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FUSION IN MULTIBIOMETRIC USING FUZZY LOGIC & ALGORITHM

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Abstract: Biometric technology used for verification and identification by employing person's physiological and behavioral traits. These systems more secured than traditional methods like key, smart card, passwords. Biometric systems have some short comings such as noisy data, non-universality, spoof attacks and unacceptable error rate.This paper contains multibiometric systems algorithm, level of fusion and fusion in multibiometric system using fuzzy logic is called fuzzy fusion. In this paper, two biometrics, fingerprint & face used as multibiometrics and it gives good result with accuracy.

Keywords: biometric, multibiometric, biometric fusion, level of fusions, fuzzy logic, fuzzy fusion

I. INTRODUCTION

Biometric system is the science of establishing recognition of a person on the basis of their physiological and behavioural characteristics. The biometrics in modern society has been used for large-scale individual identity management systems whose functionality depends on the accurate identification of an individual's in several different applications. For examples of these applications include performing remote financial transactions, share network computer resources and data, or boarding a commercial flight. The various commonly used biometric features are fingerprint, face, signature, gait, palm veins, iris, voice pattern,retina,etc. Biometric system uses for identification or verification/authentication of individual person. Traditional methods use passwords and personal identification numbers (PINs) which can be lost by individual, biometric modality can't be manipulated forgotten or lost. Biometric characteristics can't be effortlessly replicated, produced or conveyed. Unimodal biometric systems have limitations like noise, high error rate, non-universality, spoofing rate and uniqueness. For example in face recognition, it is affected by position, tension, happiness and the amount of surrounding light. It has been recently clear for most researchers thatapproximately two percent of the population does not have a legible fingerprint and therefore cannot be enrolledinto fingerprint biometrics system. Multibiometric systems combine more than one sources of the biometric evidence. The integration of information is called fusion. This system integrates the evidence from more than one sensor, matching algorithms, samples of an individual userwork on same system.

PROCESSES IN BIOMETRIC SYSTEM

Biometric system associated three primary processes as follow:

Enrollment Process: In enrollment process, utilizes the feature extractor to make person's template and this template store along with personal information of user in database.

Verification Process: In verification process, user who wants to be claims his identity which could be a username, a smartcard or Personal Identity Number and his biometric modality. The user input biometric modality and then matching module to compare the extracted features set from the query modality with the features Set fetched from the database associated to the claimed client.

Identification Process: Identification process classify into positive and negative identification.

II. MULTIBIOMETRIC SYSTEMS

A multibiometric system performs recognition based on the evidences obtained from multiple sources of biometric information. Multibiometric systems can be classified into six categories which are multi-sensor, multi-algorithm, multi-sample, multi-instance and multi-modal systems.

Multi-sensor systems: In multi-sensor systems, different sensors are used for capturing different representations of the same biometric modality to extract diverse information. For example, system may use both 2D and 3D images of the face and combine them at the data level as well as the match score level to improve the performance of a face recognition system.

Multi-instance systems: Multi-instance systems involve fusion of information from multiple instances within the same biometric trait. For example, evidence from the left and right irises or the left and right index fingers can be combined for the recognition of an individual.

Multi- algorithm systems: In multi- algorithm systems use one biometric trait but use two or more different matching algorithms. For example, In Lu et al. where three different feature extraction schemes which are Principle Discriminate Analysis (PCA), Independent Component Analysis (ICA) and Linear Discriminate Analysis (LDA) have been combined to improve a face recognition system.

Multi-sample systems: In multi-sample systems use single senor but multiple samples of the same biometric trait. For example, along with the frontal face, the left and right profiles are also captured. Multiple impression of the same finger, and multiple samples of a voice can be combined. Multiple samples may overcome poor performance. But, it requires multiple copies of sensors, or the user may wait a longer period of time to be sensed or a combination of both.

Multi-modal systems: In multi-modal systems use the

evidence of multiple biometric traits to extract the biometric information of an individual. These different biometric traits can come from a variety of modalities. The multi-modal system is reliable due to the presence of multiple independent biometrics.For example, a biometric system may use face and voice for person authentication. Multimodal systems have several advantages. Better recognition rates can be achieved combining different modalities. Higher performance improvement can be expected by using physically uncorrelated traits (e.g., fingerprint and iris) than using correlated traits (e.g., voice and lip movement). They provide very high protection against spoofing as it is quite difficult for an imposter to spoof more than one biometric trait simultaneously.

LEVEL OF FUSION IN MULTIMODAL BIOMETRIC SYSTEM

Multimodal biometric fusion combines the distinguished aspect from different biometric features to support the advantages and reduce the limitations of the unimodal biometric. The fundamental issue of information fusion is to determine the type of information that should be fused and the selection of method for fusion. The goal of fusion is to devise an appropriate function that can optimally combines the information rendered by the biometric subsystems. In multimodal biometrics, the fusion scheme can be classified as sensor level, feature level, match score level, rank level, and decision level as shown in figure. The process can be subdivided into two main categories: prior-to-matching fusion and after matching fusion. Figure shows these fusion levels possibilities at each module. The fuzzy fusion method can be employed in both level prior-to-matching and after matching stage.

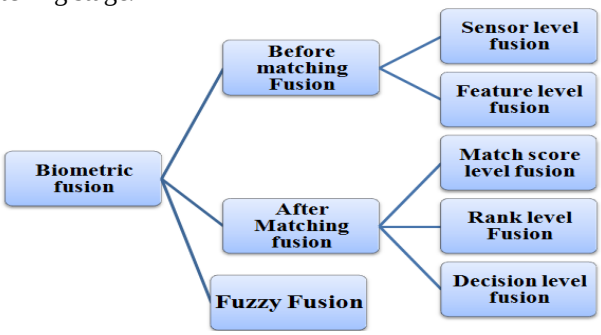

Fig 1. Biometric Fusion Classification

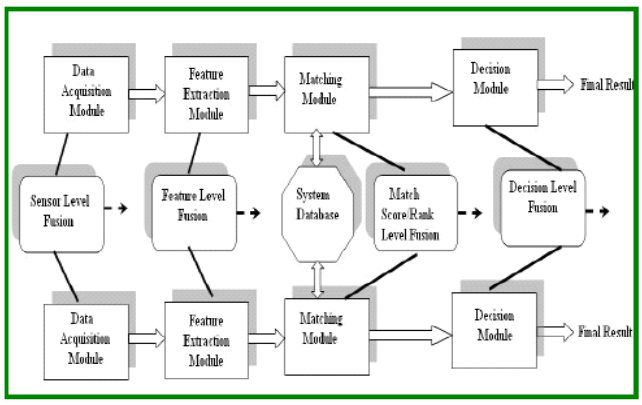

Fig 2. Fusion before matching and after matching levels

Prior to Matching Fusion: Fusion in this category integrates evidences before matching. Fusion prior to matching can be achieved with two methods:

Sensor Level Fusion Sensor level fusion is defined as "the consolidation of evidence presented by multiple sources of raw data before they are subjected to feature extraction". Sensor level fusion can be performed in two conditions i.e. data of the same biometric trait is obtained using multiple sensors; or data from multiple snapshot of the same biometric traits using a single sensor [17, 18]. This level of fusion is also known as data level fusion or image level fusion.

Feature Level Fusion Fusion at this level can be applied to the extraction of different features from the same trait or different multi traits. Feature extraction level refers to combining different feature vectors that are obtained from multiple sensors for the same biometric trait or multiple biometric traits. When feature vectors are homogeneous, a single feature vector can be calculated with "and", "or", "xor" or other operations. When the feature vectors are non-homogeneous, we can concatenate them to form a single vector [19, 20].

After Matching Fusion Fusion in this category integrates evidences of after matching module. Most multimodal biometric systems have been developed using these fusion methods as the information needed for fusion is easily available compared to fusion prior matching methods. Fusion after matching can be achieved with three different ways:

Match Score Level Fusion In score level fusion, different biometric matchers provide match scores indicating the degree of similarity between the input and template enrolled in the database for each biometric trait. These match scores are consolidated to reach the final recognition decision. Fusion at score level provides the best trade-off between the available information content and convenience of fusion. This is also known as fusion at measurement level or confidence level. Density, transformation, and classifier based score fusion are different methods to achieve this fusion level. The matching scores cannot be used or combined directly; because these scores are from different modalities and based on different scaling methods. Score normalization is required, by converting the scores into common similar domain or scale. This can be carried out with different methods.

Rank Level Fusion Rank level fusion consolidates multiple ranking lists obtained from several biometric matchers to form a final ranking list which would aid in establishing the final decision. Sometimes, only the final ranked outputs from a biometric system are available. Furthermore, in some biometric systems, the matching scores from the matchers are not suitable for fusion. Thus rank level fusion is a feasible solution in such systems.This type of fusion is relevant in identification systems where each classifier associates a rank with every enrolled identity. Ho et al. describe three methods to combine the ranks assigned by different matchers. Those are the highest rank method, the borda count method, and the logistic regression method.

Decision Level Fusion Decision level fusion method consolidates the final decision of single biometric matchers

to form a consolidated decision. When each matcher outputs its own class label (i.e., accept or reject in a verification system, or the identity of a user in an identification system), a single class label can be obtained by employing techniques, such as, "AND"/"OR", majority voting, weighted majority voting, decision table, Bayesian decision and Dempster-Shafer theory of evidence. Many biometric systems can only output the final decision, thus decision level fusion is very appropriate for biometric systems. The available information for this fusion method is binary (yes/no in most cases), which allows very simple operations for fusion.

III. FUZZY FUSSION

Fuzzy logic based fusion, often called fuzzy fusion, uses fuzzy logic. The fuzzy fusion method can be employed in both before matching or after matching stages. When this fusion method is applied in before matching stage, usually it is to reduce the size of the dataset for comparison or matching. This fusion can also be employed in after matching stage to increase the recognition performance and to obtain the level of confidence of the final outcomes.The method is based on fuzzy logic, which is the classic and most widely applied technology in computational intelligence. The fuzzy logic approach enables imprecise information is processed in a way that resembles human thinking, e.g. big versus small, high versus low.

IV. LITERATURE REVIEW

Fuzzy fusion method has been widely used in many applications, including automatic target recognition, biomedical image fusion and segmentation, gas turbine power plants fusion, weather forecasting, aerial image retrieval and classification, vehicle detection and classification, and path planning.

In Solaiman et al(1999) proposed a fuzzy-based multiple sensor evidence fusion classifier which was using to land cover classification. In this uses a Fuzzy Membership Map to combine evidence collected from multiple sensors. The using of fuzzy methods, their propose classifier was ideally matches for combining multi-sensor and a priori evidence and also outcome in confidence maps. In other study, researcher develops a new vehicle classification algorithm use a fuzzy logic concepts. In the algorithm, researcher used vehicles' speed and weight to classify diverse vehicles use fuzzy rules. In practical results, they display that the propose classification algorithm using the fuzzy logic extremely decrease the errors in vehicle classification .

In Deng et al.(2010) research the proposed data fusion technique based on Dempster-Shafer evidence theory for automatic target recognition and fuzzy set theory. In they represented both individual attribute of target point in the model data file and the sensor consideration as fuzzy membership function and construct a likelihood function to work on fuzzy data gather with each sensor. After, Dempster combination rule used for fusion of data come from different sensor sources.

Base Paper : In M. Abdolahi et al.(2013) paper, a multi-modal biometric system (Fingerprint & Iris) is used after converting fingerprint and iris image to a binary code, and with combining the results at decision level fusion. Fingerprint code is weighed as 20% and iris code as 80%. Multi-modal show better result than other using iris and fingerprint modalities as compare modalities. Using fuzzy logic and weighted code gives flexible outcome. An efficient method in fingerprint encoding is used and the fuzzy logic framework incorporates iris and fingerprint code and achieves an additional improvement of 1.7%.

N. Jeevitha,K.Krishneswari and A. Swathi (2015) proposed a novel technique for multimodal biometric system based on fingerprint & palm print.The proposed system employs genetic algorithm to select discriminating feature which provides robust solution. Templates are recognised on the basis of Euclidean distance. The performance of system was evaluated using a publically available dataset.

Ms. Shraddha S. Giradkar, Dr. N. K. Choudhari (2016) published a thesis on biometric security system methods. In the year 2003, the authors Salil prabhakar, Sharath Pankanti and Anil k. Jain proposed the biometric security for fingerprint recognition. In year 2011,the authors Bhavana chouhan and Shailaja Shukla proposed a security system which is based on Iris recognition of an individual .Authors Yeong Gon Kim ,Kwang Yong Shin, EuiChul Lee and Kang Ryoung Park in the year 2012 proposed scheme on recognition of face and both irises. In year 2013, authors Mohamad Abdolahi, Majid Mohamadi, Mehdi Jafari studied the biometric security fusion system using fingerprint and iris with fuzzy logic.

Suneet Narula Garg, RenuVig& Savita Gupta (2019) proposed a system in which they are analyzing the multimodal biometric system's performance using score level fusion. They used two data sets CASLA & IITD and firstly texture features of iris & fingerprint will be extracted. Then texture feature will be used to calculate score for both modalities & fuse using SUM, PRODUCR and MAX method. Performance of all three methods has been analyzed in terms of FAR(False Acceptance Rate), FRR(False Rejection Rate) & accuracy.

Comparison with base Paper:

- In M. Abdolahiet al.(2013) paper, a multi- modal biometric system (Fingerprint & Iris) is used after converting fingerprint and iris image to a binary code, and with combining the results at decision level fusion. I took a multimodal biometric system(Fingerprint& Face) is used after converting fingerprint and iris image to a binary code, and with combining the results at decision level fusion. An algorithm is used to get the desired result.
- I proposed an algorithm which is described in fig 3 Flowchart also described the things how the things works in sequence. With the help of this algorithm we can take each & every possibilities and output will be more clear& good.
- In base paper, the additional improvement of 1.7 % has been achieved. In my thesis the output percentage of getting the desired result is quite high.
- In base paper, they used fuzzy logic and weighted code to get the flexible outcome. We're using only

fuzzy logic in this paper.

- Both the paper Security vs System Accuracy has been maintained but in the given paper based on flexible outcome even then the matching rate of one input(fingerprint or face) is quite low even then the chances of breach is low. Security is not compromised & System accuracy is maintained.

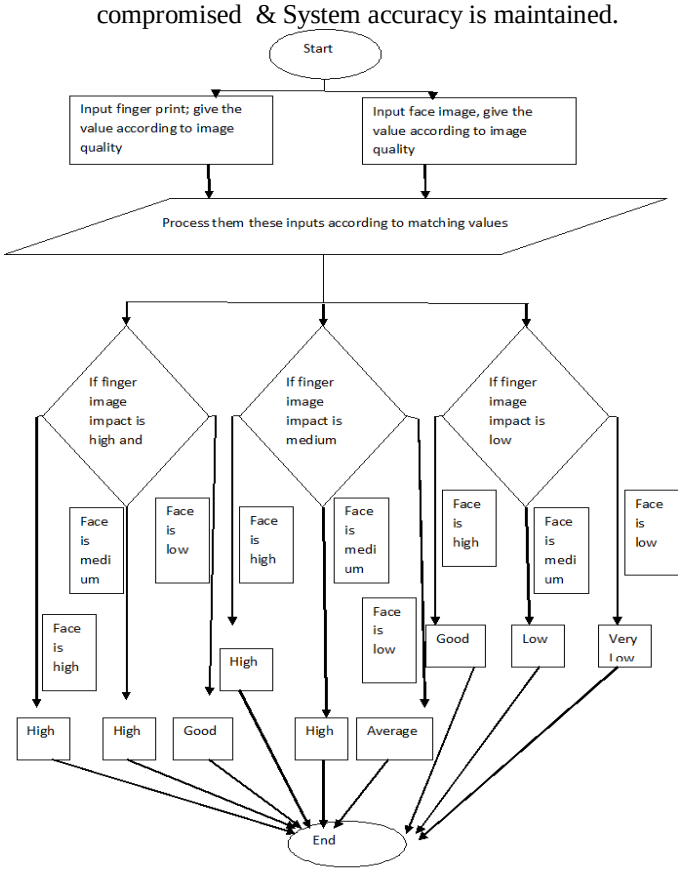

Fig. 3 Flowchart of Fuzzy Fusion Algorithm

Algorithm

Step 1: Take the image of face and finger.

Step 2: Process these image according to the input

- If the finger impact is high and face impact is high then output is high
- If the finger impact is high and face impact is medium then output is high
- If the finger impact is high and face impact is low then output is good
- If the finger impact is medium and face impact is high then output is high
- If the finger impact is high and face impact is medium then output is average
- If the finger impact is high and face impact is low then output is low
- If the finger impact is low and face impact is high then output is good
- If the finger impact is low and face impact is medium then output is low
- If the finger impact is low and face impact is low then output is very low

Step 3: According to those values we can provide access to the user.

V. ACKNOWLEDGMENT

In this paper Multimodal biometric system using Fingerprint and face biometric identifiers. To integrate the information from these two biometric identifiers, I use fuzzy fusion approaches. I also discussed fuzzy fusion which improves the accuracy and provided more confidence evidence of the outputs for the implemented multimodal biometric system. The experiments indicate that the implemented multimodal system better other commonly used fusion methods. Proposed algorithm in given research has covered all the details.

The results are found to be very encouraging and promoting for the research in this field. The overall accuracy of the system is more than 99.5%.

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