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Robust Iris and Fingerprint Biometric Fusion in Multimodal Feature Template Matching

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Abstract*: A fusion scheme in multimodal biometric system is proposed in the name of Multimodal Feature Template Matching (MTM) system derived from the two picture fused values of average point and weighted assessment point. The main objective of MTM algorithm is to design the average point fusion and weighted average point by fusion of Iris and fingerprint features. The MTM algorithm is assigned with avgweights based on their verification accuracy. A hybrid approach of combining biometric image level information id presented. The raw information is merged at image level. This integration addressed, provides a small template and resilience to attacks. However it does not improve the recognition performance, but the performances is also less combination to its unimodal counterpart. Confidence level integration of compatible features of two different uncorrelated biometric traits fingerprint and iris provides sustainable improvement in performance accuracy compared to other integration methods as well as best unimodal system. Fingerprint and iris integration approaches presented in this proposed are more robust and reliable.

***Keywords:-* Biometrics_fingerprint, fingerprint_iris, multi-biometric system, , match_level fusion.**

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I. INTRODUCTION

The reliable user matching techniques has increased in the topmost institutions about surveillance and expeditious upgrading in associate, transmission and manoeuvrability. An immense assortment of require reliable concerns authentication schemes to accept or analysis the ID of a personal soliciting their addressed. The intent of proposed method is to assurance that the accomplished maintenance is pervading trusted user, and ignore or not accepted any others. precedent of some applications include privacy access to concerns, cell phones, laptops, computer systems and different electronic gadgets. In difficult to robust individual authentication arrangements, these structures are uncovered conspiracy to the hypocrite. Conventional corroboration methods based on passwordkey and manifestation are narrow in their competence to following issues.

- Host attack - person permeate emptytext, image and document incorporate passwordskey.
- Client attack - person guessing, robbing or stealing tokens or password
- Eavesdropping - password shared by many individuals
- Trojan horse attack - Stealing password by installing fake log-in screen.
- Denial of service - Using incorrect password to disable the system.
- Non-Repudiation - individual claiming that password was lost or misplaced.
- Negative recognition - A deal with a process regulate convinced particular is certainly enrolled the measures the personal after deny it.

The effectiveness of an authenticator system is established to fortitude to different types of mischievous incursion to importance enter the incursion begun opposes verification process based on passwordskey and expressions. The advent of biometric has addressed some of the short comings of this traditional authentication system. Below figure1 represents proposed fusion system implementation.

a) Multibiometrics: A uni-biometric mode in unimodal process inefficient to reach concern needs including identical analysis imposed by huge authentication. Biometric process more functionalities in identification, screening and positive identification. But they are not ideal and perfect. These systems have to deal with many problems such as

a) Intra-class variations
b) Noise in sensed data
c) Inter-class similarities
d) Spoof attacks
e) Non-universality

Multibiometrics methods strives to solve deficiency by consolidating the evince represented to different biometrics information. This process integrates image information from multiple, sensors traits, snapshots, portrayal and identical algorithms for the same biometric. Multibiometrics methodology differentiate 5 types of integration depending on where the biometric information is combined. They are sensor level, feature level, (which are also called as pre classification integration), score or confidence level, rank level and decision level (which are also called as post classification integration) [1]. Multi-biometrics combined two or different biometric trais/modalities in a authentication process to reform the efficiency. Besides enhancing accuracy, it can address non-universality issue, problem of noisy or corrupted input data, difficult to imposter to satire multiple traits/modalities and continuous monitoring is possible even in event of failure of any sensor, as tracking can be done by other traits [2] [3].

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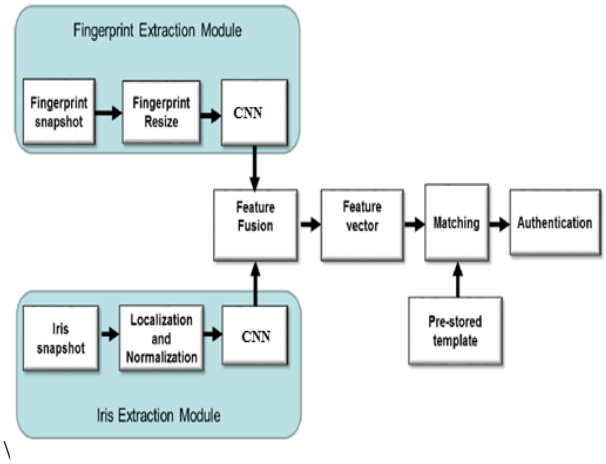

Fig1 Block diagram for multimodal fusion method

This paper is structured in the following manner: In section II, explain briefly about biometric picture such as fingerprint and iris picture and key concepts related to blending. In section III, explain image blending and related research work architecture. In section IV, explain the proposed system algorithms result and discussion. In Section V draws our conclusions from the study results. There are various studies and approaches proposed in literature for multimodal biometric system and a comprehensive review is presented below. Integration of information takes place at different level and from different sources of information.

Marcialis and Roli, et al [4] presented a system to merge the pattern of finger information of a personal acquired from an suitable types of markets available fingerprint scanners. The information data was fused at score level by sum, product and logistic transformation blending schemes. The authors, point out procuced to interdependent instructions needs to provide higher accuracy result. N. Werghi, and et al. [5] C. Tortorici Chang et al. [6] accomplished 3D and 2D picture facial information merged score level based and data level considered to improve the performance to facial information. Both are concentrated 189 and 102 objects, used to found that 3D and 2D picture results in good identification attainment correlated to the 2Diamentional picture. Lu and Jain et al. [7] integrated values, pattern Information to 3Diamentional Face authorization using 2Diamentional camera and IR camera at compare values accepting weighted added precedent, hierarchical matching. The advantage of having multi-sensor assisted in the registration, segment of images, procedures are increased proposed accuracy. Flynn, P. J et al. [8] proposed facial picture of an personal gathered implemented a thermal IRcamera and a visible light camera in the context of principal component analysis. It was shown that adding the information applied to these 2 picture (both at the rank-level and score-level) enhances matching accuracy. The combining process was done by logistic regression and fixed mean rule. They also showed principal component analysis recognition based on visible light camera outperformed recognition based on infrared camera Chang et al. [9] and R. Raghavendra, presented results of uni-modal/multi-modal facial authorization using three dimensional, two dimensional, IRpicture of the same objects. Each IRsensor captured various sorts of individual facial information, delineating emerge mirror from a IRcamera, heat emitted method. They used a database encompass a total of 142 picture and 297 expand timelapse picture. Using a PCA independently for 3Diamentional, 2Diamentional, IR picture, recognition rates were 90.6%, 91.9% and 71.0% respectively. Merged with every pair of procedure, recognition rate were 94.2, 95.3 and 97% for 3D/2D, IR/2D and 3D/IR individually. Combining all three modalities recognition rate was 100%. Chaudhary, and Sheetal, et al. [10] FpVTE 2003 was analysis to performance and calculated the efficiency of proposed method, fingerprint verification and identification systems. Its summary and analysis report Meva et al., [11] and NIST Biometric and Evaluation and Development paper by Hassan, Norsalina, and Dzati Athiar Ramli et al., [12], Dandawate, and Yogesh H et al. [13] and W. Yang, integrated information presented by two fingers at the match score level by probability proportion calculated nonparametric statistical estimates. It was found that multiple fingers improve the verification performance by 4%. Apart from this, classifier combination at decision level was also presented to improve accuracy of fingerprint verification system. Y. Xin and L.Kong et *al*. [14] come up with a mosaicking initialize a combination image conferred by various pictures of fingerprints. The proposed algorithm used simple affine transformation first to register the two picture of fingerprint. The achievement conferred mosaiced templates choose outperform personal fingerprint pictures. Aizi, and Kamel et al. [15] and M. Haghighat, a proposed combining one texturebased –matched-filter) and 3minutiae based namely Houghtransform, 1D string based and 2D dynamic programming based, at decision level in an optimum way. Their stresses were on classifier collection appear to last combination. Their scheme improved the verification performance by 3%. Shohel Sayeed, and Ilham Nasir [16] carried out a case study of combining fingerprint and Iris at score level using Linear SVM, Radial basis function SVM and Dempster model using CASIA and FVC2004 database. Best classifier of FVC 2004 competition was used. They achieved EER of 0.195 for fused system which was much better to error rate of 3.2 for iris system. H. Alshehri, and M. Hussain, et al. [17] proposed, fingerprint and iris modalities and own decision based. W. Kabir, M. and O. Ahmad et al [18] iris and fingerprint based on hammingdistance method. In their system they extracted minutiae code of fingerprint and iris code from individual fingerprint and iris classifier and fused them using simple accumulator based blending approach. Final results of the proposed method higher accuracy, unimodal and the results comparable commensurate to conventional methods.

II. SYSTEM DESIGN

Unimodal biometric recognition cannot gather the performance needs in most of the applications. Simultaneously, the multimodal biometrics recognition symbolizes a promising trend in recent times. In our research work we present a novel approach of combining image level information of fingerprint and iris.

The raw information or data is merged at pictures level or features. A particular feature initialized textural pattern based information of both fingerprint and iris.

The proposed CNN method subsist of

(a) Biometric1(finger print) feature extraction
(b) Biometric2(Iris) feature extraction
(c) Module1 and Module2 fusion

Biometric1 extraction module composes to (a) fingerprint procurement, resizing and enhancement. GLCM methods are used to extract the features both fingerprint and iris picture. Feature classification of proposed methods used to convolution neural network (CNN). In Biometric2 iris province is separation from eye picture then applying CNN. Haar method implemented to 4 bands of interdependent, subsamples are LL, HL, HH, and LH where L denotes lowpass and H denotes high pass. both fingerprint and iris are fused together and a unique feature vector is extracted from this fused image. Classification fused pictures is using Hammingdistance.

a) Fingerprint feature extraction module:

The fingerprint procurement and pre-processing. This step of image resizing and enhancement the image for further operations. Convolution Neural Network is used to decompose the image data into picture appeared at different resolutions. Convolution Neural Network (CNN) more accuracy over traditional other transform methods. A filter bank, applied to picture, the output of applying the CNN encoded and provide covenant fingerimage pattern. Convolution Neural Network (CNN) is carried out on enhanced fingerprint image.

Haarwavelet is simplest wavelettransforms and perform huge data sets to appreciably. Haar wavelettransform. disintegrate picture with yields a multi-resolution detailed picture to each level. The sub-picture (quadrants) within the imag. The sub-image LL characterizing an exact pictures further used as an input to feature blending block.

b) Iris Feature Extraction Module

The iris collected part of picture that information borrowed eye region. The stages iris feature extraction module is iris localization, normalization and CNN. Localization and normalization are implemented. Next CNN is enforced to established iris pictures. Haar method implemented to 4 bands of interdependent, subsamples are LL, HL, HH, and LH where L denotes lowpass and H denotes high pass.

C) Feature fusion Module

In multimodal biometric system employing feature fusion, picture information's are generated various sensors of same modality. These features are not independent, and impartial combined the 2 vectors to 1 vector format. The proposed vector HD also represents various spaces. Reduction method to cut down size of vector features, and features are homogenous based. hence a new distinct method of blending is been proposed. Fingerprint and iris features are extracted as explained earlier. Different transformation techniques are used in information retrieval system which can be used in transformation of biometrics scores also. The following conversion methods to convert the both iris and fingerprint information's. Information based on Zscore, MAD, minima-maxima, median and decimal, and tanh predictors. Given matching scores $\{sk\}$, k=1, 2, [1 stands for fingerprint and 2 for Iris] then conversion values are expressed to:

Min-max calculation

$$s' = \frac{s - \min\{s_k\}}{\max\{s_k\} - \min\{s_k\}} \quad ----(1)$$

Decimal calculation

$$s' = \frac{s}{10^n} \quad ---(2)$$

$$n = \log_{10} \max\{s_k\} \quad ----(3)$$

Zscore

$$s' = \frac{s - \mu}{\sigma} \quad ----(4)$$

Median Absolute Deviation (MAD)

$$s' = \frac{s - \text{median}}{MAD} \quad ----(5)$$

$$\text{MAD} = \text{median}\ (\ |\{ s_k\} - \text{median}\ |)$$

Tanh estimators

$$s' = 0.5\left(\tanh\left(0.01\,\frac{(s - \mu_{GH})}{\sigma_{GH}}\right) + 1\right) \quad --(6)$$

Where parameter μ, σ and GH are mean, variance and Gaussian dissemination. Finally transformed information merged iris and fingerprint using various fusions. Figure 2 represents the proposed system implementation step by step procedure Pseudocodes. Divergent feature extraction based GLCM algorithm for Iris and fingerprint blending produces varying percentage of the match due to varying illumination, pose and other variation conditions. SAES and DSVT provide better feature extraction of the iris.

Fingerprint features are also effectively extracted using the field coordination with field union properties. A theoretical framework for integration of evidence obtained from different classifier was developed by kittler using different schemes. The trained rules are also called as parametric rules as they require output samples to train the classifier and calculate some parameters. These parameter are them used to fuse the classifier scores.

Weighted sum and weighted Product are learning based or trained rule while sum rule, min, AND, median, product, max, OR and majority vote rules are fixed rules. We have combined scores of iris and fingerprint matcher using Simple sum

$$(SF) = \Sigma SINi = 1 \; ----(7)$$

Minimum score

$$SF = Min(S1, S2, \ldots\ldots..SN) \; --- (8)$$

Maximum score

different fusion approaches that are multimodal biometrics. Following section gives brief description of the rules used in our multimodal biometrics framework.

$$SF = Max(S1, S2, \ldots\ldots..SN) \; --- (9)$$

Product Score

$$(SF) = Prod(S1, S2, \ldots.SN) \; --- (10)$$

// Multimodal Feature Template Matching Algorithm
Begin
1: Signal process on multiple biometric Images
//Feature Extraction of Iris
2: Preprocessing performs removal of noise and backdrop disturbance
3: Segmentation of iris using the segment autonomous element search
4: Determine the nearby points blur the data of SAES using Euclidean distance
5: iris feature extraction performed using GLCM as shown in Equation (5.4)
6: Extracted features analyzed with the database for obtaining the percentage match after classification
//Feature Extraction of Fingerprint
7: Preprocess performs edge detection
8: Field coordination enhance the fingerprint extraction using finger print ridge wave filter
9: Cross union performs association with ridges and valley lines
10: Extracted features analyzed with the database for achieving the percentage match
// Matching Algorithm
11: Quality assessment computed on iris and fingerprint images
12: MFTM integrates average point and weighted average point
13: Measure the final average point value for exploiting better statistical fusion schemes using Equation.
End

FIG2 PSEUDOCODES FOR PROPOSED SYSTEM BIOMETRIC FUSION

Where SF is fused score, ith is number of matchers and Si is normalized input score and N is number of inputs. Proposed system identifies a person by an aggregation methodology using average point and weighted average point. The average point is implemented to give a match average to decide the identity. The complete procedural analysis of the average point and the weighted average point are provided.

III. RESULT AND DISCUSSIONS

The performance of proposed system carried out by experimentation with number of iris and fingerprint picture available of the dataset discussed below. The experimentation was done on a 64bit system with 4GB RAM and 3.3 Ghz processer using MATLAB 2013a.

a) Database

Experimentation has been done by using 154 test cases of fingerprint and iris. 126 test cases were used to train the database and 23 test cases were kept out of the database to find false positives. iris database is obtained from consist of 5 test samples per eye with a resolution of 320*320. CASIA fingerprint V5 database of fingerprints is obtained from which consist of 5 test samples of each fingerprint with the resolution of 320*320 in various orientation in each class. Only the class with the fingerprint samples of similar orientation were considered to meet the criteria texture based matching.

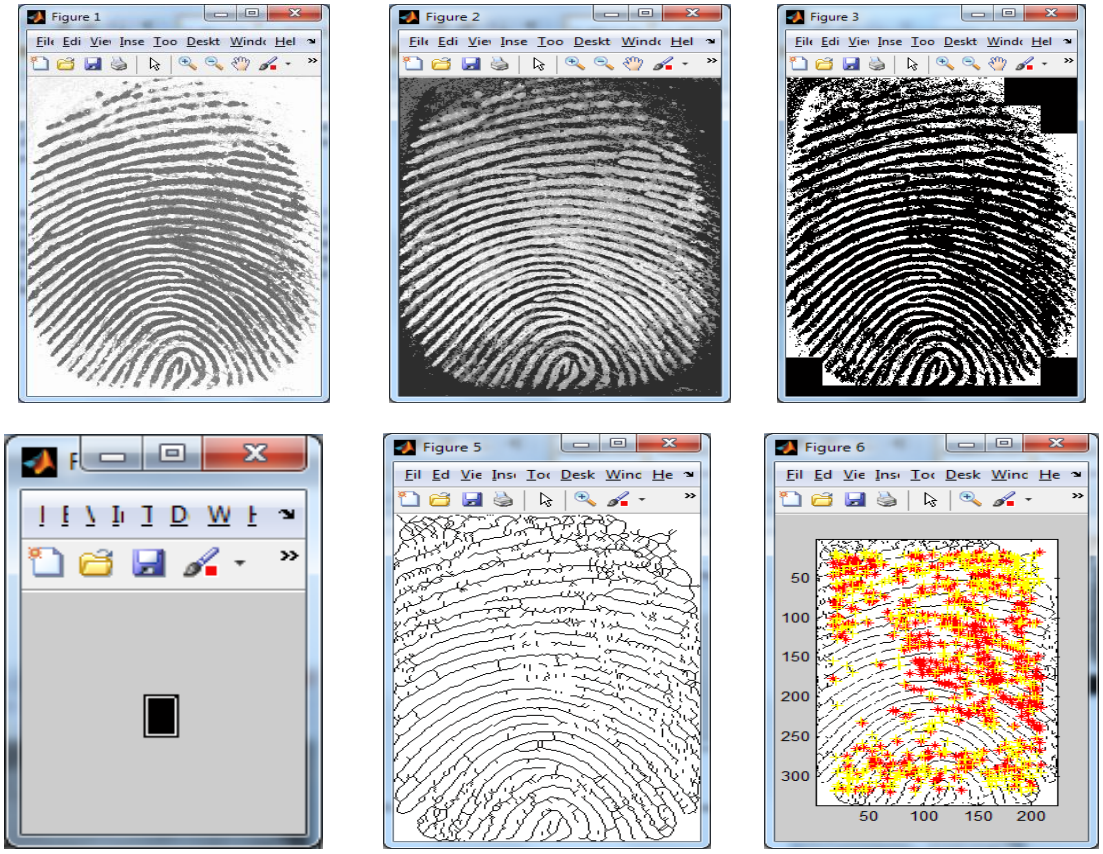

Fig3 fingerprint (a) input image (b) grayscale image (c) Binarized Image (d) Thin Image (e) fingerprint Ridge image (f) minutia image

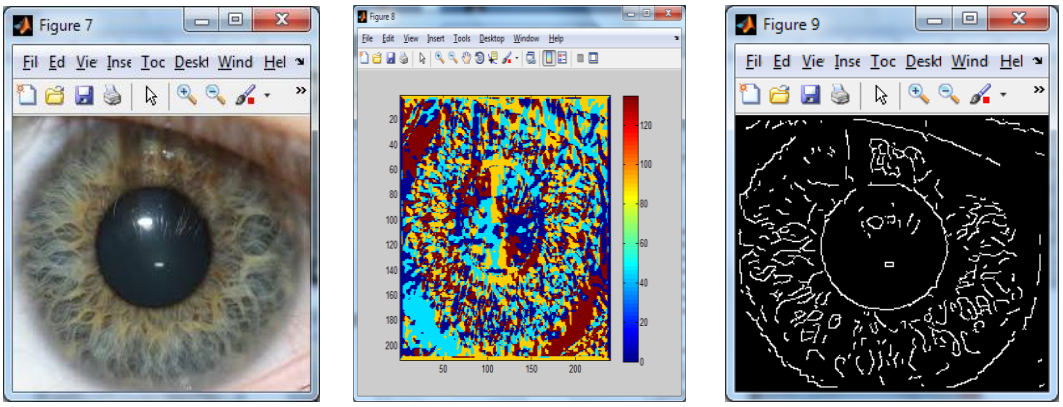

Fig4 (a) Input image (b) convolution image (c) canny filter image

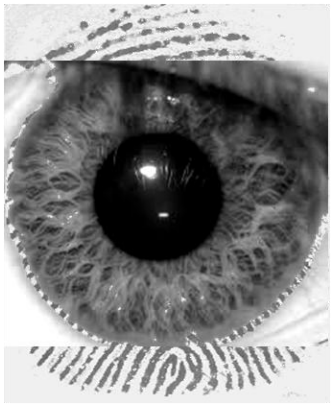

Fig5 blending image

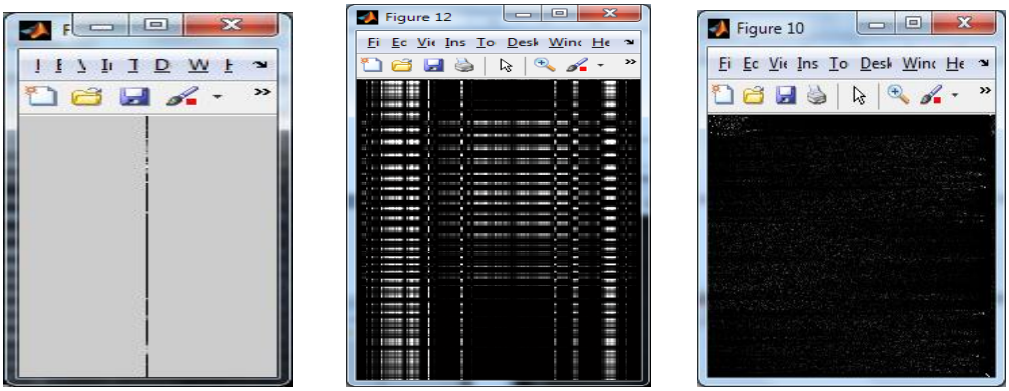

Fig 6 (a) reduced Dimension fingerprint (b) reduced Dimension iris (c) blending reduced

Proposed efficiency of any biometric method determined by measuring different ER. Based on FAR and FRR. FAR is a measure of fraud genuine users and false (fraud) users. FRR used to total users rejected to false or frauds. The error rates is measured by recording a genuine and imposter (fraud) imposter of graph depending on their frequency. Figure 4, 5 and 6 explained input fingerprint and iris various process involved to final blending of combined fused result displayed.

Fusion score integration of between ease of fusion and picture information content. Score based integration was adopted. We carried out blending of fingerprint and iris by fusion such as product score simple sum score, max, and min score,. In the study, the results were obtained in terms of Receiver operating characteristics (ROC). Two plots FAR v\s GAR plotted. EER is also obtained from the second plot.

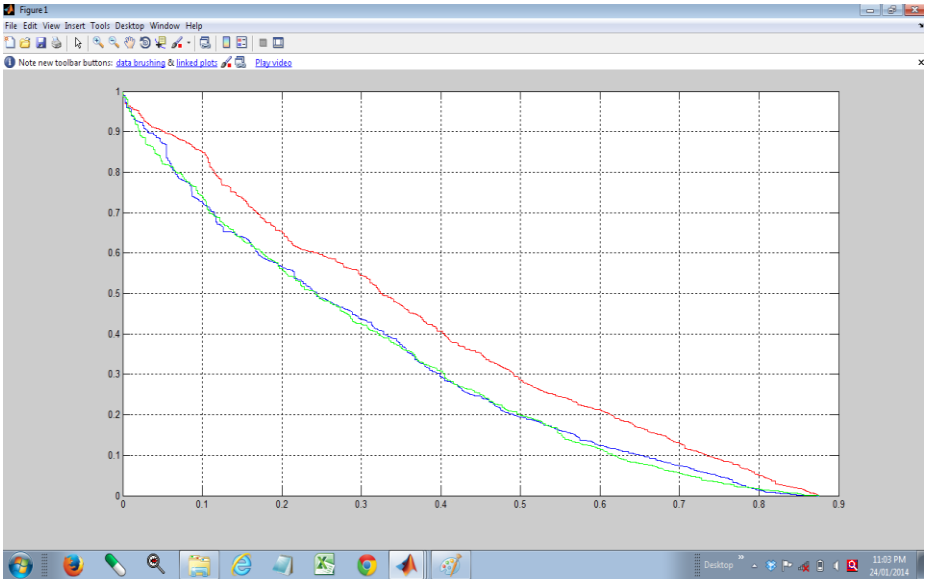

Fig7 Receiver Operating Characteristics for SUM fusion rule

From the ROC curves for the multibiometric system shown in figure 8, when fusion analysis based on max-min, sum, rules, product, based biometrics using the simple sum rule gives the best recognition performance. Min score is very simple but performs consistently poorly, max score has low to average performance, product rule does not perform well at all. Practical test show simple sum is the most accurate blending method overall. In general, the sum rule has been shown to perform well because it is distributions. On standard database transformation of only iris modality score does not yield good result at all except in some instant.

We achieve good result for minmax and Zscore transformation. While by normalizing both iris and fingerprint scores using different transformation methods and improvement in GAR.

fusing by simple sum method, it is observed that minmax, mean and zscore methods give good result compared to individual unimodal modality. This transformation method gives a GAR of approx. 38.5 and 19.5 at FAR of 10 % and 1% respectively. Transforming only fingerprint score by tanh method and keeping iris score untransformed gives the best results .We achieve a GAR of 29% when FAR=1% .Mean and zscore methods also gives good result in of FAR=10%.

The result of transformation and blending exercise of fingerprint and iris modalities and individual modalities in term of EER % is presented in table 1. It is observed that EER reduction is obtained with these two modalities transformed and fused. There is also consistence

From all this result it is apparent that in most case transformation of scores exhibit greater performance accuracy of this multimodal framework.

Table1 GAR values for different FAR for different blending rule

FAR	FINGER	IRIS	MAX	MIN	PROD	SUM
0	0.03	----	0.01	0.02	0.02	0.001
0.1	0.15	0.27	0.18	0.22	0.25	0.28
0.2	0.35	0.43	0.435	0.38	0.37	0.435
0.3	0.45	0.56	0.58	0.45	0.48	0.57
0.4	0.59	0.7	0.71	0.59	0.51	0.715
0.5	0.71	0.8	0.79	0.72	0.52	0.815
0.6	0.78	0.87	0.87	0.785	0.6	0.875
0.7	0.87	0.915	0.93	0.87	0.66	0.935
0.8	0.95	0.975	0.98	0.95	0.74	0.985

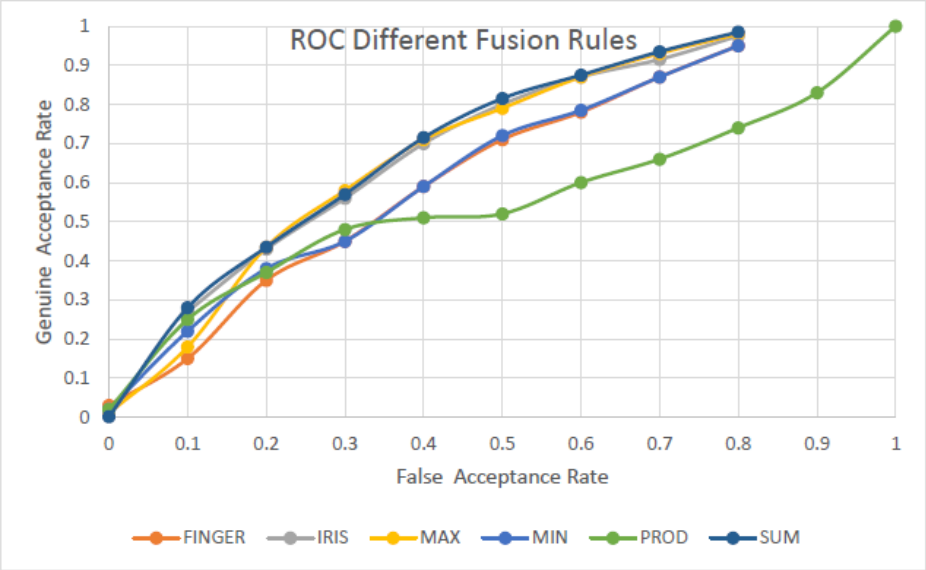

Fig8 Comparative ROC [FAR v/s GAR] for different blending rule

IV. CONCLUSION

In this proposed, scheme for fusion method achieved, score based and feature based. Proposed paper combines fingerprint and iris biometrics at confidence level to investigate and compare this multimodal biometric framework. Practical experimentation proves improved accuracy of this system over its unimodal counterpart even though it marginal in case of iris. Practical result also shows that simple CNN based fusion, more sensitive and efficiency, min-max and TANH normalization based method. It is also learned that choosing transforming of finger score rather than transforming iris or both scores gives good results and we gets best result in all ranges with tanh normalized finger scores and keeping iris score untransformed followed by simple sum blending. It has been seen that min max and zscore normalization techniques are efficient and tanh normalization gives best result for open environment and these databases.

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