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MULTIMODAL BIOMETRICS BY INTEGRATING FINGERPRINT AND PALMPRINT FOR SECURITY

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Abstract— *Multimodal Biometrics there is a combination of different biometric modalities. In most biometric systems from real world applications uses a single source of biometric modality for authentication that is only a single fingerprint, palm print, face, voice or iris which is known as unimodal biometrics.. Some of the drawbacks from unimodal biometrics are eliminated by combining information from multiple biometrics systems for unique personal identity. This paper gives a multimodal biometrics system that combines features of fingerprint and palm print to overcome several limitations of unimodal biometrics. Preprocessing is a heart of image processing in which feature enhancement is prior step, in this system feature enhancement of input image that is fingerprint and palm print are performed by applying a series of preprocessing techniques. Modified Gabor filter is used to independently extract a fingerprint and palmprint feature which provides more accuracy as compared to traditional Gabor filter In addition to this Short Time Fourier transformation is applied for better quality of resultant images. In the later step the resultant images are combined in feature level fusion method and finally using Euclidean distance method the features are classified to match the resultant image with database template. . We conclude that proposed methodology has better performance as compared to unimodal approaches using individually only a fingerprint or a palm print. The multiple biometrics helps to reduce the system error rate.*

Index Terms— **Gabor Filter, texture analysis, unimodal biometrics, *palmprint feature.***

I. INTRODUCTION

Biometric recognition or simply biometrics refers to recognizing a person based on one or more of his anatomical (e.g. face, fingerprint, iris) or behavioral (e.g. signature) traits. Most biometric systems with real world applications are unimodal, which uses a single source of information for authentication, e.g. a fingerprint, face, voice, and iris. Some drawbacks of the unimodal biometrics systems can be overcome by including multiple sources of information for establishing personal unique identity. Multimodal Biometrics uses a combination of different biometric recognition technologies. Multimodal Biometrics based Identification systems provide promising results for the applications that demand stringent robustness and a higher level of accuracy [1]. Ajay Kumar and David Zhang presented multimodal biometric identification system by integrating fingerprint, palmprint and hand-shape features [4]. The palmprint image for individual identification. Initially our system applies a 2D discrete wavelet transform (2D-DWT) to decompose the image into lower resolution before performing feature extraction. Image decomposition using 2D-DWT is able to conserve the energy signals and redistribute them into a more compact form. Also we use a Modified Gabor Filter (MGF) [2] as a feature extractor for both biometrics as they share some common characteristics such as ridges. Finally the extracted fingerprint and palmprint images are combined to utilize the proposed feature level fusion method and at the last stage the features are classified using Euclidean distance to match the resultant image with database templates. In addition to Gaussian filter Short Time Fourier Transform (STFT) [3] analysis is adopted to enhance finger image quality.

II. RELATED WORKS

There are maximum drawbacks involved in unimodal biometric systems such as non-universality, non-distinctiveness, easy spoof attacks, etc. These challenge the research community for robust and secured biometric system. The first solution is obviously a multimodal biometric system which uses multiple biometric traits to offer robust decision-making. The main motivations behind multimodal biometric system are the limitation of unimodal biometric systems Noisy sensed data like: Intra-class variations, Lack of individuality, Non-universality, Spoof Attacks. Multimodal biometry solves the above defined problems by combining the evidences obtained from different modalities with the help of an effective fusion scheme. Previous work in multimodal biometric system design shows that they may either be based on single input and multiple algorithms or multiple samples and single algorithm or they may utilize two or different modalities. It has been empirically proven in [5] that multimodal biometrics can improve the performance but this improvement comes at a cost. To date many researchers have fused on match score level fusion as it is relatively easier to access and combine the scores produced by different modalities [6]. In [4] has proposed to fuse fingerprint, palmprint and hand geometry at score level, the individual match score of the three modalities were combined using sum rule. There proposed method was able to achieve an EER of 3.53% It was illustrated in [7] that multi biometric system seek to alleviate some of this drawbacks by providing multiple evidence of the same identity.

III. LITERATURE SURVEY

A. Discrete wavelet transform – derived features for digital image texture analysis

This paper deals with using discrete wavelet transform derived features used for digital image texture analysis. Wavelets appear to be a suitable tool for this task, because they allow analysis of images at various levels of resolution. The proposed features have been tested on images from standard Brodatz catalogue.

B. Discrete Wavelet Transform for Image Processing

Image compression is a method through which we can reduce the storage space of images which will helpful to increase storage and transmission process's performance. In this paper, we present the comparison of the performance of discrete wavelets like Haar Wavelet and Daubechies Wavelet for implementation in a still image compression system. The performances of these transforms are compared in terms of Mean squared error (MSE) and Energy Retained (ER) etc. The main objective is to investigate the still image compression of a gray scale image using wavelet theory. This is implemented in software using MATLAB Wavelet Toolbox and 2D-DWT technique .The experiments and results is carried out on .jpg format images. These results provide a good reference for application developers to choose a good wavelet compression system for their application.

C. fingerprint image enhancement using stft analysis

Contrary to popular belief, despite decades of research in fingerprints, reliable fingerprint recognition is an open problem. Extracting features out of poor quality prints is the most challenging problem faced in this area. This paper introduces a new approach for fingerprint enhancement based on Short Time Fourier Transform (STFT) Analysis. STFT is a well known technique to analyze non-stationary signals. We extend its application to 2D images. The algorithm simultaneously estimates all the intrinsic properties of the fingerprints such as the foreground region mask, local ridge orientation and local frequency orientation. Furthermore we propose a probabilistic approach of robustly estimating these parameters. We compare the proposed approach to other filtering approaches and show that our tech- nique performs favorably. We also objectively measure the improvement in recognition rate due to our enhancement. We obtain a 17% improvement in the recognition rate on a set of 800 images from the FVC2002 database

D. Fingerprint-Iris Fusion Based Multimodal Biometric System Using Single Hamming Distance Matcher.

In the real world applications, unimodal biometric systems often face limitations because of sensitivity to noise, intra class in variability, data quality, and other factors. Improving the performance of individual matchers in the aforementioned situation may not be effective. Multi biometric systems are used to overcome this problem by providing multiple pieces of evidence of the same identity. This system provides effective fusion scheme that combines information provided by the multiple domain experts based on score-level fusion method, thereby increasing the efficiency which is not possible in unimodal system.In this paper, we have proposedthe development of a fingerprint and iris fusion system which utilizes a single Hamming Distance based matcher to provide higher accuracy than the individual unimodal system.

IV. PROPOSED SYSTEM

The complete system architecture with block diagram is explained in this section, in this system there are five basic steps as discussed below:

A. System algorithm

There are mainly four basic operations Image Preprocessing, Feature Extraction, Fusion, and Matching. We first apply a 2D discrete wavelet transform (2DDWT) to decompose the images into lower resolution before performing feature extraction. Image decomposition using 2D-DWT is able to conserve the energy signal and redistribute them into a more compact form. Subsequently, we adopt a Gabor filter as the feature extractor for both biometrics, as they share some common characteristics such as ridges. Finally, the proposed feature level fusion method is utilized to combine the extracted fingerprint and palmprint images. At the end fused image will be compared with database template image for final result. In the following subsections, we will present the algorithmic details of these operations.

Input: Fingerprint Image, Palmprint Image

Output: User Identity (Accept/Reject)

Begin

1. Read input image fingerprint/palmprint from database.
2. Perform image cropping:

a).Convert input image into Grayscale.

3. Decide ROI of cropped image.
4. Apply 2D DWT on resultant image from step 3. This will extract features of input image i.e. fingerprint/palmprint image.
5. Apply MGF on output of step 4. This will apply different orientations and scaling on input images. Palmprint and fingerprint share some common characteristics such as creases and ridges. Other palmprint characteristics are principle lines and wrinkles. A bank of MGF filters is used to filter palmprint and fingerprint images in different directions at different orientations and scaling factors, to highlight these characteristics and remove noises. {Step 1 to 4 will be applied sequentially on both fingerprint and palmprint separately}.
6. Apply Normalization on resultant images from step 5. This will combine the normalized features of both fingerprint

and palmprint images. Normalization is important as the filtered palmprint and fingerprint images may not share the same intensity domain.

7. Apply feature level fusion where it will combine the normalized LL sub-band images and divide it into none overlapping blocks of size m×n pixels each. Then, the resulting magnitude will be converted to a scalar number by calculating its standard deviation value

The size of each block is carefully chosen, so that no repeated feature is extracted. At last, a feature vector with 8×N×N sub-Gabor features is extracted from each image, where N denotes the number of rows and columns.

8. Finally apply decision module where the user identity will be decided which is either Accept/Reject.

End.

Fig. 1 shows the overall structure of the system in the form of flowchart and Fig. 2 shows overall architecture of proposed system.

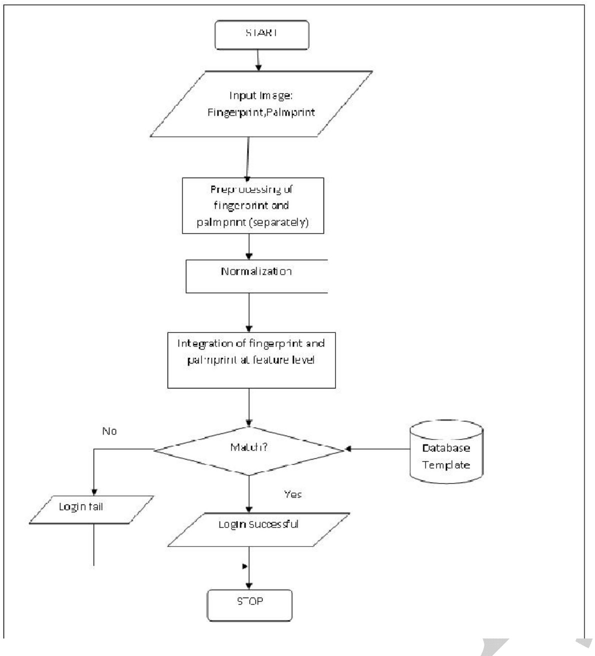

Fig.1 Flowchart of the proposed system

A. Image preprocessing

The basic preprocessing step is Image Enhancement. Before doing anything first of all we crop the image by using Gaussian low pass filter. In addition to this we apply Short Time Fourier Transform (STFT) analysis to enhance fingerprint image quality. By performing this stage it does a thinning on both the images separately.

B. Discrete wavelet transform

In mathematics, the wavelet transform refers to the representation of a signal in terms of scaled and translated copies (known as "'daughter wavelets"') of a finite length or fast decaying oscillating waveform (known as the mother wavelet). Wavelet transforms are broadly classified into continuous wavelet transform (CWT) and discrete wavelet transform (DWT). The principal difference between the two is that the discrete wavelet transform uses a specific subset of all scale and translation values whereas the continuous transform operates over every possible scale and translation. The proposed system will use WT to decompose the enhanced palmprint images and fingerprint images into lower resolution representation. Generally, 1D DWT of a signal cA can be obtained by convolving it with decomposition filters as in (1) and (2),Where n denotes the resolution level, h and g denote the decomposition low-pass and high-pass filters, respectively.

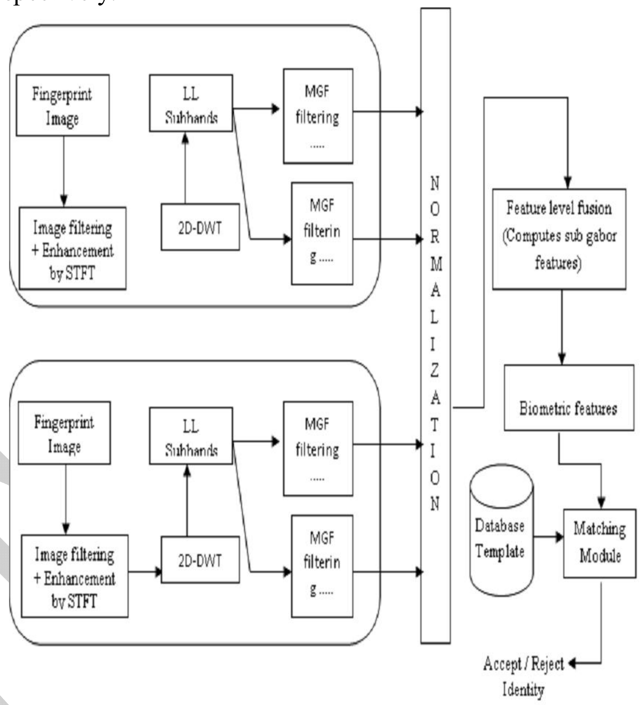

Fig. 2 System Architecture

Two-dimensional (2D) DWT for 2D signal such as images can be implemented by performing 1D DWT in each signal dimension. An image is decomposed into four frequency sub-bands at each resolution level n by applying 2D DWT. The resulted four sub-bands are, an approximation sub-band (LLn), and three detailed subbands (HLn, LHn, and HHn).

C . Modified gabor filter

The MGF discards the prior sinusoidal plane wave assumption from Traditional Gabor Filter. Palmprint and fingerprint share some common characteristics such as creases and ridges. Other palmprint characteristics are principle lines and wrinkles. A bank of 2D Modified Gabor filters is used to filter palmprint and fingerprint images in different directions to highlight these characteristics and remove noises. In Modified Gabor filters, instead of cosine function cos (x; T) another periodic function F (x; T1, T2) is used. It is composed with two cosinusoidal functional curves with different periods T1 and T2. The parts above the x-axis consist of a cosinusoidal functional curve with a period T1 and the ones below the x-axis consist of another cosinusoidal functional curve with different period T2. A 2D Modified

Gabor filter has the following form in the image domain (x, y) as shown in (3) and (4), where x and y are pixel coordinates, and Ø is the local orientation of current pixel

D. Integration strategies

To overcome the problems faced by individual biometric recognizers of palmprint and fingerprint, a novel combination is proposed for the recognition system. The integrated system also provide anti spoofing measures by making it difficult for an intruder to spoof multiple biometric traits simultaneously

The proposed method integrates filtered images into the same domain using the following method as in (6): Where I (u, v) denotes the pixel intensity at coordinate (u, v), µ1 denotes the intensity mean, and σ denotes the intensity standard deviation. This stage is important as the filtered palmprint and fingerprint images may not share LL sub-band images and divide it into none overlapping blocks of size mXn pixels each.

E. Matching module

In matching module the result of fused fingerprint image and palmprint image are matched with database templateby using Euclidean distance, in order to provide final decision i.e. Accept/Reject user identity.

V. DATABASES AND THERE FEATURES

A. Databases and there features

ƒ P1: This is our own created database; it contains 40 palmprint images captured from 10 subjects. For each subject it contains palmprint image from right hand. All palmprint images are gray level JPEG files. ƒ F1: The database contains a total of 40 fingerprint images captured from 10 subjects. For each subject it contains fingerprint image from right hand thumb. All fingerprint images are gray level JPEG files.

VI. IMPLEMENTATION RESULTS

The performance of proposed system is to evaluate the Accept or Reject authentication. The matching score of all four images of fingerprint and palmprint images for each person areaveraged and then threshold. The threshold is set at Equal Error Rate (ERR). If matching score is greater than the ERR/threshold the user is identified as valid user otherwise the user is identified as invalid or status is rejected.Fig.2 shows performance chart of proposed system. Table I is drawn to show the performance of the system based on seven different factors i.e. universality, distinctiveness, permanence, collectability, performance, acceptability, circumvention to determine the feasibility of biometric traits in various applications[8]. Table II is drawn to show the performance of proposed fusion method as compared to the unimodal biometrics.

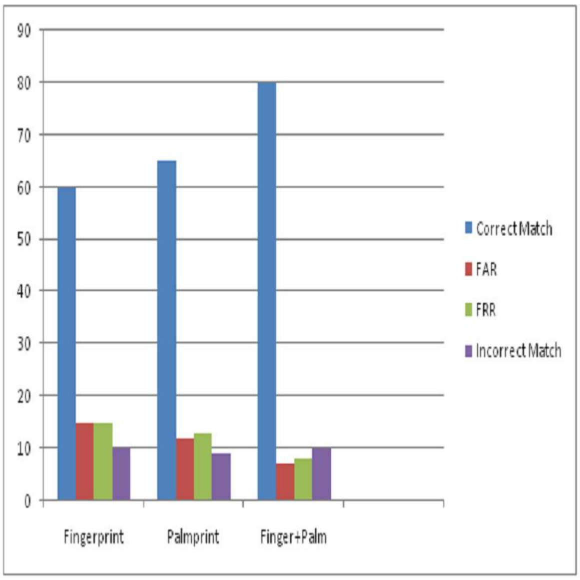

Fig. 3 Performance chart of proposed system.

Biometric Traits	Fingerprint	Palmprint	Fingerprint+Palmprint
Universality	M	M	H
Distinctiveness	H	H	H
Performance	H	H	H
Collectability	M	M	M
Performance	H	H	H
Accebility	M	M	M
Circumvention	L	L	L

TABLE I. Performance of the system
(H = HIGH, M = MEDIUM, L = LOW)

	Correct match	FAR	FRR	Incorrect match
Fingerprint	60	15	15	10
Palmprint	65	12	13	09
Fingerprint+Palmprint	80	07	08	10

TABLE II.
Performance of proposed fusion method

VII. CONCLUSION

This system formulates the multimodal biometric system. This is the proof that it is possible to improve performance by integrating multiple biometrics. This isthe novel feature level fusion method for palmprint and fingerprint biometrics. WT is applied to reduce the image resolution while retaining important palmprint and fingerprint characteristics. The proposed fusion method combines unique characteristics of palmprint and fingerprint to enable better discrimination against imposters. In addition, it requires only the same amount of memory for storage purposes. Besides that, bimodal biometrics makes it harder for adversaries to succeed in an attack as they have to spoof both biometrics simultaneously.

ACKNOWLEDGMENT

Write acknowledgements in a separate section at the end of the article before the references, if any. List here those individuals who provided help during the research.

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