameters are determined, the remainder of the region-filling process is completely automatic.

6. Feature Set Exploration –

In this paper, we adopt improved circular symmetric filter bank (ICSFB) [7] to implement multi-scale decomposition. Compared with LP decomposition, which is the multi-scale decomposition method in contour let, ICSFB has two main merits. Firstly, it doesn't introduce significant aliasing, which is a false translation of power leaked in some frequency range outside the right range. It can be caused by discrete sampling below the Nyquist frequency. and the different texture distribution could become indistinguishable when sampled, which has a negative effect on the accuracy of iris recognition. ICSFB has a constraint that the frequency domain is a circular region with radius $\pi/2$, so the sub-sampling operation would not introduce significant aliasing.

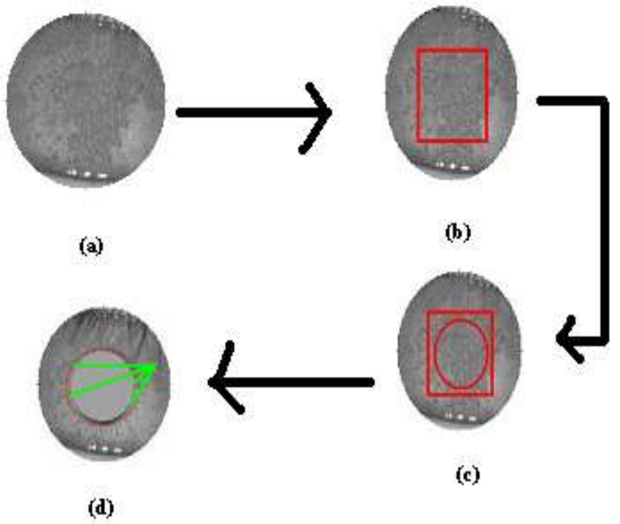
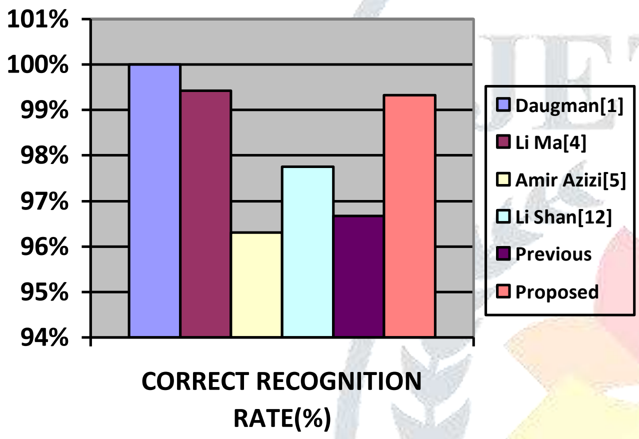


Fig. 6. (a) In-painted iris, (b) Region selected for feature extraction, (c) A circle is draw around the iris inner border, (d) Feature is extracted.

It has superior localized frequency partition. Secondly, as two images from the same person may have angular difference due to head spinning, rotation invariance is significant for iris recognition. ICSFB possesses translation and rotation invariance, which guarantees the energy of each sub-band remains unchanged even though the Iris has rotated.

ALGORITHM	CORRECT RECOGNITION RATE(%)	THE FEATURE VECTOR LENGTH
Daugman[1]	100%	2048
Li Ma[4]	99.43%	1536
Amir Azizi[5]	96.3%	56
Li Shan[12]	97.75%	>100
Previous	96.67%	128
Proposed	99.33%	64



7. Conclusion –

Accurate Iris Segmentation is fundamental for the success and precision of the sub-sequent feature extraction and recognition and consequently the high performance level of the Iris Recognition system. So, for accurate segmentation Iris Mask of high accuracy is needed to be derived during segmentation process. Iris boundaries are recognized by simple methods and less complex and faster algorithms than precious algorithms and it eliminates pupilary noises and reflections. This proposed techniques used guarantees the real-time Iris Segmentation even for Iris Images with severe occlusions. Therefore, high accuracy in Iris Segmentation leads to low error rate and high performance rate in Iris Recognition. The proposed segmentation approach is simple but extremely robust to various inputs of Iris images. This non-polar coordinate normalization preserves the geometric structure and directional information of the original iris image. Compared with contourlet transform, the proposed decomposition framework is more suitable for the non-polar coordinate normalization and has good noise immunity and more powerful ability to extract structure information.

8. References –

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