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A Novel Framework for Iris and Thumbprint Recognition using Optimization Algorithms

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Abstract

Objectives: Two biometrics i.e. iris and thumbprint has been fused. Both biometrics has been chosen as they have worked well when applied as uni-modal system. The main goal of proposed module is that worked better to optimize the extracted features. **Methods/Statistical Analysis:** For reduction of features of iris, BFO has been utilized and for thumbprint GA has been used because GA have capability to optimized feature sets on the basis of fitness function according to our requirement. **Findings**: Low the FAR, FRR rate, high the efficiency of the system and high the recall ate value high is the efficiency of the biometric system. **Application/Improvements:** It has been seen that proposed algorithm has provided good results having FAR is 0.76; FRR is 0.94 and accuracy of 98%.

Keywords: Accuracy, Fusion, Iris, Multimodal, Thumbprint, FAR, FRR

1. Introduction

Uni-modal biometric recognition system depends on the only one type of biometric recognition system like finger print recognition system, iris recognition system, face recognition system, palm recognition system and many more recognition systems. For any uni-modal recognition system has a big problem of accuracy so for more accuracy of biometric system we need to develop a multimodal biometric system. In multimodal biometric system we implement a system in which two or more than two biometric recognition system involved. In proposed work we use multimodal biometric recognition system based on Iris and Thumbprint recognition system using artificial intelligence.

In proposed work Artificial Intelligence, giving module the abilities like humans, has remained the most challenging research area after the introduction of digital computers. Giving module the power to see, to interpret and ability to read is one of the major tasks of AI. We humans have the ability for user recognition. In other words, we can differentiate between different users and recognize them as an A, or B and so on. We imbed recognition ability in proposed module for accurate classification of user at the authorization step. A great deal of activities has been performed on such function but still the results are not 100% and the researches are going on to improve results. Any existing AI we need to train our data, on the basis of training we can classify the user and differentiate between authorized and unauthorized user in proposed biometric recognition system. There are many artificial intelligence and machine leaning techniques are existing like Artificial Neural Network, KNN classifier, SVM classifier, LDA classifier etc.

Machine learning is a category of artificial intelligence that provides modules with the ability to learn how to

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Figure 1. Iris and fingerprint template.

train data, how to learn about data and how to categories the different data in different form. Machine learning focuses on the improvement of recognition system that can teach them to classify the test data and change when exposed to new data.

Recognizing people from their biological and behavioral characteristics has always been a crucial need for secure and reliable applications. A measurable feature of a person is usually called as a biometric, and several special biometrics are suitable for differentiating persons from others[1]. Biometrics such as fingerprints, iris patterns, faces, speech, retina, dynamic signature and gait are among the most frequently used modalities[2–5]. The template for iris and fingerprint are shown in Figure 1.

Among the biometrics, it is generally accepted that fingerprint and iris patterns can uniquely define each person of a very large population which makes them suitable for large-scale recognition. Therefore, fingerprint and iris recognition as a reliable multimodal method among biometric feature recognition technology are widely applied in personal identification for the purposes of high level of security[6–8].

Fusion process describes the proposed fusion system based on multimodal biometric recognition system as shown in Figure 2. There are two steps one is Iris Recognition and second is Thumbprint Recognition, if in both case we use same person data then we got an ID like Match ID 1, Match ID 2, Match ID 3……. Match ID n. in the fusion section if Match ID for both proposed biomet-

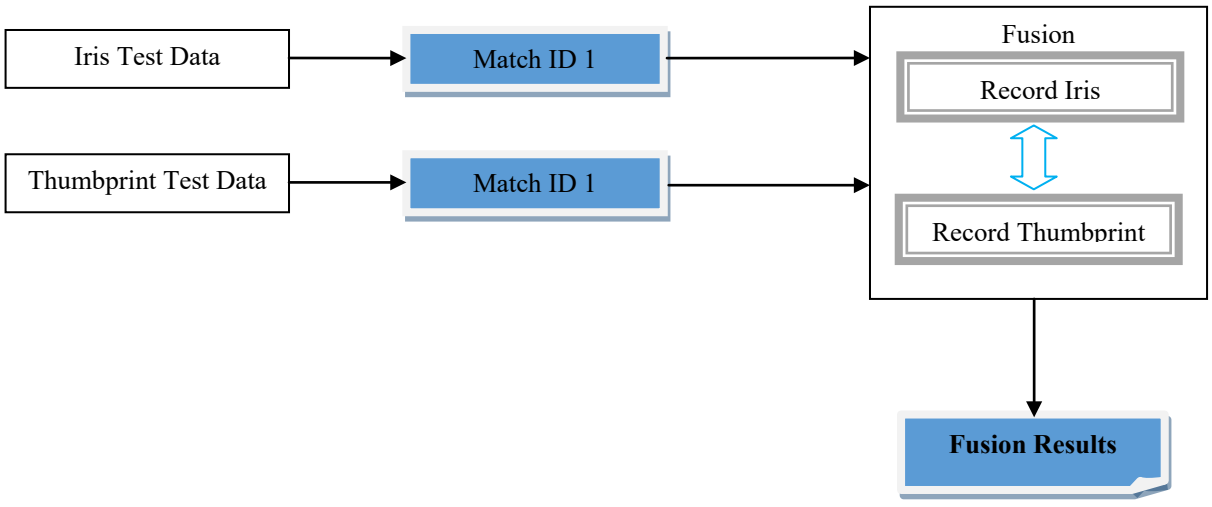

Figure 2. Fusion process.

ric recognition system is same then we got the result as 'Recognized' otherwise 'Not-Recognized'.

In proposed work Thumbprint feature set and Iris feature set are used for multimodal biometric fusion. In general, PCA can produce robust performance when a large amount of feature vectors are available[9]. However, sometimes feature extraction task cannot effectively carry out without data reduction when a feature vector dataset is too huge. Therefore, data reduction techniques can be achieved in many ways such as feature selection[10–12]. Among those techniques, Genetic Algorithms (GAs) and Bacterial Foraging Optimization (BFO) have proven to be an effective computational method because of best optimal solution based on their fitness function, especially in situations where the search space is highly dimensional.

In Thumbprint recognition system[13,14], for generating the difference of the edges overlapping, thinning process[15] is used. We can apply Morphological operations on only binary images so we convert normal image into the binary format. Thinning algorithm is a Morphological operation that is used to remove selected foreground pixels from binary images. We use Skelton technique for thinning. It preserves the topology (extent and connectivity) of the original region while throwing away most of the original foreground pixels[16].

After the pre-processing of the image, Minutia Extraction algorithm is used for differentiating termination and bifurcation points. We apply minutiae extraction technique for finding the termination points, we take the values (l=1) for termination and (l=3) for bifurcation. After image pre-processing step, minutiae extraction process is applied. Proposed algorithm can be seen on figure. Minutiae point detection depends on pixel value ('0' or '1'). Two methods are possible: first method processes only pixel with '1' value and second method is dedicated for pixel with '0' value. Method 1 count Crossing Number value on pixel value '1' or P=1, and method 2 do this process on pixel value '0' or P=0. Preprocessing: binarization and thinning algorithm on pixel representation of '0' will precede the minutiae point detection process (on '1' pixel value or on '0' pixel value). This proposed method in more detail is presented in Figure 3[17].

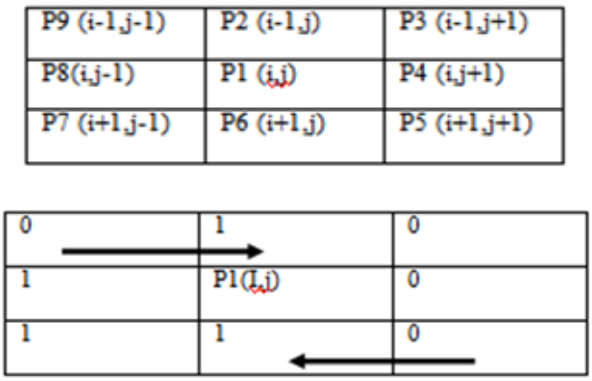

Figure 3. Checking ridges and differentiation of termination and bifurcation points.

Above figure show how to check ridge point in fingerprint[18] and how to differentiate between termination and bifurcation point. Figure show the example of termination and bifurcation points, if we got continuously 1 in a line without any braches within selected region then they denote the termination and if any branches lies then they are called bifurcation points. And check the last continuous point within the series if we got 0 that mean ridge is terminated.

Firstly, we load all extracted minutia point as shown in Figure 4 and PCA feature for the feature reduction process. Before applying Genetic Algorithm, we need to initialize the GA basic function like population size, mutation function, crossover etc. After that we use genetic algorithm for feature reduction according to the fitness function. We set fitness function[19] according to our requirement like which type of feature we can use for classification purpose. Genetic Algorithm (GA) is a method for solving both constrained and unconstrained optimization problems based on a natural selection process that mimics biological evolution. The algorithm repeatedly modifies a population of individual solutions. At each step, the genetic algorithm randomly selects individuals from the feature vector. Genetic Algorithm here in our proposed algorithm accepts three input parameters namely e, Fs, Ft. Fs is the current element of the PCA feature value and Ft is the average PCA feature value.

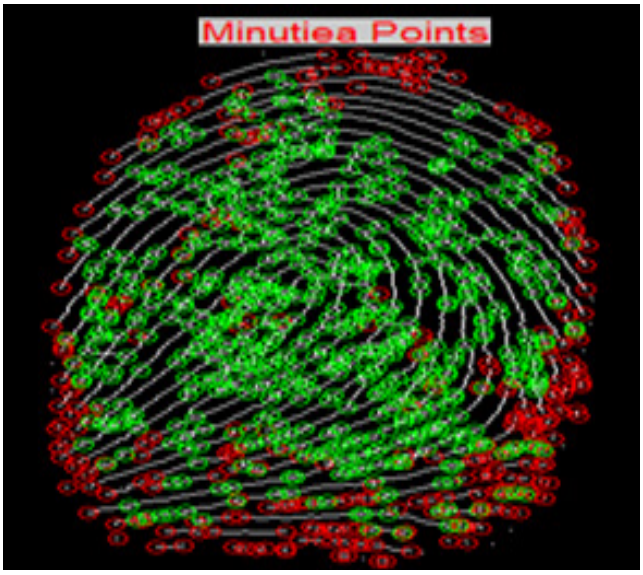

Figure 4. Minutia points.

1.1 Fitness function

Fitness function is critical to the performance of GA. In our approach, fitness function is defined by a two-step process. During the first step, the optimized transformation is used to check the global consistency between two sets of features. In the second step, local properties of the feature are used to verify the detailed matching. In proposed work Fs is the current selected feature and Ft is the threshold value of feature points. On the basis of given condition, we check the fit value which can exist in new feature set.

$$f(fit) = \begin{cases} 1, fs < ft \\ 0, fs \geq ft \end{cases}$$

Where f(fit) is fit value according to the fitness function.

Similarly, we apply BFO on extracted minutia point to find the optimal feature set from the minutia feature points. We define the fitness function for the minutia points are on the basis of this we optimized extracted minutia points. BFO works on the basis of low cost value and use reproduction steps to find the best low cost feature set. Behalf of this step BFO optimized minutia feature points and return a set of feature set which are appropriate for the classification[19,20].

2. Proposed Work

The whole propose work is being done for fusion of iris[21,22] and thumbprint biometrics using minutia and PCA feature extraction technique as shown in Figure 5. Firstly, feature extraction using minutia and PCA is done then feature reduction is taken place using GA for thumbprint and using BFO for iris samples.

Proposed work can be explained

Start
Upload iris and fingerprint for training.
Move forward for testing process
Load test images of iris and fingerprints.
PCA utilization for feature extraction, in which feature vectors will be saved.
Feature optimization of Iris will be done using GA.
Feature optimization of thumbprint will be done using BFO.
Fusion will be done fusion score values.
Evaluation of FAR, FRR and Accuracy.
End.

Iris uploading of sample

1. *Start*
2. *find binary image*
3. *Trace region boundaries in binary image*
4. *Measure properties of image regions*
5. *round off the properties values*
6. *conversion of image from RGB to GRAY*
7. *find edge of image using canny*
8. *end*

Thumbprint Uploading of Sample

1. *open file selection*
2. *Get no. of images*
3. *Apply for loop for all images*
4. *combine pathname and filename*
5. *if uploaded image is colour*
6. *then convert to gray scale*
7. *otherwise do following*
8. *when uploaded image is not colour*
9. *Do thinning*

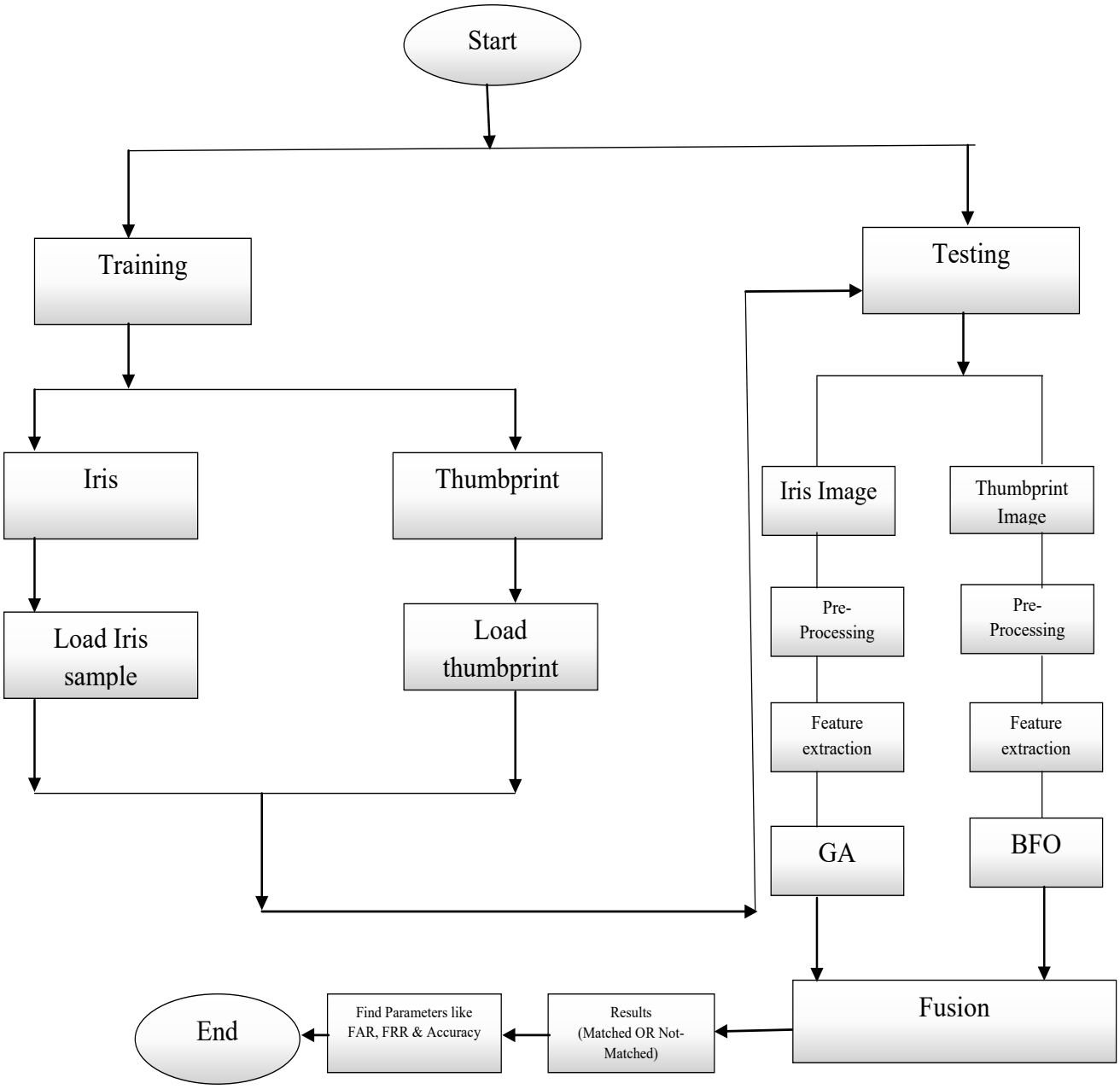

Figure 5. Proposed flowchart.

PCA for Feature Extraction (Iris)

1. *find the mean of image region*
2. *find the size of image region(test sample)*
3. *generate a blank matrix*
4. *apply loop to double precision for training*
5. *Computing the difference image for each image in the training set*
6. *Merging all cantered images*
7. *generate covariance matrix*
8. *find Eigen values*
9. *generate a blank matrix*
10. *generate Eigen vector*
11. *reduce unwanted features*
12. *end*

Minutia for Feature Extraction (Thumbprint)

1. *find the ridge*
2. *find the size of ridge*
3. *generate a blank matrix*
4. *Computing the termination points*
5. *Computing the bifurcation points*
6. *generate a combine feature sets*
7. *end*

Fitness Function of GA

1. *Get parameters fitness_fn(e,Fs,Ft)*
2. *if Fs<Ft*
3. *f=1;*
4. *else*
5. *f=0;*
6. *end*

Fitness function of BFO

1. *Upload BFO data*
2. *Get the number of bacteria's*
3. *Then the number of elimination-dispersal events*
4. *Application of Elimination and dispersal loop*
5. *Apply Chemostatic Loop*
6. *Find healthy data*
7. *Then find best solution*
8. *End*

3. Results and Discussion

In Table 1, the FAR, FRR according to the testing has been

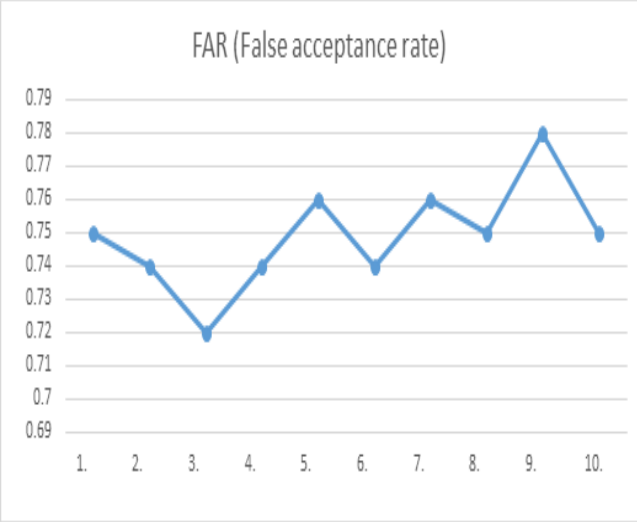

Figure 6. FAR for Fusion process using proposed work.

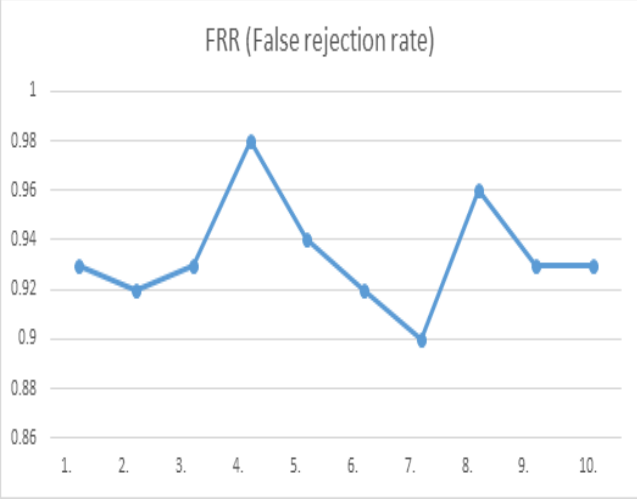

Figure 7. FRR for Fusion process using proposed work.

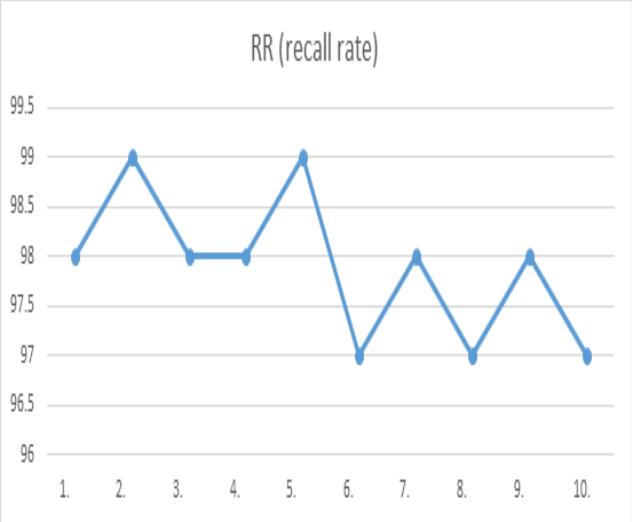

Figure 8. RR for Fusion process using proposed work.

shown. In addition, to this RR has also been shown for 10 samples.

Figure 6 shows the FAR (False acceptance rate) values for 10 sample fusion and average value is .79

Figure 7 shows the FRR (False rejection rate) values for 10 sample fusion and average value is .96.

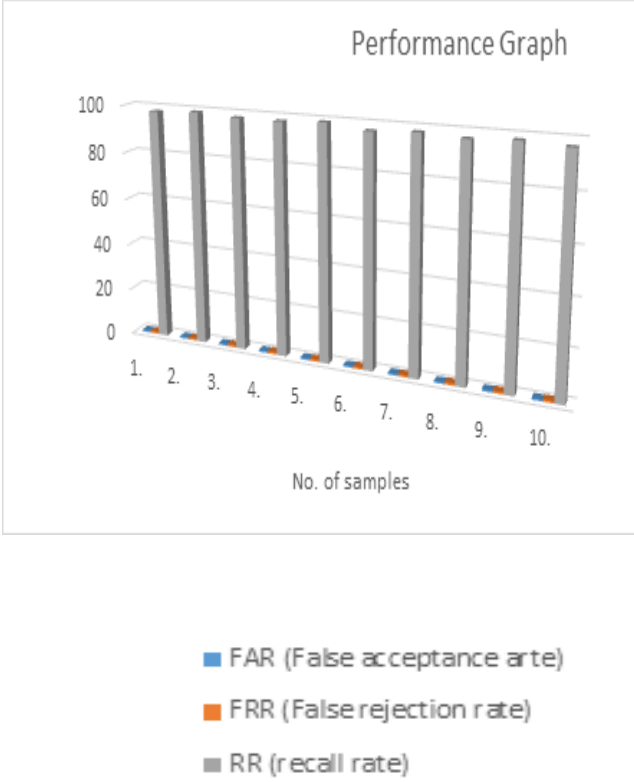

Figure 9. Performance graph.

Table 1. Performance of Parameters

Sample No.	FAR (False acceptance rate)	FRR (False rejection rate)	RR (recall rate)
	.75	.93	98
	.74	.92	99
	.72	.93	98
	.74	.98	98
	.76	.94	99
	.74	.92	97
	.76	.90	98
	.75	.96	97
	.78	.93	98
	.75	.93	97

Figure 8 shows the RR (Recall rate) values for 10 sample fusion and average value is 98. Figure 9 shows the performance graph of FAR (False Acceptance rate), FRR (False Rejection Rate) and RR (Recall rate). The comparison has been done on the basis of number of samples. It is being clearly shown that the value for recall rate is more which is 97.9. The average rate of FAR is 0.749 which is less as compare to FRR value that is 0.934.

4. Conclusion

In the proposed work, multimodal fusion system has been developed using iris and thumbprint. From result simulations, it has been observed that the proposed work model has returned the robust results in terms of FAR, FRR and RR by providing values 0.75, 0.93 and 98 respectively. Utilization of GA and BFO are the key factors in the enhancement of result values in proposed work in which they worked by reduce the obtained no. of features. Both optimization techniques used fitness function for enhancing the efficiency of the system by getting optimal values of fusion between iris and thumbprint templates. Low the FAR, FRR rate, high the efficiency of the system and high the recall ate value high is the efficiency of the biometric system. So, FAR, FRR and RR are inversely proportional to each other. Application of our proposed work is Use for the security purpose in any place like House, Company and Access control to computer systems.

5. References

1. Wayman J, Jain AK, Maltoni D, Maio D. Biometric systems: Technology, design and performance evaluation. 11th Edn. Springer; 2004.
2. Ross AA, Nandakumar K, Jain AK. Handbook of Multibiometrics. 11th Edn, Springer; 2006.
3. Wang ZM. Image denoising based on probability wavelet shrinkage with Gaussian model. International Conference on Wavelet Analysis and Pattern Recognition; 2007. p. 544–8.
4. Candès EJ, Donoho DL. Curvelets A surprisingly effective nonadaptive representation for objects with edges. Curve and surface fitting. Vanderbilt University. Nashville; 1999.
5. Startck JL, Candès EJ, Donoho DL. The curvelet transform for image denoising. IEEE Transactions on Image Processing. 2002; 11(6):670–84. Crossref.
6. Feng N, Ma L, Shen Y. Fuzzy partition based curvelets and wavelets Denoise algorithm. International Conference on Computational Intelligence and Security Workshops; 2007. p. 23–6. Crossref.
7. Daugman JG. How iris recognition works. IEEE Transactions on Circuits and Systems for Video Technology. 2004; 14(1):21–30. Crossref.
8. Jain AK, Prabhakar S, Hong L, Pankanti S. Filterbankbased fingerprint matching. IEEE Transactions on Image Processing. 2000; 9:846–59. Crossref. PMid:18255456
9. Altun AA, Allahverdi N. Neural network based recognition by using genetic algorithm for feature selection of enhanced fingerprints. 8th International Conference on Adaptive and Natural Computing Algorithms. 2007; 2:467–76. Crossref.
10. Blum A, Langley P. Selection of relevant features and examples in machine learning. Artificial Intelligence. 1997; 1–2:245–71. Crossref.
11. Kim K, Han I. Genetic algorithms approach to feature discretization in artificial neural networks for the prediction of stock price index. Expert Systems with Applications. 2000; 19(2):125–32. Crossref.
12. Liu H, Motoda H. Feature transformation and subset selection. IEEE Intelligent Systems and Their Applications. 1998; 13(2):26–8. Crossref.
13. Lumini A, Nann L. Advanced methods for two-class pattern recognition problem formulation for minutiae-based fingerprint verification. Journal of the Pattern Recognition Letters. 2008; 29:142–8. Crossref.
14. Tong X, Liu S, Huang J, Tang X. Local relative location error descriptior-based fingerprint minutiae matching. Journal of the Pattern Recognition Letters. 2008; 29:286–94. Crossref.
15. Lam L, Lee SW, Suen CY. Thinning methodologies–A comprehensive survey. IEEE Transactions on Pattern Analysis and Machine Intelligence. 1992; 14:869–85. Crossref.
16. Mohamed. SM, Nyongesa H. Automatic fingerprint classification system using fuzzy neural techniques. IEEE International Conference on Artificial Neural Networks. 2002; 1:358–62.
17. Hsieh CT, Chia-Shing. Humanoid fingerprint recognition based on fuzzy neural network. International Conference on Circuit, Systems, Signal and Telecommunication; 2007. p. 85–90.

18. Tomasq M, Dąbrowski A, Chmielewska A, Krzykowska AA. Selection of parameters in iris recognition system. Multimedia tools and Applications. 2014; 68(1):193–208.Crossref.
19. Haiqing. A brief survey on recent progress in iris recognition. Biometric Recognition. 2014; 8833:288–300.
20. Kiran BR, Raghavendra R, Vemuri VK, Busch C. Smartphone based visible iris recognition using deep sparse filtering. Pattern Recognition Letters. 2015 May; 57:33–42. Crossref.
21. Zhen J. Iris recognition based on block theory and self-adaptive feature selection. International Journal of Signal Processing, Image Processing and Pattern Recognition. 2015; 8(2):115–26. Crossref.
22. Li Y. Iris Recognition algorithm based on MMC-SPP. International Journal of Signal Processing, Image Processing and Pattern Recognition. 2015; 8(2):1–10. Crossref.