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EFFICIENT IRIS RECOGNITION SYSTEM USING TEXTURAL AND FAKE DETECTION FEATURES

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Abstract

In recent years, automatically recognizing irisplays a vital role in real world applications. Iris recognition is the automated biometric recognition technique based on iris patterns obtained from human iris images. The unique pattern of iris makes iris recognition system more accurate.Many novel methods have been proposed to tackle the automatic Iris recognition problem. One of the difficult issues for a successful iris recognition system is, to design a robust system with fake detection features. In the proposed method, Fake detection features and textural features are used for the recognition of human iris. Input images are obtained from CASIA v4 database. Input image obtained are enhanced using histogram equalization. Features are obtained directly from the histogram equalized image and are stored in the database. In the matching phase, the features of test image is compared with already extracted features that are stored in the database .This is done by using Support Vector Machine (SVM) classifier. If both the feature of test image and feature that are stored in the database matches, the person will be authorized else the person will be unauthorized.This method produces high degree of accuracy.

Keywords:

Iris recognition;

Histogram equalization;

Textural features;

Fake detection features;

Support Vector Machine Classifier (SVM).

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1. Introduction

A biometric system provides automatic recognition of an individual based on some sort of unique feature or characteristic possessed by the individual. Biometric systems have been developed based on fingerprints, facial features, voice, hand geometry, handwriting, the retina and the iris. A good biometric is characterised by use of a feature that is highly unique so that the chance of any two people having the same characteristic will be minimal, stable so that the feature does not change over time, and be easily captured in order to provide convenience to the user, and prevent misrepresentation of the feature. The iris is a thin circular diaphragm, which lies between the cornea and the lens of the human eye. The iris is perforated close to its centre by a circular aperture known as the pupil. The function of the iris is to control the amount of light entering through the pupil, and this is done by the sphincter and the dilator muscles, which adjust the size of the pupil. The average diameter of the iris is 12 mm, and the pupil size can vary from 10% to 80% of the iris diameter. The iris consists of a number of layers, the lowest is the epithelium layer, which contains dense pigmentation cells. The stromal layer lies above the epithelium layer, and contains blood vessels, pigment cells and the two iris muscles. The density of stromal pigmentation determines the colour of the iris. The externally visible surface of the multi-layered iris contains two zones, which often differ in colour. An outer ciliary zone and an inner pupillary zone, and these two zones are divided by the collarette which appears as a zigzag pattern.

A biometric is a unique, measurable characteristic or trait of a human being for automatically recognizing identity. This measurable characteristic can be physical, such as eye, face, retina, iris, finger print, hand geometry and voice or behavioural, like signature and typing rhythm. Biometric system must be able to recognize or verify the person quickly and automatically. By means of biometric highest level of security is achieved. The accuracy and performance of biometric system is measured using false rejection ratio of true owner of biometric and false acceptance ratio of fraudulent user.As compared to other biometric traits iris, a thin circular diaphragm, which lies between the cornea and the lens of the human eye has unique epigenetic pattern remains stable throughout adult life. Iris patterns are characterized by high level of stability and distinctiveness. Each individual has a unique iris. The difference exists between identical twins and even between the left and right eye of the same person. Also iris detection is one of the least invasive technique.These characteristics make it very attractive for use as a biometry for identifying individuals

The success of iris recognition method depends upon the features that are obtained from the iris images. Iris Recognition system concept was first proposed by Flom and Safir in 1987. Adams wai-kin Kong proposed resampling algorithm to detect statistical dependence between bits for analysis of iris codes[1].Liu et al. [2] involved orientation matching to recognize iris boundaries and circle fitting to remove outliers. Additionally, eyelid and eyelashes are delineated to improve segmentation efficacy. Moreover, Frucci et al. [3] devised watershed based recognition in noisy images.Bhateja et al. [4] advocated sparse representation and knearest subspace in segmentation. In [5], employed an adaptive histogram equalization and median filtering to segment iris from an eye image. Michalhaindl and MikulasKrupicka uses multispectral spatial probabilistic model and adaptive thresholding for the detection of iris from non-occlusion region[6].In[7], contour of iris boundary are detected by using radius vector function for iris recognition. Statistical moment is used for feature extraction in [8]. Canny edge detection and circular hough transform are used for edge detectionin [9],[11].

In [10] one dimenstional Gabor wavelet transform is used for feature extraction.Daughman's Algorithm is used for feature extraction[12]and in[13] hard thresholding and morphological processing is used for feature extraction. In [14] wavelet transform and histogram equalization are used for authentication. Wavelet transform modulus maxima edge detection and improved canny edge detection are used for finding edge of an image in[15].

Researchers have also proposed a wide range of other descriptors for iris based on Discrete Cosine Transforms (DCT) [16], Discrete Fourier Transforms (DFT) [17], ordinal measures [18], class specific weight maps [19], compressive sensing and sparse coding [20], hierarchical visual code-books [21], multi-scale Taylor expansion [22], [23], etc. Deep learning has completely transformed the performance of many computer vision tasks [24], [25].In [26] Restricted Circular Hough Transform (RCHT) is used in combination with inverse transform. In this method some search points are assigned randomly and based on the search points the circular boundaries are calculated. The major drawback in this method is that it cannot be used for detecting all edge points in the image. The edges of the image vary depending upon the selection of the search points. In [27], Automatic Segmentation and Recognition of Iris from an eye image (ASR) using Fuzzy interference logic is for edge detection and the drawback here is some misclassifications occur. To over this limitation, in the proposed method additional features are used which improves the accuracy of the iris recognition system.

2. Proposed Method

In the proposed method,a new iris recognition system is designed to automatically recognize iris in real environments.Figure 1 shows the block diagram of the proposed method. The proposed work consists of two phases namely training phase and testing phase. In both the phases iris images from CASIA Iris V4 database are acquired, pre-processed and the features are extracted. Finally, at the testing phase, the extracted features of the test image are matched for authorization. If there is a match, the test image is authorized else it is unauthorized.

2.1 Preprocessing

Preprocessing is the process of improving image data that supressess unwanted distrotions or enhances some image features that are important for further processing. In the preprocessing stage, initial if the image is in RGB color converted to gray image else the gray image can be used for the further processing. Preprocessing also involves Histogram Equalization.

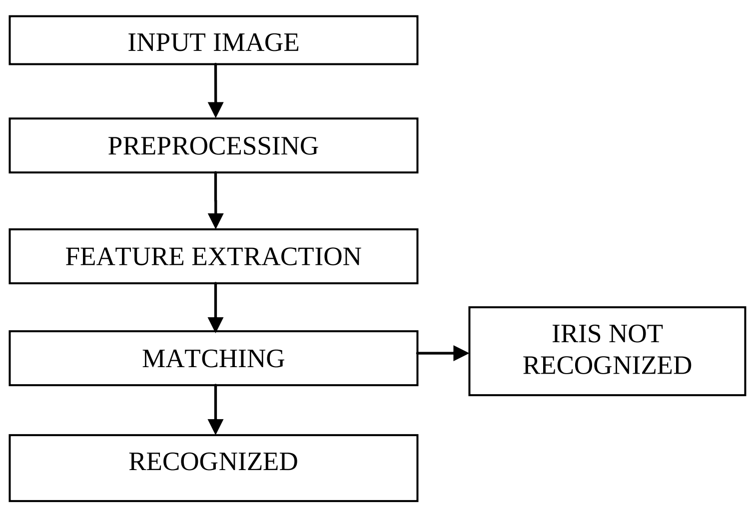


Figure1. Block Diagram of Iris Recognition System

Histogram equalization is a technique for adjusting image intensities to enhance contrast. Let f be a given image represented as a mrowsand n columns matrix of integer pixel intensities ranging from 0 to L − 1. L is the number of possible intensity values, often 256. Let pn denote the normalized histogram of f with a bin for each possible intensity. So

$$pn = \frac{\text{number of pixels with intensity } n}{\text{total number of pixels}}, \quad n = 0, 1, ..., L - 1. \qquad (1)$$

2.2 Feature Extraction

Texture feature means which measures smoothness, coarseness, and regularity of pixel in an image. In feature extraction phase both texture feature and fake detection features are obtained for accurate classification of iris biometric system.

Structural Content (SC):

It is defined as the ratio between the square of sum of original image and reference image.

$$SC(I, \hat{I}) = \sum_{i=1}^{N}\sum_{j=1}^{M}(I_{i,j})^2 / \sum_{i=1}^{N}\sum_{j=1}^{M}(\hat{I}_{i,j})^2 \qquad (2)$$

Where,

M*N is the size of the image matrix

Iis the original image

Îis the reference image

i,j denotes the pixel

Normalized Absolute Error (NAE):

It is defined as the ratio between sum of absolute of difference image and absolute of original image. The equation is given by

$$NAE(I, \hat{I}) = \sum_{i=1}^{N}\sum_{j=1}^{M}|I_{i,j}-\hat{I}_{i,j}| / \sum_{i=1}^{N}\sum_{j=1}^{M}|\hat{I}_{i,j}| \qquad (3)$$

R-Averaged Maximum Difference (RAMD):

Average maximum difference is calculated to the sum of maximum of R number value and divided by R .The equation is given by,

$$RAMD(I, \hat{I}, R) = (1/R)\sum_{i=1}^{N}\max_r|I_{i,j}-\hat{I}_{i,j}| \qquad (4)$$

In RAMD,

R is the greatest pixel difference of two images

Spectral Magnitude Error (SME):

The variance between the Fourier transform of real image to the Fourier transform of reference image is averaged using total number of pixel. The equation is given by, SME (I, Î) = (1/NM) $\sum_{i=1}^{N}\sum_{j=1}^{M} (| F_{i,j} | - | \dot{F}_{i,j} |)^2$ (5)

$F_{i,j}$ is the Fourier transform of original image

$\dot{F}_{i,j}$ is the Fourier transform of reference image

Spectral Phase Error (SPE):

The variance between the Fourier angle transformed real image to the Fourier angle transformed reference image is averaged using total number of pixel. The equation is given by

SPE (I, Î) = (1/NM) $\sum_{i=1}^{N}\sum_{j=1}^{M} | \arg(F_{i,j}) - \arg(\dot{F}_{i,j}) |^2$ (6)

$\arg(F_{i,j})$ is the Fourier angle transformed real image

$\arg(\dot{F}_{i,j})$ is the Fourier angle transformed reference image

Gradient Magnitude Error (GME):

The variance between the gradient of real image to the gradient of reference image is averaged using total number of pixel. The equation is given by,

GME ((I, Î) = (1/NM) $\sum_{i=1}^{N}\sum_{j=1}^{M} (| G_{i,j} | - | \bar{G}_{i,j} |)^2$ (7)

$G_{i,j}$ is the gradient of real image

$\bar{G}_{i,j}$ is the gradient of reference image

Gradient Phase Error (GPE):

The variance between the gradient angle of real image to the gradient angle of reference image is averaged using total number of pixel. The equation is given by,

GPE (I, Î) = (1/NM) $\sum_{i=1}^{N}\sum_{j=1}^{M} | \arg(G_{i,j}) - \arg(\bar{G}_{i,j}) |^2$ (8)

$\arg(G_{i,j})$ is the gradient angle of real image

$\arg(\bar{G}_{i,j})$ is the gradient angle of reference image

Mean:

Mean or average, in theory, is the sum of all the elements of a set divided by the number of elements in the set.

Mean = Sum of all the set elements / Number of elements

$$f(x, y) = \frac{1}{\mathrm{mn}} \sum \mathrm{g(r, c)}$$

(9)

mn	-	mxn matrix
f(x,y)	-	mean
g(x,y)	-	Set elements
(x,y)	-	pixel values of an image

Variance:

Variance is a measurement of the spread between numbers in a data set. The variance measures how far each number in the set is from the mean. Variance is calculated by taking the differences between each number in the set and the mean, squaring the differences and dividing the sum of the squares by the number of values in the set.

$$\sigma^2 = \sum_{i=1}^{n} (\mathrm{Xi} - \mu)2 \qquad (10)$$

Xi: individual data point

μ: mean of data points

N: no.of points

Standard Deviation:

Standard deviation (SD) is a measure that is used to quantify the amount of variation or dispersion of a set of data values. A low standard deviation indicates that the data points tend to be close to the mean (also called the expected value) of the set, while a high standard deviation indicates that the data points are spread out over a wider range of values.

$$\sigma = \sqrt{\sum_{i=1}^{n} \mathrm{pi}(\mathrm{xi} - \mu)2} \qquad (11)$$

Where, σ is the standard deviation of the image.

Energy:

Ability to detect and visualize classification can be improved using energy vector computation. Energy of image is computed by squaring and suming the pixels in ransformed image and is given by:

$$E=\sum_x \sum_y I(x,y)^2 \qquad (12)$$

Where I is the intensity of pixel value at x,y.

Contrast:

Contrast featurs extracted are used in classification to identify iris properly. Contrast information is estimated as:

$$C = \sum_x \sum_y (x-y)^2 I(x,y) \qquad (13)$$

Entropy:

The statistical evalution of randomness which characterizes the texture feature in an image is said to be entropy and is given by:

$$E_n = -\sum_x \sum_y p(x,y) log[p(x,y)]$$

(14)

Where p is the probabilty of occurrence of a particular pixel value.

2.3 Matching:

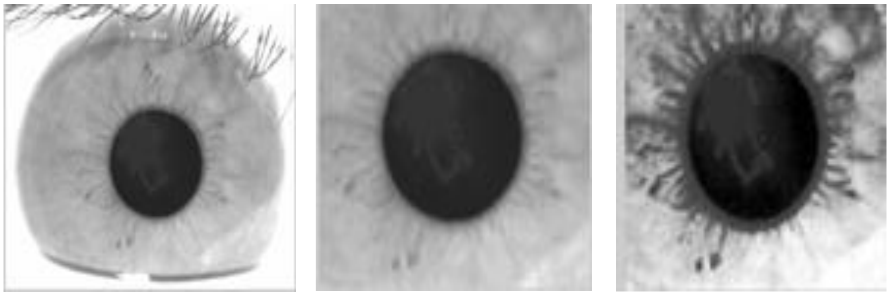
In the matching phase, the input image features are compared with already extracted features in the database. If both features match, the person will be authorized or else unauthorized. This is indicated with the help of a dialog box.

2.3.1 Support Vector Machine:

It is a supervised machine learning algorithm which can be used for classification. It transforms data and based on transformation it founds the optimal boundary between the outputs. Support Vector Machines (SVMs) are state-of-the-art classification methods based on machine learning theory. Compared with other methods such as artificial neural networks, decision trees, and Bayesian networks, SVMs have significant advantages because of their high accuracy, elegant mathematical tractability, and direct geometric interpretation. Besides, they do not need a large number of training samples to avoid over fitting.

3. Results and Discussion

Input images are obtained from CASIA database. CASIA Iris-V4 contains a total of 54,601 iris images with 1,800 genuine subjects and 1,000 virtual subjects. All iris images are 8 bit bitmap image format. They are collected from near infrared illumination.



(a) (b) (c)

Figure2. Iris Recognition system outputs (a) Input image (b) Cropped image (c) Image after Histogram Equalization

Input image is gray image. Input image used for training and testing data set are obtained from CASIA V4 database. A sample of input image is shown in Figure 2 (a). Figure 2 (b) shows sample cropped image which is used for further processing. Input image is cropped to obtained the iris region so that the accurate output can be obtained. Histogram equalization is a technique for adjusting image intensities to enhance contrast. Let f be a given image represented as a m rowandn column matrix of integer pixel intensities ranging from 0 to L − 1. L is the number of possible intensity values, often 256. Let p denote the normalized histogram of f with a bin for each possible intensity

Featues are extracted from the histogram equalization image. A sample of feature extracted is provided below.

Features =

SC	: 1.00040538552243
NAE	: 0.0330744382225920
RAMD	:1.88705018328604
SME	:832386.232606213
SPE	:5843.18304880370
GME	:36.5093769365704
GPE	:138659050.901504
Contrast	:1.85141731225650
Energy	:0.691256581377091
Mean	:0.646791737055516
Standard Deviation	:0.153515855322076
Entropy	:0.527789586941895
Variance	:0.0221311664271881

In matching phase, the features of test images are matched with already extracted features present in the database. If both the features matches, it will be indicated by using the dialog box iris recognized as shown below

Figure3. Iris recognized

Performance Evaluation:

The performance of the proposed method can be evaluated in terms of accuracy. Here the accuracy of proposed method is compared with other two methods.

Accuracy= [(Total identification attempted - (FA+FR)/ Total identification attempts] * 100 (15)

In the above equation,

FA represents thenumber of false acceptance and FR indicates thenumber of false rejections.

The comparision of the proposed method with other existing methodsis shown in Table1, which shows the better performance of proposed method.

Table1. Performance evaluation of the proposed method using accuracy

Method	**FA**	**FR**	**Accuracy**
RCHT [26]	15	11	95.667
ASR [27]	7	5	98
Proposed method	5	4	98.5

4. Conclusion

Iris recognition is the automated method for human identification. Human iris is stable and remains unchanged throughout human life. The proposed method employs Fake detection features and textural features are used for the recognition of human iris. Texture

Features and Fake detection are extracted and are stored in database. These features are then compared with the features of test image.If both the feature of test image and feature that are stored in the database matches, the person will be authorized else the person will be unauthorized. This method shows improved accuracy. In future, iris recognition framework can be extended to twins.

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