

A review of advancement in Multimodal Biometrics System

Neha¹

Research Scholar, Department of Computer Science & Applications, Kurukshetra University,
Kurukshetra, Haryana
Email: raoneha207@gmail.com

Ms Monika²

Assistant Professor, Department of Computer Science & Applications, Kurukshetra University,
Kurukshetra, Haryana
Email: monikaporiye@gmail.com

Abstract: The Unimodal biometrics has many problems such as noisy data, intra-class variations, confined degrees of freedom, non uniformity, spoof attacks, uniqueness, diverseness, non invariant and spoofy attack. The use of single property works as exclusive source of information for authentication (e.g. fingerprint, face, voice, gait etc.) generally leads to high false acceptance rate (FAR) and false rejection rate (FRR), Failure to Enroll rate(FER). . In order to conquered the limitations provided by unimodal system there is need of system which can combine of two or more attributes types of biometrics systems known as multimodal biometric systems. These systems are more authentic and trustworthy due to the presence of multiple, self contained, individualistic biometrics attributes. The spoofing problem is solved easily because it is very difficult for deceiver to take-off multiple biometric traits. The advantages of multimodal biometric systems is that there are multiple sources of information . As multimodal biometric systems use more than one biometric trait so it provide more security and more reliable and provide maximum accuracy.

1. INTRODUCTION

The term Biometric made with two terms Bio means life and metrics means to measure. Biometric authentication system are becoming popular due to increased security and proven its superior performance due to increasing demand in society. It uses measurable human physiological or behavioral characteristics to verify identity of individual and has the ability to distinguish between an authorized person or fake ones. Biometric system improved the recognition technique by determining the physiological ,behavioural traits. Physiological characteristics which remain constant lifetime include fingerprint, face, retina ,DNA, iris etc. and each of these properties are remarkable to every person. Behavioural traits are signature, voice, speech patterns, gait, keystroke etc which amend with time due to age, disease, fractured, accident and several other things affect behaviour . Biometric features are unique for every individual so cannot be forgotten by users and outperforms technology. Even though it

used in every field like in forensic, commercial, medical, financial institution, border security, and so on but has its drawbacks in terms of cost, accuracy, throughput and ease of use. Biometrics based on single peculiarity is known as unimodal system with a variety of problems like noisy data, false rejection, intra class variation, fake biometric trait, non universality, inter-class similarity, spoofy attacks. To overwhelm these problems multimodal biometrics is used. In multimodal different cues or traits are collected from different sources of same person.

2. Multibiometrics

Biometric systems based on single eccentricity of information for person authentication are called Unimodal systems . however these system posses several drawbacks like noise in sensor data , non universality, intra class variation, inter class similarity and spoofy attacks. To overcome these problems concept of multimodal

biometrics is come that combine more than one biometric traits from more than one sources. It improve the performance of biometrics and deterring spoof attacks as if one trait is acquired by hackers another trait is available and thus reducing failure to enroll rate. The key point in multimodal biometrics is the fusion of various biometric modality data. Information from different biometric attributes can be integrated at the feature level (integrating the features of different biometrics), score level (combination of accurate matching score of the real and pretender scores), or decision level (combining the decisions)[1].

Two different biometrics (like face, fingerprint, iris, hand geometry are expected to be more reliable and improve matching accuracy ,protect from spoofy attacks. Two different properties (like optical scanner and USB Iris camera images are combined from different sources) of the same biometric can also be combined.

A multibiometric system uses multiple sensors for data acquisition which allows capturing of multiple traits of a single biometric source and/or traits of multiple biometric samples. These systems are more reliable due to the presence of multiple, unbiased, unrelated and autonomous biometrics trait.

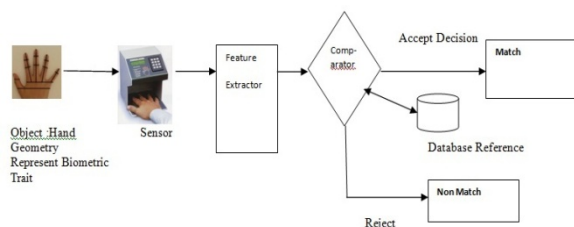


Fig 1 : general function of biometric

2.1 ADVANTAGES OF MULTI BIOMETRICS

1. The system gives better result in multimodal biometrics.
2. Better accuracy as compared to unimodal biometrics.
3. Performance is improved as compared to single biometric system.
4. Prevent from spoofy attack as it store multiple characteristics in system

database. For eg database is stolen by intruders in single template this gives high false rejection rate.

5. Multimodal solve the non universality issue.

3. Types of Multibiometric System:

1. Multi Sensor Systems : The information is captured from multiple sensors for example fingerprint information obtained from an optical sensor and from a solid state sensor or from a capacitive sensors. For eg. a multispectral camera may be used to acquire images of the iris, face, or eyes .

2. Multi Algorithm : A Multi algorithm uses multiple features extracted from different algorithm like face recognized using Principle Component Analysis (PCA) and from Linear Discriminant Analysis (LDA) and extract out a new featured face.

3. Multi Instance System : These systems combined information of multiple instances from the same individual body . for example in order to obtain more reliable result of a person authentication the integration of evidence across multiple fingers is taken rather than taking sample of a single finger .This type of application is used where large database is available. Similary ,an eye scan system may not be considered a good choice so for more reliable result both eyes image is taken .

4. Multi Sample : a single sample may not be sufficient in biometrics so taking multiple samples to obtain a complete representation of an individual trait. For eg. A face recognition system operating the frontal view and side view of an individual to view 3d face modal.

5. Multi unit Systems : the system combine evidences from multiple units like fingerprint and iris.

6. Hybrid System : in this system extract the information using different modalities as described above. Eg. combine match score of two different image of face with different pose of a person (Multi algorithm) and consideration of both irides (multi insatnce).

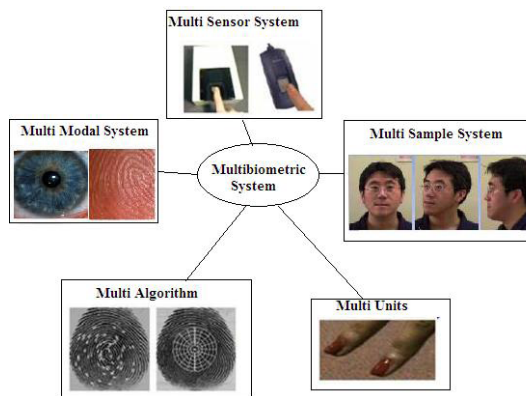


Fig. 2. Five scenarios of Multi biometric Systems

4. Levels of Fusion

Based on information available in biometrics there are different levels of fusion are defined. Fusion is classified into two categories: Pre-classification or fusion before matching and Post-Classification fusion after matching .

4.1 Preclassification fusion :

Fusion prior to Matching is known as Preclassification fusion in this fusion Integration of information at sensor and feature level is occurred. This fusion is further categorized as combination and classification. In former approach scores from different sources are normalized and converted into a common domain. In later approach input obtained is further considered as input for another level

4.1.1 Sensor-level fusion

Sensor level fusion is consolidation of information from multiple sources or from a single source . for eg . 2d face combined with 3d model of face image captured from a video sequence or from a still image or range image are fused . in this fusion data is captured from various sources so data may or may not be compatible with each other. For eg. Image of face captured from a video sequence with different resolution and size not possible to fused

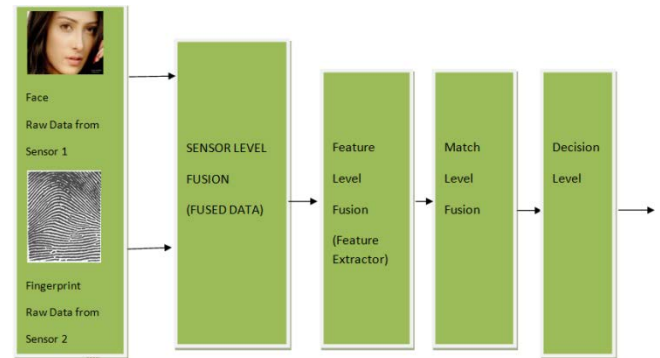


Fig-3 Sensor level fusion

4.1.2 Feature level fusion

Feature level fusion refers to combining the extracted features from multiple biometrics sources and create a new feature set. This fusion contains the richest information of extracted feature data sets so give better result. However if the biometrics modalities is not compatible with each other then this type of fusion is not recommended always. However very few researchers prefer this fusion generally prefer match scores and decision the reason of this may be if the different biometric systems features space may not be known. Second reason is this fusion technology need to normalized the different feature values into a single common domain feature which sometimes lead to computational cost. It is difficult to concatenate features obtained from different feature space vector and with different modalities like face and hand geometry.

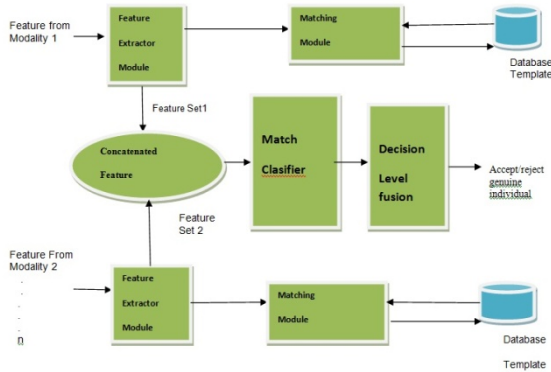


Fig4 : Feature Level Fusion

4.3 Post Classification Fusion

Integration of information after matching stage is fusion after matching or called post classification fusion. Fusion rank level ,fusion at match score level , fusion at decision level. Fusion is done after consolidate match score or decision obtained from matching data with database.

4.3.1 Match Score Level Fusion

Match score is measure of degree of similarity between input and the template database feature sets. In order to arrive at final decision consolidate the match score after matching score by different fusion. For eg . match score generated by face and fingerprint are combined using sum fusion rule [2]. Currently this type of fusion is better as it gives better performance

In order to arrive at final decision this fusion uses arithmetic fusion rules like Product rule, sum rule, min-max rule ,median rule . for eg . face , fingerprint of a person’s modalities are combined using sum rule then using max/min rule extracting the decision.

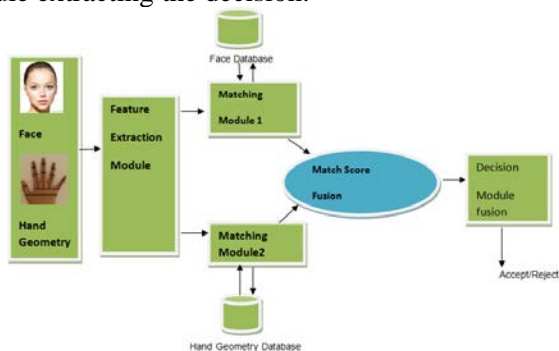


Fig 5 : Match score level

4.3.2 Decision level fusion

Decision level identifies whether the user is genuine or an imposter based on score obtained after matching. In multimodal biometrics the consolidation of final decision is done using AND/OR rule ,Majority voting , weighted majority voting rule , Bayesian decision rule[3]

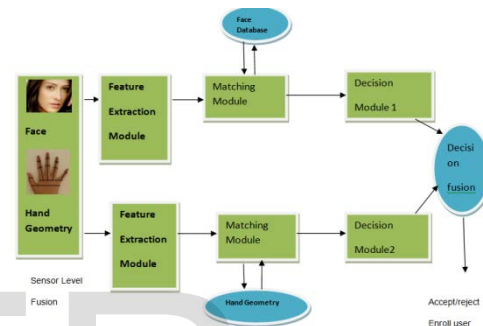


Fig 6: Decision Level fusion

4.3.3 Rank Level Fusion

In this fusion consolidation the ranks of different biometric characteristics and obtained final decision. Techniques such as Highest rank method, Borda count method , Logistic Regression method is used to make a final decision.

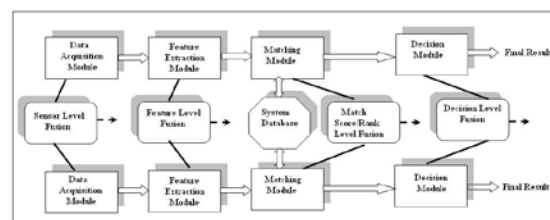


Fig. 7: Possible fusion before matching and fusion after matching levels [4]

5. Review of RELATED WORK

Abdallah et al [5] proposed a multimodal biometric system by fusion of palmprint and finger-knuckle-print using hidden markov model

and thus provide a better result in biometric system.

Muhammad Imran Ahmad et al [6] proposed the information fusion of face and palmprint biometrics using feature level.

S. Khellat-Kihel et al[7] proposed the multimodal fusion of the finger vein, fingerprint and the finger-knuckle-print using Kernel Fisher analysis. The author propose an identification system using multimodal fusion of finger-knuckle-print, fingerprint and finger's venous network using various techniques of fusion feature level fusion and decision level fusion is proposed .

G. Prabhu et al. [8] integrating Fingerprint, Palmprint and Hand geometry had proposed for identification / verification process. In this author suggest the classification of gender by employing hand geometry information extracted from various sources and minimize the search time to enhance accuracy . In this paper firstly the preprocessing of images is done using filtering of images of fingerprint and palmprint then apply 2D discrete wavelet transform and gabor filter were used then through normalization extraction of common biometric features is done .

Masatsugu Ichino et al. [9] propose a method of text-prompted speaker recognition based on multimodal biometrics by using the kernel fisher discriminant analysis.

Muhammad Imran Razzak et al. [10] combined the face and finger veins characteristics to increase the accuracy of the biometric identification system. Mohamed Soltane et al. [11] combine Face and speech combine in order to improve the reliability and robustness of biometric authentication system. A multimodal biometric system used lip movement and gestures proposed by Piotr Dalka et al. [12]. Face and ear combine for increasing the security, proposed by A.A. Darwish et al. [13].

Kawulok et al. [14] presented a combination of face and eyes for better results of biometric system.

Linlin shen et al. [15] proposed integrating face and palmprint to efficient match between stored

template in the database and acquired template and thus provide a reliable authentication.

[16]. A. Prakash proposed Fusion of soft biometric and hard biometric can be use to increase security of biometric system.

C.K.Verma[17] proposed a combination of soft biometric with fingerprint and face for providing a better fusion result and for increasing the accuracy of biometric system.

Shigefumi Yamada et al. [18] propose the multimodal biometric system that captures a palm vein and three fingerprint . For improving the recognition accuracy FAR. In this paper author aims to evaluate the result whether biometric traits are independent .

V. D. Mhaske et al. [19] combines the features of fingerprint and palm print to overcome several limitations of unimodal biometrics. The author used modified gabor filter as compared to gabor filter and then apply the Fourier transformation and finally through Euclidean distance features are classified for a perfect match the resultant image with database templates. For providing a better performance and better quality resultant image in biometric system author combines the palmprint and fingerprint features.

Rami Al-Hmouz et al. [20] proposed multimodal speaker identification approaches are suggested to remove limitations of unimodal system. The author presents statistical approach of combining information at the score level. In this paper, features of speech from single source or from multiple source are combined using MFCC(Mel-frequency cepstral coefficients), LPC and DWLPC(discrete wavelet linear predictive coding). The author evaluate the multimodal speaker identification schemes using TIMIT dataset. Relatively using short window lengths resulted better classification when using LPC(linear predictive coding) and DWLPC.

Fei Su Liwen Xia Anni Cai et al.[21] proposed dual-biometric-modality personal identification system, which has both outstanding result and more accuracy. The dual modal system fused fingerprint with EEG(electroencephalogram) this give high identification performance as EEG

is hard to reproduce and is perfect for liveness detection also its an effective approach for an anti spoofing property. EEG-based on restful EEG signals which are generating when a user open/close eyes. During matching testing EEG is matched with stored EEG .

David Marius Daniel et al. [22] proposed the fusion of two fusion technique together. In order to take advantage of both fusion technique the author proposed the fusion methods used at the first type of fusion or at the second type of fusion of iris and fingerprint traits . In this paper combination of two fusion feature and score level fusion of iris and fingerprint is approached . in feature level combination of two features of fingerprint and iris are combined and finally joint feature vector is evolved . at the end matched score of both trait is matched with database. The Author implements authentication system that combines two biometric fusion methods.

6. Applications of Biometric Identification System

Bank and business transaction require fraud activities detection biometric used here to improve the security and reliability. The Defence and intelligence Bureau officers need it to track the criminal activities. After 9/11 attack National Science And Technology Council established by Federal Govt. in nov 1993 this virtual agency use biometric for identifying Terrorists operational activities. One of key area at Airport ,Border security biometric used there for checking the trespassers. For eg . Department of Homeland Security use fingerprint technique in airport. Biometric used for Surveillance fugitive criminals , missing people, border security for automated recognition system. For a very long history biometric proof that its also used for justice and law enforcement to enhancing public security and privacy and to chase unwanted person. Access Control is a major area where biometric play a key role for cyber protection , Password resetting , Processing Payments . Biometrics also used in Health care to protect patient information for securing access the data , in case of emergency patient identification file is needed . Biometric is also used in immigration sector

eg. in passport checking for inspecting identity of individual during travelling to check physical access of employee. Biometric also include application in military sector for national security purpose also hold digital information of voter id cards for avoiding duplicate entry during voter registration in election , in national identification cards holding the data of whole population of our country. Today biometric also used in android mobile like secureBRave appthat support multi biometric features –fingerprint,iris etc better solution for health services and disaster alerts.

7. Challenges of multimodal system:

Biometric template if stolen or lost so improving the biometric template security is main risk. Performance of multimodal biometrics is depend on nature of the database used. Database can be true or virtual databases. In virtual which contain records from different databases. While in true database collect records from same person. Multimodal biometrics performance depends on matching algorithm, integration of multiple sensors performance , decision making process, accuracy of a system determined by high degree of confidence which is tested by checking traits on the large number of databases . Current Multimodal system can be tested only on a 1000 individual which is a very small amount this is mainly due to performance, cost and the efforts in matching with the database needs lots of time , money and large number of multimodal biometric data. Another issue is fake identity data, failure to enroll, large rejection rate, spoofy attacks . Performance of the multimodal system depends on its testing methodology used, implementation strategies, communication with other system(compatibility issue), adoption of biometric standards.

Accuracy is main factor which determine the performance of multimodal biometrics . Error rate evaluated by three factors:

- False accept rate (FAR)
- False reject rate (FRR)

• Failure to enroll rate (FTE)

The literature work in designing work related to multimodal biometrics are concerned with these terms describe below[8]:

- At which level fusion is needed
- Privacy concern and accuracy
- Architecture
- Choice of biometric traits
- Total no of traits that going to be fused and no of modalities

- Safe and user friendliness
- Cost issue for large datasets and scalability
- Multimodality database

One of the issue is that is appropriate dataset available or not-well designed dataset can greatly support the research while poorly designed can be worsen. Next issue is researchers use appropriate best fusion technique for fusing the result in experiment. Another issue that confront to researchers is that few studies show that is it really not clear multi sample always outperform than multimodal. The researchers motive is always to gain accuracy but with some technical problems they cannot get the result accurate for eg. If a person has fracture in their hand not able to get perfect result.

8. MUBI TOOL used for multimodal biometrics:

MUBI refers to Multimodal Integration Tool which is free of cost and available at website . User need to provide match score and it will calculate automatically and plot ROC curve. MUBI tool is portable and can run on any software/windows, also its an open source, and written in java this tool used for normalization , fusion strategies, also used in evaluation of cascaded or multibiometric system, evaluate trade off from different biometrics, evaluate risks in biometric system. User just need to select the modalities trait and device and this will show the best performances.

9. CONCLUSIONS

This paper presents an introduction of biometrics techniques, multimodal biometrics fusion . today biometrics plays an important role in every areas such as in hospitals, colleges , forensics ,access control , time and attendance systems , Law Enforcement , commercial area , government application , border security , financial institution etc. In this research paper, unimodal and multimodal biometrics are introduced. Various level of fusion in multimodal biometrics and classification of multibiometrics have also been included. Application and challenges of biometrics is also discussed. Multimodal biometric system are expected to be improve the accuracy of identification in biometric using multiple sources of information. Typically early integration fusion i.e. feature level performs better result than late integration (eg. Score level). Use of soft biometrics with multimodal biometric can improve the performance if an appropriate fusion strategy is used.

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