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Effective Fusion Mechanism for Multimodal Biometric System-Palmprint and Fingerprint

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Abstract: *Security is main issue in every where today. This paper proposes the multimodal biometrics system (MBS) for identity verification using three traits i.e., finger print, iris and palm print. The proposed MBS system is designed for applications like authentication where the training database contains a finger print images and palm print for each individual. Palm print is chosen as a biometric trait as no two palm print match unless they are of the same person also palm has a good vascular pattern making it a good identifying factor for an individual as compared to other biometric traits. The images captured by the designed hardware are preprocessed using Image enhancement techniques and Features are extracted by Gaussian kernel, Gabor Filter and Principal Component analysis. These feature vectors are fused at feature level and later matched by using Euclidean distance or Manhattan distance. Quality measures are also found for these above modalities.*

I. INTRODUCTION

Biometrics refers to metrics related to human characteristics. This system use biological information about person to create a detailed record of their personal characteristics. Nowadays biometric system provides highly secure and authenticated is low-cost, non-invasive and provides easy access to Biometric Authentication called multimodal biometric system (MBS) system. Biometric system has categorized into two main types- 1) Unimodal Biometric System (UBS), 2) Multimodal Biometric System (MBS). UBS has developed from many years but it suffers from various problems like enrollment problems, insufficient accuracy .The biometric system uses two or more biometric modalities for authentication. In this paper, we propose to an effective fusion mechanism for MBS. We use modalities like Fingerprint, Palm print. After capture, preprocessing is done and features are extracted and later fused at feature level. These features compared with stored feature template to give the accurate decision like accept or reject.

II. METHODOLOGY

First database of iris, palm print, fingerprint is collected. These are pre-processed individually and features are extracted which are fused to form a single feature vector. This vector is stored at the server side. Matching is then done i.e. test image is compared with stored feature vector, based on the minimum Euclidean distance.

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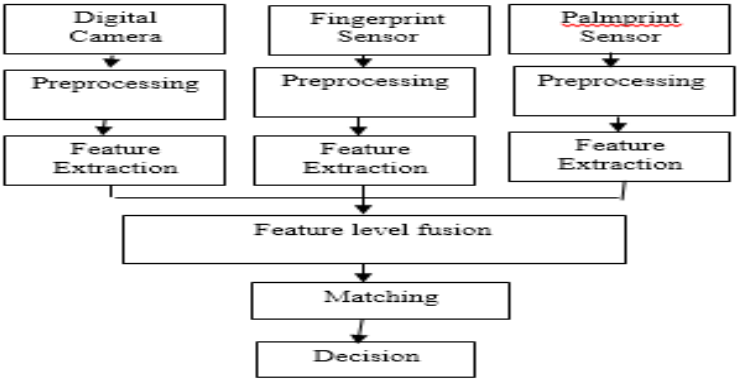

Figure 1. Block Diagram

A. Data acquisition and preprocessing

1) Palm print

A system is designed for capture of palm vein images based on principle of near infra-red imaging. The system consists of a CCD camera and a lightening system. The CCD camera is modified to see only IR light which involves removal of infrared filter inside the camera as shown in Fig 2. Finally to make this IR-only camera the visible light needs to be filtered out for the same filter is made for the front of the lens out of fully exposed 35mm color negative film. The red tinged glass in Fig 2 (c) The lightning system consists of an Matrix arrangement of Near IR LED`s (SFH4550) 850nm. As matrix arrangement of LED`s offer best distribution of intensity with uniformity matrix arrangement is chosen. A variable power supply having rating 0-12V and 0.4A is designed; with the help of an adjustable potentiometer the intensity is varied.

The camera i-Ball Face to Face c12.0 (640x480) is mounted on a wooden stand. The LED assembly is placed below. A simply paper material box is placed over the LED assembly over which the palm is placed. With the help of a switch the LED assembly can be turned ON and OFF. The camera has a USB interface hence the image captured are stored on the computer. Fig 2(a) shows the system for palm print capture. The image captured by the system has clear visibility of palm print as shown in Fig 2(b).

The above system could also be used to capture palm vein images. The captured hardware design is very cost effective and the palm vein images captured when combined with authentication algorithms provide good accuracy.

Palm vein images are low in contrast hence the data values are remapped by contrast adjustment. Gray values between low to high are mapped onto bottom to top. Depending on the Gamma correction factor [7] the mapping of values between input and output image may be linear. Further after preprocessing palm vein images boundary of the hand is found out by border tracing algorithm which locates the position of fingers to find Region of interest (ROI) by Euler's distance diagram.

Fig.1 i-ball camera

Fig.2 a) Palm print capture system

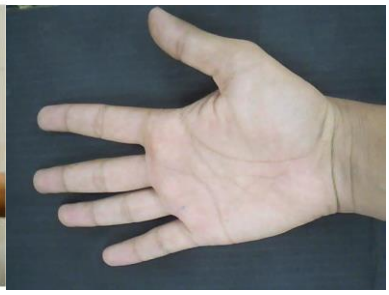

Fig.2 b) Palm print

2) Fingerprint

A contactless capture of Fingerprint is performed. One hundered subjects both male and female took part in the experiment. The capture of fingerprint involves using Xpro night vision web camera shown in Fig 1. It`s a 20.0Mega Pixel Camera with a high quality CMOS sensor and five glass optical coating lens. The frame captures size of 640x480. It is driver free for windows XP and above. It`s compatible with MAC with 2.0 USB port and windows. The camera also has USB port and frame rate 30F/S @ VGA. Fig 1(b) shows a fingerprint image captured by the camera. A completely contactless fingerprint capture makes it a highly hygienic process.

Fig. 3a) Xpro camera

Fig. 3b) captured fingerprint

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B. Feature Extraction.

Feature Extraction is transforming the input data into the set of features. Gaussian kernel with Principal Component Analysis, Gabor filter is used for palmprint and fingerprint feature extraction respectively.

1) Palm print Features:

Principal lines are extracted using Gaussian Kernel and canny edge detector. Features are selected like length of two principal lines and orientation between them for each individual. Then PCA applied for feature extraction.

PCA is a statistical procedure that uses an orthogonal transformation to convert a set of observations of possibly correlated variables into a set of values of linearly uncorrelated variables called principal components. Its objective is to reduce the large dimensionality of the data space to smaller intrinsic dimensionality of feature space. PCA involves [8] calculation of Eigen value decomposition of data covariance matrix after mean centering the data.

2) Fingerprint Features:

Gabor filter impulse response is defined by a sinusoidal wave (a plane wave for 2D Gabor filters) multiplied by a Gaussian function.

Gabor filters [5] are characterized by spatial frequencies and orientation capabilities hence they are used for finger print feature extraction. Spatial frequencies and orientation are important characteristics of textures in images. Gabor filters are used for finger print feature extraction. A Gabor filter is obtained by combining a sinusoid with a Gaussian. Gabor filter centered at origin with frequency θ and orientation ϕ is,

C. Fusion

In feature level fusion, different feature vectors extracted from proposed biometric trait are combined together into a single feature vector .This process undergoes two stages which are feature normalization and feature selection.

III. EXPERIMENTS AND RESULTS

The methods are implemented by MatLab 8.2® on a computer with Intel® Core(TM) 2-Duo T6570 CPU @ 2.10GHz, 4GB RAM, Windows 7, 64-bit operating system. The following figures show the experimental results. Experiments are performed on 100 persons including 60 male and 40 female. The age distribution is from 20 years to 60 years. 10 images of each person were captured of all three modalities i.e. Fingerprint and palm print. Hence in total the database has 2000 images of 100 persons. For training, 600 images were used for each modality and 400 images were used for testing. In Fig 4 (a) is the original input image of size 640x480 captured from Xpro web camera. Fig 4(b) represents the histogram of the original image. Histogram equalization is applied to the original image which expands the range of gray level near Histogram maxima; hence this transformation improves the detectability of many image features. In Fig 5 (a) is a fingerprint image 640x480 captured by touchless fingerprint capture camera Xpro 20.0MP.

Fig.4a) Fingerprint Fig. 4b) Palm print

Palm print images require ROI extraction, then principal lines are extracted and length is calculated.

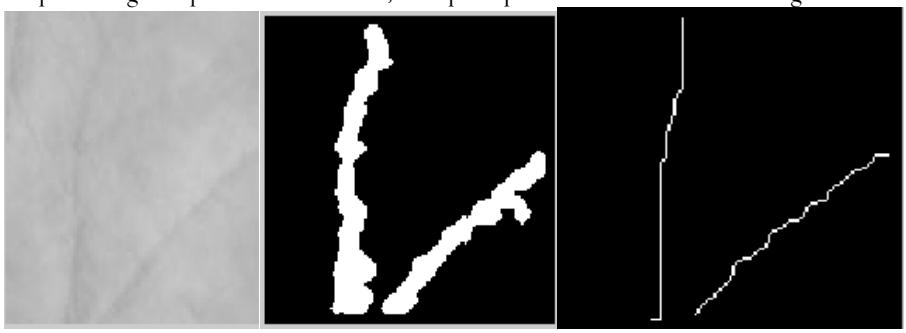

Fig.5a) ROI extracted Fig.5b) Principal line detected Fig.5c) Thinned principal lines

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The feature vector matrix of fingerprint and palm print is of the order 13900x1, 10816x1 respectively. Feature level fusion is applied to the above feature vectors and a fused matrix is obtained of order 217738x900. Testing is carried out using 100 images which gives accuracy of 99%.

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