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Multimodal Biometric System by Feature Level Fusion of Palmprint and Fingerprint

Navdeep Bajwa
M.Tech (Student) Computer Science
GIMET, PTU Regional Center
Amritsar, India

Er. Gaurav Kumar
M.Tech (Supervisor) Computer Science
GIMET, PTU Regional Center
Amritsar, India

***Abstract*— Biometrics is the technology for measuring and analyzing human characteristics such as palmprint, fingerprint, voice, facial pattern, signature etc, for authentication purposes. Biometrics has been emerged as the most powerful and reliable means of personal authentication. Most biometric systems are unimodal, which rely on single source of information for authentication. But these systems have major problems such as noisy data, non-universality, intra-class variation, inter class similarities and spoofing attacks. To overcome these drawbacks, multimodal biometrics emerged as new research area in the field of security. This paper focuses on the fusion of palmprint and fingerprint with feature level fusion. The feature values of fingerprint and palmprint are extracted using thinning and Hidden Markov Model and then their values are fused.**

Keywords*— Biometrics, Multimodal biometric, Feature level fusion, Binarization, Thinning, Hidden Markov Model.

I. INTRODUCTION

In our society, personal identification and verification both play important role. Today more and more business applications such as e-banking and security applications demand fast, real time and accurate personal identification [4]. There are many conventional means for personal identification such as password, smart card, credit card etc, but they have some disadvantages. There is chance of forgetting a password or it can be guessed by an unauthorized user and smart cards can be stolen or theft. As a solution to these problems, biometric systems are proving to be efficient. A biometric system is essentially a recognition system which makes a personal identification by determining the authenticity of specific physical or behavioral characteristics possessed by the user such as face, palmprint, voice, signature and gait. Any physical or behavioral characteristics of a human can be considered as biometric if it exhibits characteristics of universality, uniqueness and permanence.

The biometric system can be classified into unimodal biometric system and multimodal biometric system. The unimodal biometric employs single biometric trait to identify or verify the user. Unimodal biometric system suffers from number of problems such as noisy data, non-universality, spoofing attacks. Problems arises in the unimodal system can be resolved using multimodal biometrics. Multimodal biometric system utilizes more than one physiological and behavioural characteristic for enrolment, verification and identification. The reason to combine different modalities is to improve recognition rate, minimize error rate and enhance performance and security. Recently, wider research and development is done in multimodal identification. The multimodal biometric system eliminates the problems imposed by unimodal biometric system. They address the problem of non-universality since multiple traits ensure sufficient population coverage [2]. Multimodal biometric system also addresses the problem of spoofing since it becomes difficult for intruder to spoof or attack multiple traits of genuine enrolled user simultaneously. The multimodal biometric system are more reliable and accurate due to the use of multiple traits. The main goal of the multimodal biometrics system is to reduce false accept rate, false reject rate, failure to enrol rate.

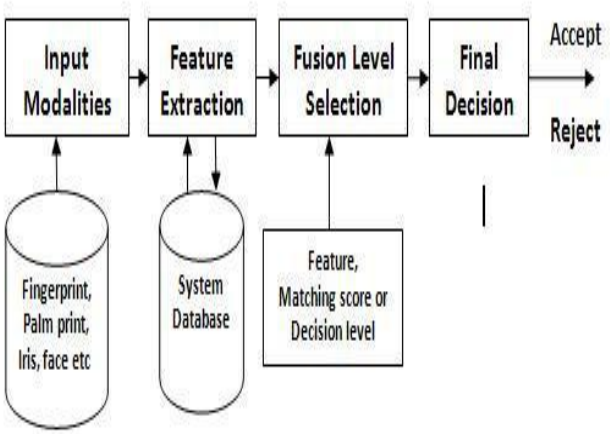

Fig. 1. Block diagram of general multimodal biometric system [13].

The key to multimodal biometric system is fusion in which features of two or more modalities are fused to generate a joint feature vector for identification of an individual. The various levels of fusion are sensor level fusion, score level fusion, feature level fusion, decision level fusion. This work purposes a feature level fusion. In feature level fusion, feature set is extracted from the multiple sources of information and is further combined into a joint feature vector. This new feature vector represents an individual. Then this vector is compared to an enrolment template

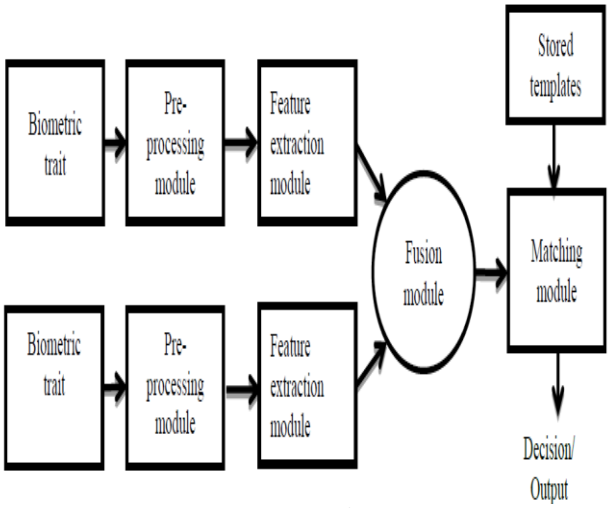

Fig. 2. Feature level fusion[10].

II. Related Work

A number of studies show that multimodal biometric system has many advantages over unimodal biometrics system. Multimodal systems are more reliable as multiple modalities are used for identification and verification. The work that had been done related to multimodal biometrics is described as below:

Abdallah et al. [1] proposed a multimodal biometric system by fusion of palmprint and finger-knuckle-print using hidden markov model. The author uses 2D-BDCT technique for feature extraction of both modalities and Hidden Markov Model is employed for modeling the feature vector. The features of both modalities are fused using score level fusion. Young Ho Park [15] proposed a multimodal biometric recognition of touched fingerprint and finger vein. Abdallah et al. [] proposed multimodal person recognition system based on fingerprint and finger-knuckle-print using correlation filter classifier. Dr. S Ravi et al. [2] purposes a multimodal biometric approach using face, fingerprint and enhanced iris features recognition. Ola M Aly et al [9] purposes a multimodal biometric system using iris palmprint and finger knuckle. Vincenzo Conti *et.al* [4] has proposed fusion of features of fingerprint and iris with frequency based approach and hamming distance based matching algorithm. Monwar *et.al* [8] has discussed rank level fusion of face, ear and signature with principal component analysis and fisher's linear discriminant analysis for matching purpose. The fusion of various modalities has been done by four methods: sensor level fusion, feature level fusion, score level fusion and decision level fusion [11].

III. Proposed Multimodal Biometric System

Multibiometric system, which employs two or more biometric traits to authenticate a person identity, are gaining popularity because they are capable to overcome drawbacks of unimodal system and provide greater performance and higher reliability. By integrating multiple biometric identifiers these systems enhance matching performance, deter spoofing and increase population coverage. Various fusion levels are possible in multimodal biometric to combine two or more biometric traits. In the proposed multimodal biometric system fingerprint and palmprint modalities are integrated using feature level fusion.

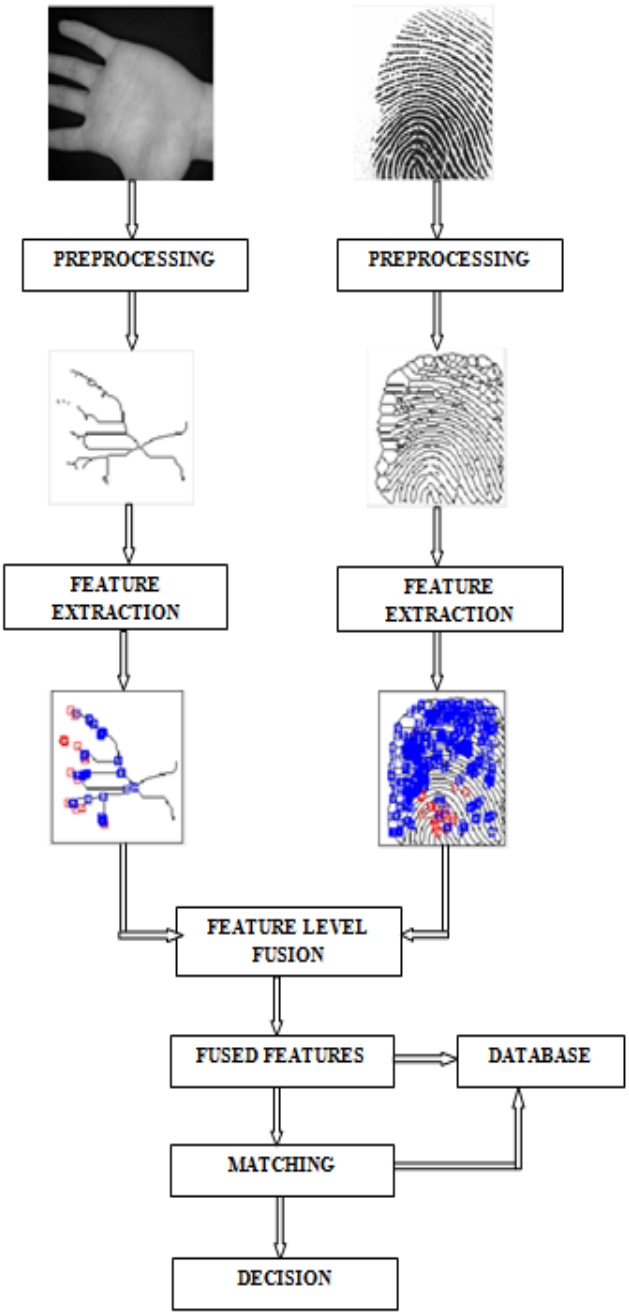

Fig. 3. Proposed multimodal biometric system.

A. *Preprocessing of palmprint and fingerprint images*

The first step of the proposed multimodal system is to pre-process the input fingerprint and palmprint images. The pre-processing sets up a coordinate system to align palmprint and fingerprint images and to segment region of interest (ROI) by which features can be easily identified. For this, techniques of binarization and thinning are employed. Binarization converts the gray-level images to binary images. It improves the contrast between ridges and edges. Thinning is the process of eliminating unwanted pixels from the binary image.

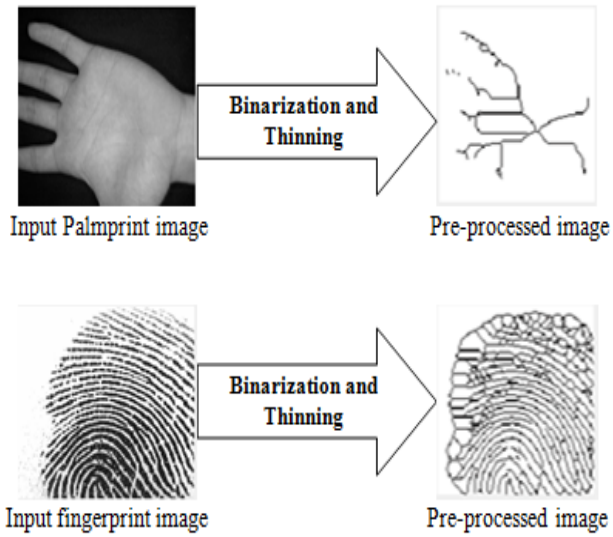

Fig. 4. Preprocessing of palmprint and fingerprint images.

B. *Palmprint and Fingerprint feature extraction*

The thinned images of palmprint and fingerprint obtained after pre-processing are further processed for feature extraction using the technique of Gabor Hidden Markov Model (HMM). First the bifurcation and ridge ending algorithms are employed to extract minutia feature vector. HMM is used for modeling the minutia feature vector of each palmprint and fingerprint image [fig. 5].

C. *Feature level fusion of palmprint and fingerprint*

In feature level fusion, after extracting the features from the palmprint and fingerprint images, the fusion is done to generate a joint feature vector. This new feature vector represents an individual. The fusion is done using wavelet decomposition application *wfusmat*, which is used for the fusion of two arrays or matrices. The fused features are saved for storage in the database for matching and verification purposes.

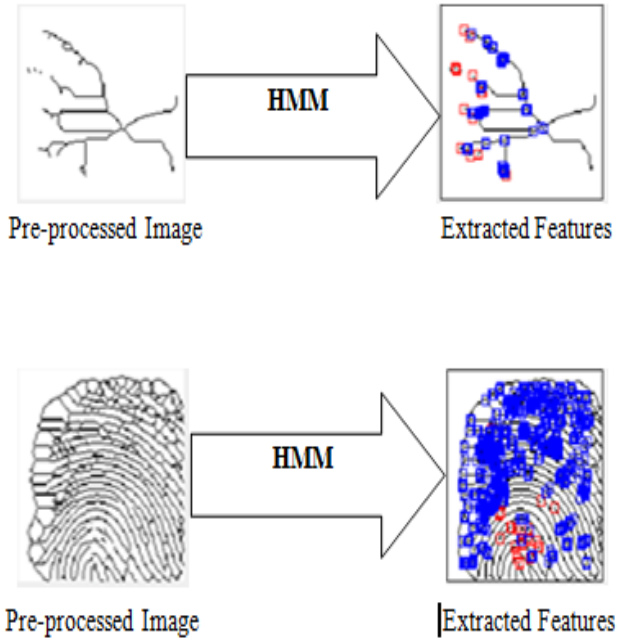

Fig. 5. Palmprint and fingerprint feature extraction.

IV. IMPLEMENTATION

The proposed work is implemented using MATLAB tool which offers great variety of in-built functions to support biometric implementation. The implementation is basically divided into enrolment and verification phase. The CASIA database is used to get the palmprint and fingerprint images for the creation of the dataset during the enrolment. The verification phase involves the matching of system input with the stored dataset for deciding the authentication and identification of person as imposter or genuine [fig. 6,7].

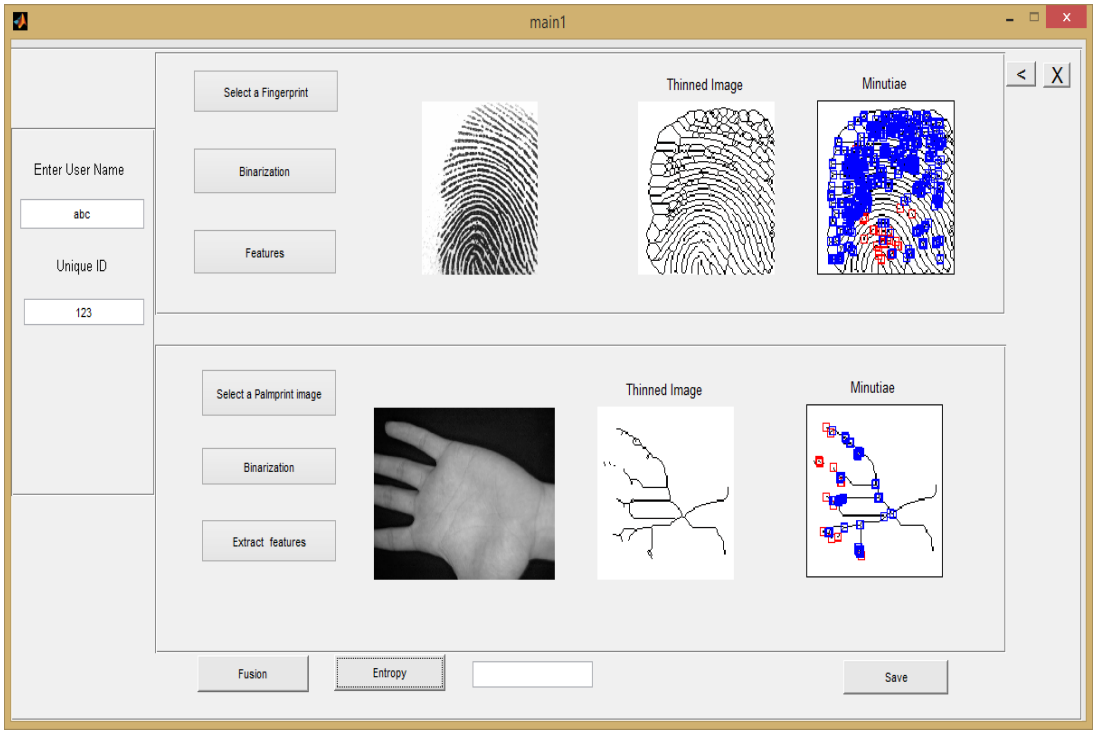

Fig. 6. Enrollment phase of multimodal biometric system.

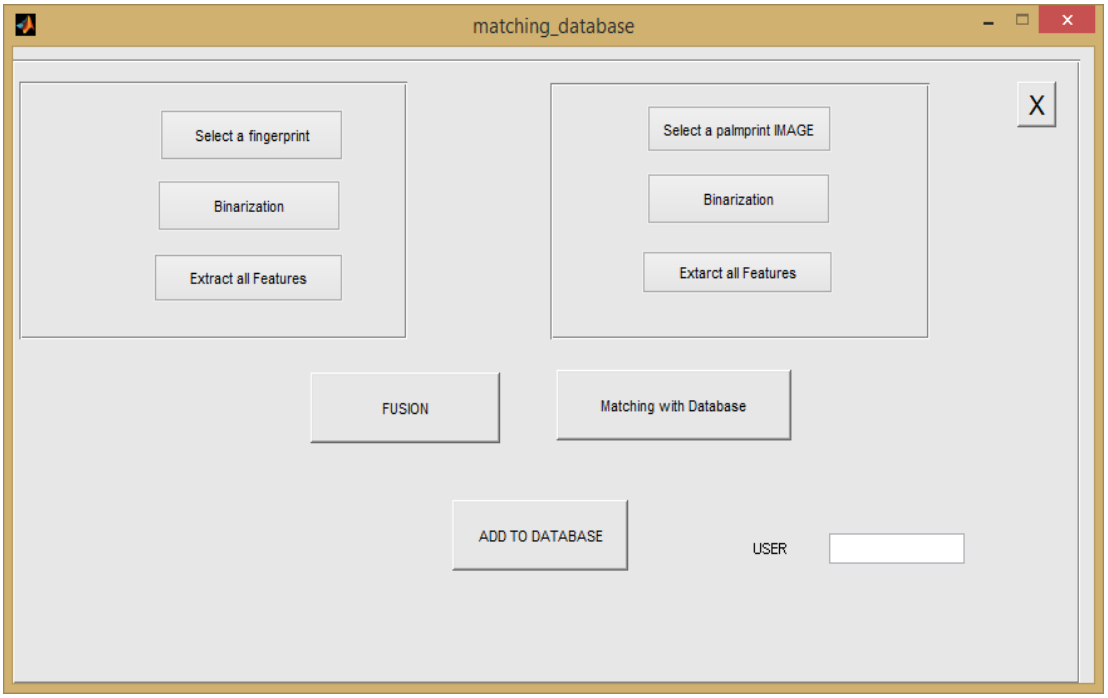

FIG. 7. Verification phase of multimodal biometric system

V. CONCLUSION

Biometrics has become essential for human identification and can be made more secure by combining two or more biometrics, known as multimodal biometric systems. This paper describes the feature level fusion of palmprint and fingerprint modalities. The implemented multimodal biometric system will be evaluated in terms of false acceptance rate, false reject rate and false enroll rate for accuracy.

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