Multimodal Biometric Face and Fingerprint Recognition Using Neural Network

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Abstract

This paper presents multimodal biometric face and fingerprint recognition using neural network. Multimodal has great demands to overcome the issue involved in single trait system and it has become one of the most important research areas of pattern recognition multimodal biometrics system for identity verification using two traits: face and fingerprint System based on adaptive principal component analysis and multilayer perception to improve accuracy and performance. The advantages of using biometrics to verify a person's identity over using passwords or token have been broadly presented in many research papers .The main aim of this review is to develop an efficient Multimodal Biometric face and Fingerprint Recognition system to provide good recognition by selecting good algorithms for feature extraction and recognition.

Keywords *- Adaptive principal component analysis, Biometrics, Feature extraction, Multilayer perception, Neural network, Recognition***.**

1. Introduction

Multimodal Biometric is the field of pattern recognition research that recognizes the human identity based on physical patterns or behavioural patterns of human. The advantage to a biometric is that it doesn't change or lose. Many body parts, personal characteristics and imaging methods have been used for biometric systems such as fingers, hands, feet, eyes, ears teeth, veins voices, signatures, typing styles and gaits. Each biometric has its own strength and limitations and accordingly each biometric is used in Identification (authentication) applications. Biometric system using single traits, has several limitation, that is noise during sensing, non-universality, inter-class similarities, intra-class variations, spoof attach and distinctiveness etc. Thus single biometric system may leads to false acceptance rate (FAR) and false rejection rate (FRR).Biometric recognition systems are inherently probabilistic and their performance needs to be assessed within the context of this fundamental and critical characteristic. Biometric recognition involves matching, within a tolerance of approximation, of observed biometric traits against biological attributes and behaviours both within and between persons. Consequently, in contrast to the largely binary results associated with most information technology systems, biometric systems provide probabilistic results. This new Multimodal biometric face and fingerprint recognition systems perform better than uni-modal biometric systems and are popular.

Adaptive Principal Component Analysis

A common method from statistics for analyzing data is principal component analysis (PCA) Principal component analysis is implemented as a neural algorithm called APEX (Adaptive Principal component Extraction) developed by Kung and Diamantaras(1990).Adaptive principal component Extraction (APEX) for multiple principal component extraction. All the synaptic weights of the model are trained with the normalized Hibbing learning rule. The network structure features a hierarchical set of lateral connections among the output units which serve the purpose of weight orthogonalization. This structure also allows the size of the model to grow or shrink without need for retraining the old units. The exponential convergence of the network is formally proved while there is significant performance improvement over previous methods. By establishing

an important connection with the recursive least squares algorithm they have been able to provide the optimal size for the learning step-size parameter which leads to a significant improvement in the convergence speed. This is in contrast with previous neural PCA models which lack such numerical advantages. The APEX algorithm is also parallelizable allowing the concurrent extraction of multiple principal components. Furthermore, APEX is shown to be applicable to the constrained PCA problem where the signal variance is maximized under external orthogonality the APEX algorithm is applied to the face database by Olivetti research laboratory (ORL), for face feature extraction. Simulation results demonstrate that it is a valid feature extraction method for face recognition.

Multi-LAYER PERCEPTRON

A multilayer perceptron (MLP) is a feed forward artificial neural network model that maps sets of input data onto a set of appropriate output. An MLP consists of multiple layers of nodes in a directed graph, with each layer fully connected to the next one. Except for the input nodes, each node is a neuron (or processing element) with a nonlinear activation function. MLP utilizes a supervised learning technique called back propagation for training the network. Several properties concerning the representational power of the feed forward MLP have been proven. Learning arbitrary functions: any function can be learned with an arbitrary accuracy by a three-layer network learning continuous functions: every bounded continuous function can be learned with a small error by a two-layer network (the number of hidden units depends on the function to be approximated).Learning Boolean functions: every Boolean function can be learned exactly by a two-layer network although the number of hidden units grows exponentially with the input dimension. A network with a layer of input units, a layer of hidden units and a layer of output units is a two-layer network. A network with two layers of hidden units is a three-layer network, and so on. A justification for this is that the layer of input units is used only as an input channel and can therefore be discounted.

2. OPERATION OF A BIOMETRIC SYSTEM

Biometrics is the automated recognition of individuals based on their behavioural and biological characteristics. It is a tool for establishing confidence that one is dealing with individuals who are already known (or not known)—and consequently that they belong to a group with certain rights (or to a group to be denied certain privileges). It relies on the presumption that individuals are physically and behaviourally distinctive in a number of ways.

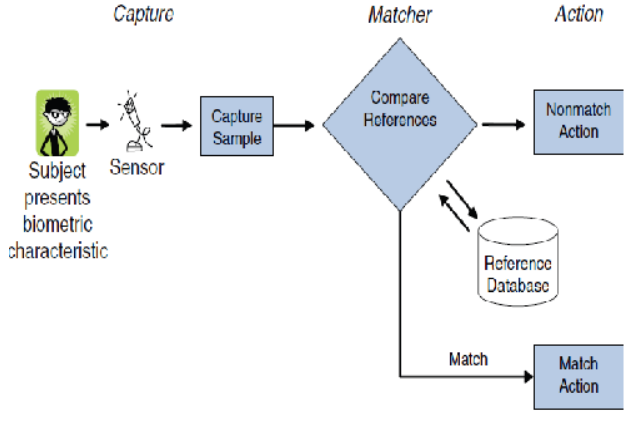

Figure 1 Operation of a biometric system

Figure.1- illustrates the basic operations of a recognition process. The two basic operations performed by a general biometric system are the capture and storage of enrolment (reference) biometric samples and the capture of new biometric samples and their comparison with corresponding reference samples (matching). This figure depicts the operation of a generic biometric system although some systems will differ in their particulars. The primary components for the purposes of this discussion are "capture," where the sensor collects biometric data from the subject to be recognized; the "reference database," where previously enrolled Subjects' biometric data are held; the "matcher," which compares presented data to reference data in order to make a recognition decision; and "action," where the system recognition decision is revealed and actions are undertaken based on that decision.

3. LITERATURE SURVEY

The earlier system based on feature extraction using principle component analysis and recognition using the feed forward back propagation .that does not execute parallel. Problem in this approach we recognize the Face first and then the fingerprint in sequence it is based on unimodal biometric system. Unimodal biometric systems have variety of problems such as noisy data, intra-class variations, restricted degree of freedom, non-universality, spoof attack and unacceptable error rates. The system based on AND & OR Configuration this approach can not normalize the False accept rate (FAR) False reject rate (FRR) Failure to enroll rate (FTE).

In July - 2012 Dr. Shubhangi D C et al suggest that "Artificial Multi-Biometric Approaches to Face and

Fingerprint Biometrics". As a part the work, an ANN is implemented. Feature extraction using principle component analysis and recognition using the feed forward back propagation neural network. Their work deals with a task where recognize the Face first and then the fingerprint in sequence. the trained ANN groups the input pixels into the different clusters which provide the results. [1].

In August 2012 Hiren D. Joshi suggests that A Multimodal Biometric Authentication System for Person Identification and Verification using fingerprint and face recognition. He multimodal biometric takes the individual scores of two traits (face and fingerprint) which are combined at classifier level and trait level The logic of the multi-biometric system may be implemented in an AND configuration or in an OR configuration . [3]

In 2010 Sasidhar et al to him they develop multimodal biometric systems – study to improve accuracy and performance. a framework was established with assessing the performance of multimodal biometric systems.

Not allowing for a common middleware layer to handle the multimodal applications with a small amount of common information. [2]

In August 2012 Trupti S. Indi suggests the Biometric Feature based Person Unique Identification System different image enhancement techniques such as Gaussian smoothing function, adjusting intensity values of each pixels etc. We have studied different binarization methods and selected one which gives us best results for input thumb image. We have studied some thinning algorithms like Hilditc, Rosenfeld and ZS algorithms. Based on results we have used ZS (Zhang-Suen) thinning algorithm. Problem of ANN based is difficult to understand structure of algorithm, too many attributes can result in over fitting, optimal network structure can only be determined by experimentation. [6]

In 4 September, 2010 Muhammad Imran Razzak introduced an automatic method for the detection of exudates multimodal face and finger veins recognition systems in which multilevel score level fusion was performed. The imposter and genuine score are combined using Fuzzy fusion to increase the face recognition system. [5]

4. Proposed Methodology

We have concentrated our implementation on multimodal biometric face and fingerprint recognition using neural network. multimodal biometrics system for identity verification using two traits: face and fingerprint System based on adaptive principal component analysis and multilayer perception A proposed scheme of multimodal biometric face and fingerprint recognition using neural network is parallel the multimodal biometric takes the individual scores of two traits (face and fingerprint) which generate range approximate value for training that is in discrete interval form than system will produce good accurate result with high efficiency. Current work deals with an efficient face and fingerprint recognition algorithm combining ridge based and Eigen face approach for parallel execution. Here I am proposing a method to overcome the drawback of earlier problem, which based on combination on neural network an efficient Face and Fingerprint recognition algorithm combining ridge based and Eigen face approach. The main purpose of the proposed system is to reduce the error rate as low as possible and improve the performance of the system by achieving good acceptable rate during identification and authentication.

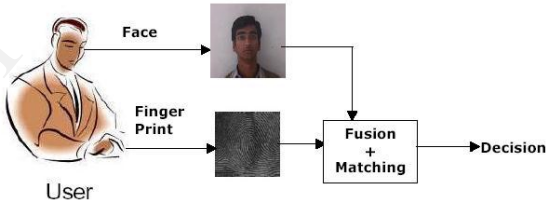

Figure.2 multimodal biometrics system using two traits: face and fingerprint

Proposed implementation steps –

Sensor level:

We combine the biometric traits taken from different sensors to form a composite biometric trait and process. Here an image of an object or a scene is captured by a digital camera or is scanned for use as the input to the system.

Feature level:

Signal coming from different biometric channels are first pre-processed, and feature vectors are extracted separately, using specific algorithm and we combine these vectors to form a composite feature vector. This is useful in classification. These are a series of steps which should be taken for making an image suitable for manipulation and interpretation by subsequent stages. The steps include removal of noise and variation of intensity recorded, sharpening, improving the contrast

and stringing the texture of the image. Another important aspect is image restoration which extracts image information from a degraded form to make it suitable for subsequent processing and interpretation.

The Matcher level:

Rather than combining the feature vector, we process them separately and individual matching score is found, then depending on the accuracy of each biometric matching score which will be used for classification.

Decision level:

Each modality is first pre-classified independently. Multimodal biometric system can implement any of these fusion strategies or combination of them to improve the performance of the system;
Different levels are shown in below figure

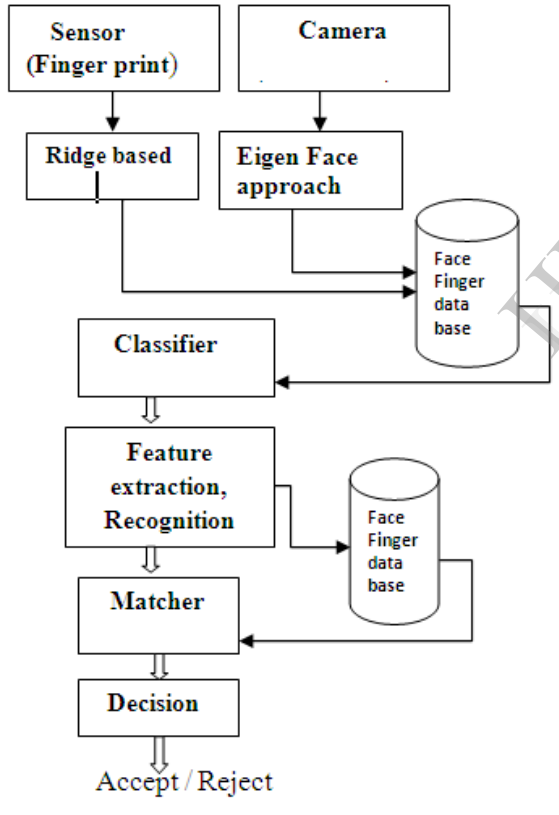

Figure.3 faces and fingerprint recognition systems

5. Experimental Results

The multimodal biometric databases can be either true or virtual. True multimodal database is a database consists of different biometric traits obtained from the same person. Virtual multimodal database is a database consists of pairing a biometric trait from one unimodal database with another unimodel database. The virtual multimodal biometric database is based on the assumption that different biometric traits of the same person are independent. The data has taken from 200 different users vary from the ages 20-52 which includes both male and females. The data are taken at normal computer laboratory environment.

Table I FRR Vs FAR in a Multimodal Biometric Authentication System

False Accept Rate (FAR)	False Reject Rate (FRR)		
	Face	Fingerprint	Multimodal
1%	14.45%	3.6%	1.53%
0.1%	41.32%	6.9%	4.30%
0.01%	62.5%	9.4%	6.6%
0.001%	66.27%	15.2%	10.33%

The above table shows result for single biometric trait and then integration of these two single multiple biometric traits. As the data shows single biometric has a high False Rejection Rate (FRR) while the integration of fingerprint and face has low FRR for the same False Acceptance Rate (FAR). The following chart shows a comparison of the data presented in the table. As from the chart we can say that the multimodal (integration) of the biometric trait has significantly improved the performance.

Table II Results for PCA

No. of Face & Finger Image	Successfully Recognized	Unrecognized	Efficiency (%)
5	4	1	84.62%
13	11	2	80%
20	18	2	77.27%
22	21	1	88%
25	22	3	76.67%

Therefore the efficiency of the face and fingerprint recognition System by using principle component analysis Algorithm is 84.62%. These results demonstrate the utility of using multimodal biometric systems for achieving better matching performance. They also indicate that the method chosen for fusion has a significant impact on the resulting performance. In operational biometric systems.

Table III Results for APCE

No. of Face & Finger Image	Successfully Recognized	Unrecognized	Efficiency (%)
5	3	2	64.00%
13	12	1	92.31%
20	19	1	93.33%
22	19	3	88%
25	24	1	96%

Therefore the efficiency of the face and fingerprint recognition System by using Adaptive Principal component Extraction Algorithm is 96.00%.
Application requirements drive the selection of tolerable error rates and in both single modal and multimodal biometric systems, implementers are forced to make a trade-off between usability and security.

6. Conclusion

Our implementation mainly incorporates normalize the False accept rate (FAR) False reject rate (FRR) Failure to enroll rate (FTE).Reliable method for security and integrity of the biometrics data. A system can achieve higher recognition accuracy than uni-modal systems. A system can minimize the recognition response time. Multimodal biometric systems better perform than uni-modal biometric systems as the high frequency coefficient is less sensitive to human visual systems, first few coefficients of each block is constructed. The proposed prediction models based on soft computing on the other hand are easy to implement. We have developed a prototype biometric system which integrates faces and fingerprints in authenticating a personal identification. The proposed system overcomes the limitations of both face-recognition systems and fingerprint-verification systems.
We further wish to enhance effectiveness of the system in unique identification by incorporating XOR Configuration multimodal biometric in addition to thumbprint. Together a matching score, based on ear & thumb images, will be generated to more accurate identification. The program can also be used by researchers to learn how to design high-speed face recognition systems.

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