International Journal of Engineering and Advanced Technology (IJEAT)
ISSN: 2249-8958 (Online), Volume-4 Issue-4, April 2015

Performance Analysis on Iris Feature Extraction Using PCA, Haar Transform and Block Sum Algorithm

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Abstract: ***Iris recognition is the most accurate biometrics which has received increasing attention in departments which require high security. In this paper, we make a Comparative study of performance of image transforms using Haar transform, Principle of Component Analysis (PCA), Block sum algorithm technique for iris verification. to extract features on specific portion of the iris for improving the performance of an iris recognition system. The main aim of this paper is to show that how can we get better overall accuracy than the existing methods of feature extraction of iris recognition system. The proposed methods are evaluated by combining Haar transform and block sum algorithm based upon False Rejection Rate (FRR) and False Acceptance Rate (FAR) and the experimental results show that this technique produces good performance on CASIA VI iris database.***

Keywords: Iris recognition, biometrics, Block sum algorithm, Haar transform, PCA.

I. INTRODUCTION

Security related an issue has become an important aspect in each and every organization. Every organizations requires that there security methods should be as efficient as possible. Developments are being made day by day to enhance and improve the security. One such efficient method that is brought forward by means of this paper is Biometric. Biometric refers to the use of psychological or biological characteristics of human beings to determine the identity of the person. Identification of person is very important and is done is the most of the important sites such as banks, airports, companies and many more to identify the identity of the person. There are various methods to do the job such as assigning Id and password which is also called as knowledge based processing. But these approaches have limitations. Face recognition and speech recognition have also been widely studied over the last 30 years, whereas iris recognition is a newly emergent approach to personal identification in the last decade. Among all biometrics (such as fingerprint, face, palm print, gait, voice, iris, dental radiographs etc.), iris recognition is the most consistent one. The iris is a thin circular diaphragm, which lies between the cornea and the lens of the human eye. The pattern of the human iris differs from person to person; there are not ever two irises alike, not even for genetically identical twins. The iris is considered one of the most stable biometric, as it is believed to not change significantly during a person"s lifetime and its physiological response to light, Which provides the detection of a dead or artificial iris, avoiding this kind of counterfeit? Other properties of the human iris that increase its suitability for use in automatic identification include its inherent isolation and protection from the external environment, being an internal organ of the eye, behind the cornea and the aqueous humour.

Manuscript published on 30 April 2015.
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1.1 Primary Iris Recognition Process:

A typical iris recognition system is schematically shown in Fig.2. The whole iris recognition process is basically divided into four steps:

1) Image acquisition;
2) Iris image pre processing;
3) Iris feature extraction; and
4) Matching.

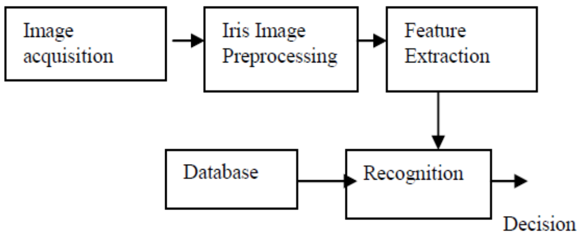

Figure 1.Typical Iris Recognition system

A typical iris recognition system is schematically shown in Fig. 1. The whole iris recognition process is basically divided into four steps: 1) Image acquisition; 2) iris image pre processing; 3) iris feature extraction; and 4) matching. Nowadays, various algorithms for iris recognition have been presented. Furthermore, the pre processing of iris image includes four aspects: localization, normalization, enhancement, denoising, and the selection of iris valid areas. Various algorithms have been applied for feature extraction and pattern matching processes. These methods use local and global features of the iris. A great deal of advancement in iris recognition has been made through these efforts; therefore, a detailed performance Comparison of all these algorithms is necessary. The goal of this paper is to compare feature extraction algorithm based on PCA, Haar transform, Block sum algorithm and proposed algorithm.

The remainder of this paper is organized as follows: Section 2 briefly discuss the image pre processing including iris localization, iris normalization and iris enhancement. A detailed description of the feature extraction based on PCA, Haar transform, Block sum algorithm is given in Section 3. Section 4 shows experimental result of proposed algorithm. Section 5 concludes this paper.

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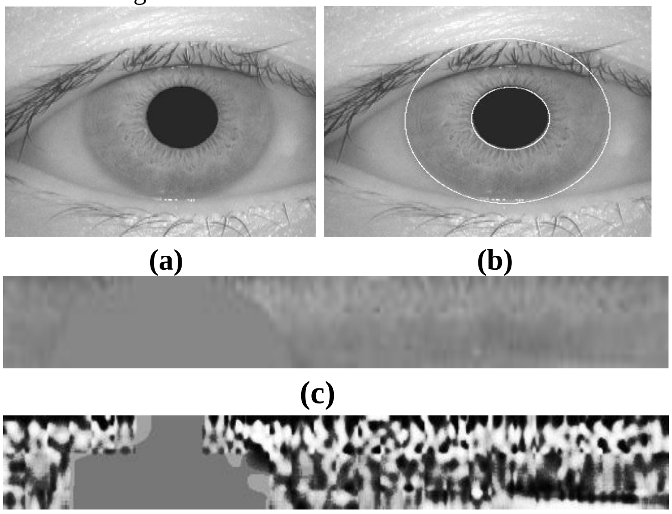
II. IMAGE PREPROCESSING

A captured iris image contains not only the region of interest (iris) but also some un useful parts (e.g. eyelid, pupil etc.). So, the image cannot be used directly without pre processing. In addition, a change in the camera-to-face distance may result in the possible variation in the size of the same iris. Furthermore, the brightness is not uniformly distributed because of non-uniform illumination. For the purpose of recognition, the original image needs to be pre processed to localize iris, normalize iris, and reduce the impact of the factors mentioned above. The pre processing is described in the following subsections.



(a) **(b)**

(c)

(d)

Figure 2. Pre processing of Iris Image
(a) Original Iris Image (b) Image after Iris Localization
(c) Normalization of Iris Image (d) Enhanced iris image

2.1 Iris Localization

The iris localization is to identify the iris area between pupil and sclera from an eye image. Both the inner boundary and the outer boundary of a typical iris can be identified as circles. However, the two circles are usually not co-centric. The method we utilized for iris localization includes simple filtering, edge detection, and Hough transform. The overall method is very efficient and reliable. An example of iris localization is shown in Figure 2b. We can see that the iris can be exactly localized using this technique.

2.2 Iris Normalization

A normalization process is needed to compensate for size variations due to the possible changes in the camera-to-face distance and to facilitate the feature extraction process by transforming the iris area represented by polar coordinate system into Cartesian coordinate system. Here, we anti-clockwise plot the iris ring to a rectangular block of texture of a fixed size. According to the requirement of feature extraction, this block is then divided into smaller sub images. The result after iris normalization is shown in Figure 2c.

2.3 Iris Image Enhancements and Denoising

The normalized iris image still has low contrast and may have non-uniform illumination caused by the position of light sources. All these may affect subsequent feature extraction and pattern matching. We enhance the iris image by means of local histogram equalization and remove high-frequency noise by filtering the image with a low-pass Gaussian filter. Figure 1d shows the pre processing result of an iris image. The iris has a particularly unique structure and provides rich texture information. So, it is necessary to explore representation methods which can describe global and local features in an iris. This section presents detailed description of iris recognition methods based on PCA, Haar transform and Block sum algorithm and proposed algorithm.

III. FEATURE EXTRACTION

3.1 Feature Extraction with Principal Component Analysis

The aim of feature extraction is to find a transformation from an n-dimensional observation space to a smaller m-dimensional feature space. Main reason for performing feature extraction is to reduce the computational complexity for iris recognition. Most existing iris recognition methods are based on the local properties such as phase, shape, and so on. However, iris image recognition based on local properties is difficult to implement. Principal component analysis can produce spatially global features. The original data are thus projected onto a much smaller space, resulting in data reduction.PCA was invented in 1901 by Karl Pearson. Principal component analysis (PCA) is a classic technique used for compressing higher dimensional data sets to lower dimensional ones for data analysis, visualization, feature extraction, or data compression. PCA involves the calculation of the eign value decomposition of a data covariance matrix or singular value decomposition of a data matrix, usually after mean entering the data for each attribute.

3.2 Feature extraction using Block sum:

Normalized iris image is used for features extraction.

Overall feature extraction processing is as following :

Step l. Divide normalized iris image into basic cell regions for calculating cumulative sums. (One cell region is a m x n pixels size, and an average grey value is used as a representative value of a basic cell region to calculate the cumulative sum) Step 2. Basic cell regions are grouped in a horizontal direction and in a vertical direction as shown in Fig. 3. (Five basic regions are grouped into a group) Step 3. Calculate cumulative sums over the each group like equation (2).Step 4. Generate iris feature codes. The cumulative sums are calculated as follows: Suppose that X1, X2, . .., X5 mean five representative values of each cell regions within a group.

$$X = X_1+X_2+...+X_5/5$$

1) First calculate the average 5

2) Calculate cumulative sum from 0: $S_0 = 0$

3) Calculate the other cumulative sums by adding the difference between current value and the average to the previous sum,

i.e., $S_i = S_{i\pm l} + (X_i - X)$ for i = 1,2,..., 5. (2)

After calculation cumulative sums, iris codes are generated for each cells using following algorithm after obtaining MAX and MIN values among cumulative sums.

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if Si located between MAX and MIN index
if Si on upward slope
set cell's iris code to "1"
if S5 on downward slope
x set
cell's iris code to "2"
else
set cell's iris-code to "0"

This algorithm generates iris codes by analyzing the changes of grey values of iris patterns. Upward slope of cumulative sums means that iris pattern may change from darkness to brightness. Downward slop of cumulative sums means the opposite change of upward slope.

3.3 Feature extraction using Haar Transform:

This sequence was proposed in 1909 by Alfréd Haar. Haar used these functions to give an example of a countable ortho normal system for the space of square-integral functions on the real line. The study of wavelets, and even the term "wavelet", did not come until much later. The Haar wavelet is also the simplest possible wavelet. The technical disadvantage of the Haar is that it is not continuous, and therefore not differentiable. This property can, however, be an advantage for the analysis of signals with sudden transitions, such as monitoring
of tool failure in machines. The Haar function ψ(t) can be described as:

$$\psi(t) = \begin{cases} 1 & 0 \le t < \frac{1}{2} \\ -1 & \frac{1}{2} \le t < 1 \\ 0 & \text{otherwise} \end{cases}$$

and its scaling function φ(t) can be described as:

$$\phi(t) = \begin{cases} 1 & 0 \le t < 1 \\ 0 & \text{otherwise} \end{cases}$$

3.4 Feature extraction using Proposed Algorithm :

By studying above algorithm we have used here the combination of Haar transform and Block sum algorithm.
The algorithm that we have used for our study on iris recognition is as given below:

1. Creation of feature vector database

1.1. Read the database image.

1.2. Extract the Red, Green and Blue component of that image.

1.3. Apply Haar transform and Block sum algorithm the Red, Green and Blue components of the image . This is the Feature Vector (FV) of that image.

1.4. Repeat steps 1 through 3 for every database image.

2. Testing phase

2.1. Read the Query image.

2.2. Repeat step 1.2 and 1.3 for the query image so as to obtain its Feature Vector.

2.3. For every Database image „i" and a Query image „q" the Mean Squared Error (MSE) is calculated using Equation 6.

$MSE\ (i) = 1/3M^{\Sigma m-1 \Sigma n=0 \Sigma d=0[}\ FVi(m,n,d) - FVq\ (m,n,d\ )]^2$

2.4. The trainee image with the least MSE is declared as the identified user.

2.5. Repeat steps 2.3 and 2.4 decreasing the value of M gradually from 128 to 1 and record the error obtained in user dentification for every fraction of the original feature vector.

IV. Experimental results and comparison:

Evaluating the performance of biometric algorithms is a difficult issue. Currently, there is also no detailed comparison among the iris recognition methods. For the purpose of comparison; we implement these methods according to the published papers. To compare their performance, we construct an iris image database named CASIA VI Iris Database. We use images of eyes from 25 persons, and every person has 5 images of eyes. MATLAB image processing tools were used to implement system. We use the usual methods to locate and normalize iris regions, and use the three methods mentioned above to extract the feature. Therefore, we only analyse and compare the accuracy and computational complexity of feature representation and matching of these methods. For each iris pattern, we randomly choose several samples for training and the rest for testing. After feature extraction, an iris image is represented as a feature vector. We used Hamming Distance similarity measures to measure the similarity of iris features. Two distance measure lead to similar results and recognition result does not vary drastically. Recognition rate is shown in Table 1

Method	FAR/FRR	Overall Accuracy (%)
Haar Transform	5/1	95%
PCA	¾	96.3%
Block Sum Algorithm	2.43/3.17	97.67%
Proposed algorithm	5/4	98%

Table 1. Experimental Results

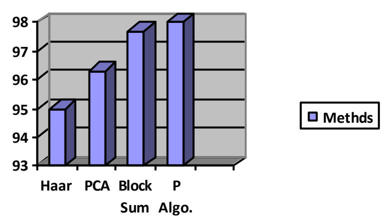

Fig.3. Accuracy of Haar, PCA, Block Sum and Proposed algorithm

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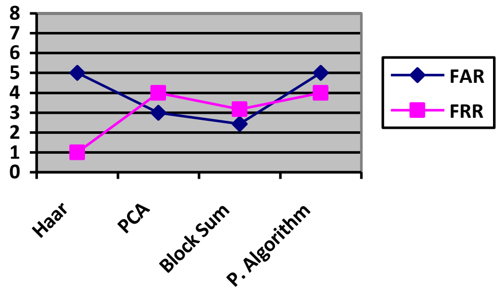

Fig.4. FAR/ FRR in Percentage (%) of Haar, PCA, Block Sum and Proposed algorithm

The results clearly demonstrate the effectiveness of the Daugman‟s method. With strict image quality control, our proposed algorithm is better than the Block sum, PCA and Haar transform algorithm. FAR and FRR in % with respective various methods as shown in graph.

V. Conclusion

In this paper, we have discussed Iris Recognition using Haar transform, PCA and Block sum algorithm and proposed algorithm. We have applied these transforms on the iris images for finding out the recognition rate. Results of this experiment have shown that the accuracy in recognition using proposed algorithm is better than Block sum, PCA and Haar transform. Also FAR and FRR in % with respective various methods as shown in graph. Thus, proposed algorithm provides better accuracy and recognition rate.

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