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Multiple Biometric Features Extraction Using 2-D and 3-D Hand-Geometry

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Abstract Personal authentication by multiple biometric is the main purpose to identify moderate performance because the information carried is discriminatory by Two-dimensional (2-D) hand-geometry features. So it investigates a new approach to achieve performance improvement by simultaneously acquiring and combining three-dimensional and 2-D features from the human hand. Two new representations that effectively characterize the local finger surface features are extracted from the acquired range images and are matched using the proposed matching metrics. In addition, the characterization of 3-D palm surface using Surface Code is proposed for matching a pair of 3-D palms. The proposed 3-D hand-geometry features have significant discriminatory information to reliably authenticate individuals. By consolidating 3-D and 2-D hand-geometry features results in significantly improved performance that cannot be achieved with the traditional 2-D hand-geometry features alone.

Keywords: **Two-dimensional (2-D) hand-geometry features, Hand-Geometry-Based biometric systems, Feature extraction algorithm, Digital scanner.**

I. INTRODUCTION

Two-dimensional (2-D) hand-geometry features carry limited discriminatory information and therefore yield moderate performance when utilized for personal identification. This paper investigates a new approach to achieve performance improvement by simultaneously acquiring and combining three-dimensional (3-D) and 2-D features from the human hand. The proposed approach utilizes a 3-D digitizer to simultaneously acquire intensity and range images of the presented hands of the users in a completely contact-free manner. Two new representations that effectively characterize the local finger surface features are extracted from the acquired range images and are matched using the proposed matching metrics. In addition, the characterization of 3-D palm surface using Surface Code is proposed for matching a pair of 3-D palms. The proposed approach is evaluated on a database of 177 users acquired in two sessions. The experimental results suggest that the proposed 3-D hand-geometry features have significant discriminatory information to reliably authenticate individuals. Our experimental results demonstrate that consolidating 3-D and 2-D hand-geometry features results in significantly improved performance that cannot be achieved with the traditional 2-D hand-geometry features alone. Furthermore, this paper also investigates the performance improvement that can be achieved by integrating five biometric features, i.e., 2-D palmprint, 3-D palmprint, finger texture, along with 3-D and 2-D hand-geometry features, that are simultaneously extracted from the user's hand presented for authentication.

Hand-Geometry-Based biometric systems typically exploit shape features from the human hands to perform identity verification. Commonly used hand-geometry features include length, width, thickness, and area of fingers and palm. Due to limited discriminatory power of these features, hand-geometry systems are rarely employed for applications that require performing identity recognition from large-scale databases. Nevertheless, these systems have gained immense popularity and public acceptance as evident from their extensive deployment for applications in access control, attendance tracking, and several other verification tasks. History of hand-geometry biometric technology/systems dates back over three decades. It is generally believed that the hand-geometry system—Identimat developed by Identimation [23]—is one of the earliest reported implementations of any biometric system for commercial applications. Since then, the hand-geometry biometric systems have found applications in wide variety of fields ranging from airports to nuclear power plants [23].

A number of techniques for the personal verification based on hand-geometry features have been proposed in the literature. Often, users are required to place their hand on flat surface itted with pegs to minimize variations in the hand position [1]–[3]. Although such constraints make the feature extraction task easier and consequently result in lower error rates, such systems are not user-friendly. For example, elderly or people with arthritis and other conditions that limit dexterity may have difficulty placing their hand on a surface guided by pegs. In order to overcome this problem, a few researchers have proposed to do away with hand position restricting pegs [4], [8], [9], [13], [18] the feature extraction algorithm in their approaches takes care of possible rotation or translation of the hand images acquired without guiding pegs. However, users are still required to place their hand on a flat surface or a digital scanner. Such contact may give rise to hygienic as well as security concerns among users. Security concern on the contact-based approaches arises from the possibility of picking up fingerprint or palmprint impressions left on the surface by the user and thereby compromising the user's biometric traits.Moreover, most of the hand-geometry systems/techniques proposed in the literature are based on users' gray level hand images. These approaches extract various features from the binarized version of the acquired hand image. Unique information in such binary images is very limited, leading to low discriminatory power from the hand-geometry biometric systems.With the advent of advanced three-dimensional (3-D) data acquisition devices, researchers have investigated the use of 3-D features for face [15], and ear [16], biometrics. Few researchers have also explored 3-D hand/finger information for identity verification and recognition [5], [17]. The objective of this work is to further explore 3-D hand/finger geometry features and to build a robust and reliable hand-geometry system, without sacrificing user friendliness and acceptability. We investigate how much performance improvement can be achieved by combining 2-D and the 3-D hand-geometry information. In addition, we combine multiple 3-D and 2-D hand features, i.e., 3-D hand geometry, 2-D hand geometry, 3-D palmprint, 2-D palmprint, and finger texture, that can be simultaneously extracted from the acquired data and ascertain the performance improvement that can be achieved by such unified framework for hand authentication.

II. SYSTEM ANALYSIS

Project Scope:

Hand-geometry biometric technology/systems is one of the earliest reported implementations of any biometric system for commercial applications. Since then, the hand-geometry biometric systems have found applications in wide variety of fields ranging from airports to nuclear power plants. So the scope of the project is personal verification based on hand-geometry features.

Problem Definition:

The objective of this study is to achieve performance improvement by simultaneously acquiring and combining three-dimensional and two dimensional features from the human hand. The proposed approach utilizes a 3-D digital camera to simultaneously acquire intensity and range images of the presented hands of the users in a contact-free manner. The proposed approach acquires hand images in a contact-free manner to ensure high user friendliness and also to avoid the hygienic concerns. Simultaneously captured range and intensity images of the hand are processed for feature extraction and matching. Besides hand-geometry information, other hand biometric features such as 2-D palmprint, 3-D palmprint, and 2-D finger texture can also be simultaneously extracted from the acquired images.

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Existing System:

The overview of the proposed approach for biometric authentication that simultaneously employs multiple

2-D and 3-D hand features is shown in Fig 3.1. Major computational modules of the proposed approach involve image normalization (in the pre-processing stage), feature extraction and feature matching. The intensity and range images of the user‟s hand, acquired by a 3-D digital camera, are processed to locate and extract individual fingers and palm print. Feature extraction modules further process the respective Regions of Interest (ROIs) in order to extract the discriminatory features. Individual matching modules compute the matching distance by comparing the extracted features with the corresponding feature templates enrolled in the database. Multiple matching scores generated by the preceding stage are then combined at the fusion module, to obtain a consolidated match score. Finally, the decision module compares the consolidated match score with the preset threshold to determine whether the claimant is genuine or an impostor.

Proposed System:

This project presented a new approach to achieve reliable personal authentication based on simultaneous extraction and combination of multiple biometric features extracted from 3-D and 2-D images of the human hand. The proposed approach acquires hand images in a contact-free manner to ensure high user friendliness and also to avoid the hygienic concerns. Simultaneously captured range and intensity images of the hand are processed for feature extraction and matching. In order to extract discriminatory information for 3-D hand-geometry-based biometric authentication, this system introduced two representations, namely, finger surface curvature and unit normal vector. The proposed 3-D hand-geometry features explicitly capture curvature variation on the cross-sectional finger segments. Simple and efficient metrics, capable of handling limited variations in the hand pose, are proposed for matching a pair of 3-D hands.

III. MODULES DESCRIPTION

A new approach for reliable personal authentication using simultaneous extraction of 3-D and 2-D hand-based biometric features is investigated. The key advantage of the proposed approach is that it simultaneously acquires range and gray-level images from the palm side of user‟s hand and thereby offers range of features (2-D and 3-D hand geometry and finger texture) that can be simultaneously extracted and combined to achieve reliable and secure multimodal biometric authentication. The unified framework for hand identification described in this paper is evaluated on a relatively large database of intensity and range images to achieve more reliable estimates of performance for contact less hand imaging. The objective of this study is to achieve performance improvement by simultaneously acquiring and combining three-dimensional and two dimensional features from the human hand. The proposed approach utilizes a 3-D digital camera to simultaneously acquire intensity and range images of the presented hands of the users in a contact-free manner.

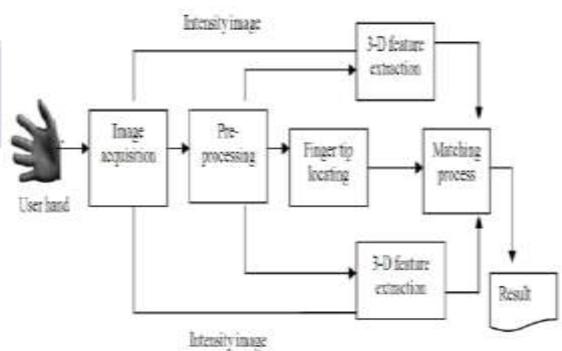

Fig 1: Block Diagram of the proposed system

Preprocessing:

The acquired intensity image is pre-processed in order to improve the clarity of the picture by removing the noises present in the image, to adjust the resolution of the image according to the requirements and finally in order to improve the over all performance rate. First in order to remove noises present in the image, it is subjected to the filter called median filter. The median filter is nonlinear digital filtering technique, often used to remove noise. Second we need to binarize the image to improve the performance rate. A binary image is a digital image that has only two possible values for each pixel. Typically the two colours used for a binary image are black and white though any two colours can be used. The gray level intensity images are first binarized using Otsu‟s thresholding algorithm.

Fig 2: Binarized image

Finger Edge Location :

Traversing the extracted hand contour, local minima and local maxima points, which correspond to finger tips and finger valleys, are located. In order to estimate the orientation of each finger, four points on the finger contour (two points each on both sides of the fingertip) at fixed distances from the fingertip are identified. Two middle points are computed for corresponding points on either side and are joined to obtain the finger orientation. Points at the center and bottom part of the finger are not considered for the estimation of orientation, as some of the fingers are found to be no symmetric at these parts. Once the finger orientation and fingertip Valley points are determined; it is a straightforward task to extract a rectangular ROI from the fingers. Similarly, based on the two finger valley points (between little-ring and middle-index fingers), a fixed ROI can be extracted. Fig. 3 shows the extracted finger edge locations.

Fig 3: Finger Edge Located Image

2-D Hand Geometry and Texture Process:

This system acquire low-resolution hand images and employ a 2-D Gabor filter-based competitive coding scheme to extract features from the 2-D hand images. The competitive coding scheme proposed in has been one of the best performing feature extraction methods. This approach uses a bank of 2-D Gabor filters to extract information. The three parameters of the Gabor filter are empirically determined to be (35, 2.6, 0.7), respectively.In Image Processing, a Gabor filter, named after Dennis Gabor, is a linear filter used for edge detection. Frequency and orientation representations of Gabor filters are similar to those of the human visual system and they have been found to be particularly appropriate for texture representation and discrimination. In the spatial domain, a 2D Gabor filter is a Gaussian kernel function modulated by a sinusoidal plane wave.

Hand-geometry features are extracted from the binarized version of the acquired intensity images of the hand. Features considered in this work include finger lengths, finger widths at equally spaced distances along the finger area and finger perimeters. The Extracted 2-D features are shown in Fig 4.

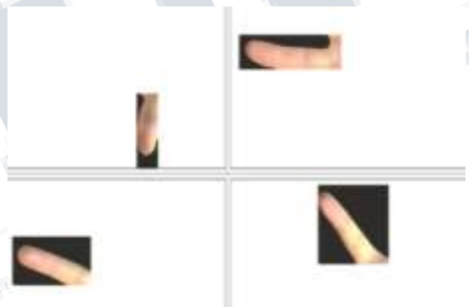

Fig 4: 2-D features of the hand image

3-D Hand Geometry and Texture Process:

The finger localization algorithm developed in the previous section is employed to locate and extract individual fingers from the acquired range images. This system uses the terms 3-D hand geometry and 3-D finger geometry synonymously as they represent features extracted from the 3-D hand data. Each of the four finger range images is further processed for feature extraction. The 3-D feature extraction approach adopted in this work is inspired by the conventional finger width features in the hand-geometry verification. For each finger, a number of cross-sectional segments are extracted at uniformly spaced distances along the finger length. The Extracted 3-D curvature of the hand image are shown in Fig 5.

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Matching Module:

In order to match hand and finger surface features, two simple but efficient matching distance metrics are introduced. The proposed metrics of using hamming distance can effectively deal with small changes resulting from hand pose variations during the imaging process. Features extracted from each of the four fingers are matched individually and then combined to obtain a consolidated match score. The Hamming distance between two strings of equal length is the number of positions at which the corresponding symbols are different. Put another way, it measures the minimum number of substitutions required to change one string into the other, or the number of errors that transformed one string into the other.

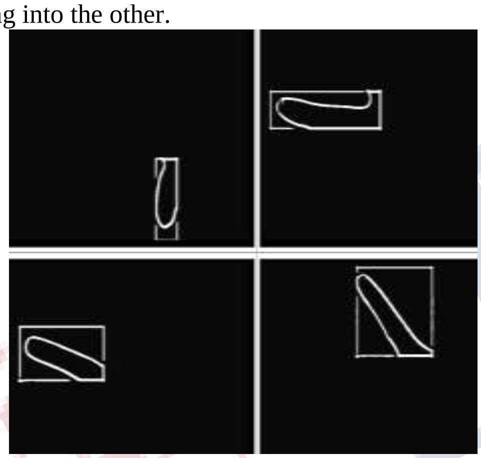

Fig 5: 3-D curvature of the hand image

IV. IMPLEMENTATION RESULTS

Fig 6: Hand Image

The acquired intensity images are first processed to automatically locate the finger tips and finger valleys. These reference points are then used to determine the orientation of each finger and to extract them from the acquired hand image. Since the acquired intensity and range images are registered, we work only on the intensity image to determine the key points and the finger orientation. The key processing steps involved in the automated extraction of fingers are illustrated in Fig. 6.

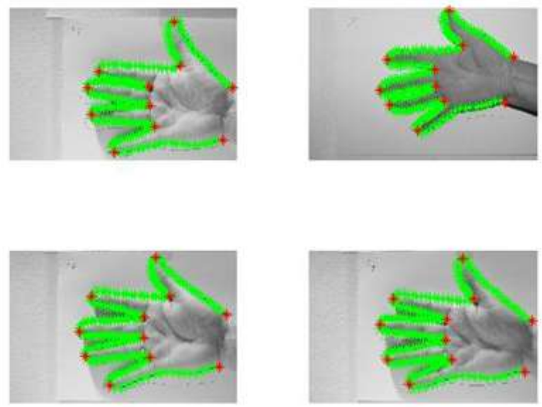

Fig 7 : Two-dimensional hand geometric features marked on a hand

Hand-geometry features are extracted from the binarized version of the acquired intensity images of the hand. Features considered in this work include finger lengths, finger widths at equally spaced distances along the finger length, finger area, palm length, and finger perimeters. Fig. 7 illustrates the hand-geometry features utilized in this work. Note that these features are similar to the ones employed in [1] and [2].

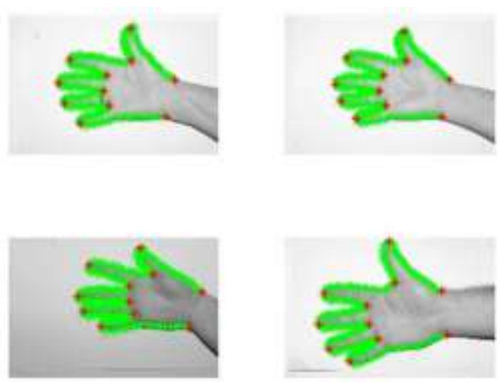

Fig 8 : Two-dimensional hand geometric features marked on different positions on hand

However, the finger width features employed in [1] and [2] require a mirror to reflect the side view of the hand on to the CCD. Since our imaging scheme does not acquire a lateral view of the user's hand, finger width features are not utilized in this work. Features extracted from individual fingers (excluding thumb) are concatenated to form a feature vector. The computation of matching distance between the template and query feature vectors is based on the simple Euclidean distance.

Fig 9 : Two-dimensional hand geometric features marked on a hand for a single sample and Rendered view of the acquired 3-D data.

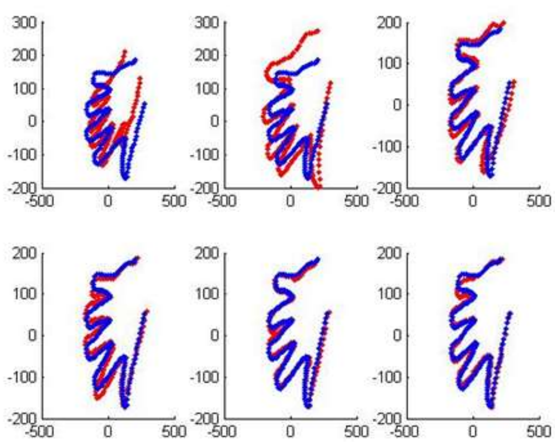

Fig 10: Preprocessing and finger

Fig 11 : Acquired intensity image

Fig 12 : Binary hand image after thresholding

V. CONCLUSION

The Project presents a new approach to achieve reliable personal authentication based on simultaneous extraction and combination of multiple biometric features extracted from 3-D and 2-D images of the human hand. The proposed approach acquires hand images in a contact free manner to ensure high user friendliness and also to avoid the hygienic concerns. Simultaneously captured range and intensity images of the hand are processed for feature extraction and matching. In order to extract discriminatory information for 3-D hand-geometry-based biometric authentication, two representations are introduced, namely, finger surface curvature and unit normal vector. The proposed 3-D hand-geometry features explicitly capture curvature variation on the cross-sectional finger segments. Simple and efficient metrics, capable of handling limited variations in the hand pose, are proposed for matching a pair of 3-D hands. A new feature representation, namely, Surface Code, for 3-D palm print which achieves better performance and results in significant reduction in template size. The results on a database of 177 subjects demonstrate that the 3-D hand-geometry features have high discriminatory information for biometric verification. In addition, the results presented in this paper further demonstrate that significant performance improvement can be achieved by combining the 3-D hand-geometry information with the 2-D hand-geometry features extracted from user's 2-D hand images. Besides hand-geometry information, other hand biometric features such as 2-D palm print, 3-D palm print, and 2-D finger texture can also be simultaneously extracted from the acquired images. Therefore, investigated the potential of integrating these hand-based features into unified framework and obtained the best performance when all of the features are combined. Although combining these hand features is a straightforward task, there is actual need to quantify the performance improvement that can be achieved by such combinations, especially in the touchless imaging setup. Moreover, all hand biometric features considered in this work can be simultaneously extracted from the acquired images with little additional cost for imaging. Therefore, it is prudent to combine all available biometric features. Slow acquisition speed of 3-D imaging device, such as Vivid 910 3-D digitizer employed in this work, limits the online usage of the proposed system for the civilian applications. This limitation can be potentially overcome by acquiring 3-D data with alternative imaging technologies, such as stereo imaging, which is part of our future work. Also, the 3-D digitizer employed in this work is quite expensive and large in size. However, customized low-cost and compact 3-D scanners can be developed(similar to the one developed for 3-D fingers in or for 3-D palm in to overcome this problem. Future work would also involve increasing the size of the current hand image database and exploring more feature sets for 3-D hand-geometry-based authentication. We are currently investigating the possibility of combining the proposed 3-D finger feature representations at the feature level. It would also be interesting to assess the vulnerability of the proposed 3-D hand-geometry approach to sensor level attacks using fabricated hand models and is suggested for future work.

At the tests the effectiveness of EHD and the dynamically parameterized HOG implementation was compared. It was examined with more databases. In our experience the HOG in more cases was much better than the EHD based retrieval. However, the situation is not so simple. The edge histogram descriptor can mainly look better for information-poor sketches, while in other case better results can be achieved for more detailed. This is due to the sliding window solution of HOG. Using the SIFT-based multi-level solution the search result list is re ned. With the categorization of retrieval response a bigger decision possibility was given to the user on that way, he can choose from more groups of results.

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