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BIOMETRIC FUSION BASED ON IRIS & THUMBPRINT USING ARTIFICIAL NEURAL NETWORK WITH OPTIMIZATION

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ABSTRACT

In the authentic world applications, biometric systems often face limitations because of feature selection, noise, size of data etc. Multi biometric systems are used to overcome this type of difficulty by providing various pieces of confirmation of the same identity. The proposed work belongs to biometric safekeeping domain for the identification and authentication. It gives explanation to the predicament of identification with lower errors, high accuracy, and less complexity of the proposed system. For solving the problem in proposed work, a multimodal biometric system by combining iris and thumb impression at match score level using artificial neural network (ANN) is being developed. In the proposed work, we present the biometrics recognition system based on the iris and thumbprint using the artificial neural network as a classifier. There are two sections, first section is iris recognition and second section is thumbprint recognition, after that we fused the result of both system to achieve better results. The work is being designed and developed on the basis of ANN as a classifier and as a feature extraction technique we use SIFT and minutia for iris and thumbprint respectively with BFO (Bacterial foraging optimization) and GA (Genetic Algorithm) as optimization techniques. Our investigational results suggest that the ANN method for the recognition at the decision level is the most excellent followed by the different techniques like Sum Rule, SVM, Clustering and KNN. The performance evaluation of proposed technique is reported in terms of FAR, FRR, and Accuracy after doing comprehensive tests on the CASIA-Iris databases for iris and the FVC 2004 fingerprint database and we concluded the accuracy of proposed system is more than 98% with a better FAR and FRR value..

KEYWORDS: Biometric Fusion System, Feature Extraction, SIFT Feature Descriptor, Minutia, BFO, Genetic Algorithm and Image Processing.

I. INTRODUCTION

The A biometric system [1] is essentially a pattern recognition system that operates by acquiring biometric data from a personality, extracting a feature set from the acquire data, and comparing this characteristic set against the pattern set in the database. Biometric authentication systems verify a person's claimed identity from behavioral traits (signature, voice) or physiological traits (face, iris, and ear). These types of systems are developed for security purposes in various fields like crime investigation, e-commerce and military purposes. Biometric system developed using fingerprint, hand geometry, they required the concerned human to make physical contact with a sensing device [4].

Biometric recognition, or just biometrics, refers to the mechanical recognition of persons based on their physiological and behavioral individuality. Most of the existing biometric systems developed were based on single biometric features (fingerprint, ear, face, iris and so on). Each biometric trait has its own strength and weakness.

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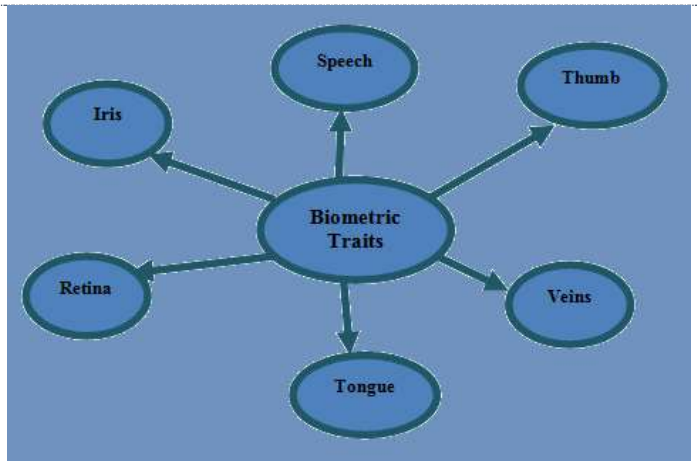

Figure 1: Biometric Traits

Above figure show the different types of biometrics traits which are used to develop a biometric system based on the multiple traits. The iris is a thin circular anatomical structure in the eye. The iris's function is to control the diameter and size of the pupils and hence it controls the amount of light that progresses to the retina. A front view of the iris and thumbprint is shown in figure 2 with important descriptions.

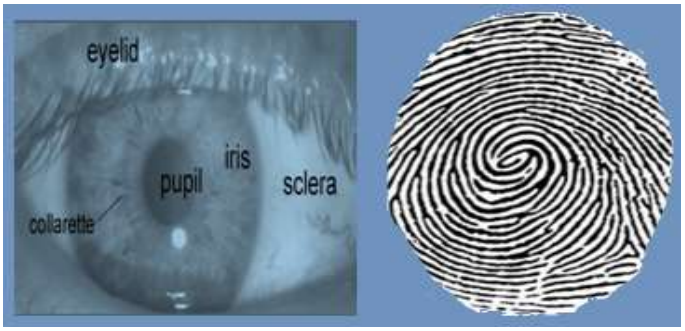

Figure 2: Iris and Thumbprint

Block Diagram of Biometric Fusion System

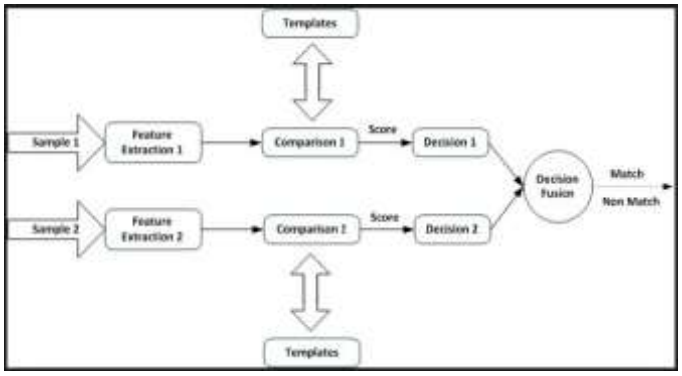

Figure: 3. Block Diagram of Biometric Fusion System

Above figure describe the Biometric Fusion System with the matching technique from the templates. The aim of Biometric Fusion System is present a more accurate and effective biometric system.

Yueqing Ren et.al, [1] has proposed a robust iris segmentation algorithm by using active contours without edges and improved circular Hough transform. . But in proposed work, they cannot effectively be used for iris images where the shape contour is not accessible, or when the shape content of iris image is more significant than contour feature. These limitations can be solved by using the optimization technique with a suitable feature

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extraction technique using their shape. M.Oravec, et.al, [15] has discussed the problems in unimodal biometric system during recognition accuracy. Experimental calculations were achieved on public dataset representing the accurateness of the system. The efficiency of proposed system about FAR and FRR is calculated by using Multimodal Biometric combination software. The most important problem with these approaches is that the discriminative capability is not much improved because the proposed methods have not utilized the inter-channel information of the used images very efficiently.

II. PROPOSED METHODOLOGY

In purposed work we used SIFT and Minutia feature extraction technique which is also known as rotation invariant interest point detector and descriptor with optimization technique to verify the efficiency and accuracy of an efficient Biometric Fusion System. We perform several experiments with this procedure on several Iris & Thumbprint images. In proposed work several steps will use to fusion of the images according to the trained database. The methodology of propose work is given below:

Step 1: Design and develop a particular GUI of proposed Biometric Fusion System according to the requirements and after that upload the images in both phase training as well as testing.

Step 2: Develop a code for the pre-processing on database images and test images.

Step 3: Develop a code for the feature extraction from the pre-processed image and we use separate algorithms to extract the features. The proposed algorithms used for feature extraction techniques are given below;

a. Uses SIFT Descriptor to extract the feature sets from the iris image.
b. Uses Minutia Extractor to extract the feature sets from the thumbprint image.

Step 4: Develop a code for the optimization from the extracted image and separate algorithms are used to optimize the features. Used optimization techniques are given below;

a. Uses BFO Descriptor to optimize the feature sets from the iris image
b. Uses GA to optimize the feature sets from the thumbprint image. Initialize genetic algorithm to optimize the SURF feature set. After that set the fitness function of Genetic Algorithm according to the requirement so we can find out the appropriate and optimal feature sets. The fitness function is given below,

$$\boldsymbol{Fitness\ Function} = \begin{cases} \boldsymbol{False}, & \boldsymbol{fs < ft} \\ \boldsymbol{True}, & \boldsymbol{fs \geq ft} \end{cases}$$

Where fs is selected feature and ft is the threshold feature.

Step 5: Initialize ANN for both biometric system.

Step 6: Apply training and testing on both biometric system. After training, the data is saved in the data base for both the images

Step 7: Testing is applied in both cases

a. For iris, if data is matched with the stored images in the data base, then fusion occurred. If not then the image is rejected.
b. Similarly, testing is performed on thumb print if data is matched with the recorded images then thumb print is recognized otherwise, the thumb print is rejected.

Step 8: After fusion, the parameters for the evaluation of the work are calculated like FAR, FRR and Accuracy. Below we describe the test image feature matching procedure with database feature sets in proposed Biometric Fusion System.

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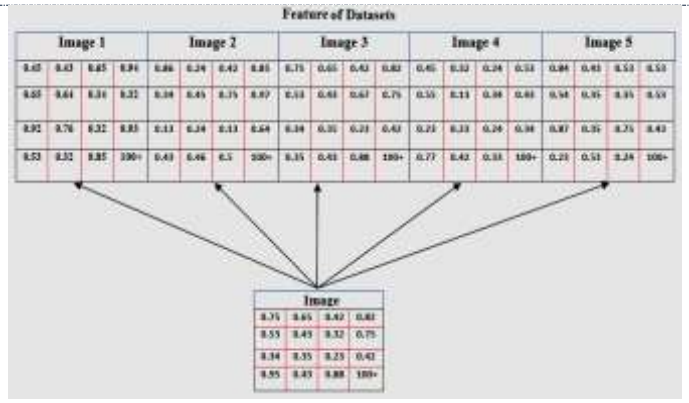

Figure: 4. Feature Matching of proposed work

In above figure the matching process in our proposed work is given. Using ANN training we check the test image feature data matching ratio with dataset features. After that we observed that test image features matched with 3rd number of dataset features. But some feature point different from dataset feature so we calculate FAR, FRR and Accuracy to check the efficiency of proposed CBIR system.

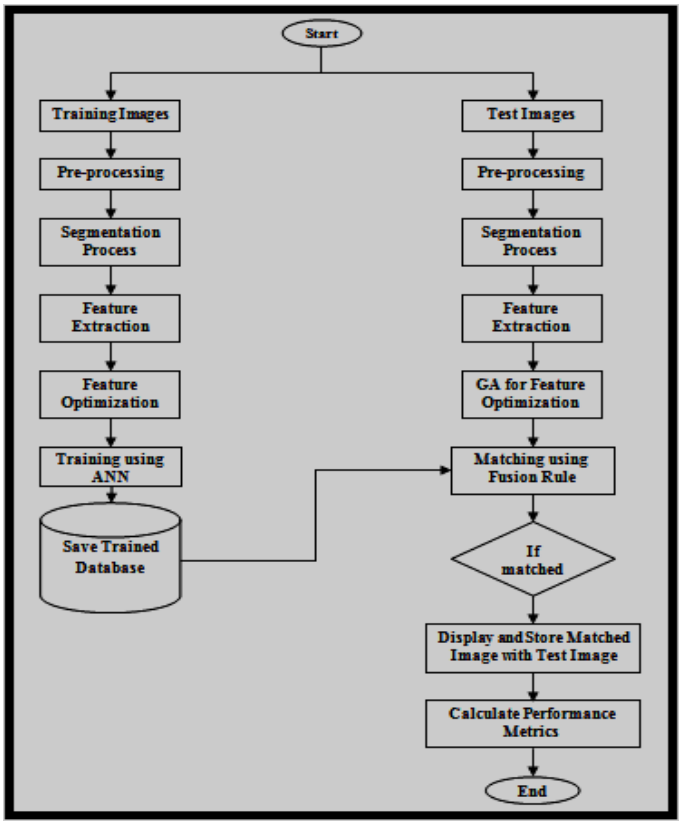

Figure: 5. Flow chart of proposed work

Above figure shows the flow chart of proposed work for the Biometric Fusion System based on SIFT and Minutia feature with optimization technique. By using above procedure we achieve better results which are well described in the next section with the simulation results.

III. SIMULATION & RESULTS

In this section we describe the simulation of proposed work with results. There are some algorithms which are used in the proposed simulation work:

ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

Algorithm 1st: Canny Edge Detection

Upload image
Apply pre-processing on uploaded image
Generate blurring in the image
Initialized canny magnitude technique
For I = 1 to all pixels
    Smoothing=Image (I)
    Finding gradients= Image (I)
    Non-maximum suppression= Image (I)
    Double Thresholding= Image (I)
    Edge tracking by hysteresis= Image (I)
End

Algorithm 2nd: Hough Circular Transform

Upload Edge image
Define the radius range
For I = 1 to all maximum radius
    Circular_Image=Edge_Image (I)
    Inner_part=Small_Rdius(I)
    Outer_part=Large_Radius(I)
    Seg_Image=Image-(Inner_part+Outer_part)
End

Algorithm 3rd: Proposed SIFT Algorithm

For I = 1 to all pixels
    Detection = Feature points (I)
    Points localization= DoG (I)
Where DoG is Difference of Gaussians
If localization need orientation
    Orientation=Keypoint_localization (I)
End
    SIFT_Keypoint=All best Feature
End

Algorithm 4th: Proposed Minutia Algorithm

For I = 1 to all ridge
    Termination = Ending (I)
    Bifurcation= Branches (I)
End

Algorithm 5th: Proposed Optimization Algorithm

Define the population size or bacteria of the GA (50)
Initialized the GA or BFO in MATLAB
Set all initialization parameters
Load feature sets
For I = 1 to all features
    For r=1 to all rows (features)
    For c=1 to all columns (features)
Define Ft (Threshold) = Average of feature value
Define Fs = feature (r, c)
Call fitness function
Fit_data= fitness functions (Ft, Fs)
    If fitness functions==True
        Fit_data= Fs
    Else

ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

```
        Fit_data= Ft
        Consider as best solution and store as Optimized _data
      End
    End
    End
End
```

Algorithm 6th: ANN Algorithm

```
Load Optimized _data
Training_data = Optimized _data
Initialize ANN
Generate group of data = group
Set iteration = 50
For I = 1 to iteration
    Weight = Optimized _data (i)
    Hidden_Neurons = [10] (tansig)
    Net_algo = trainlm
    Generat Net structure of ANN (net)
    Net = train (net, Training_data, group)
End
```

Save Net as a trained data of proposed work for the next phase. On the basis of above trained data we can test the most proposed work. The simulation of proposed work is given below with the implementation.

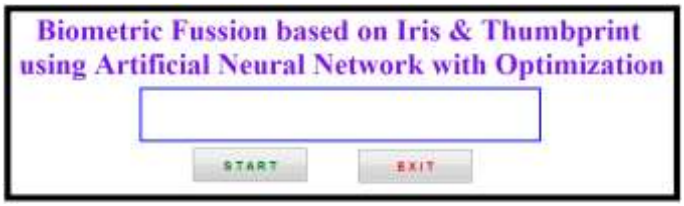

Figure: 6. Main window of proposed work

Above figure show the main figure window of proposed work. Main figure window is the title page of proposed Biometric Fusion System and there are START & EXIT button. If we press the START then working figure window is open and we can simulate the proposed Biometric Fusion System.

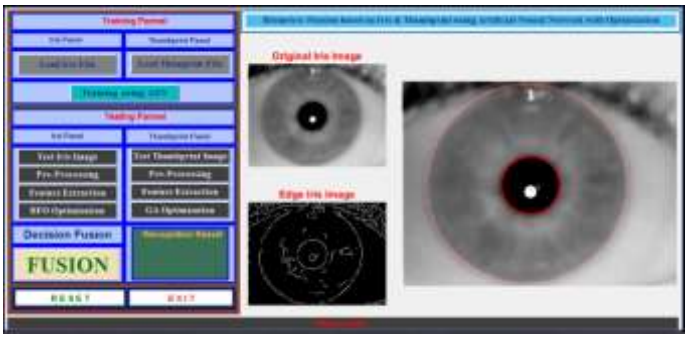

Figure: 7.Working window for Iris

Above figure show the working figure window of proposed Biometric Fusion System with the Iris panel. There are two section in the working window, 1st is the training and 2nd is classification panel. The procedures are same in the training and classification panel and the main steps of proposed iris recognition is given as,

1. Original eye image
2. Edge detection on eye image after the pre-processing
3. Iris localization and segmentation using the Hough Circular Transformation
4. SIFT feature extraction
5. Feature Optimization using the BFO

ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

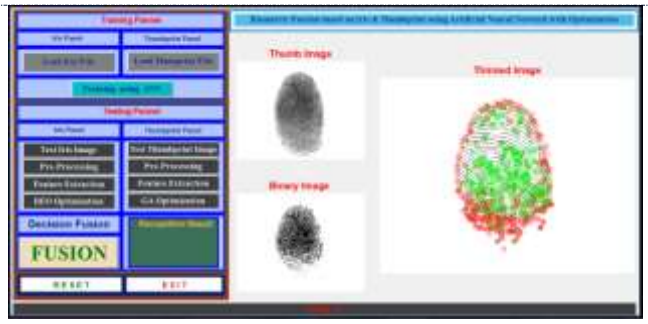

Figure: 8.Working window for Thumbprint

Above figure show the working figure window of proposed Biometric Fusion System with the Thumbprint panel. There are also two section the working window for thumbprint, 1st is the training and 2nd is classification panel. The procedures are same in the training and classification panel and the main steps of proposed thumbprint recognition is given as,

1. Original thumbprint image
2. Binarization and thinning on thumbprint image after the pre-processing
3. Thumbprint feature extraction is done using the Minutia feature
4. Feature Optimization using the GA

Table 1: Performance metrics comparison

No.	FAR		FRR		ACCURACY	
	Proposed	Previous	Proposed	Previous	Proposed	Previous
1	0.923	0.364	0.973	0.643	98.08	78.54
2	0.913	0.497	0.983	0.733	98.12	75.83
3	0.921	0.762	0.918	0.735	98.29	91.46
4	0.922	0.735	0.963	0.563	96.07	87.37
5	0.921	0.738	0.962	0.634	98.27	73.64
6	0.924	0.972	0.995	0.742	98.85	78.72
7	0.929	0.836	0.963	0.635	99.09	89.72
8	0.939	0.872	0.972	0.835	97.97	78.36
9	0.923	0.749	0.983	0.773	98.46	88.92
10	0.925	0.638	0.995	0.647	97.34	84.69

Above table represent the comparison of the performance metrics like FAR, FRR and Accuracy of previous work as well as proposed work.

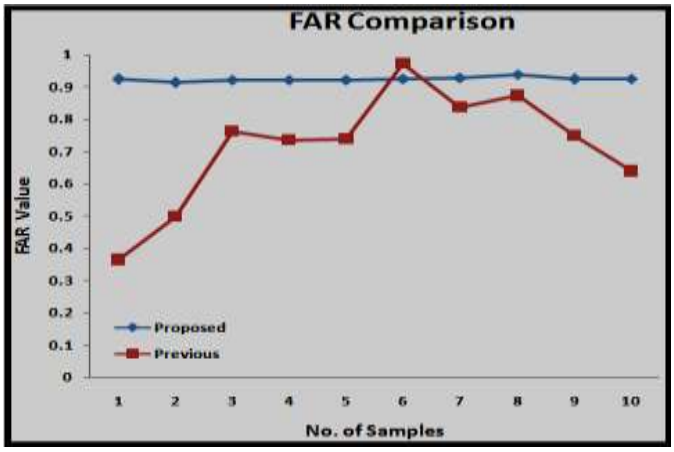

Figure: 6. Comparison of False Acceptance Rate

ISSN: 2277-9655
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CODEN: IJESS7

Above figure show the graphical representation of FAR value for proposed work and we compare the proposed FAR with previous work and founded that the proposed FAR is better as compare to the previous work.

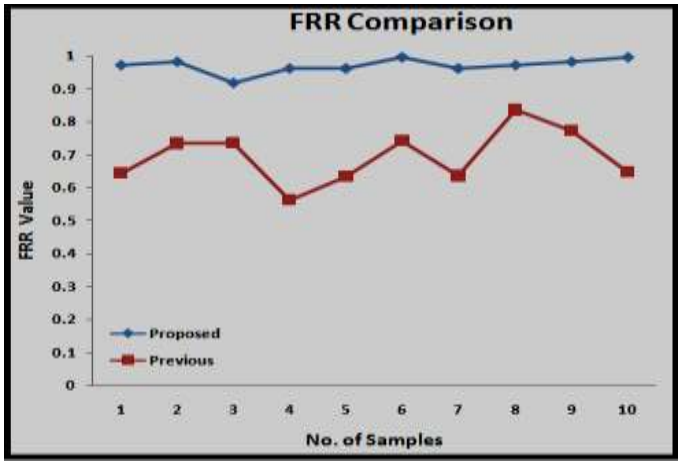

Figure: 7. Comparison of False Rejection Rate

Above figure show the graphical representation of FRR value for proposed work and we compare the proposed FRR with previous work and founded that the proposed FRR is better as compare to the previous work by using the SIFT descriptor and Minutia feature with GA and BFO optimization technique.

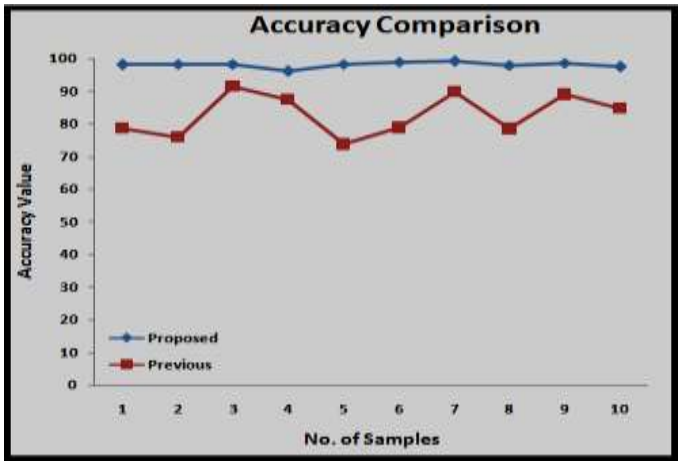

Figure: 9. Comparison of Accuracy

Above figure show the graphical representation of Accuracy value for proposed work and we compare the proposed accuracy with previous work and founded that the proposed accuracy is better as compare to the previous work. The accuracy value show the recognition rate by using the SIFT and Minutia feature extraction based on the GA and BFO for the feature optimization.

IV. CONCLUSION

In this section, we introduced Biometric Fusion System based on SIFT and Minutia feature with optimization technique using Artificial neural network as a classifier. SIFT descriptor is used to extract the feature from the uploaded Iris image and minutia feature are extracted from the thumbprint. In the section of iris the segmentation is done using the Hough Circular Transformation based on the canny edge detection technique. In the section of thumbprint the processing are done on the basis of morphological operations like binarization and thinning of thumbprint. The extracted feature sets are optimizing using the BFO and GA for iris and thumbprint respectively. In the proposed Biometric Fusion System, the artificial neural network is used as classifier to classify the test image according to the training. The experimental results analyzed that proposed Biometric Fusion System using SIFT descriptor and Minutia feature with BFO and genetic algorithm provides better results having the average accuracy are more than 98% and the average value of FAR is 0.984 and FRR is

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Impact Factor: 4.116
CODEN: IJESS7

0.986. In the future work, Biometric Fusion System will have proposed using the hybridization of optimization algorithm.

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