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A Multimodal Approach to Raise the Security of Biometric System

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Abstract: Biometric authentication system is used for identification and verification of individuals by employing their physical and behavioral features. A biometric system can be a unimodal and multi-biometric. Unimodal biometric system often fall limitation because of sensitivity of noise, intra class variation, spoof attacks etc. Multi-biometric systems are used to overcome this problem by providing multiple piece of evidence of the same identity. Multimodal biometric systems increase the recognition rate of the biometric systems either by reducing the false acceptance rate (FAR) or false rejection rate (FRR). Here in this paper, we have proposed a multimodal approach for integrating the biometrics face, fingerprint and iris to enhance the accuracy and security of biometric recognition system. Fusion at the match score level is the most popular fusion method and it is easier to access and combine matching scores. In our approach we have also proposed an algorithm to authenticate user. And we have proposed a combined architecture of three different sensors to raise the system security. The proposed approach was implemented using MATLAB software.

Keywords: Biometrics, Fingerprint, Iris, Face, Fusion, Multimodal.

1. Introduction

A Biometric system is a recognition system which operates by acquiring biometric data from person, extracting feature sets from data and comparing it with the existing database. In biometric system used two types of features:

- Physiological: fingerprint, face, iris, ear, retina etc.
- Behavioral: signature, voice, gait etc.

Biometric system which uses single trait for recognition is called unimodal system [1]. In unimodal system have some problems for example, face recognition suffer from the problem of lighting, fingerprint may have some cuts or injuries, voice may change due to cold etc. So the problems which faced in unimodal biometric systems are overcome by a new approach that is multibiometric system. It divided into five categories i.e. multi-sensor, multi-instance, multi-algorithm, multi-sample and multimodal systems. In this paper presents a proposed approach of multimodal biometric system [2].

The multimodal biometrics combines more than one modalities of biometrics to improve the recognition rate. The multimodal biometric systems provide advantage over the conventional unimodal biometric systems in various ways. Fusion technique is used to combine the score from multiple biometrics and produced a single score [3].

1.1 Fusion Techniques:

Fusion technique can be divided into two main categories:

- Pre-mapping fusion (before the matching phase)
- Post-mapping fusion (after the matching phase).

The first technique deals with the sensor level fusion, feature level fusion. Usually, these techniques are not used because they result in many implementation problems. The second technique is realized through fusion at the decision level, based on some algorithms, which combine single decisions for each module of the system. Furthermore, the second strategy is also based on the matching-score level, which combines the matching scores of each component system [4].

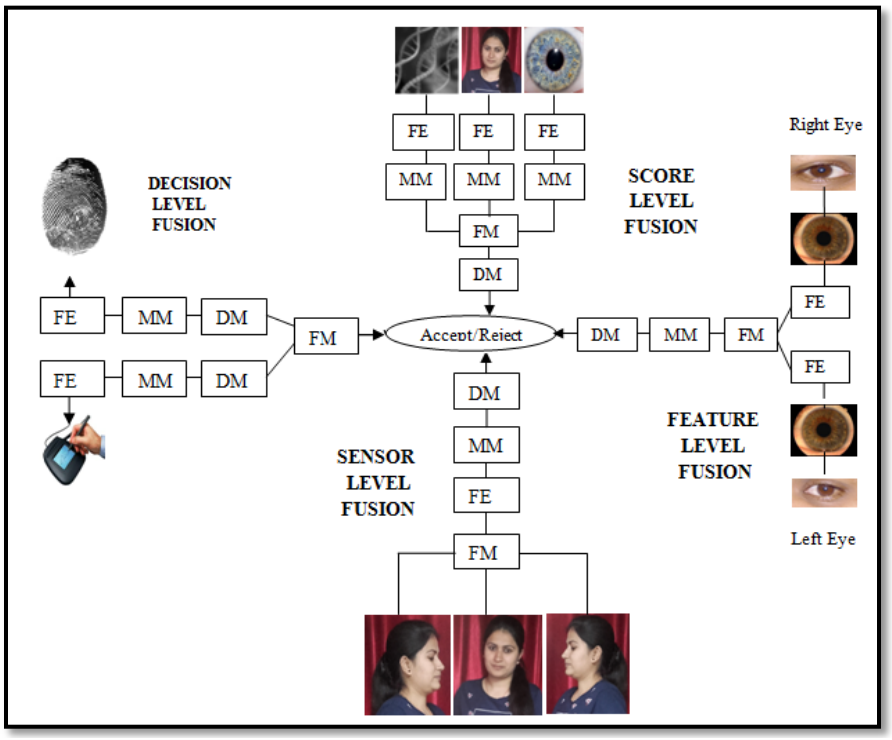

Figure1: Different types of fusion

1.1.1 Sensor level fusion:

In sensor level fusion multiple modalities obtained from different sensors will be combined together and treated as a single biometric modality.

1.1.2. Feature level fusion:

In this fusion, the features set are extracted from the all biometrics traits. Extracted features can be fused together into a joint feature vector of higher dimension [5].

1.1.3. Score level fusion: In score level fusion the similarity scores of the individual biometrics are generated and the scores are fused together for recognition of an individual.

1.1.4. Decision level fusion:

The decisions result obtained from the individual authentication system by using AND, OR Majority vote decision methods are fused to authenticate a person.

This paper presents a proposed approach of multimodal biometric system with integration of face, iris and fingerprint. The main goals of proposed multi-modal biometrics approach is to reduce one or more of the following; FAR (False Accept Rate), FRR (False Reject Rate), FTE (Failure to Enrollment rate) and mimics.

The rest of the paper is organized as follow: Section 2 describes the related work, and section 3 presents details of proposed model. Section 4 reports the experimental results and the conclusion is drawn in section 5 and references are given in section 6.

2. Related work:

Ashraf Aboshosha et. al [6] In this paper fusion of fingerprint, iris and face traits are used at score level in order to improve the accuracy of the system. Scores which obtained from the classifiers are normalized first using min-max normalization. Then sum, product and weighted sum rules are used to get fusion. Experimental results show that multimodal biometric systems outperform unimodal biometric systems and weighted sum rule gives the best results comparing with sum or product method.

Sheetal choudhary [7] This paper presents a robust multimodal biometric recognition system integrating iris, face and fingerprint based on match score level fusion using multiple support vector machines (SVMs). Here, multiple support vector machines are applied in parallel fashion to overcome the problem of missing biometric traits. It considers every possible combination of all the three biometric traits (iris, face and fingerprint) individually. Each possible combination of biometric traits has a separate SVM to combine the available match scores to generate the final decision.

Ms. Poonam Mote [8] In this paper author propose the multimodal biometric system using two traits i.e. face and fingerprint. The final decision is made by feature level fusion. Feature extraction is based on Gabor filter for fingerprint as well face. In the proposed system the stored feature dataset is updated every time hence the proposed system is more reliable than the others. This system is tested with the standard datasets of face and FVC2004 datasets of fingerprint. The proposed system has lower computational complexity and higher accuracy.

T.Karthikeyan et. al [9] In our proposed system gives how to set a model to extract the feature of different irises and match them is especially important for it determines the results of the whole system directly. Gabor wavelets are able to provide optimum conjoint representation of a signal in space and spatial frequency. A Gabor filter is constructed by modulating a sine/cosine wave with a Gaussian. Feature Encoding was implemented by convolving the normalized iris pattern with 1-D Gabor filters. For Matching hamming distance will be calculated and accurate recognition was achieved.

P. D. Garje [10] In this paper, multibiometric identification system aim to fuse iris n fingerprint traits. During enrollment stage system generate iris and fingerprint template separately and stored in database. Approach for fingerprint recognition is to extract minutiae from fingerprint images. It makes possible to achieve highly robust fingerprint recognition for low-quality fingerprints. During iris recognition images are segmented, normalized and features are extract by using Log-Gabor filter. Finally matching is done with help of hamming-distance. Once both iris n fingerprint template are match separately scores are combined by using sum rule-based score level fusion which increase the recognition rate. Thus improve system accuracy and dependability.

Chander Kant [11] in this paper, a new approach is used that is integrating the soft biometrics with fingerprint and face for improving the performance of biometric system. Here we have proposed architecture of three different sensors to evaluate the system performance. The approach includes soft biometrics, fingerprint and face features, we have also proven the efficiency of proposed system regarding FAR (False Acceptance Ratio) and total response time, with the help of MUBI tool (Multimodal Biometrics Integration).

3. Proposed Framework:

This paper proposed an architecture and algorithm with the combination of face, fingerprint, and iris. This combination provides higher security as compare to other existing multimodal biometric systems.

3.1. Image Acquisition and Feature Extraction:

Here in the proposed approach suitable sensors are used to acquire the face, fingerprint and iris images.

3.1.1 Image preprocessing:

The feature set originating from different sensors (face, fingerprint, iris) are initially preprocessed. Raw images are difficult to recognize, hence the images are preprocessed for easier detection of the region from the surrounding area.

3.1.2. Feature extraction: This stage is used for extracting the feature set that can be used to differentiate different subjects, creating a template that represents the most discriminate features of the face, iris and fingerprint.

3.2. Architecture of Proposed Scheme:

It is present that face, iris and fingerprint biometric traits combination has better accuracy than other combination biometrics. Proposed scheme (as shows figure 2) works by first capture face, iris and fingerprint after that preprocessing is performed to remove the noise part of the images and then extracts their feature set, compare it with database, compute match score. The match score is obtained by Euclidean distance formula. Min-Max Normalization and then Simple Sum rule Fusion method apply on all three computed match score and generate a fused match score. If this fused score is less than and equal to threshold value then the query user is genuine otherwise imposter.

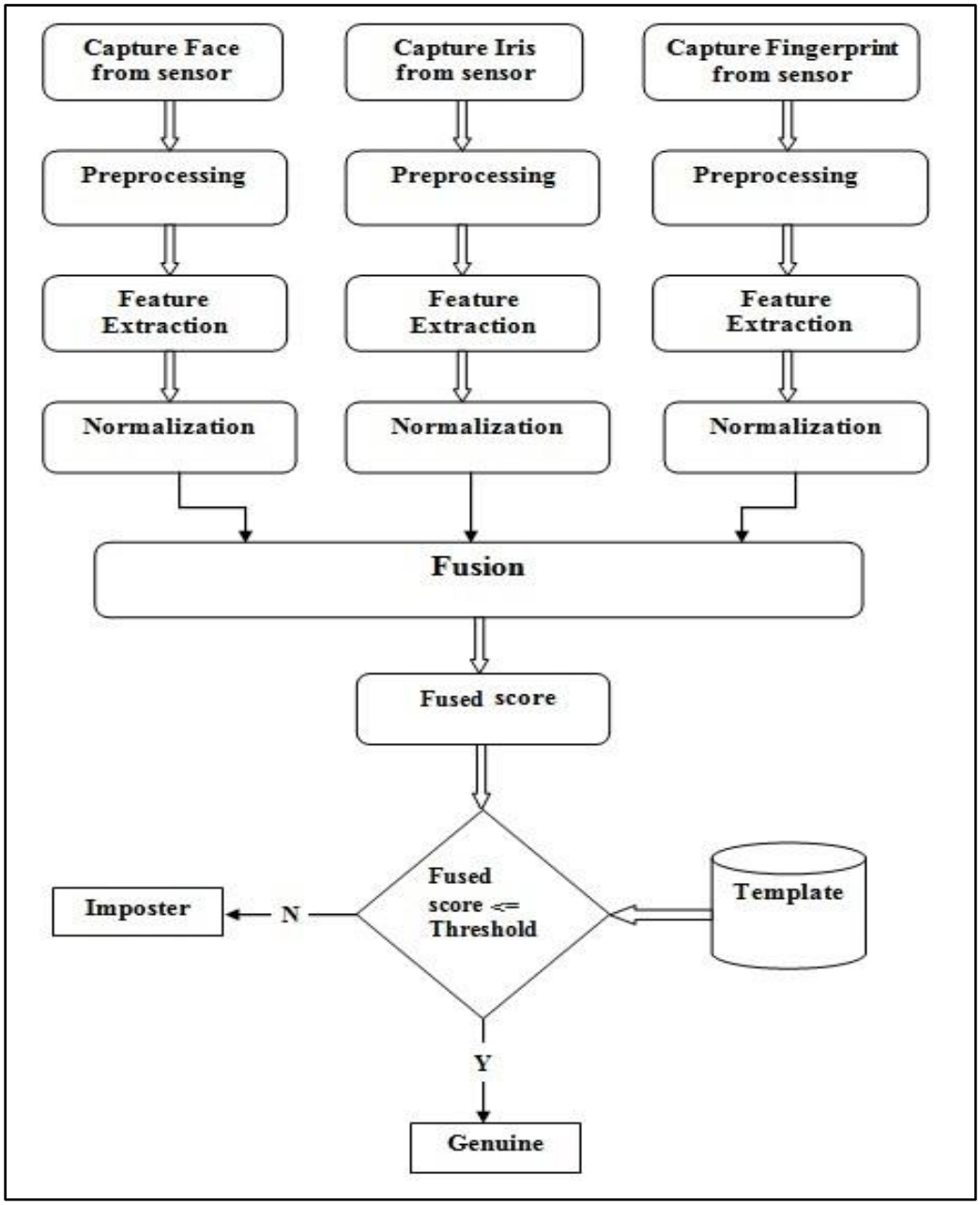

Figure 2: Proposed Scheme Architecture

3.2.1 Algorithm for proposed Architecture:

1. Capture Face image by suitable sensor
2. Perform preprocessing
3. Extract feature set of face
4. Compare with database compute Match Score of matched face
5. Capture iris image by suitable sensor
6. Perform preprocessing
7. Extract feature set of iris
8. Compare with database compute match Score of matched iris
9. Capture Fingerprint image by suitable sensor
10. Perform preprocessing
11. Extract feature set of fingerprint
12. Compare with database compute match Score of matched face
13. Apply Min-Max Normalization on all three (face, iris and fingerprint) match scores, get match scores in a common range
14. Apply Simple Sum Rule Fusion method
15. Combined Fused Score
16. If (Fusion Score <= threshold value)
17. Genuine user
18. else
19. Imposter
20. End

3.3 Mathematical terms:

3.3.1 Euclidean Distance:
The Euclidean distance measure is used to calculate the minimum distance between the training and testing dataset is considered as the match score.

$$d(x,y) = \sqrt{\sum_{i}^{n}(x_i - y_i)^2}$$

3.3.2 Score Normalization:
Min-Max normalization method used that map raw score in the range [0, 1]. It gives lower and upper bound values of score [12].
The normalized scores generated by the following equations:

$$N_{face} = \frac{\mathrm{MS_{face}} - \mathrm{min_{face}}}{\mathrm{max_{face}} - \mathrm{min_{face}}}$$

$$N_{iris} = \frac{\mathrm{MS_{iris}} - \mathrm{min_{iris}}}{\mathrm{max_{iris}} - \mathrm{min_{iris}}}$$

$$N_{finger} = \frac{\mathrm{MS_{finger}} - \mathrm{min_{finger}}}{\mathrm{max_{finger}} - \mathrm{min_{finger}}}$$

Where N_{face} , N_{iris} , N_{finger} are the normalized scores of face, fingerprint and iris respectively.
where [$\min_{face}$, mix_{face}], [$\min_{finger}$, mix_{finger}] , [$\min_{iris}$, mix_{iris}] are the minimum and maximum scores for face, fingerprint and iris biometrics respectively [13].

3.3.3 Fusion:

In the sum rule, to obtain the final score, normalized scores of individual matcher (face, fingerprint and iris) are sum together to obtain the final score. It is defined mathematical as

$$\textbf{Sum=} \sum_{i=1}^{n} Si$$

4. Results:

In this paper proposed multimodal biometric system fusion of three modalities is carried out at match score level. MATLAB 2013 is used to analyze the efficiency of proposed approach. The data set for face was taken from ORL database [14], fingerprint was taken from FVC 2004[15] and iris was taken from CUHK website [16]. The ROC (Receiver operating characteristics) curves for the proposed system are obtained by plotting the true positive rate versus false positive rate with different value of thresholds. TPR measure the proportion of positives that are correctly identified. FPR measure the proportion of positives that are incorrectly identified.

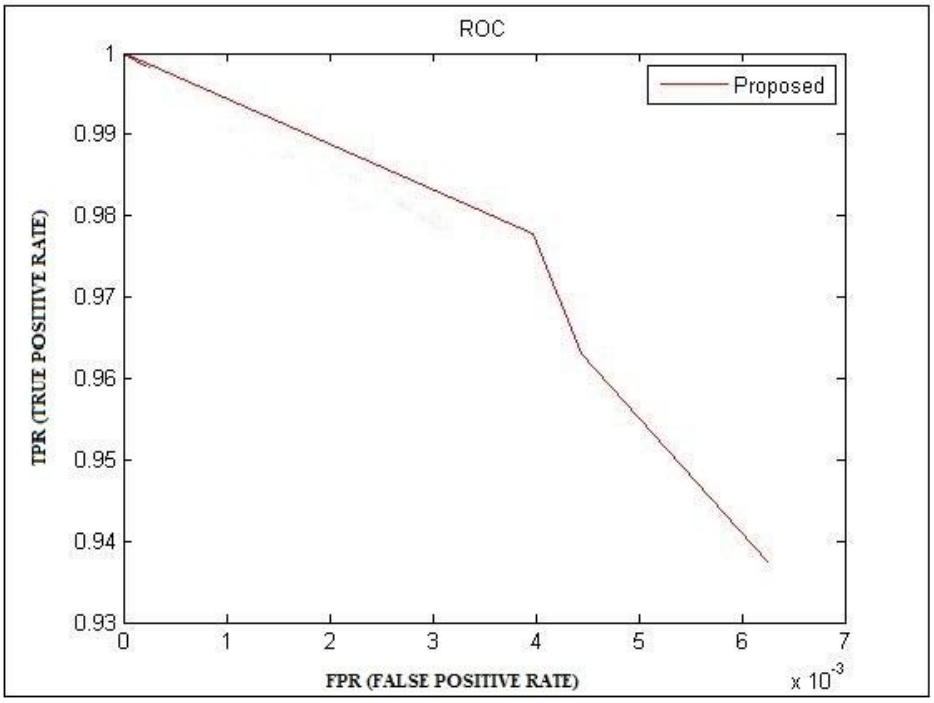

Figure 3: Roc curve of proposed approach

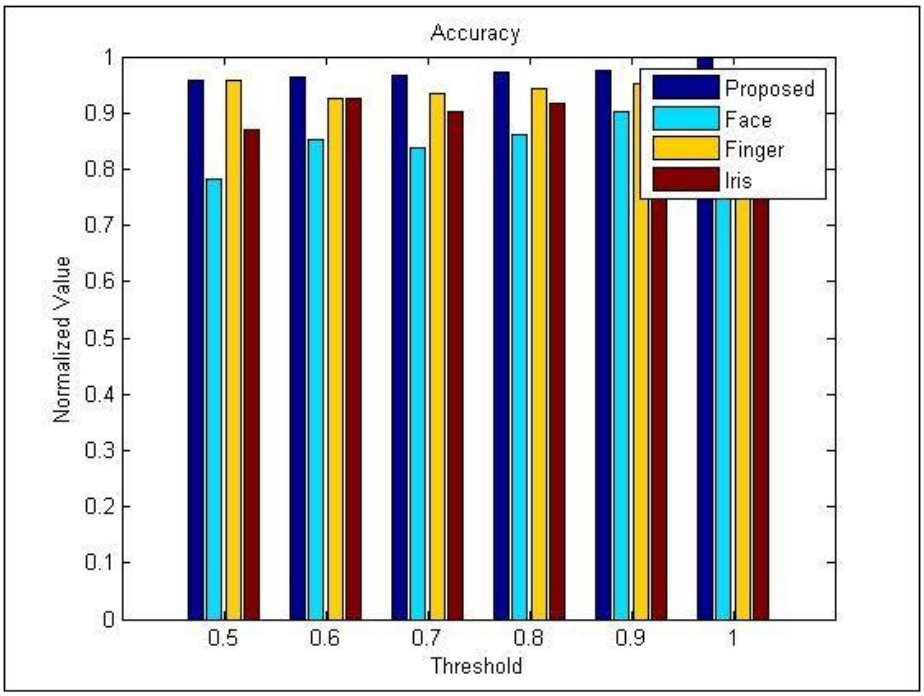

Figure 4: Bar chart presenting Accuracy of each modality

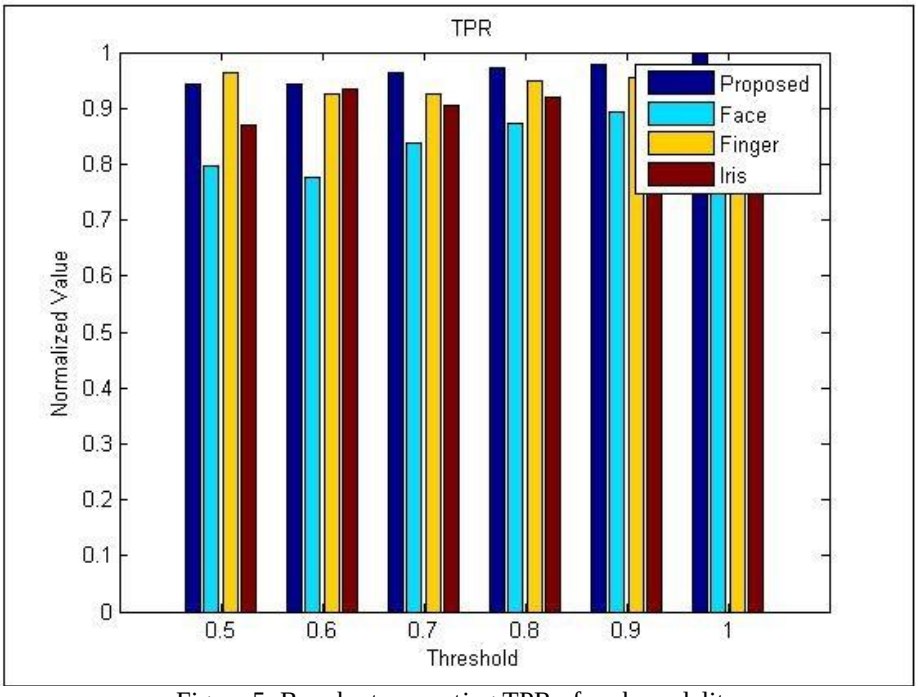

Figure 5: Bar chart presenting TPR of each modality

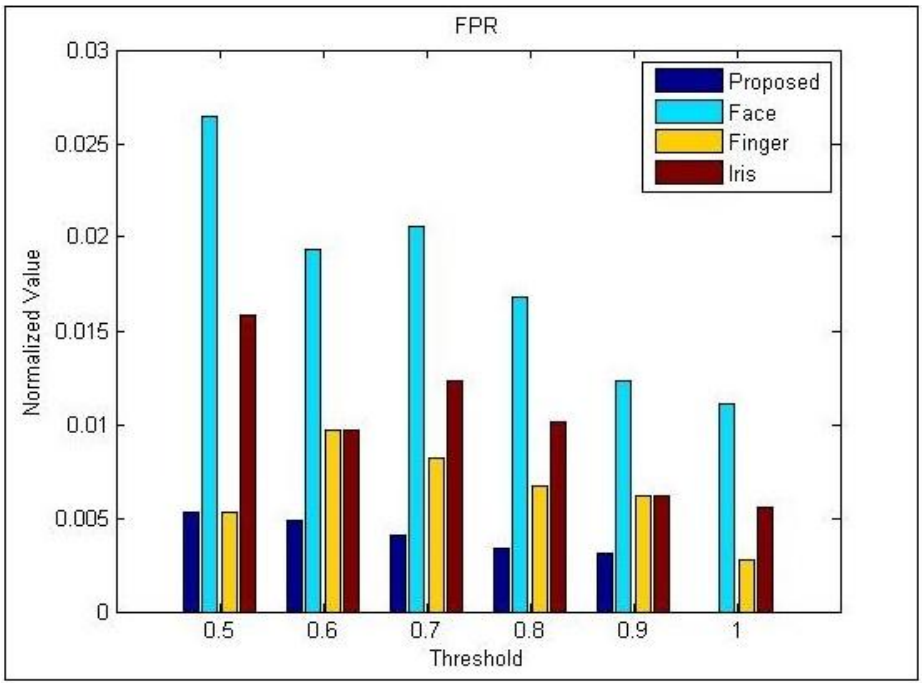

Figure 6: Bar chart presenting FPR of each modality

Table 1: Comparison of proposed scheme with existing biometric techniques:

S. No.	Biometric Technologies	Accuracy
1	Proposed Approach	97.77%
2	Face	87.80%
3	Finger	95.12%
4	Iris	92.68%

Table 1 describes the average accuracy of every modality in proposed system. It is clear from the table that proposed approach has highest accuracy. Multimodal biometric system achieves better accuracy and increased the reliability of authentication than the unimodal systems.

5. Conclusion:

In this paper, a multimodal biometric recognition system is proposed. It integrates three biometric traits (iris, face and fingerprint) at match score level fusion. Combining various modalities for identification and verification system would definitely improve the security. Fusion at the match score level is the most popular fusion method owing to the fact that it is easier to access and combine matching scores. In proposed approach used most widely chosen modality are face, fingerprint and iris. Face and fingerprint have high acceptance rate than other biometric traits. And iris and fingerprint both are unique for each person therefore provides accurate result. The combination of face, iris and fingerprint increases the security of biometric system.

6. References:

[1] Saritri.B.Patil, "A Study of Biometric Systems: Fusion Technique Application and Challenges," IJCST, Vol.3, 2012.

[2] Anil K. Jain, Arun Ross, Patrick Flynn, "Handbook of Biometrics", Springer, 2008.

[3] Houda Benaliouche, Mohamed Touahria "Comparative study of multimodal biometric recognition by fusion of iris and fingerprint", The Scientific World Journal, 2014.

[4] Dr. N. Radha, S.R. Soruba Sree, "A Survey on Fusion Techniques for Multimodal Biometric Identification," Vol. 2, No. 12, Dec. 2014.

[5] S. K .Bhardwaj, "An Algorithm for Feature Level Fusion in Multimodal Biometric System," International Journal of Advanced Research in Computer Engineering & Technology Vol. 3, No.10, Oct. 2014.

[6] Ashraf Aboshosha, Eman A. Karam, "Score level Fusion for Fingerprint, Iris and Face Biometrics" International Journal of Computer Applications volume 111 – no 4, Feb 2015.

[7] Sheetal Chaudhary, "A Robust Multimodal Biometric System Integrating Iris, Face and Fingerprint using Multiple SVMs "International Journal of Advanced Research in Computer Science, Volume 7, No. 2, April 2016.

[8] Ms. Poonam Mote, "Multimodal Biometric system using Gabor Filter" Iternational Journal of Advanced Trends in Computer Science and Engineering Volume 1, No.2, June 2012.

[9] T. Karthikeyan, B. Sabarigiri, "An Efficient Iris Feature Encoding and Pattern Matching for Personal Identification "International Journal of Advanced Research in Computer Engineering & Technology (IJARCET) Volume 2, Issue 3, Mar 2013.

[10] P. D. Garje, "Multibiometric Identification System Based On Score Level Fusion" IOSR Journal of Electronics and Communication Engineering (IOSRJECE) Volume 2, Issue 6, Oct. 2012.

[11] Chander Kant "A Multimodal Approach to Improve the Performance of Biometric System" BIJIT - BVICAM's International Journal of Information Technology Bharati Vidyapeeth's Institute of Computer Applications and Management (BVICAM), New Delhi (INDIA), April 2015.

[12] A. K. Jain, A. Ross, and S. Prabhakar, "An Introduction to Biometric Recognition", IEEE Transactions On Circuits and Systems For Video Technology, vol. 14, no. 1, pp. 4–21, Jan 2004.

[13] A. K. Jain, K. Nandakumar, & A. Ross, "Score Normalization in multimodal biometric systems", The Journal of Pattern Recognition Society, 38(12) , 2270-2285, 2005.

[14] Olivetti Research Laboratory (ORL) database of faces, 2002. www.cl.cam.ac.uk/research/dtg/attarchive/facedatabase.html.

[15] Fingerprint Verification Competition, 2004, bias.csr.unibo.it/fvc2004/download.asp.

[16] Computer vision Laboratory (CVL) CUHK Iris image dataset. www.mae.chuk.edu.hk/~cvl/main_database.html.