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A Hybrid Approach for Secure Biometric Authentication Using Fusion of Iris and Ear

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Abstract*— Biometrics is always developing innovation which has been broadly utilized as a part of numerous official and business distinguishing proof applications. The expanded concerns in security amid late years have basically brought about more consideration being given to biometric-based validation methods. A biometric based verification is fundamentally an example acknowledgment issue which settles on an individual distinguishing proof choice so as to focus the power taking into account of particular physiological or behavioral elements Multimodal biometric acting an important role in human recognition, which overcome the issue of unimodal biometric system. The proposed research is based on fusion of two unique traits, iris and ear and to study their enactments. This paper proposes a technique for individual identification using fusion of ear and iris data. The features of iris and ear traits are extracted using Principal Component Analysis algorithm mainly for dimensionality reduction without information failure and used for identification and then again using PCA technique in hybridization with BFO algorithm for optimization has been used. the ear and iris traits area unit combined along using score level fusion, after that matching will be done on the basis of fusion and its performance is verified during authentication. The show evaluation of proposed method is done using FAR, FRR, Accuracy and Recognition rate in MATLAB environment.

Keywords*— Multi model Biometric, Fusion and traits, Principal component analysis, and Bacterial Foraging optimization.

I. INTRODUCTION

Biometric authentication system authenticates a person's declared identity from behavioral individuality like signature and voice or physiological traits like face, iris and ear. Multimodal biometric system overcome the limits of unimodal biometric systems such as non-universality, noise in sensed data, spoofing, intra class [1] variability, inter class variability. Multimodal biometric system can be build using more than one physiological or behavioral characteristic for recognition and authentication purposes. These types of systems are developed for security reason in a diversity of fields like crime research, e-commerce and military purposes. Multimodal biometric system developed using fingerprint, hand geometry, they essential the concerned human to make physical contact with an intellection device. Figure no: 1 shows that's 1 the different biometric traits popular recently.

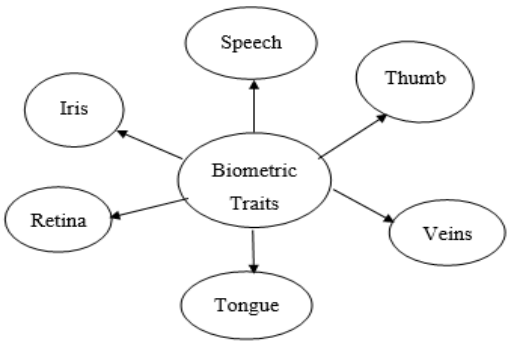

Figure no: 1 Biometric Traits [1]

Some of the complexity with fingerprint recognition system is fingerprint images have been experiential to have poor edge details [2]. An equally, face recognition system be unsuccessful due to variation in facial appearance. Hence while developing biometric systems the option of biometric behavior is significant in order to achieve improved performance. In this planned work, two restricted personality iris and ear are fused to attain a better presentation and high security.

- *Iris recognition:* Iris Recognition is the best way of recognition in today's world. There are some features [5] that make iris recognition high efficient and precise like: steady, exclusive, flexible, reliable, and non-invasive.
- *Ear Recognition:* Ear recognition in the field of biometrics is a new method. The structure of the ear is robust because it does not change with the facial expressions. The external ear constitutes the most unique design, characteristic features and peculiarities [6] for the purpose of identification.

- *Multimodal Biometric System:* A multi-biometric structure is one in which a variety of list of information are created and utilize for a scope of reason [7].

Figure no: 2 shows a common diagram of multimodal biometrics. In the proposed work, Principal component analysis algorithm is used to extract the features of input iris and ear images. Segmentation, normalize and feature encoding are the subsystem. Score level fusion is made by matching the trial image with the descriptions register in the record using Euclidean distance [3]. The system error of a multi modal biometric system is a grouping of the False Acceptance Rate and the False Rejection Rate from different biometric knowledge. A different Uni-modal biometrics, the grouping of several dimensions makes it harder to examine the accuracy of a multi modal biometric system [4]. An investigational consequence has been analyzed and conclusion and expectations work has been discussed.

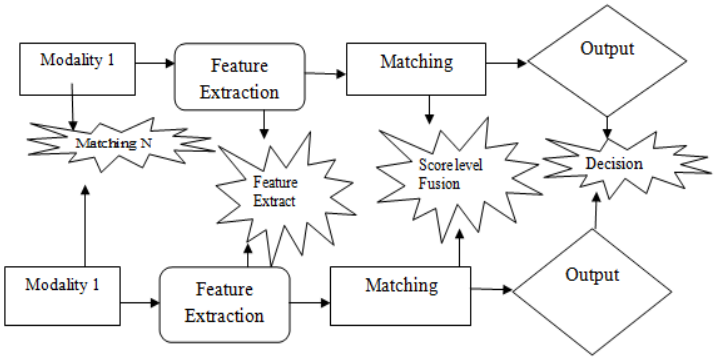

Figure no: 2 Multi model Biometric System [18]

Characteristics of biometric system:

- Uniqueness
- Acceptability
- Performance

Table no 1 Types of biometric operations

Verification	Identification
In verification phase the system check the identity of the person by relating the taken biometric data with the template data that is stored in the database [8].	To identity of an individual's take place by examining the templates of every person in the database for matching.
In this system a person claims the identity that needs to be recognize via user name, a Personal Identification number after that comparison is conducted that whether the claim is right or wrong.	The identity of the individual one too many comparison is conducted. No claiming is done in this phase [9].
Verification is important so that several persons could not use the same identity or individuality	Identification is done to check that whether the person is not denying

- ***Fusion***

The fusion of biometric traits leads to the improvement of the performances by reducing the negative results. E.g. fusion of iris and ear is more effective in accordance to the use of only iris or speech modalities. Fusion has been used effectively for years in large scale automatic many recognition system. Today, a variety of fusions are used in a number of dissimilar types of biometric systems. Fusion can be used to deal with a number of issues faced by the expensive, implementers, and operative of biometric systems [10]:

- Accuracy
- Efficiency
- Robustness
- Applicability

Fusion for combining two or more biometric systems. The three likely levels of fusion are:

- Fusion at the feature extraction level
- Fusion at the matching scores level
- Fusion at the decision level.

We applied in Score level Fusion; each system gives a matching score representative the proximity of the feature vector with the pattern vector. These scores can be combined to declare the authenticity of the claimed identity. Techniques such as logistic regression may be used to combine the scores report by the two sensors. These techniques challenge to minimize the FRR for a given FAR.

- *PCA (Principal Component Analysis):* The most accepted a person recognition algorithm is Principal Component

Analysis [11]. The main proposal is to design relate data in order to highlight difference and comparison by finding the principal directions i.e. the eigenvectors of the covariance matrix of a multi-dimensional data. For testing the biometric system, iris [L] or ear [L] images were used from the training set of iris [L] and ear [L] images. A previous to going to next step first train the PCA using the instruction set of images, to produce eigenvectors. They represent image is computed by the training data as:

$^{M}_{n-1}\Gamma_n$ ……. *(1)*

Each training image is decreased by mean image as:

$_1 = \Gamma_1 -$ *i=1, 2 ...M* ……. *(2)*

It is large vectors set subjected to PCA which seeks a set of M ortho normal vectors, Un. The kth vector, Ua, is chosen such that:

$_k = 1/M \, ^{M}_{n-1}(U_a{}^{T}{}_n)^2$ ……(3)

The vectors Ua and scalars λk are the eigenvectors and Eigen values correspondingly of the following co-variance matrix:

$C = 1/M \, ^{M}_{n-1}(_n{}_n{}^{T}) = AA^{T}$ …… (4)

The mean image Ψ of the covered set is total. This is predictable onto the "iris break" or "ear space" by the M Eigen vectors derivative from the training set. This gives:

$^k = {}^{T}_{K1}$ K=1…….. M …….. (5)

Euclidian distance is calculated for iris or ear class as follows:

$D_k = {}_k$ ..... (6)

Where kth iris or ear class is describing by Dk vector. Each image in the preparation set is partial into the image space and its component is kept in memory. The image space has to be filled with these known images. Euclidean distance to be calculating by this stored images.

BFO (Bacterial Foraging Optimization): Bacterial Foraging Optimization Algorithm is an optimization algorithm which reduces the noise, features selected [12], unnecessary data and gives the high accuracy. Kelvin M Passion invented the BFO algorithm. It is basically a feature selection algorithm that led to following objectives:

- bound storage necessities, increase speed of processing
- Performance enhancement to achieve high correctness
- Exploitation of full resources.
- Improving identification rate

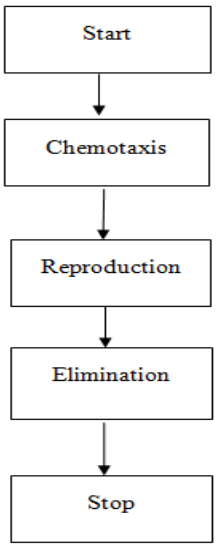

Figure no: 3 Flow Chart of BFO [12]

II. RELATED WORK

Kumar et. al. (2012)[13] explored a fresh method for the automatic human recognition utilizing 2D ear imaging. Here, they demonstrated an entirely automatic method meant for the robust subdivision of the curved area of interest utilizing morphological operators as well as Fourier descriptors. They also investigated a different feature extraction methodology intended for ear identification utilizing localized orientation data as well as also inspect local gray-level stage data utilizing multifarious Gabor filters. Their research work created a computationally smart as well as effective substitute to illustrate the spontaneously segmented ear images utilizing a couple of log-Gabor filters. A rank-one recognition accuracy of 96.27% and 95.93% is reached during investigational outcome, correspondingly, on the database. **Ashraf Aboshosha et. al. (2015) [14]** described that there was many problems in single biometric system such as skit attacks, noisy data and non-universality. To solve these types of problems multiple biometric systems was wormed. Multimodal biometric system uses two or more distinct modalities. They used three traits iris, fingerprint and features. Then score level fusion take place for synthesis to get better the accurateness. Min-max normalization is use to normalize the score obtain from classifiers. To acquire fusion sum, product and weighted sum rules are used. After investigational result it was proving that multimodal biometric systems overtake unimodal biometric systems and best results are agreed by

weighted sum rule as compare to sum/product method. **Harpreet Singh Brar et. al. (2014)[15]** introduced a remarkable bacterial Foraging Optimization method for the acknowledgment of unique finger impression on the premise of the minutia disinterested focuses whose constituent has been clarified in the sub segments of the paper. They additionally introduced an examination of the examination of precision of BFO and SVM classifier. **M. Fathima Nadheen et. al. (2013) [12]** report that the essential goal of the proposed framework was to investigated the execution of two qualities, in particular, ear and iris, independently and consolidated them by applying score level combination system. Ear and Iris Recognition structure was fictitious by removing their elements utilizing Principal Component Analysis procedure by deciding the Eigen vectors for dimensionality reduction without data misfortune. The closeness between the test information and the training set is calculated and joined mutually utilize total standard based score level combination strategy. This proposed framework is executed to believe and look at the execution of multi characteristics amid combination. The combination work results to 95% attainment rate, which was advanced as different to a Unimodal framework.

III. SIMULATION MODEL

The methodology of the process can be understood with the following flow diagram which clearly explains the work in steps. The below figure shows the various steps that are being followed to get the biometric fusion of iris [L] and ear [L].

Figure no: 4 Purposed Work

- *Training: PCA*
- *Upload the left iris samples*- Image acquisition has been done from UCI online website.

Figure no: 5 Iris [L] Biometrics [12]

Compute edge using Canny Edge detection .apply initial filter using threshold rule. Image contains unusual parts, so it is needed to cut the useful part then forward it to further processing. It is called pre-processing. Canny edge detector is applied to get the edges of the image. The purpose of edge detection in general is to significant reduce the amount of data in an image, while preserving the structural properties to be used for further image processing.[24].then apply Hough circular transformation to detect circular region in the iris image.

- *PCA algorithm*- Apply PCA algorithm over the segmented part and extract PCA features**.**
- *Upload a Left ear samples*- Converted into grey scale image acquisition of ear biometrics. Image acquisition/capturing of image is the first step of our proposed technique which is collected online. Captured image is of size 10-12 kb and of any format like bmp, png, jpg etc.

Figure no: 6 Ear [L] Biometric [19]

- *PCA algorithm* - Apply PCA algorithm and extract PCA points.
- *Score level Fusion*- Fuse scores of iris and ear and save it to the database. Score level fusion has been take place for iris and ear biometric. The basic fusion formula can be described as below:

  F= i1 e1 + 12e2

  Where i1 and i2 is iris matching score and ear matching score, e1 and e2 are their weights, F is the fusion score. The weights e1 and e2 are varied over the range [0, 1], such that the constraint e + e = 1 is satisfied.
- *Testing: PCA*
- *Upload a Left iris and Left ear image*- Upload an iris file and extract PCA points by following the same procedure as that have been done in Training. Upload an ear file and extract the PCA points as same as Training part
- *Extract Features and fuse*- Feature extraction take place by PCA algorithm Fuse the test scores with score level fusion and match them with scores of database. If the scores of any file of database is same as that of the scores of testing part then the database set is considered to be matched else not matched.
- *Matching Of Left Iris And left ear Biometrics*- Matching is done by using Euclidean reserve. Current fusion value and the cost saved in database will match by using Euclidean distance

  Evaluate FAR, FRR, Accuracy Values.
- *Calculate FAR*

  Total Number of Images in the database=

  Number of Images that falsely accepted=

$$FAR=\frac{\text{Total Number of Illustrations}-\text{Number of Illustrations falsely accepted}}{\text{Total Number of Illustrations}}$$

- *Calculate FRR*

  Total Number of Images in the database=

  Number of Image that falsely accepted=

$$FRR=\frac{\text{Total Number of Illustrations}-\text{Number of Illustrations falsely accepted}}{\text{Total Number of Illustrations}}$$

- *Calculate Accuracy* 100− (FAR+FRR) %
- *Training: PCA+BFO*
- *Upload left iris samples*- Compute edge using canny edge detection. Apply initial filter using threshold rule. Apply Hough circular transformation to detect circular region in the iris image
- *PCA & BFO Algorithm*- Apply PCA algorithm over the segmented image to find features and then BFO is applied to the features of PCA.
- *Upload left Ear samples*- Upload a left ear sample and converted into grey scale image.
- *PCA & BFO algorithm* – PCA will be applied on ear image and then features are extracted then BFO is applied to optimize the fitness Function. Bacterial Optimization Algorithm optimization of fitness function in proposed work can takes place using following formula;

  Function [f, fs, ft, e] = fitness_fn (e, Fs, Ft)
- *Score level Fusion*- Fuse scores of iris and ear and save it to the database. Score level fusion has been take place for iris and ear biometric. The basic fusion formula can be described as below:

  F= i1 e1 + 12e2

  Where i1 and i2 is iris matching score and ear matching score, e1 and e2 are their weights, F is the fusion score. The weights e1 and e2 are varied over the range [0, 1], such that the constraint e + e = 1 is satisfied.
- *Testing :PCA+BFO*
- *Upload iris & ear image* – Upload iris image and follow the same procedure as did in Training part. Upload an ear image and extract the features.
- *Extract features and fuse*- In this features are extracted by using PCA then BFO is too applied for optimize the fitness function.

- *Matching using Euclidean Distance*- In matching Process, Training values that is stored in database and the new values that is come during Testing Part is to be matched by Using Euclidean Distance.

Evaluate FAR, FRR, Accuracy Values

- *Calculate FAR*

  Total Number of Images in the database=

  Number of Images that falsely accepted=

  $$FAR=\frac{\text{Total Number of Illustrations}-\text{Number of Illustrations falsely accepted}}{\text{Total Number of Illustrations}}$$

- *Calculate FRR*

  Total Number of Images in the database=

  Number of Image that falsely accepted=

  $$FRR=\frac{\text{Total Number of Illustrations}-\text{Number of Illustrations Falsely Rejected}}{\text{Total Number of Illustrations}}$$

- *Calculate Accuracy* 100− (FAR+FRR) %

  Comparison between Using PCA Only and PCA+BFO- In this step comparison between PCA and PCA+BFO algorithm are to be done using various parameters like FAR, FRR and accuracy.

IV. RESULT DISCUSSION

The system is tested on iris [L]/ear [L] images obtained from UCI machine learning algorithms database. Iris [L] using HCT performs better as compared to other localization methods in case of obstruction due to eyelids and eyelashes. It is difficult to detect eyelid boundaries if the images are taken under intensive light conditions. Thus the image of iris should be taken under exact lightening and illumination condition. Same in case of ear detection it is performed better with canny edge detector to get edges.

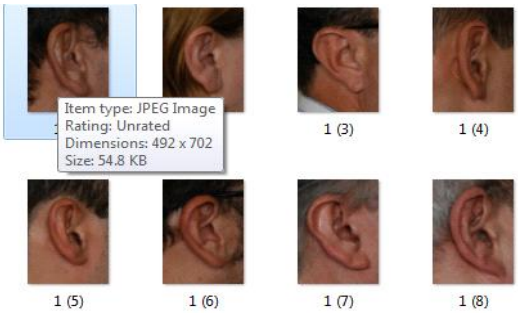

Figure no: 6 Ear [L] database

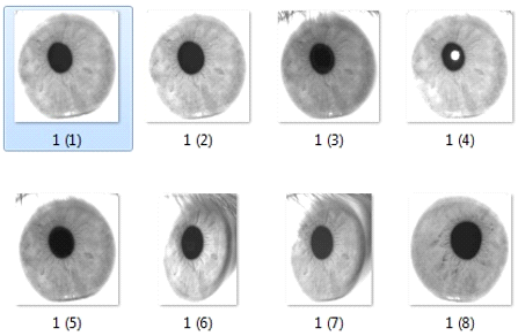

Figure no: 7 Iris [L] Database

Comparison of PCA only and PCA +BFO

The values of FAR, FRR, Accuracy and Recognition Rate when feature extraction has been done using PCA and BFO algorithm. Testing image dataset has been taken of 10 images, so values are obtained accordingly. From the above table it has been concluded that PCA+BFO obtained values are much better in comparison to PCA only. Accuracy of PCA+BFO is better than PCA. As BFO works as optimization algorithm to optimize the PCA obtained values.

Comparison of FAR between PCA only and PCA+BFO

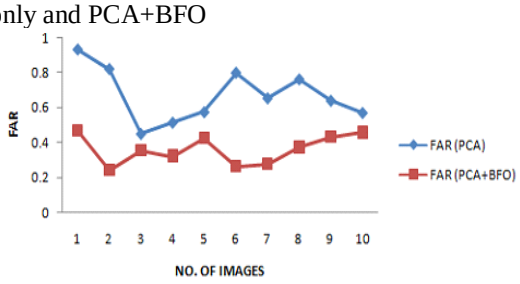

Figure no: 8 Comparison of FAR between PCA only and PCA+BFO

Comparison of FRR between PCA only and PCA+BFO

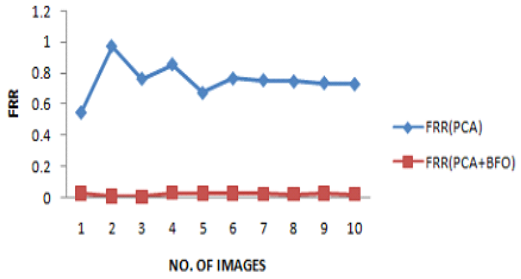

Figure no: 9 Comparison of FRR between PCA only and PCA+BFO

Comparison of Accuracy between PCA only and PCA+BFO

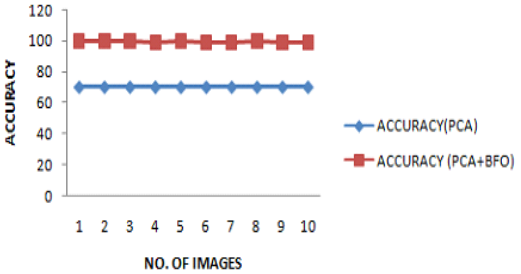

Figure no: 10 Comparison of Accuracy between PCA only and PCA+BFO

V. CONCLUSION AND FUTURE SCOPE

In this proposed work, iris and ear identification system was developed individually first. Feature vectors of iris and ear expanse was extracted using Principal component analysis. A new technique is generated at score level fusion to increase the performance of the iris and ear authentication system. In this firstly multimodal system is developed using PCA only then it is developed using PCA +BFO. After that FAR, FRR and accuracy has been evaluated in which PCA+BFO performs good having results like For PCA Accuracy = 70%, FAR=.81, FRR= .14 and For PCA +BFO Accuracy = 99.87 %, FAR= .31, FRR= .25.This improves the performance rate compare to single biometric authentication system and also increase the security level of authentication. But at rest performance can be enhanced by using other appropriate feature extraction technique.

The Future work to study the fusion of a variety of traits at feature level and analyze its performance. Also to find some trait withdrawal technique suitable for ear and iris other than wavelets. Future works could go in the direction of using Genetic algorithm or ICA in hybridization with BFO. Independent Component Analysis (ICA) is a computational method to get hidden values of random variables. ICA basically designed for multivariate data. The data used for analyzing using ICA can be originated from many fields like economics, digital images, document databases etc. Also GA optimization Algorithm is more powerful for the problems with several amounts of variables given. GA is very well organized in discovering the whole search space or any of the solution space, which is very large and difficult.

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