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Iris Normalization using Circular Masking

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Abstract— Iris recognition is one of the most accurate biometric methods in use today. In present biometric identification systems iris is taking too much attention because of its reliable and secure identification measures. Regular iris recognition systems capture an image from an individual's eye. This iris image is then segmented and normalized for feature extraction process. The performance of any 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. The proposed method uses circular masking technique for iris normalization and the results obtained are satisfactory compared to regular iris normalization techniques. Here we use CASIA V1 database for the proposed work and is implemented using OpenCV built-in library functions on Microsoft Visual Studio 2012 IDE.

Index Terms— CASIA V1, Circular Masking, Feature Extraction, Iris Recognition, Normalization, OpenCV, Microsoft Visual Studio 2012 IDE.

1 INTRODUCTION

Humans have distinctive and unique traits which can be used to distinguish them from others, acting as a form of identification. A number of traits characterizing physiological or behavioral characteristics of human can be used for biometric identification. Basic physiological characteristics are face, fingerprint, iris, retina, hand geometry, odour. And voice, signature, typing rhythm, gait are related to behavioral characteristics. The critical attributes of these characteristics for reliable recognition are the variations of selected characteristic across the human population, uniqueness of these characteristics for each individual, their immutability over time. Human iris is the best characteristic when we consider these attributes. The iris is a protected internal organ and it can be used as an identity document or a password offering a very high degree of identity assurance. Iris is the part between the pupil and the white sclera. The iris texture provides many minute characteristics such as freckles, coronas, stripes, furrows, crypts. These visible characteristics are unique for each subject. The primary function of the iris is to regulate the amount of light entering the eye by dilating or contracting a small opening in it called the pupil. The iris contracts the pupil when the ambient illumination is high and dilates it when the illumination is low. The texture of iris is complex, unique, and very stable throughout life. Iris patterns have a high degree of randomness in their structure. This is what makes them unique. Nowadays, iris recognition is one of the most reliable and accurate biometrics that plays an important role in identification of individuals. The iris recognition method delivers accurate results under varied environmental circumstances.

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Regular iris recognition systems are based on the algorithm developed by Dr. Daugman. Iris recognition system is basically divided into following steps.

- Image Acquisition
- Pre-processing
- Iris Localization
- Normalization
- Feature Extraction
- Matching

A. Image Acquisition

In this step, the images from the Chinese Academy of Sciences Institute of Automation (CASIA) iris database version 1 are used. It has database for 108 distinct persons which includes grey scale eye images of resolution 320x280 pixels.

B. Pre-processing

For any biometric identification technique before extracting the features some set of operations should be performed in order to improve the quality of the image. In the current work the iris database images are resized manually before loading in to the database.

(i) Resizing: in order to standardize the inputs to the system all the images in the database are resized to a uniform size of 256x256. This operation is done manually on each image of the database.

C. Iris Localization

Iris localization or segmentation segments the iris from the rest of the acquired image. The main steps in iris localization is to detect inner and outer circles, i.e. pupil boundary and iris-sclera interface. Generally Hough transform is used to localize the iris. But for the proposed method there is no need to locate pupil and iris.

D. Normalization

In general, inner and outer circle parameters obtained from the iris localization is given as input to the Rubber-Sheet model which performs polar to rectangular conversion. As a result iris template is generated. From this template features are extracted using different feature extraction algorithms. In our work, we have proposed a new technique for the iris normalization.

E. Feature Extraction

Various feature extraction techniques are applied for the iris template obtained from the normalization and feature vectors are generated. In this case, Biorthogonal wavelet transform and singular value decomposition techniques are used for feature extraction.

F. Matching

In the proposed work, for comparing feature vectors, Euclidean distance measure is used.

The Euclidean distance is calculated using following equation:

$$d(p,q) = \sqrt{(p_i - q_i)^2 + (p_j - q_j)^2}$$

Where,

(p_i, p_j) - The feature values of database image.

(q_i, q_j) - The features value of test image.

The paper is organized as follows. In section 2, some well-known previous papers of iris recognition are described. Next, the outline of the proposed algorithm is presented in section 3. In section 4, the implementation of the proposed work is described and experimental results are provided in section 5. And in section 6, some conclusions and future work are discussed.

2 Previous Works

A huge number of methods have been proposed for iris recognition. Among which Lenina Birgale et al., [1] proposed a method for Iris Recognition without Iris Normalization to improve system performance and reliability of a biometric system which avoided the iris normalization process used traditionally in iris recognition systems. Raida Hentati et al., [2] proposed an approach of Development a New Algorithm for Iris Biometric Recognition. In the proposed method a new algorithm based on Iris biometric is discussed. This technique uses normal methods for normalization and iris template is generated using Gabor filter. The algorithm is implemented using C/C++ code with OpenCV library functions. Mahmoud Elgamal et al., [3] proposed An Efficient Feature Extraction Method for Iris Recognition Based on Wavelet Transformation, in this a new approach of iris image compression and feature extraction based on discrete wavelet transformation (DWT) is applied. Ayra Panganiban et al., [4] proposed a method of Wavelet-based Feature Extraction Algorithm for an Iris Recognition System. The proposed algorithm aims to find out the most efficient wavelet family and its coefficients for encoding the iris template of the experiment samples. Swanirbhar Majumder et al., [5] proposed a singular value decomposition (SVD) and wavelet-based iris biometric watermarking. In this approach the discrete cosine values of templates are extracted through discrete cosine transform and converted to binary code. This binary code is embedded in the in Singular values of the host image's coefficients generated through wavelet transform. Sachin Gupta and Ashish Gagneja, [6] proposed a method of Iris Recognition Algorithm through Image Acquisition technique. This algorithm works in both environments such as indoor and outdoor conditions. V.Saravanan and R.Sindhuja, [7] proposed a method of Iris Authentication through Gabor Filter Using DSP Processor. This paper uses Gabor filters for feature extraction methods for iris authentication. Mohammed A. M. Abdullah et al.,[8] proposed a Efficient Small Template Iris Recognition System Using Wavelet Transform. In this paper, an effective eyelids removing method, based on masking the iris, has been applied. M. Vatsa, R. et al., [9] proposed a approach for Reducing the False Rejection Rate of Iris Recognition Using Textural and Topological Features. Here Gabor wavelet is used to extract textural features and Euler numbers are used to extract topological features of the iris.

3 Proposed Method

The proposed method gives a brief idea of a new iris normalization technique using circular masking. For the proposed method, CASIA V1 iris database is used. After the selection of database, these database images are preprocessed (resized) manually to 256x256 image size. These preprocessed images are given as input to the circular masking algorithm. And is described as follows:

The steps involved in the circular masking technique:

1. Read Input Eye Image:

In this step, preprocessed iris image is taken as input eye image.

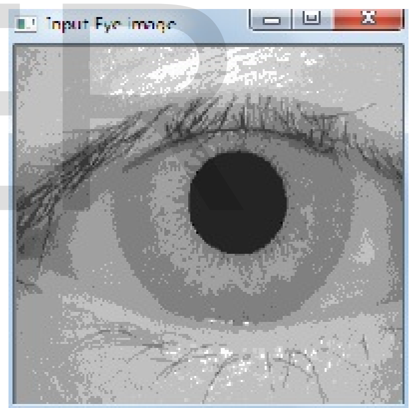

Fig.3.2(a) Input Eye image

2. Create a Blank Image:

Create a blank image, which has dimensions exactly that of input eye image shown in figure 3.2(a).

3. Creating Mask Image:

Now, draw a circle on the blank image which is created earlier (in step 2) using OpenCV built-in function 'ellipse'. In this case, size of the mask depends upon the iris area of input eye image that can be varied manually which depends on your selected images in the database.

Syntax to create mask image:

void ellipse (Mat&*img*, Point *center*, Size *axes*, double *angle*, double *startAngle*, double *endAngle*, const *Scalar&color*, int *thickness*=*1*, int *lineType*=*8*);

Here, the parameters are defined as -

- img - Image
- center - center of the ellipse

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- axes - size of the ellipse main axes

  In this case, the arguments of axes represent the length of the ellipse's major and minor axes. And since we're creating a circular mask here, we need to give same values for major and minor axes.
- angle - ellipse rotation angle in degrees
- startAngle - starting angle of the elliptic arc in degrees
- endAngle - ending angle of the elliptic arc in degrees
- color - ellipse color
- thickness - thickness of the ellipse arc outline if positive or equal to = +1, otherwise this indicates that a filled ellipse sector is to be drawn (if it is set to '-1')
- lineType - type of the ellipse boundary

Figure 3.2(b) below shows the mask image corresponding to input eye image.

4. Masked image or Circularly masked image:

Here, the selected portion of iris image i.e. circularly masked image (figure 3.2(c)) is generated by performing 'bitwise_AND' operation between input eye image (figure 3.2(a)) and mask image (figure 3.2(b)).

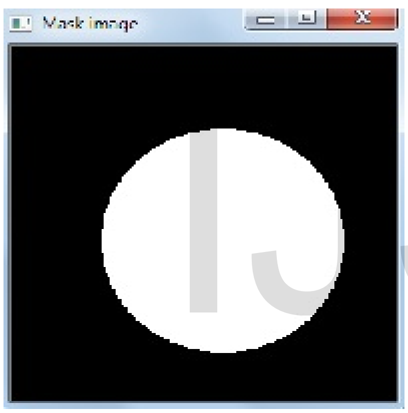

Fig.3.2(b) Mask image

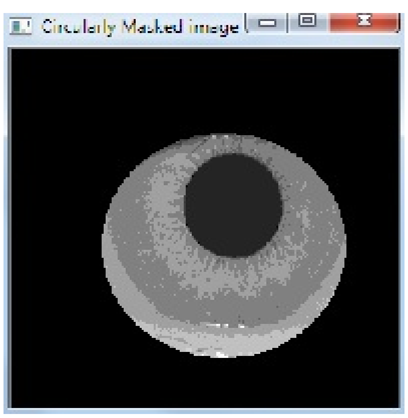

Fig.3.2(c) Circularly masked image

Syntax to create circularly masked image:

```
void bitwise_and(Mat&img1, Mat&img2, Mat&res);
```

Here,

img1 - input eye image
img2 - Mask image
res - circularly masked image

5. Apply Threshold:

The circularly masked image shown in figure 3.2(c) contains some unwanted data for the feature extraction (i.e. pupil, eyelashes, bright pixels that obtained during image acquisition and some portions of sclera). By applying threshold we are able to eliminate the unwanted pixel values from the circular portion of iris image. This can be explained as follows -

For the circularly masked image:

i) Initially, we have obtained all the pixel values which are greater than zero. There we found, pupil pixel values does not exceed single digit.
ii) Then we have set a threshold to obtain pixel values which are greater than largest pupil pixel value (X) and less than 255 (represents white pixel value) and resultant pixel values are stored in one variable. (X > pixel value < 255)
iii) Now by formal verification we found the maximum portion of iris data for some threshold. This is how we found the maximum and minimum pixel value of iris data for an input eye image.
iv) Next, we have repeated above steps for all images present in the database and the final threshold values are set. i.e. (X1 > pixel value < Y1)

Where,

X1 - minimum pixel value for considered database
Y1 - maximum pixel value for considered database

This is how we have obtained the effective iris data (figure 3.2(d)) from the circularly masked image. And this effective iris data is given as input to the feature extraction algorithm for further calculations. Here, the effective iris data obtained from the proposed method is less; as a result, algorithm takes less computation time.

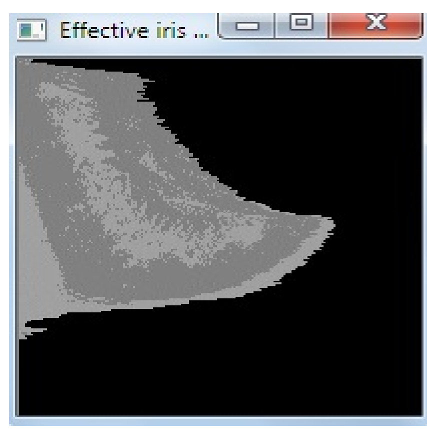

Fig.3.2(d) Effective iris data

And the flowchart of the circular masking technique is shown

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in figure 3.3.

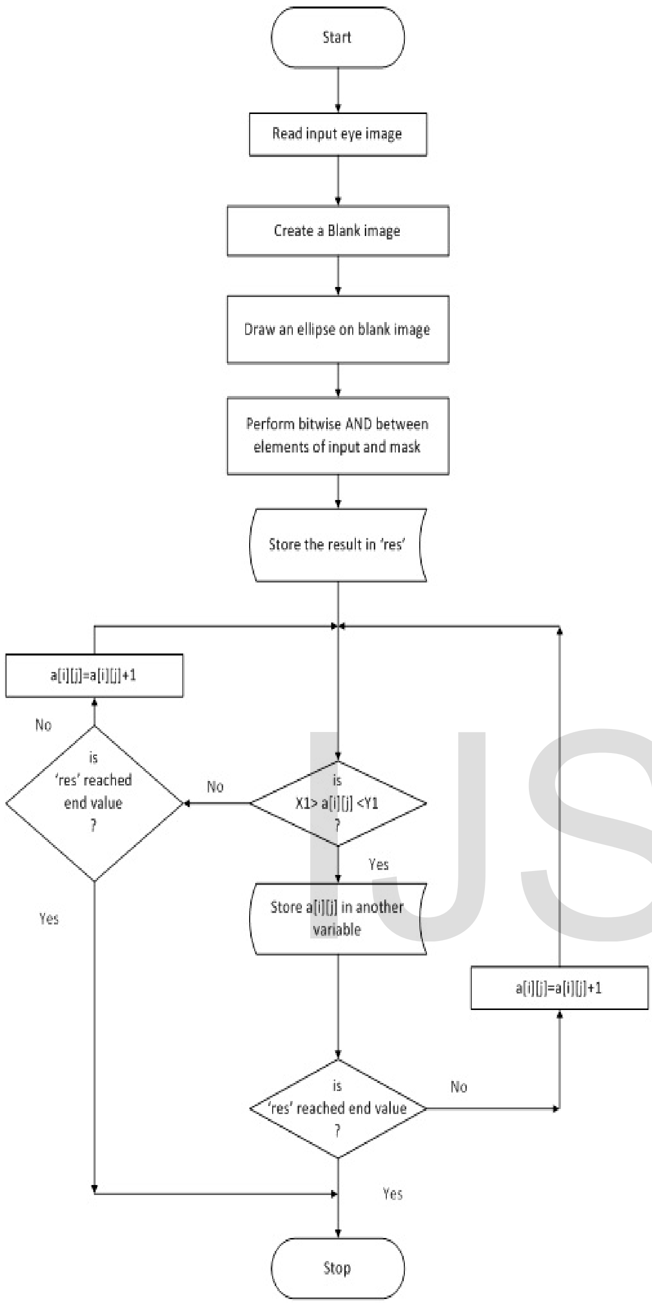

Fig.3.3. Flowchart of Circular Masking technique

4 IMPLEMENTATION

Implementation of proposed work is carried out in the following steps:

Step1: An iris image from CASIA V1 is taken as input.

Step2: Image is resized manually to 256x256.

Step3: The size of the image is extracted and converted into a matrix.

Step4: Circular masking technique is used to extract effective iris data.

Step5: Biorthogonal wavelet transform/SVD features are extracted from the iris matrix.

Step6: Steps 2 to 5 are repeated for the test image.

Step7: The test image features are compared with database image features using Euclidean distance.

Step8: Based on Euclidean distance, match/mismatch is evaluated by fixing a threshold.

Step9: The performance parameters FAR, FRR, EER and TSR are calculated.

5 EXPERIMENT RESULTS

For the experimental computations we have considered 14 persons from the CASIA V1 database. Then for the effective iris data (obtained from the circular masking technique), biorthogonal wavelet transform and singular value decomposition feature extraction techniques are applied. And performance parameters are calculated using Euclidean distance measure. All these experiments are conducted on Microsoft Visual Studio 2012 IDE using OpenCV 2.4.8 built-in library functions. And the results are tabulated below in table 1.

Table 1: Comparison with Biorthogonal wavelet and SVD

Method	TSR(%)	EER
Biorthogonal Wavelet	85.714%	0.1428
SVD	92.857%	0.0714

6 CONCLUSION AND FUTURE WORK

In the proposed work, iris normalization is performed using circular masking technique. Here, mask image is generated for each image (of database) during run-time. And the occlusions present in the image (i.e. pupil part, eyelashes, bright pixels and some portions of sclera) are eliminated by applying threshold. By this technique, the effective iris data can be extracted. In the future, these results can be improved by applying histogram technique to find maximum and minimum iris pixel value.

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