

A Review Paper on Multimodal Biometrics and Its Fusion Techniques

Wamane Sangita Jagannath¹, Kharde P.S.², Nirmal P.B.³

Assistant Professor^{1,2,3}

Department of CSD¹, E&TC², Math³

DVVP college of Engineering, Ahmednagar, Maharashtra, India

Corresponding Author's Email:- wamanesangita6@gmail.com¹

Abstract

To perform human identification or user verification presently, a variety of biometric modalities are applied. A Unimodal biometric system (UBS) is a technique which authenticates only a single source of information. However, the unimodal biometric systems performance is restricted in terms of, non-universality, susceptibility to spoof attacks, large intra-user variations, and noise in sensed data. The various limitations of unimodal biometric systems defeat in Multimodal biometric systems as the sources of different biometrics typically compensate for the inherent limitations of one another. This paper analyze various levels of fusion for biometrics, and also conclude with direction on future research proficiency in a multimodal biometric system using ECG, Fingerprint and Face features.

Keywords: *Unimodal, Verification, Multi-Modal, Authentication.*

INTRODUCTION

An important activity of national and international security is controlling access to prohibited areas. By using biometrics Security can be provided. Bios means life and Merton means measuring, for measuring and analyzing persons unique characteristics bio metric is used. Person can be identified by using behavioural or physical or soft biometrics. Some of the physical characteristics include, ear, face, iris, hand geometry etc. key strokes, Voice, gait, signature are behavioral characteristics. weight, height, age, Gender, etc are soft

characteristics. Choice of choosing biometric depends on application. The below Fig1. shows various biometric traits.

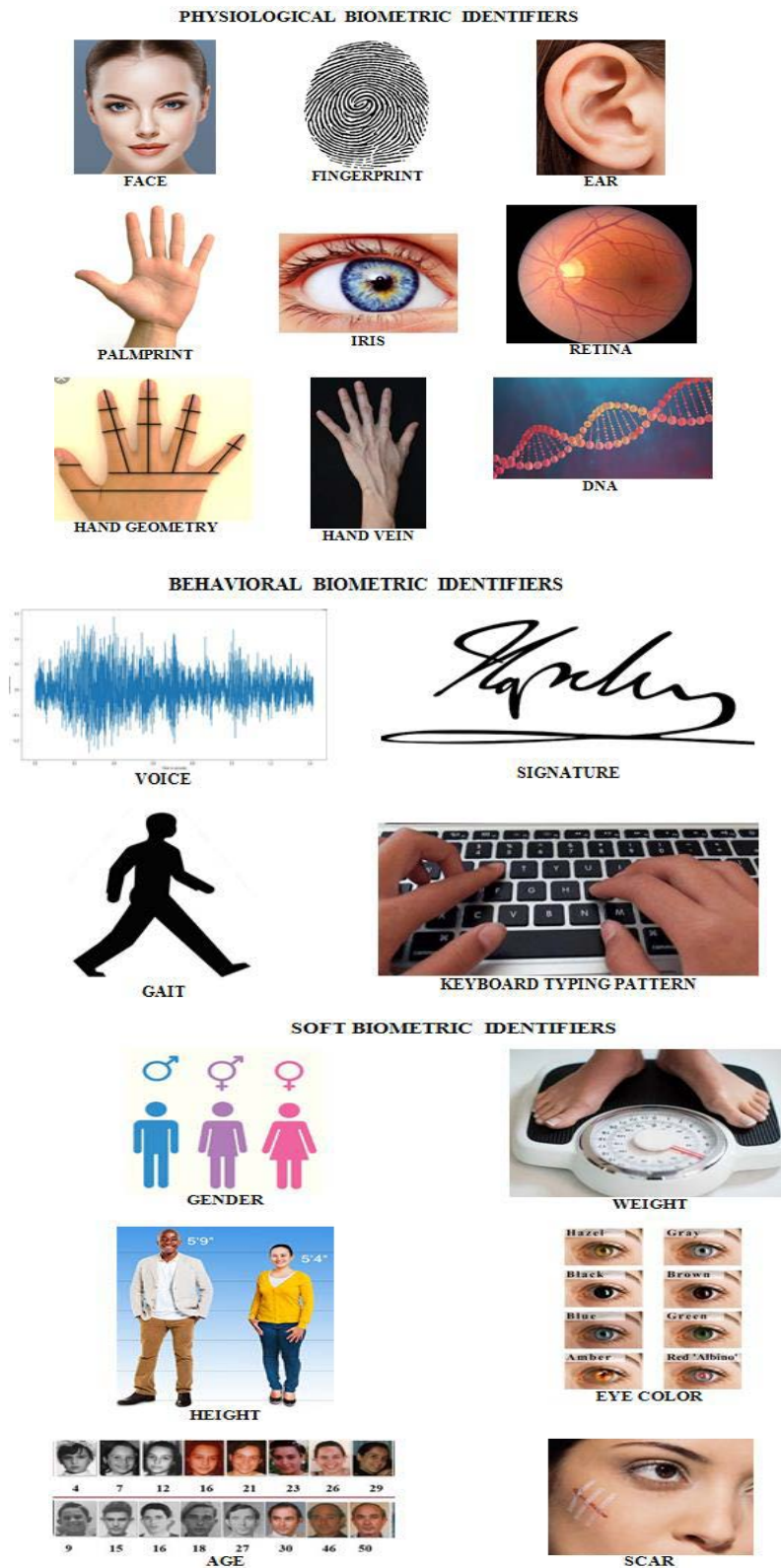


Fig. 1. Physiological, behavioral and soft biometric traits (sources: Google Image [ImaG])

Many advanced biometric systems are facing numerous problems. Noisy data: At the time of acquisition biometric data affected by noise which result in poor recognition performance. Ex. during heavy rain capturing voice biometric trait .

Non-universality: biometric trait is said to be universal if all members of the population can be enrolled in the biometric system. For example, iris or retina biometric trait of blind person cannot be presented in front of sensors. Lack of individuality: false recognition rate can be higher due to biometric obtained from different subject are similar. For example father and son facial appearance can be similar.

Applications: A combination of two or more biometrics is nothing but Multimodal biometrics system. Due to this accuracy in recognition rate is increasing.. The places where you have important information and stuffs Biometric door lock security systems are used at that place. In that kind of places multi biometric electronic door lock security systems that are based on finger print and iris recognition. Airport security, smart cards, Law enforcement, ATMs, Aadhar cards, driving license, pass ports, cellular telephones. [20]

Overview of Multimodal Biometric Systems

Biometric system is optimal if it is distinctiveness, universality, acceptability, security, permanence and collectability. These number of properties satisfies only the multimodal biometric system. the system which uses more than one physical or behavioural characteristic are Multimodal biometric system . Biometric systems mainly consist of four Modules. Sensor module which acquires biometric data from sensors. Ex- camera, fingerprint sensors, etc. The feature extraction module which extracts the features from acquired biometric traits. In database these feature sets are stored as a template. In the matching module. The template stored in the database and the feature set extracted are compared with based on degree of similarity the decision is taken at decision module. Enrolment and identification are the two modes at which Biometric system operates. All users in enrollment mode stored biometric features and other useful information in data base in form of a template with user identity. In authentication mode biometric data is captured once again and compared with templates corresponding to claimed identity

Databases: In fusing multimodal biometrics many researchers are putting efforts. For improving matching accuracy Fusion combines two or more biometrics traits. There are different approaches for biometric fusion. One biometric trait from one database and other trait from another database is heterogeneous database. But the performance of multimodal users is not reflecting by this approach. In Homogeneous approach different biometrics from the same person is used. Only few multimodal databases are available publicly. The two traits XM2VTS and BANCA which includes face and voice. BIOMET which include voice, face, fingerprint, hand and signature. BIOSEC includes fingerprint, ace, iris and voice. But these databases have some limitations.

Performance Parameter

The parameters to define the effectiveness of any biometric security system can be stated as False Acceptance Rate (FAR) and False Rejection Rate (FRR). The recognition performance of any good multi-modal biometric system will depend on these parameters.

1. False Acceptance Rate: During the authentication process of a biometric system if a non-authorized user is accepted as an authorized user, it is called false acceptance. A secure system ensures a low false acceptance rate.
2. False Rejection Rate: If a valid user, who is already enrolled into the system, is rejected by the system during live capture, it is false rejection. The rate at which genuine users are rejected by a biometric system is referred to as false rejection rate, for good system performance this rate needs to be kept very low.
3. Equal Error Rate: EER is FAR: FRR ratio, it is the value when FAR is equal to FRR. For keeping the value of EER a logical threshold needs to be selected, this is crucial to keep the system running with good performance.
4. Genuine Acceptance Rate: How many times a genuine user is accepted is measured by the GAR rate, it needs to be very low in a good system.

Different Levels of Fusion in Multimodal Biometric System

We need more than one decision channels Since we use more than a single biometric modality,. A method called as “fusion” is used in order to join two or more biometric traits. A biometric fusion is nothing but the design process that can combine the classified results from every biometric channel. Multimodal biometric fusion is used in order to reduce the error rates which occur during the verification process and also combine the different

biometric samples in a better way in order to enhance the strength . In this section we present different situations of fusion used in the multimodal biometrics.

The features which are suited to Biometric fusion are as follows: [5]

1. Iris, Face
2. Ear form, Voice
3. Fingerprint, Face
4. Voice, Hand geometry
5. Voice, Lips movement
6. Facial thermo gram, Face
7. Fingerprint, Face, Voice
8. Palm print, Hand geometry
9. Voice, Face, Lips movement
10. Fingerprint, Face, Hand geometry

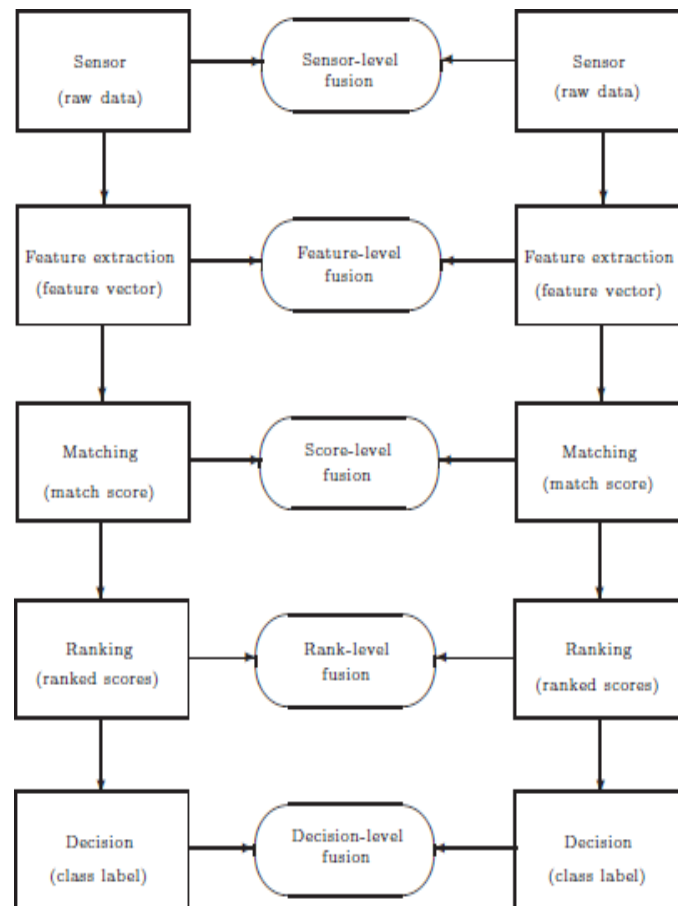


Figure 4: Levels of fusion.

LITERATURE REVIEW

There are two different ways from which fusion can be achieved, fusion prior to matching and the fusion after matching. The main work related to the research in multimodal biometric systems are reviewed. Fusion at the rank, match score, feature and decision levels has been extensively studied in the literature.

1. Multilevel score fusion is performed by Muhammed Razzak et. al [3] combined the face and finger veins to increase the robustness of the authentication system. The score level fusion of client specific linear discriminant analysis (CSLDA) for fusion of finger veins and face result is performed. Using weighted fuzzy fusion the score of face and finger veins are combined. This system is efficiency in reducing the FAR 0.05, FRR 0.23 and the accuracy of the system is 95%.
2. A human recognition method proposed by Mohammed soltane et. al [4] combined face and speech information in order to improve the problem of single biometric authentication. In text-independent speaker recognition Gaussian Mixture modal(GMM) is the main tool used, in which it can be trained using the expectation maximization(EM) and Figuieredo-Jain algorithms for score level data fusion is Extracted face and extracted audio is fused to achieve recognition rate of 96%. Face speech biometric FAR is reduced to 0.087 and FRR is 0.67 and accuracy is 96%.
3. experiments with two modalities: palmprint and palm vein performed by Dhanashree vaidhya et. al [5] in which feature level fusion is used based on the Entropy technique. The system performance is 99% with FAR 0.02929%, FRR of 00 % and accuracy of 99%.
4. The face and fingerprints in which feature level fusion is performed by Rattani et. al [6] combined to enhance the performance of the face and fingerprint modalities alone by 5.05% and 0.82 % respectively. The feature level fusion outperforms the score level fusion by 0.67%. The system performance is FRR of 1.98 %, FAR of 3.18 % and the system accuracy is 98 %.

5. Feature level fusion is performed by Bhagat et. al [7] proposed a multimodal biometric by combining palm vein and face biometric, The overall accuracy of the system is more than 95%, FAR of 0.5%, FRR of 1.0% and accuracy of 3%.
6. Score level fusion is performed by Feifei et. al [8] combined the fingerprint and finger vein .The overall accuracy of the system before fusion fingerprint accuracy is 95.3%, finger vein is 93.72% but after fusion the accuracy of the system is 74% with FAR of 1.2%, FRR of 0.75%.
7. Feature level fusion were used by Krishneswari et. al [9] combined the fingerprint and palm print using wavelet based image fusion techniques with min-min approximation. Features were extracted using information Gain (IG). The average verification accuracy obtained was 98.34% and the FAR of 1.02%, FRR of 0.9% and accuracy of 98%.
8. Decision level fusion is performed by Krzysztof et. al [12] by combining the face and speech . The system performance is FAR of 0%, FRR of 1.1% and the accuracy of 87%.
9. Multimodal biometrics by fusing the fingerprint and iris is proposed by Mohamad al [13] in which decision level fusion is used. For better performance and accuracy of 98% with FAR of 2%, FRR of 2% and accuracy of 98% a fuzzy logic method is used for fusion
10. The palm print and face image combined by Lin Hong et. al [14] in which decision level fusion is performed. Decision fusion formulated in the system enables performance improvements by fusing the extracted features of face and fingerprints are fused to achieve the recognition rate of 92%, FAR 1%, FRR is 8%.
11. A feature level fusion system of face and palm print traits presented by Gayatri Bokade et. al [15] using a simple fusion algorithm. Since feature set contains relevant and richer information about the captured biometric evidence, fusion at feature level is expected to provide more accurate results as compared to other fusion methods. The GAR using face images is found to be 88.88%. The GAR using palm images only is found to be 81.48%. The fusion results indicate substantial increase in system to be 95%, FAR of 5%, FRR of 1.2%.

12. The two biometric palmprint and fingerprint at feature level fusion combined by Mitul Dhameliya et. al [16] to develop a multimodal biometric system. Features are extracted using Gabor filtering. The average recognition rate obtained was 87% with FAR 2% of and FRR of 1.1%.
13. The fusion of fingerprint and iris combined by Jegadeesan et. al [17] in which feature level fusion is used and the images are preprocessed. The system performance is 91% with FAR of 10% and FRR of 3%.

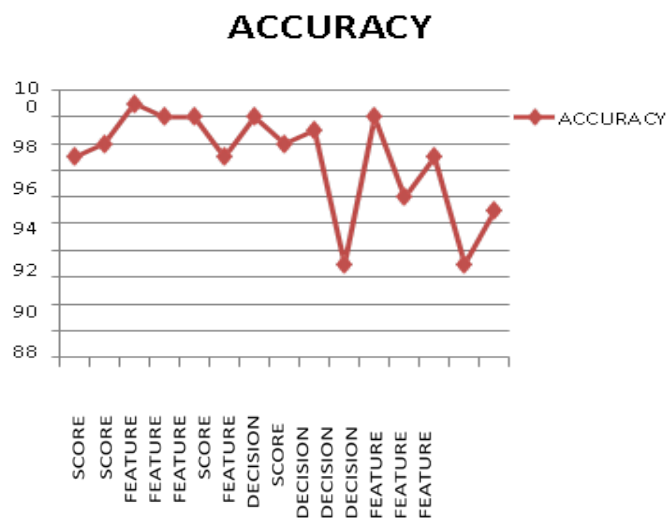


TABLE 1: Comparison of fusion techniques and its dataset, FAR, FRR and accuracy rate by various authors

AUTHOR	FUSION	DATA SET	FAR (%)	FRR (%)	ACCURACY (%)
Muhammed et al.	SCORE	Face, Fingervein	0.05	0.23	95
Mohammed et al.	SCORE	Face, speech	0.087	0.67	96
Dhanashree et al	FEATURE	Palmprint, palm vein	0.029	1.0	99
Rattani et al.	FEATURE	Face, fingerprint	1.98	3.18	98
Bhagat et al	FEATURE	Palmvein, face	0.5	1.0	98
Feifei et al	SCORE	Fingerprint, F.vein	1.2	0.75	95
Krishneswari et al	FEATURE	Fingerprint, palmprint	1.02	0.9	98
Nazmeen et al	DECISION	Face, ear	0	4	96
Nageshkumar et al	SCORE	Palmprint , face	2.4	0.8	97
Krzyszof et al	DECISION	Face, speech	1.1	3.0	87
Mohamed et al	DECISION	Fingerprint, iris	2	2	98
Lin hong et al	DECISION	Palmprint, face	1	1.8	92

Gayatri et al	FEATURE	Face, palmprint.	0.5	1.2	95
Mitul et al	FEATURE	Palmprint, fingerprint	0.2	1.1	87
Jegadeesan et al	FEATURE	Fingerprint, iris	10	5.3	91

CONCLUSION

Multi modal biometrics mainly preferred than the unimodal biometrics even through the time taken by multimodal biometric is greater than the unimodal and also it is still used in places where security is main important. It improves recognition rates by using appropriate fusion techniques. In this paper we discussed a multimodal biometric recognition system. Various fusion level techniques are also discussed. score level fusion works better because of easy implementation . Various performance parameter are also discussed in this paper. There are also other advantages in multimodal biometric systems, including the robustness to noise, ease of use and the availability of low cost.

REFERENCES

1. K.Geetha, V.Radhakrishnan,” Multimodal biometric system: A feature level fusion approach”, International journal of computer applications Vol.71, No.4, 2013.
2. P.S.Sanjekar, J.B.Patil,”An overview of multimodal biometrics”, Signal and image processing: An International journal (SIPIJ) Vol.4, No.1, 2013.
3. Muhammed Imran Razzak, Rubiyah Yuosf and Marzuki Khalid, “Multimodal face and finger veins biometric authentication”, Scientific Research and Essays, Vol.5, No.17, pp. 2529-2534, 2010.
4. Mohammed soltane, Nouredine Doghmane,”Face and speech based multimodal biometric authentication”, International journal of advance science and technology, Vol 21, No.8, pp 41-46, 2010.
5. Dhanashree vaidhya, sheetal pawar, “Feature level fusion of palmprint and palm vein for personal authentication based on Entrophy technique”, International Journal on Electronics and communication Technology, Vol.5, Issue spl-1, 2014.
6. A.Rattani, D.R.Kishu, M.Bicego,” Feature level fusion of face and fingerprint Biometrics”, Biometrics: Theory, applications and systems, First IEEE International conference, 2007.

7. S.F.Bahgat, S.Ghoniemy, M.Alotabi,” Proposed Multimodal palm-veins- face biometric Authentication”, International journal of advanced computer science and applications, vol-4, No.6, 2013.
8. Feifei cui, Gongping yang, “Score level fusion of fingerprint and finger vein Recognition”, Journal of Computer Information’s systems: 16, 5723-5731, 2011.
9. Krishneswari K, Arumugam S,” Multimodal Biometrics using feature fusion”, Journal of computer science 8(3):431-435, 2012.
10. Nazmeen bibi boodoo, R.K.Subramanian, “Robust multi-biometric recognition using face and ear images”, IJCSIS-International journal of computer science and information security, Vol.6, No.2, 2009.
11. Nageshkumar, Mahesh.PK, Shanmuka swami M.N, “A Efficient Multimodal biometric fusion using palmprint and a face image”, International Journal of computer science, Vol.2, Issue 3, 2009.
12. Krzysztof, Jonas Richard, Plamen Prodanov, Andrzejn Drygajlo, “Reliability- Based decision fusion in multimodal biometric verification systems”, EURASIP Journal on advances in signal processing, Article ID 86572, 9 Pages, 2007.
13. Mohamad Abdolahi, Majid Mohamadi, Mehdi Jafari,” Multimodal biometric system fusion using fingerprint and iris with fuzzy logic”, International Journal of soft computing and engineering, Vol.2, Issue-6, 2013.
14. Lin Hong, Anil Jain, “Integrating faces and fingerprints for personal identification for personal identification”, IEEE Transactions on pattern analysis and machine intelligence, Vol.20, No.12, 2008.
15. Gayathri umakant bokade, ashok M.sapkal, “Feature level fusion of palm and face for secure recognition”, International Journal of Computer and Electrical Engineering, Vol.4, No.2, 2012.
16. Mitul D. Dhameliya, Jitendra P.Chaudri,” A multimodal biometric recognition system based on fusion of palmprint and fingerprint”, International journal of engineering trends, Vol.4, Issue 5, 2013.
17. A.Jagadessan, Dr.K.Duraisamy,”Secured Cryptographic Key Generation from multimodal biometrics: Feature level fusion of fingerprint and Iris”, International Journal of computer science and information security, Vol.7, No.2, 2010.

-
18. Sumeet kaur, Priyanka Sharma,” Analysis of multimodal biometrics by feature level fusion: A Review”, International journal of advanced research in computer science and software engineering, Vol.3, Issue 7, 2013.
 19. DivyaKant T.Meva, C.K. Kumbharana,” Comparative Study of Different fusion techniques in multimodal biometric authentication”, International Journal of Computer Applications, Vol.66,No.19, 2013,
 20. Deepa Kumar Sahu, Parsai M.P, “Different Image Fusion Techniques-A critical Review”, International Journal of modern Engineering Research (IJMER) Vol.2, Issue-5, pp 4298-4301, 2012.
 21. Dapinder kaur, Ganganpreet kaur,” Level of fusion in multimodal biometrics: A Review”, International journal of advanced research in computer science and software engineering, Vol.3, Issue 2, 2013.
 22. Sakshi Kalra, Anil Lamba,” A survey on multimodal biometric”, International journal of computer science and information technologies, Vol.5, No.2, pp 2148-2151, 2014.
 23. Rupali L.Telgad, Almas M.N.Siddiqui, “Automated biometric verification: A survey on multimodal biometrics”, International journal of computer science and business informatics, Vol.6, No.1, 2013.