Face-Iris Multimodal Biometric System using Feedforward Backpropagation Neural Network

Deepali Singhal, Amit Doegar

Abstract: ***Multimodal biometric systems are used to verify or identify people by utilizing information multiple biometric modality. It combines the advantages of a unimodal biometric system to address their limitations. An efficient Face-Iris multimodal Biometric system based on artificial intelligence technique is presented in this paper. The main goal of this article is to enhance the authentication performance by fusing two biometric traits such as face and iris modalities. A feature extraction algorithm Maximally Stable Extremal Regions (MSER) along with feature optimization technique Artificial Bee Colony (ABC) is used to extract the key points and optimized these key points respectively. To detect or match face and iris Feed forward back propagation neural network (FFBPNN) is used. Evaluating overall performance of the designed modal based on accuracy, False Acceptance Rate (FAR), False Rejection Rate (FRR), Error and Receiver Operating Characteristic (ROC) analysis suggests that the proposed multimodal biometric system achieves improved results compared to existing work.***

Keywords: Multimodal biometric system, Iris-face, MSER, ABC, FFBPNN.

I. INTRODUCTION

Biometrics technology is used to determine the physiological as well as behavioral nature of an individual. These captured images should be unique and non-invasive over time [1]. The captured images are saved in a pattern. This pattern is compared to the biometric pattern saved in database. Many physiological features such as finger, hand, irises, faces, ears and sounds) and body parts (such as body, scents, legs and signature) have been used as process features for biometric systems[2]. These systems find application in various locations like as airports, buildings, and military security control points. As the traditional uni-modal biometric system uses single biometric trait for the verification of an individual therefore it suffers from number of problems such as inadequacy of unlikeness, less ubiquity, noisy information, susceptible to spoofing and high error identification rate [3]. The solution to these problems is the use of multimodal biometric system. In this more than one biometric trait is used. The steps performed using multimodal traits are (i) pre-processed input Biometric data (ii) extract features (iii) Matching module (iv) Match score fusion (v) decision module and (vi) Accept or reject. [4] In [5] they integrated iris and fingerprint In [6] iris, finger vein and fingerprint traits are used to develop a multimodal biometric system.

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The detection accuracy upto 98.43% and an error rate upto 1.57% have been achieved. In this paper, we have designed a multimodal fusion system using face and iris trait. To design a model using face is one of the most accepted ways to identify a person, and the utilization of the iris as a biometric trait is the most appropriate biometrics. This research has the advantage of capturing face as well as Iris of the same person through single camera. Also, the concept of integrating face and iris provide a high degree of accuracy.

II. RELATED WORK

Over the past few years, several more biometric systems have been proposed. Each system has used a special fusion level, the method of production, and the methods of matching between them. A few of them are discussed in this section.

Ammour et al. (7, 2018) proposed a multimodal biometric recognition model using face with the iris as biometric modalities. For extracting the features from the face and iris traits "Log Gabor filter" in combination having spectral regression kernel- Discriminant analysis has been used. The extracted features have been utilization during fusion as well as in the classification process. With the test analysis, it has been observed that the proposed multimodal system lessens the error rate by 0.24% when compared with uni-modal technique.**Mohamed and Nyongesa (22, 2002)** utilized a Fuzzy Neural Network (FNN) to indicate the fingerprint recognition technique. Some fingerprint features such as points of extraordinary positions, core and delta directions obtained from a binary fingerprint image have been translated into binary form was used. This effort has provided excellent results. The problem of false classification has been overcoming using feature extraction technique. **Bicego et al (8, 2006)** discussed some patterns of identifying and cataloguing strategies that is applied to biometrics globes. The SIFT recovery feature is more hilarious and there are chances that it can be reduced by enhancing SIFT feature extraction technique on behalf of filters. **Alvarado et al (9, 2009)** demonstrated a novel method to identify patterns with wavelets, modular NN and fuzzy logic. Authors recognize the face of the person and the fingerprint by using these methods. It has been observed that the modular face recognition method is a better alternative through traditional methods such as voting, monolithic and by using specific methods. Methods such as PCA (Principal component analysis) and pre-processing data, eigenfaces can be used for improving system performance. **Chaudhary and Nath (10, 2015)** introduced that there are

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various problems in the uni-modal biometric system during recognition accuracy. Problems are spoofing, noisy data, inter-class diversity, inter-operability issues and identity. To eliminate the problems of the biometric system of uni-modal authors introduced a multimodal biometric system where many individual features were included for enhancing recognition rate. A combination of iris, voice and face has been used in this paper. These modalities have been combined at the score match level with sum rule. **Arul kumar et al. (11, 2018)** offered a multimodal biometric system that uses face and fingerprint in the merger. This proposal describes a new sample compatibility based on multimodal biometric methods, especially the face and fingerprint. There are basically three modules that are used for the true holding feature; the compatibility of the patterns for the multimodal biometric sample generation, as well as for better results for the proposed work. Minutiae scores, facial features, and other features have been removed from the face and fingerprint images at startup. As a result, using the density-based fusion, the attributes combined have been incorporated into account conformity levels to generate many biometric patterns. Then, the vector marking study was used for embroidery matching. The assessment process has proven that the proposed system is in the skill of art, using a wide range of topics to access the system. **Kaur et al. (12, 2018)** presented a multimodal biometric system (Face with the Fingerprint). From the results, it has been concluded that a multimodal biometric system provides higher accuracy to authenticate various identities because in the uni-model biometric system the probability of mismatching features have been increases. The proposed system offered accuracy rate up to 98.7% and hence provide good security as compared to other biometric system.

From above discussion, it has been concluded that the research in multimodal biometric recognition system has to be performed by various researchers using iris and fingerprint as the combination of these traits provides higher accuracy. But, in combination of face and iris the recognition rate is not obtained as per requirement. Also, feature extraction algorithm have not used in hybridization with feature selection algorithm.

III. PROPOSED MULTI-MODAL BIOMETRIC SYSTEM

In this research, a biometric image fusion system based on face and Iris has been designed. The flow of work is shown in figure 1.

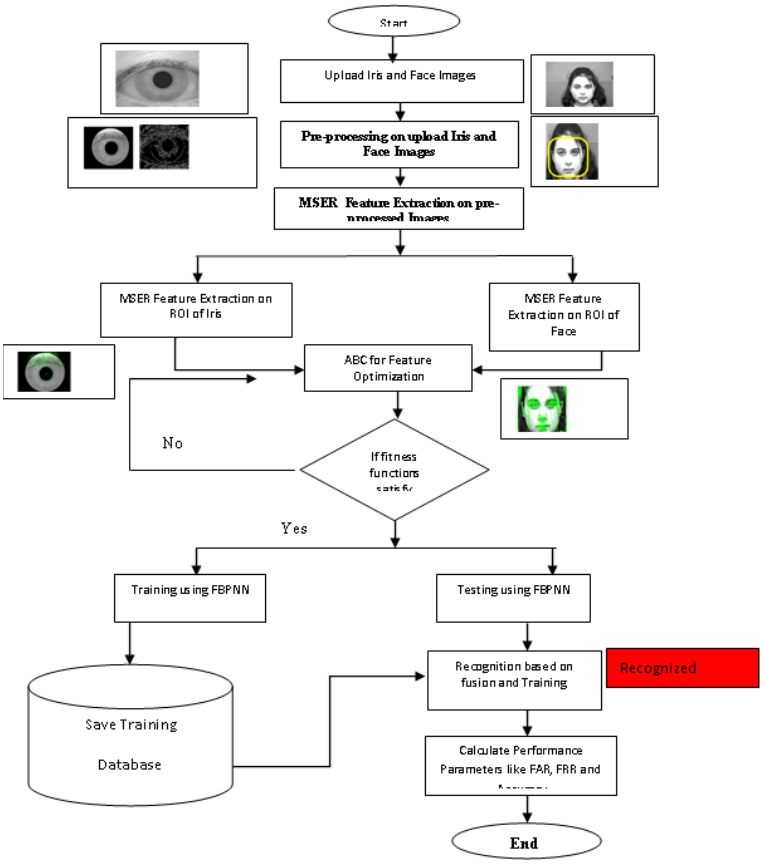

Figure 1: Proposed Multi-Modal system

3.1 Pre-processing

This is the initial step in any image recognition system. The aim of applying pre-processing on Face and iris image is to obtained high quality image. The RoI of the face as well as the iris has been detected and the face image is cropped comprises of eyes. An ROI could be denoted with the creation of binary mask being a binary image as a similar image being required by the designer for processor with the pixels which labels the ROI sets towards 1 and each of pixels being set to zero. The example of pre-processing applied on the face and iris image is shown in figure below.

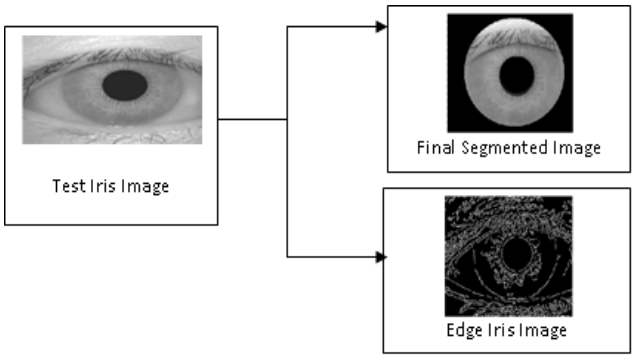

Figure 2: Pre-processing of test iris image

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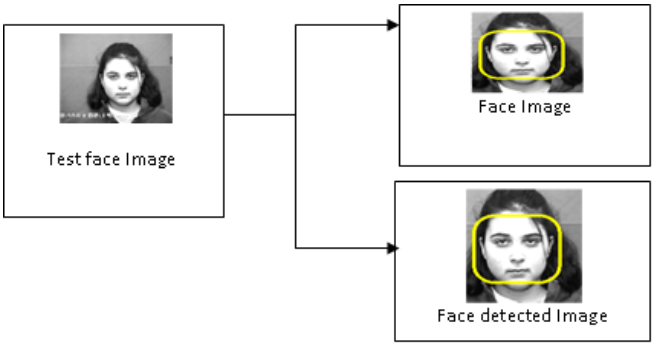

Figure 3: Pre-processing of Face image

3.2 MSER feature extraction of iris and Face image

The MSER as a feature extraction algorithm for both iris and face has been applied. This technique helps for extracting the key-features by means of iris with face image. In the computer vision system, MSER technology is used as an image spot detection tool. This technology was developed by Matas et al to find two illustrations that have different perspectives from the appropriate picture element. This method of extracting multiple image elements helps to adapt to the appropriate base, which results in better stereo mapping and object recognition algorithms.

The MSER image for the uploaded iris and face images are shown in figure 4 and 5 respectively.

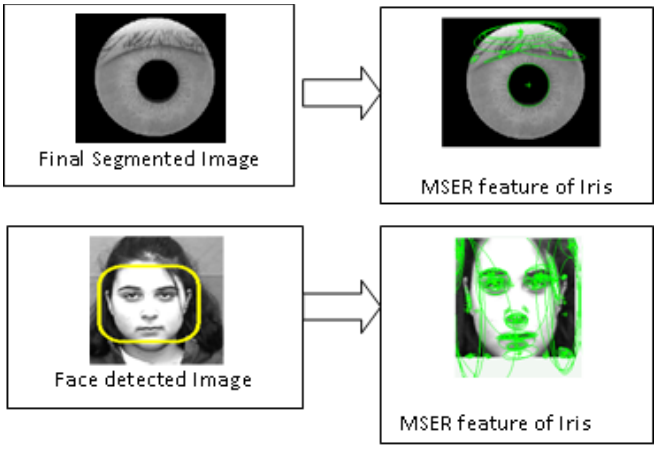

Figure 4: Feature extraction process of Iris and Face image

3.3 Feature Optimization

The ABC algorithm is considered as a swarm-based meta-heuristic algorithm that works as the similar way as that colonies of honey bees. The algorithm is consisted of three significant elements, such as, employed, unemployed foragers with the food sources. ABC comprises with three main sets of artificial bees such as employed, onlooker with the scout bees. The initial part has employed bees whereas remaining part of the colony by onlooker bees. The employed bees are connected to precise food source. The onlooker bees analyze the employee bee's dance in the hive for choosing the food source.

3.4 Fusion Process

In this process, the features of iris and face are combined using feature level fusion technique. Since, a feature set is expected to provide better recognition of integration at this level, as these are rich in biometric data than the raw material or the final decision.

3.5 Feedforward Back Propagation Neural Network (Training)

FFBPNN is an artificial neural network in which connection among the nodes that does not construct a cycle. The information for the network is moving in one direction, from access points, hidden intersections (if any) and output junctions. In case of FFBPNN, the output is fed reverse to the input layer nodes, if any error occurs then the weight is adjusted in such a way so that to obtained the desired output. The structure of FFBPNN is shown in figure below:

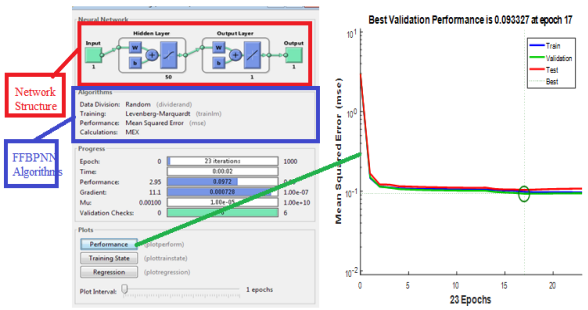

Figure 5: Training of biometric system using FFBPNN

The FFBPNN structure comprises of three layers such as input, hidden and output layer as shown in figure 5 under red block. FFBPNN works on Lenberg-Marquardt algorithm and the performance has been analyzed using mean square error show in the right hand side of FFBPNN structure. The MSE is less means that the network trained with high accuracy. The test results examined after training the system are described in section 4.

IV. RESULT AND ANALYSIS

The results in terms of FAR, FRR, Error, and accuracy are analyzed in MATLAB simulator tool. To show the efficiency of the proposed multimodal system the comparison with the existing technique has also been provided and discussed.

Table 1 Computed parameters

Sample	FAR	FRR	Error	Accuracy
1	0.042	0.050	0.024	99.88
2	0.038	0.054	0.017	99.75
3	0.043	0.051	0.101	99.80
4	0.046	0.055	0.116	99.78
5	0.044	0.052	0.105	99.72
6	0.045	0.053	0.028	99.85
7	0.045	0.050	0.070	99.83
Average	0.043	0.052	0.065	99.80

The average value of FAR for the proposed work is 0.043. FAR represents the falsely accepted images (Face & Iris) in the proposed work. While comparison with the existing work presented by Ammour et al.(13), it has been observed that the FAR of proposed work has been reduced by 28.33 %. This means that FFBPNN has performed better and

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reduce FAR in the proposed work. The comparison graph of FAR is shown in figure 6.

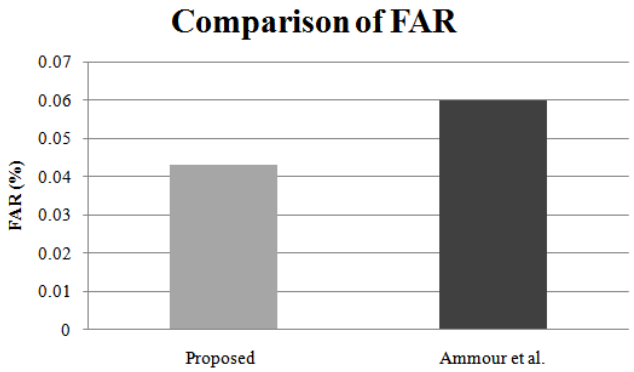

Figure 6 FAR

Figure 7 represents the comparison of FRR between the proposed and existing work performed by Ammour et al. FRR parameter is used to examine the rate of rejecting the test samples falslly, while the samples are correct. Therefore this rate should be less.The average FRR measured for the proposed work and existing work (Ammour et al.) is 0.052 and 0.50 respectively. Therefore there is a decrement of about 89.6 % .

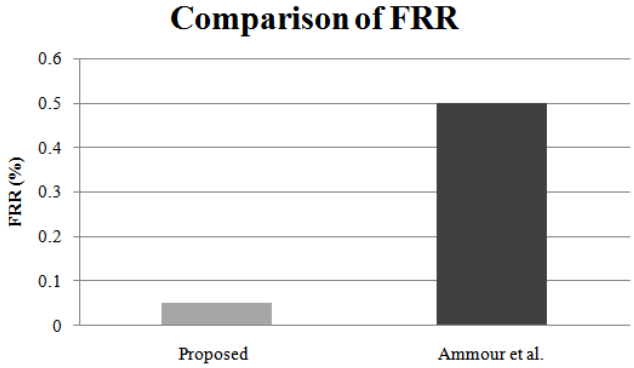

Figure 7 FRR

The average value of error for the proposed work and existing work(Ammour et al.,) is shown in figure 8. The examined values for proposed work (FFBPNN) and existing work is 0.065 and 0.24 respectively. Therefore, the error occurred during the detection of proposed multimodal system is less compared to existing work and about 72.92 % reduction in error rate has been examined. The comparison of error is shown in figure 8.

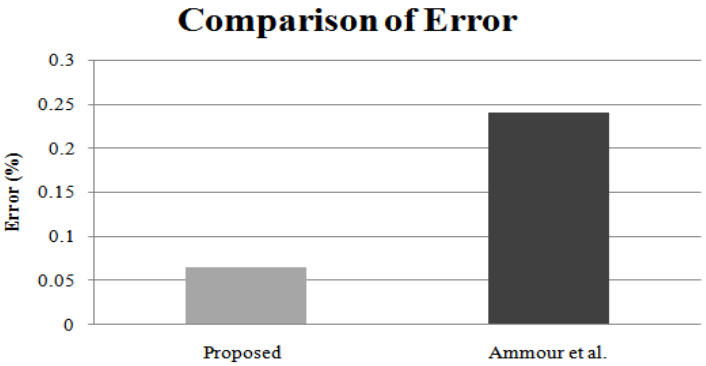

Figure 8 Error

The average value of throughput analyzed for the proposed work and existing work is demonstrated in figure 9. The average value of throughput examined for seven number of test samples is 99.80. After comparing the throughput with the existing work, the enhancement of about 0.3 % has been achieved.

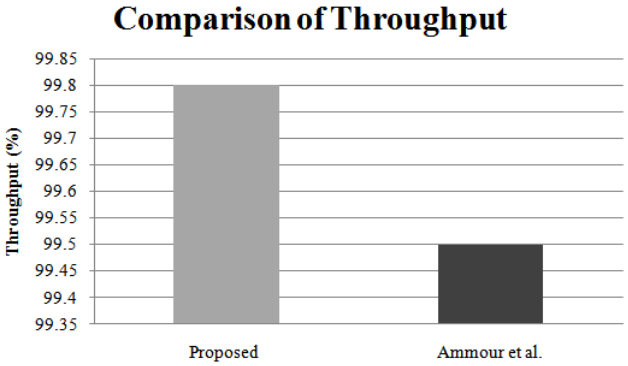

Figure 9 Throughput

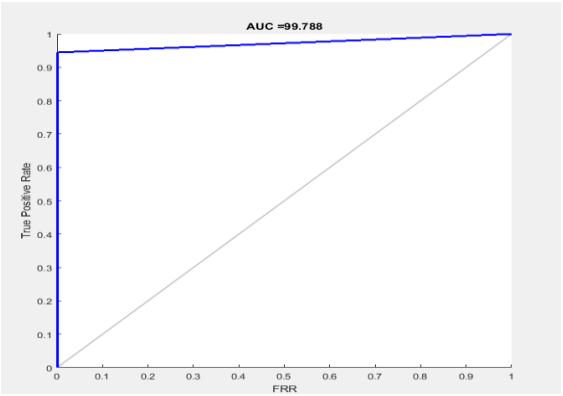

Figure 10 ROC

What the system uses while working in authentication mode is the Recipient Operating Characteristics (ROC), sometimes known as ROC curve. That's represents the FFR with respect to FAR. In the proposed system the ROC curve approaches to 99.78, which means that the system authenticates with higher accuracy.

V. CONCLUSION

In this article, an efficient multimodal biometric (face with iris) system has been developed in MATLAB simulator. Our proposed modal utilized ABC as an optimization technique to reduce computation time and memory consumption, by properly selecting the best features from the face and iris images. Also the best recognition rate has been provided by authenticating the modal using FFBPNN. The hybrid biometric system obtained an improvement upto 0.3% in terms of error rate compared to existing work.

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