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Automated Biometric Verification: A Survey on Multimodal Biometrics

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ABSTRACT
In the world of computer science & Information Technology security is essential and important issue. Identification and Authentication Techniques plays an important role while dealing with security and integrity**.** The human physical characteristics like fingerprints, face, hand geometry, voice and iris are known as biometrics. These features are used to provide an authentication for computer based security systems. Biometric verification refers to an automatic verification of a person based on some specific biometric features derived from his/her physiological and/or behavioral characteristics. Biometrics is the science and technology of measuring and analyzing biological data of human body, extracting a feature set from the acquired data, and comparing this set against to the template set in the database. The future in biometrics seems to belong to the multimodal biometrics (a biometric system using more than one biometric feature) as a Unimodal biometric system (biometric system using single biometric feature) has to contend with a number of problems. In this paper, a survey of some of the multimodal biometrics is conducted.

Keywords
Biometrics, Unimodal Biometrics, Multimodal Biometrics, Verification, Identification, Recognition.

1. INTRODUCTION
The term Biometric comes from the Greek word bios which mean life and metrikos which means measure. It is well known that humans intuitively use some body characteristics such as face, gait or voice to recognize each other. Since, a wide variety of application requires reliable verification schemes to confirm the ID of an individual, recognizing human on basis of their characteristics [1].The characteristics are as follows: voice, fingerprints, body contours, retina & iris, face, soft biometrics, etc.

Biometric systems based on single source of information are called Unimodal systems [2]. Unimodal biometric system has some limitations of these Systems are considered when deploying with the real World applications. Some of the challenges encountered by these systems are

Noise in sensed data, Intra class variations, Inter class similarities, Non universalities, spoof attacks [3]. Multi biometric (multimodal) systems seek to alleviate some of the drawbacks encountered by Unimodal biometric systems by consolidating the evidence presented by multiple biometric traits / sources [4]. Biometric system can also be designed to recognize a Person based on information acquired from multiple biometric sources. Such system is known as Multimodal biometric system. Multibiomeric system can offer substantial improvement in the matching information being combined and fusion methodology accuracy of a biometric system depending upon the adopted. It addresses the issue of non universality or insufficient population coverage. This system also effectively addresses the problem of noisy data. These systems also help in continuous monitoring and tracking of individual in situation when a single trait is not sufficient. Fusion schemes should be employed to combine the information presented by multiple biometric sources. There are various data combination levels that can be considered, examples are the feature level, score level and decision level [5].

This paper proceeds as follows. Section 2 presents introduction of unimodal Biometrics, section 3 presents literature survey of Multimodal biometrics, Section 4 describes related works in this field, etc.

2. UNIMODAL BIOMETRICS

Biometric systems based on single source of information are called Unimodal Biometric system. Unimodal Biometric system considers the single Biometric trait. Unimodal biometric systems rely on the evidence of a single source of information for authentication of person. Though these Unimodal biometric systems have many advantages, it has to face with variety problems like [6]:

2.1 NOISY DATA

Susceptibility of biometric sensors to noise leads to inaccurate matching, as noisy data may lead to false rejection

2.2 INTRA CLASS VARIATION

The biometric data acquired during verification will not be identical to the data used for generating template during enrollment for an individual. This is known as intra-class variation. Large intra-class variations increase the False Rejection Rate (FRR) of a biometric system.

2.3 INTERCLASS SIMILARITIES

Inter-class similarity refers to the overlap of feature spaces corresponding to multiple individuals. Large Inter class similarities increase the False Acceptance Rate (FAR) of a biometric system.

2.4 NON UNIVERSALITY

Some persons cannot provide the required standalone biometric, owing to illness or disabilities [7].

2.5 SPOOFING

Unimodal biometrics is vulnerable to spoofing where the data can be imitated.

3. LITERATURE SURVEY ON MULTIMODAL BIOMETRICS:

[11] Proposed a multimodal biometric system using Fingerprint and Iris features. They use a hybrid approach based on: 1) Fingerprint minutiae extraction and 2) Iris template encoding through a mathematical representation of the extracted Iris region. This approach was based on two recognition modalities and every part provided its own decision. The final decision was taken by considering the Unimodal decision through an AND operator. No experimental results have been reported for recognition performance.

[12] Proposed a multimodal biometric system using Finger print and Face. They use Scale Invariant Features Transform (SIFT), Fingerprint Verification based on Minutiae matching Technique and Feature Level Fusion for the recognition. This paper present multimodal biometric system based on the integration of face and fingerprint traits at feature extraction level were presented. Both fingerprint and face images are processed with compatible feature extraction algorithms to obtain comparable Features from the raw data. As even in the literature, it is claimed that ensemble of classifier operating on uncorrelated features increases the performance in comparison to correlated features.

[13] Proposed a multimodal biometric system using Ear and Face. They use Iterative Closest Point (ICP) algorithm, Local 3D feature, PCA. The approach is based on local 3D features which are very fast to compute and robust to pose and scale variations and occlusions due to hair and earrings. An expression-robust multimodal ear-face biometric recognition approach is proposed with fusion at the score level in this paper.

[14] Proposed a multimodal biometric system using Fingerprint and Iris. They use PCA (Principal Component Analysis) and FLD (Fisher Linear Discriminant) methodology for Biometric recognition. This paper presents the difference between borda count method and logistic regression methods. From the comparison results that rank-level fusion with the logistic regression approach provided the better performance in terms of error rate and increase the recognition rate of multi biometric systems, because in this approach, weights are assigned to different matchers according to their performance.

[15] Proposed a multimodal biometric system using Face. They use the methodology PCA (Principal Component Analysis) +RMPM (Reduced Multiple Polynomial Model) to develop the multimodal Biometric system. This paper presents stereo face recognition formulation which combines appearance and depth at feature level. A Reduced Multivariate Polynomial Model was adopted to fuse the appearance and disparity images. RMPM is extended so that the problem of new user registration can be overcome. The face recognition approach is useful for some online application such as visitors.

[16] Proposed a multimodal biometric system using Face and Finger Veins. They use the LDA methodology for this system. This paper presents the multimodal low resolution face and finger veins recognition system at score level fusion. Proposed multimodal recognition system is very efficient to reduce the FAR .000026 and increase GAR 97.4.The proposed system is difficult due to the extra processing required for the feature spaces.

[17] Proposed a multimodal biometric system using fingerprint and voice. They use Leave-One-Out Cross Validation technique (LOOCV) and Gaussian mixture model for score level fusion. The proposed system in this paper Optimum reliability ratio based integration weight optimization scheme for fingerprint and voice modalities is implemented. The performance of the system is calculated under different noise condition. One drawback of this method is that under extreme noise conditions it gives attenuating fusion.

[18] Proposed a multimodal biometric system using Fingerprint and Finger Vein They use MHD(modified Hausdorff distance)algorithm as well as Minutia extraction and matching based on turnery vector .This paper proposed the system of score level fusion based on finger print and finger vein. The process of recognition experiments based on homologous biometrics database.

[19] Proposed a multimodal biometric system using palm print by using rank level fusion. The authors in this paper have investigated the rank level combination for palm print matchers using four different approaches, i.e., Borda count, weighted Borda count, Highest and product of ranks, and Bucklin majority voting, and also proposed a new nonlinear approach for combining the ranks. The experimental results suggested in this paper put forward that the considerable performance improvement in the recognition accuracy can be achieved from rank-level combinations as compared to those from individual palm print representations

[20]Proposed a multimodal biometric system using Finger print and Face by using Normalization method and Adaptive method. This paper studies a population approaching 1,000 individuals which is larger. The performance of multimodal biometric authentication systems using state-of-the-art

Commercial Off-the-Shelf (COTS) fingerprint and face biometric matchers on a population approaching 1,000 individuals is studied in this paper.

[21] Proposed a multimodal biometric system using face and signature with Score level fusion technique The performance of single modality based biometric recognition has been suffered from the different noisy data, non-universality of biometric data, and susceptibility of spoofing. The multimodal biometric system can improve the performance of the system. In this paper shows that face and signature based bimodal biometric system can improve the accuracy rate about 10%, than single Face/signature based biometric system.

4. MULTIMODAL BIOMETRICS

Noisy data, Infraclass Variation, Interclass Similarities, Non universality, Spoofing etc problems are imposed by Unimodal biometric systems which tend to increase False Acceptance Rate [FAR] and False Rejection Rate [FRR], ultimately reflecting towards poor performance of the system. Some of the limitations imposed by Unimodal biometrics can be overcome by including multiple source of information for establishing identity of person [7]. Multimodal biometrics refers to the use of a combination of two or more biometric modalities in a Verification or Identification system. They address the problem of non- universality, since multiple traits ensure sufficient population coverage [8].

Multimodal biometrics also address the problem of spoofing as it concern with multiple traits or modalities, it would be very difficult for an imposter to spoof or attack multiple traits of genuine user simultaneously. Multimodal biometric system has the potential to be widely adopted in a very broad range of civilian applications: banking security such as ATM security, check cashing and credit card transactions, information system security like access to databases via login privileges. A decision made by a multimodal biometric system is either a “genuine individual" type of decision or an “imposter" type of decision. In principle, Genuine Acceptance Rate [GAR], False Rejection Rate [FRR], False Acceptance Rate [FAR] and Equal Error Rate [ERR] is used to measure the accuracy of system. Generally multimodal biometrics operates in two phases i.e. Enrollment phase and authentication phase which are described as follows [9]:

4.1 ENROLLMENT PHASE

In enrollment phase, biometric traits of a user are captured and these are stored in the system database as a template for that user and which is further used for authentication phase.

4.2 AUTHENTICATION PHASE

In authentication phase, once again traits of a user captured and system uses this to either identify or verify a person. Identification is one to many matching which involves comparing captured data with templates corresponding to all users in database while verification is one to one matching which involves comparing captured data with template of claimed identity only [7].

5. METHODS FOR MULTIMODAL FUSION

The fusion methods are divided into the following three categories: rule-based methods, classification based methods, and estimation-based methods [10]. This categorization is based on the basic nature of these methods and it inherently means the classification of the problem space, such as, a problem of estimating parameters is solved by estimation-based methods. Similarly the problem of obtaining a decision based on certain observation can be solved by classification-based or rule based methods. However, if the observation is obtained from different modalities, the method would require fusion of the observation scores before estimation or making a classification decision. The fusion methods are divided into the following three categories: rule-based methods, classification based methods, and estimation-based methods [10]. This categorization is based on the basic nature of these methods and it inherently means the classification of the problem space, such as, a problem of estimating parameters is solved by estimation-based methods. Similarly the problem of obtaining a decision based on certain observation can be solved by classification-based or rule based methods. However, if the observation is obtained from different modalities, the method would require fusion of the observation scores before estimation or making a classification decision.

5.1 RULE-BASED FUSION METHODS

The rule-based fusion method includes a variety of basic rules of combining multimodal information. These include statistical rule-based methods such as linear weighted fusion (sum and product), MAX, MIN, AND, OR, majority voting. There are custom-defined rules that are constructed for the specific application perspective. The rule-based schemes generally perform well if the quality of temporal alignment between different modalities is good.

5.2 CLASSIFICATION-BASED FUSION METHODS

This category of methods includes a range of classification techniques that have been used to classify the multimodal observation into one of the pre-defined classes. The methods in this category are the support vector

machine, Bayesian inference, Dempster–Shafer theory, dynamic Bayesian networks, neural networks and maximum entropy model. Note that we can further classify these methods as generative and discriminative models from the machine learning perspective. For example, Bayesian inference and dynamic Bayesian networks are generative models, while support vector machine and neural networks are discriminative models.

5.3 ESTIMATION-BASED FUSION METHODS

The estimation category includes the Kalman filter; extended Kalman filter and particle filter fusion methods. These methods have been primarily used to better estimate the state of a moving object based on multimodal data. For example, for the task of object tracking, multiple modalities such as audio and video are fused to estimate the position of the object.

6. CONCLUSIONS

Unimodal biometric systems fail in case of lack of proper biometric data for a particular trait. It is robust to use multiple biometrics for providing authentication .We have observed that multimodal biometrics overcome the problems related with Unimodal biometrics like noisy data, interclass similarities, intra class variation, non universality and spoofing. There are many multimodal biometric systems in existence for authentication of a person but still selection of appropriate modals, choice of optimal fusion level and redundancy in the extracted features are some challenges in designing multimodal biometric system that needs to be solved.

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REFERENCES

[1] Neena Godbole, *"Information Security System", Wiley Publication.*

[2] Prof. V. M. Mane and Prof. (Dr.) D. V. Jadhav, *"Review of Multimodal Biometrics: Applications, challenges and Research Areas", International Journal of Biometrics and Bioinformatics (IJBB), Volume 3, Issue 5.*

[3] Arun A. Ross, Karthik Nandakumar, Anil K. Jain, *"Hand book of Multibiometrics", Springer International Edition.*

[4] Arun Rossa and Rohin Govindarajanb, *"Feature Level Fusion Using Hand and Face Biometrics", Appeared in Proc. of SPIE conference on biometric technology for human identification II.*

[5] Fortuna, J., Sivakumaran, P., Ariyaeeinia, A. and Malegaonkar, A., 2004. *"Relative effectiveness of score normalization methods in open-set speaker identification". Proc.IEEE Speaker and language Recognition Workshop (Odyssey'04)", pp. 369-376.*

[6] P. S. Sanjekar and J. B. Patil ,"AN OVERVIEW OF MULTIMODAL BIOMETRICS", *Signal & Image Processing : An International Journal (SIPIJ) Vol.4, No.1, February 2013.*

[7] M. Golfarelli, D. Maio and D. Maltoni,"*On the Error-reject Tradeoff in Biometric Verification Systems," IEEE Trans. on Pattern Analysis and Machine Intelligence, vol. 19, no. 7, pp.786-796, July 1997.*

[8] A. Ross and A. Jain, "Information Fusion in Biometrics," *Journal of Pattern Recognition Letters,vol. 24, pp. 21 15-2125, 2003.*

[9] V. Mane and D. Jadhav, *"Review of Multimodal Biometrics: Applications, Challenges and Research Areas," International Journal of Biometrics and Bioinformatics (IJBB), vol. 3, no. 5, pp. 90-95, 2009.*

[10] Dapinder Kaur , Gaganpreet Kaur ,*"Level of Fusion in Multimodal Biometrics: a Review"* International Journal of Advanced Research in Computer Science and Software Engineering 3(2), February – 2013.

[11] F. Besbes, H. Trichili, and B. Solaiman, ―*Multimodal biometric system based on Fingerprint identification and Iris recognition,‖ in Proc. 3rd Int. IEEE Conf. Inf. Commun. Technol.: From Theory to Applications (ICTTA 2008), pp. 1–5. DOI: 10.1109/ ICTTA.2008.4530129.*

[12] A. Rattani, D. R. Kisku, M. Bicego, Member, IEEE and M. Tistarelli," *Feature level fusion of face and finger Biometric".*

[13] S.M.S. Islam, M. Bennamoun, A.S. Mian, d R. Davies," *Score Level Fusion of Ear and Face Local 3DFeatures for Fast and Expression-Invariant Human Recognition*", ICIAR 2009, LNCS 5627, pp. 387–396, 2009.Springer-Verlag Berlin Heidelberg 2009.

[14] N. Radha, A. Kavitha," *Rank Level Fusion Using Fingerprint and Iris Biometric", Indian Journal of Computer Science and Engineering (IJCSE) ISSN: 0976-5166 Vol. 2 No. 6 Dec 2011-Jan 2012.*

[15] Jian-Gang Wang , Kar-Ann Toh, Eric Sung , Wei-Yun Yau, "*A Feature-level Fusion of Appearance and Passive Depth Information for Face Recognition*", Source: Face Recognition, Book edited by:Kresimir Delac and Mislav Grgic, ISBN978-3-902613-03-5, pp.558, I-Tech,Vienna, Austria, June2007

[16] Muhammad Imran Razzak, Muhammad Khurram Khan Khaled Alghathbar,Rubiyah Yusof, "*Multimodal Biometric Recognition Based on Fusion of Low Resolution Face and Finger Veins*" , International Journal of Innovative Computing, Information and Control ICIC International 2011 ISSN 1349-4198 Volume 7, Number 8, August 2011 pp. 4679{4689}.

[17] Anzar S .M. Sathidevi P. S. "*Optimal Score Level Fusion using Modalities Reliability and Separability Measures"*, International Journal of Computer Applications (0975 - 8887) Volume 51 - No. 16, August 2012.

[18] Feifei CUI, Gongping YANG, "*Score Level Fusion of Fingerprint and Finger Vein Recognition,*" F. Cui et al. Journal of Computational Information Systems 7:16 (2011) 5723-5731 5724.

[19] Ajay Kumar, Senior Member, IEEE, Sumit Shekhar," *Personal Identification Using Multibiometrics Rank-Level Fusion*", IEEE TRANSACTIONS ON SYSTEMS, MAN, AND CYBERNETICS—PART C: APPLICATIONS AND REVIEWS.

[20] Robert Snelick, Umut Uludag, Alan Mink, Michael Indovina and Anil Jain, "*Large Scale Evaluation of Multimodal Biometric Authentication Using State-of-the-Art Systems*" IEEE Transactions on Pattern Analysis and Machine Intelligence, Vol. 27, No. 3, Mar 2005, pp 450-455.

[21] Kazi M. M. , Rode Y.S. ,Dabhade S. B. , Al-dawla N. N. H. ,Mane A.V. , Manza R. R. ,Kake K.V. *"Multimodal Biometric System Using Face And Signature : A Score Level Fusion Approach", Advances in Computational Research ISSN: 0975-3273 & E-ISSN: 0975-9085, Volume 4, Issue 1, 2012.*