Secure and Efficient GA based Algorithm for Iris and Ear Biometric System

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Abstract- Uni-modal biometric frameworks have to deal with a range of problems such as noisy-data, intra-class disparities, spoof-attacks, and undesirable error-rates. Some of these restrictions could be addressed by multi-modal biometric systems which assimilatenumerous sources of human data to recognize andadditionally to deliverextreme-secure system for the data. The key objective of the proposed-system is to examine the performance of two-traits that namely are, ear & iris, and united them by using score level fusion approach. Ear & Iris Recognition system was constructed by taking out their features with the help of Independent Component Analysis (ICA) technique. The features of both traits are extracted using common method, ICA is used for feature extraction, Genetic algorithm has been used for feature reduction, and then hamming distance is used for matching purpose. The whole stimulation take place in MATLAB environment.

Keywords- *Ear Biometrics; Iris Biometrics; Security; Multimodal.*

I. INTRODUCTION

Biometric authentication systems verify a person's claimed ID from their various behavioral traits such as signature, voice etc. or by their physiological traits such as face, iris, and ear. Multimodal biometric system overcomes the limitations of unimodal biometric systems such as non-universality, intra-class variability, noise in sensed data, spoofing, and inter-class variability [1]. Multi-modal biometric system could be constructed using more than one physiological or behavioral distinctive characteristic for verification as well as identification purposes. These types of systems are developed for security reasons in numerous fields such as e-commerce, crime investigation, and military purposes. Multi-modal biometric system developed by utilizing fingerprint, or hand geometry, they requisite the concerned human to make physical contact with a sensing device.

Most of the existing biometric systems developed were based on single biometric features such as ear, iris, fingerprint, face, etc. Each of the biometric-trait has its specific strength and weakness. Fig. 1 shows the different biometric traits which are popular these days.

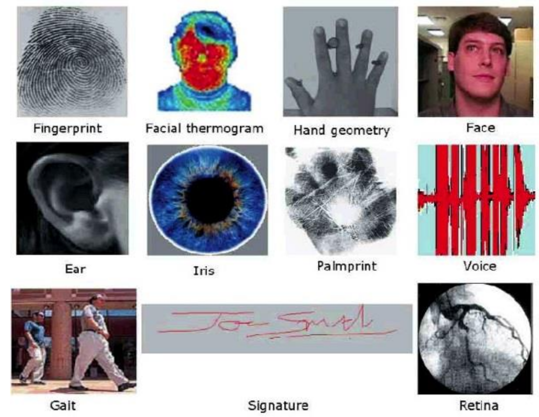

Fig. 1: Various Biometric traits of human beings

Some of the problem with fingerprint recognition system is finger-print pictures have been perceived to have quite poor-ridge details. Similarly, face recognition system fails due to difference in facial-expression. Therefore, while evolving biometric systems the choice of biometric traits is important in order to accomplish muchbetter performance.

In this proposed work, two of the unique traits of human being such as iris and ear are fused to obtain a better performance and higher security.

II. MULTIMODAL FUSION

Fusion in multimodal biometric system can be done at different levels of biometric verification process: feature extraction level, matching score level and decision level [4].

A. *Feature extraction level*

Feature vectors acquired by taking outsome resultant features from dissimilar traits are self-determining to each other. They are fused into a single vector for identification procedure. If the fused-vector has huge dimensionality, then feature reduction methods could be implemented to decrease the dimensionality of the specific feature data.

B. *Matching score level*

When some specific feature vectors are matched with the template-vector, a similarity score will be obtained. This measure indicates the proximity of the vectors for individual's identification.

C. *Decision level*

Each acquired input trait is handledindependently& the resultant feature-vector is categorized into two separate decisions, i.e. either they are accepted or rejected for every single trait. Established on the major voting system, final decision would be taken.

As our main objective is to utilize iris along with ear traits, the initial step is to acquire feature vectors of both traits individually and implement the fusion in it based on the necessity.

III. EDGE DETECTION & LOCALIZATION

The first step in any recognition system is to segment some specific region from original image. Iris segmentation [6] locates the iris boundary and pupil boundary, using canny edge detector. The mathematical model of canny edge detector is given as:

Initially, eye image is convolved with Gaussian filter to eliminate noise, then the gradient magnitude and the direction of the image is computed. The mathematical model of 1D Gaussian filter is:

$$gf_1(a) = \frac{1}{\sqrt{2\pi\sigma}} e^{\frac{-a^2}{2\sigma^2}} \quad (1)$$

The resultant image has some wide ridges. Non-maxima suppression approach removes the wide ridges, by suppressing the edge points that do not constitute the local maxima. Finally hysteresis thresholding is applied, which make use of two thresholds to remove the false edge points. The above steps give the edge points of iris region. The segmented Iris region is shown in Fig. 2.

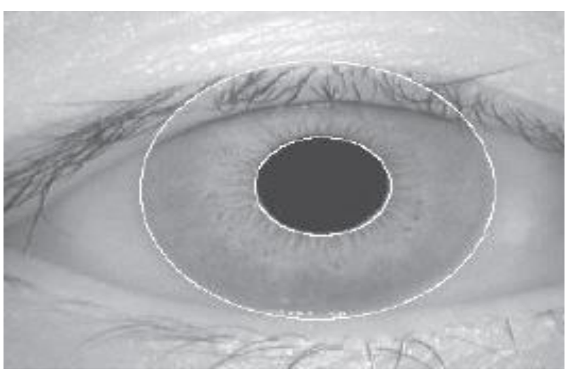

Fig. 2: Segmented Iris Region

To detect the iris boundaries in the case of darker iris person, Circular Hough transform is applied, which takes each edge point as centre and draw circles of different radii. The centre through which large number of circles passes and its corresponding radius is chosen as iris boundary. To find the pupil boundary, apply canny edge detector and Circular Hough transform, to the region within the detected iris boundary. The top and bottom eyelid region are removed by eliminating the pixel values outside the iris boundary. The pixel values between the iris and pupil boundary gives the iris region.

IV. FEATURE EXTRACTION

The region of interest for each trait, iris and ear is segmented by edge detection [7], Hough transform [8],[9],[10] and morphological operations [11] respectively. The features are extracted from both traits independently by appropriatetechnique of extracting features. The feature extraction techniques can be chosen either classifier- based such as such as Principal Component Analysis (PCA),Independent Component Analysis (ICA), Linear Discriminant Analysis approaches or wavelets for instance Gabor wavelet, Haar wavelet depending on the requirements concentrated either on specific features [11] or general geometric features [12].

A. *ICA Technique*

Independent Component Analysis (ICA) is a measurable system that speaks to a multidimensional source vector as a direct blend of non-Gaussian irregular free variables called free segments. ICA basically designed for multivariate data. ICA is somewhat related to Principal ComponentAnalysis (PCA). But it is capable when PCA fails. The data used for analyzing using ICA can be originatedfrom many fields like economics, digital images, document databases etc. It expects to catch the free sources keeping in mind the end goal to examine the basic haphazardness of the watched signs.All in all terms ICA grabs the free segments of the pictures.

Steps of ICA Algorithm are:

Step 1: Make data to mean zero
Step 2: Choose the number of components.
Step 3: Whiten the data.
Step 4: Choose random matrix.
Step 5: Orthogonalised the matrix.
Step 6: Do converged.
Step 7: Repeat again.
Step 8: Stop.

V. FEATURE REDUCTION

In this features are reduced and optimized from extracted features through ICA. Mathematically it can be written as following in steps:

- Use statistical “latent variables“ system
- Random variable s_k instead of time signal

$$xj = aj1s1 + aj2s2 + .. + ajnsn, for\ all\ j \quad (2)$$

$$x = As \quad (3)$$

- IC's **s** are latent variables & are unknown AND Mixing matrix **A** is also unknown
- Task: estimate **A** and **s** using only the observeable random vector **x**
- Lets assume that no. of IC's = no of observable mixturesand **A** is square and invertible
- So after estimating A, we can compute $W=A^{-1}$ and hence

$$s = Wx = A - 1x \qquad (4)$$

A. Genetic Algorithm

Genetic Algorithm (GA) are adaptive heuristic searchalgorithm based on the evolutionary ideas of normal range and inheritance. As such they signify an intelligent operation of an arbitrary search used to solve optimization problems [13].

In this method, a population is created with a group of individuals created randomly. The individuals in the populace are at that time calculated. The fitness function is delivered through programmer which also provides individuals a score based on how well they perform at the given task. Two individual are then chosen dependingupon their fitness, greater the fitness, the higher and the chance of being selected. These individuals then "reproduce" to create one or more offspring, after which the offspring are mutated randomly. This process will carry on unless an appropriate answer has been established or a definite amount of generations have passed, depending on the needs of the programmer.

VI. MATCHING

In this stage, the comparison is performed between test image and trained image. For the testing image processing steps such as segmentation, normalization and feature extraction are carried out. The generated feature vector from the testing image is then compared with training image feature vectors. The similarity between test images with the training set is measured by hamming distance.

VII. FUSION

Fusion in multimodal biometric system occurs at various levels. Score level fusion is the simpler form of fusion, which takes place prior to matching. Score level fusion combines [14, 15, and 16] the similarity scores of all the traits involved in recognition. The sum rule based fusion and support vector machine based score level methods are experimented over National Institute of Standards and Technology- face, fingerprint and multimodal biometrics which shows multimodal biometric system produces higher accuracy. A new normalization scheme called Reduction of High score effect is introduced in[15] that minimizes the variations in scores. The results suggest that preprocessing the scores using any normalization scheme can improve the results of score levelfusion. The matching scores can also be assigned with weights according to different approaches [17]. The first step in score level fusion is similarity score generation. The similarity score between test images and all images in the training set is measured independently for iris and ear

Based on the idea of sum rule based score level fusion, the generated matching scores of iris and ear data are summed uptogether to form a final fused score. The final score iscompared against the threshold (.2). If the score is higher than athreshold, the person is rejected. Otherwise, the person identityis authenticated. The fused final score is calculated as given in Equation.

$$Fusion_{sco} = Sco_{Iris} + Sco_{Ear} \qquad (5)$$

$Fusion_{sco}$- final fused score

Sco_{Iris} - Iris similarity score

Sco_{Ear} - Ear similarity score

VIII. EXPERIMENTAL RESULTS

The system is tested on iris [R]/ear [R] images obtained from UCI machine learning algorithms database. Iris[R] using Hough transform performs better as compared to other localization techniques in case of occlusion due to eyelids and eyelashes. The detection of eyelid boundary fails in case of images taken under intensive light conditions. Thus the image of iris should be taken under controlled lightening and illumination condition. Same in case of ear detection it is performed better with canny edge detector to get edges.

The average values obtained from proposed framework are given as Accuracy= 99.88, FAR= .0011 and FRR= 2.34. These parameter values are computed when feature extraction has been done using ICA and GA algorithm.

Table 1: Parameter Values

Images	FAR	FRR	Accuracy
1.	2.245	0.00263	99.4057
2.	2.443	0.00246	99.6523
3.	2.547	0.00529	99.3657
4.	2.743	0.00669	99.7482
5.	2.655	0.00712	99.8681
6.	2.442	0.00443	99.8588
7.	2.341	0.00201	99.3943
8.	2.506	0.00391	99.8956
9.	2.143	0.00317	98.9945
10.	2.641	0.00232	99.9024

Above tables shows the values of FAR, FRR and Accuracy when feature extraction has been done using ICA algorithm. For testing 10 images from image dataset has been taken, and so results are obtained accordingly from those images.

Table 2: Comparison Parameters

Parameters	Proposed Method (GA +ICA)	Base Paper Method (PCA)
Accuracy	99.86	95
FAR	0.001	0.12
FRR	2.34	0.225

From the above table it has been concluded that GA+ ICA obtained values are much better in comparison to PCA only. As GA works as optimization algorithm to optimize the ICA obtained values.

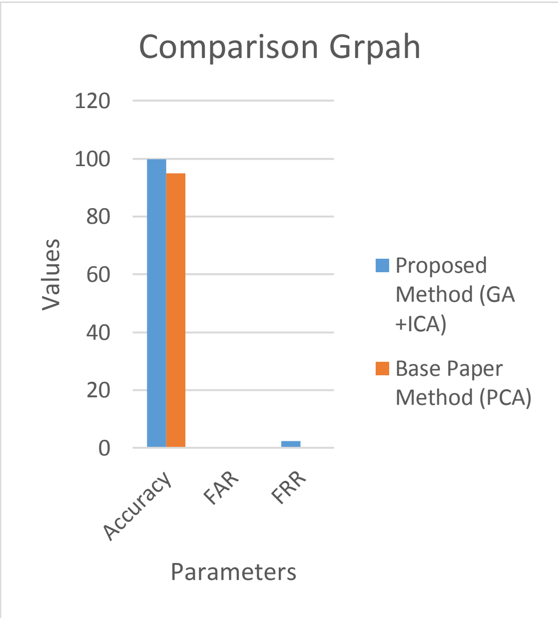

Fig. 3: Comparison Graph

IX. CONCLUSION

In this proposed work, two of the unique traits of human being such as iris and ear are fused to obtain a better performance and higher security.The features of both traits are extracted using common method, ICA is used for feature extraction, Genetic algorithm has been used for feature reduction, and then hamming distance is used for matching purpose. Here, these two traits are united using score level fusion. The results obtained from the proposed system are being evaluated using FAR is 0.0020, FRR is 2.14 and Accuracy 99.86%. In the end, these results are compared with PCA only, which shows the proposed system gives better accuracy than previous one.

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