Study and Comparative Analysis of Features Extraction Based Iris Recognition Algorithms

Nisha Chauhan, Dr. Sandhya Tarar
School of ICT, Gautam Buddha University, Greater Noida

Abstract: Iris recognition is very famous and authentic process for identification of an individual. It consist 3 main steps to describe iris recognition process. Those steps are: segmentation, normalization and feature extraction. Iris is an internal part of an eye. It is considered as valuable human body part for the purpose of Authentication with maximum accuracy. Many techniques have been approached for iris recognition process. As Feature extraction is a very essential step in iris recognition. In this paper many feature extraction algorithms are analyzed such as Haar wavelet, PCA, 2d Log gabor filter, Biorthogonal wavelet transform, Singular value decomposition, Daubenichies Wavelet and Fast wavelet transformation. Compare these algorithms on the basis of following parameters: Accuracy, FAR, FRR, EER and CRR and generate a result. Result through comparison is used to conclude the best algorithm for iris recognition system and that can help in further research.

Keywords: Principle Component Analysis(PCA), Iris recognition, False Acceptance Rate(FAR), False Rejection Rate(FRR), Equal Error Rate(EER), Correct Recognition Rate(CRR), Fast Wavelet Transform(FWT).

1. Introduction
Iris is an internal part of an eye. It has very unique features and it has found that each and every eye have different and unique pattern. Even eyes (left and right) belong to an individual have different patterns from each other. These characteristics of eyes can use for authentication. In many places different processes are using for authentications such as user_id card, fingerprint, and face recognition and so on but there might be possibilities of false occurrences or less accuracy. Iris recognition provides more accurate result as compare to others.

It is one of the most promising approaches due to its high reliability for an individual identification. It is highly impossible for 2 irises to generate same iris code. As iris is an internal part of an eye so the possibilities of getting affected from environment or any modification in iris pattern is zero. Iris recognition system is very safe and useful for security purposes i.e. (Border identification, Airport, Refugee migration and so on).

Iris recognition includes following steps: image acquisition, segmentation, normalization, feature extraction, matching.

Figure1: Iris recognition process

The fast and effective implementation of iris recognition system depends on iris recognition algorithm [11]. Various algorithms have been proposed in this field. These algorithms are used to extract iris pattern and convert them into iris code.

In this paper different approaches/techniques are studied and analyzed. Among all feature extraction algorithms, PCA is a technique which is use to extract main variations in feature vector. It is use to project n dimensions into k dimensions hence to reduce the dimensionality for computation. It is effective if there is no noise [1]. SVD is a method which identify and ordering the dimension of data sets exhibit most variation. It is more accurate and fast algorithm for feature extraction [12]. Fast wavelet transform is a mathematical method to define time domain into space domain. This algorithm has less complexity rate as well as fast computational rate. Major issues in iris recognition system are computational rate and memory management. A large memory space is required to maintain database and feature vector.
Haar wavelet transform uses energies to encode the iris pattern according to the threshold value and result small size of feature vector i.e. 64 bits. 64 bits vector size can store easily and reduces matching time [13]. Gabor wavelet is used to analyze iris pattern and encode in terms of phase structure at various scale. When these phase information are quantized they generate random bit stream for iris pattern [1]. Like these algorithms there are many more exists. Further detailed discussions on the performance of algorithms take place in section 2. To judge which algorithm is performing well there is a comparison conducted in this study.

Related to this system many researchers have contributed with different approaches and techniques, in this system most of good papers are studied in sequence.

2. Literature Review and Comparative Analysis of Iris based Feature Extraction Algorithms

Extraction of feature is an essential part of iris recognition system therefore this part should be done accurately. Iris recognition system performance can be adversely affected if there is low feature accuracy. Feature extraction indicates which iris pattern is useful to map and contain maximum information of iris. Many researchers have already done in this aspect and multiple algorithms/techniques have been proposed such as:

Pravin S. Patil, S. R. Kolhe, R. V. Patil, and P. M. Patil [1] represented PCA method which is used for feature extraction. It reduces computational complexity. It produces spatially global features for iris pattern. PCA algorithm aim is to search x orthogonal vectors that can be used to represent data, with maximum variation. Thus it results into data compression [1]. PCA maps high dimensional dataset into low dimensional dataset. After implementing algorithm on CASIA [14] database it conclude feature vector length and recognition rate which are as follows: 1100 and 90.2% respectively [1]. Accuracy, FAR and FRR are 96.3, 3 and 4 respectively [16]. MATLAB various image processing tools were used for implementation.

Advantages of PCA: lack of data redundancy [15], it has low noise sensitivity, lesser memory requirement; it is computationally inexpensive [1]. Disadvantage of PCA: difficult to evaluate covariance matrix in an accurate manner [15].

Mahesh Patil, Raghuveer K [2], studied Biorhogonal wavelet which required two filters one for synthesis and another for analysis of input from dataset. First number indicates order of synthesis filters and second number indicates analysis filters. Software Microsoft Visual Studio 2012, OpenCV 2.4.8 and Beagleboard-Xm hardware is used. Euclidean distance for matching is used to compare feature vectors [2]. Database CASIA IV used for sample eye images. FAR, FRR, EER and CRR are .16, .22, .1428 and 99.8572 respectively.

Vanaja Roselin.E.C and Dr.L.M.Waghmare [3] suggested haar wavelet for feature extraction using five levels decomposition to construct the feature vector [3]. This has performed on CASIA IV database using Matlab software for implementation. Haar wavelet has implemented on lower half of iris. FAR, FRR and EER are .025, .033 and .03% respectively. Its CRR is 99.97% [3]. Advantages: It increases accuracy, efficiency and reduces computational complexity [3].

Abikoye Oluwakemi C., Sadiku, J. S., Adewole Kayode S., and Jimoh Rasheed G, [4] proposed fast wavelet algorithm to generate iris code. Fast wavelet transformation method is defined as fast and has less complexity rate. This algorithm is proposed for feature extraction to extract the features of the iris and encodes the features to generate its 2048bits iris feature codes [4]. Advantages: it is fast and less complexity rate.

Anap Manisha Baban & Vikhe Pratap. S. [17] proposed 2d log gabor filter for iris code generation. It has implemented for feature extraction where polar iris image is decomposed into 2D signal. Then 2D signal then convolved with filter in frequency domain. It is used for an individual identification with lower FAR, FRR and high accuracy. It has tested on CASIA [14] database. FAR, FRR and accuracy are .00, .075 and 99.96 respectively. Advantage: It reduces false rejection cases to zero.

Mahesh Patil, Raghuveer K [2], studied SVD method which is a matrix factorization technique that factors a x by z matrix B into product of 3 matrices. It represents an expansion of the original data into coordinate system where the covariance matrix is a diagonal. Software Microsoft Visual Studio 2012, OpenCV 2.4.8 and Beagleboard-Xm hardware is used. Euclidean distance for matching is used to compare feature vectors [2]. Database CASIA IV used for sample eye images. FAR, FRR,
EER and CRR are .44, 0, .0714 and 99.928 respectively.

P. S. Revankar, Anisa Anjum [18] proposed Daubenchies Wavelet method. It employed for feature extraction. Decomposed normalized iris image using it at 4th level. Reliable and better result achieved by DB10 with lower FAR. FAR and FRR are 0 and .62% respectively. Feature vector size is 1216 bits.

<table>
<thead>
<tr>
<th>Algorithms</th>
<th>FAR</th>
<th>FRR</th>
<th>EER</th>
<th>CRR/Accuracy rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCA</td>
<td>3</td>
<td>4</td>
<td>3.7</td>
<td>96.3</td>
</tr>
<tr>
<td>Biorthogonal wavelet</td>
<td>.16</td>
<td>.22</td>
<td>.1428</td>
<td>99.8572</td>
</tr>
<tr>
<td>Haar wavelet</td>
<td>.025</td>
<td>.033</td>
<td>.03</td>
<td>99.97</td>
</tr>
<tr>
<td>2d log gabor filter</td>
<td>.00</td>
<td>.075</td>
<td>.04</td>
<td>99.96</td>
</tr>
<tr>
<td>SVD</td>
<td>.44</td>
<td>0</td>
<td>.0714</td>
<td>99.928</td>
</tr>
<tr>
<td>Daubenchies Wavelet</td>
<td>0</td>
<td>.62</td>
<td>.48</td>
<td>99.52 [19]</td>
</tr>
<tr>
<td>FWT</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Figure2: Analysis of Iris Recognition Algorithms in terms of FAR, FRR, EER and CRR/Accuracy

Figure3: Comparative Analysis of PCA, Biorthogonal Wavelet, Haar Wavelet, 2 D Log Gabor Filter, SVD, and Daubenchies Wavelet Algorithms

3. Conclusion

Iris recognition system which is use to identify an individual is an authentic way. In this paper many feature extraction algorithms are discussed in detail. Techniques has been analyzed and compared on the basis of FAR, FRR, EER and CRR/Accuracy parameters. Haar wavelet has maximum accuracy i.e. 99.97% and minimum EER .03%. Best algorithm with maximum accuracy is Haar wavelet algorithm. 2d log gabor filter reduces false rejection cases to zero can also results into effective Iris recognition system.

4. REFERENCES


36 Nisha Chauhan, Dr. Sandhya Tarar


[14] CASIA database


