International Journal of Emerging Technology and Advanced Engineering
Website: www.ijetae.com (ISSN 2250-2459, ISO 9001:2008 Certified Journal, Volume 2, Issue 12, December 2012)

Finger Knuckle Surface Biometrics

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***Abstract*—The texture pattern produced by the finger knuckle bending is highly unique and makes the surface a distinctive biometric identifier. This paper presents literature survey for an emerging biometric identifier, namely finger-knuckle-print (FKP), for personal identification. Proposed work flow diagram is also presented. Different edge detection methods, to detect edges in knuckle image, are employed in this paper.**

***Keywords*— Biometrics, Finger knuckle, Region of Interest (ROI)**

I. Introduction

The finger-back surface, also known as dorsum of hand, can be highly useful in user identification and has not yet attracted the attention of researchers. The contact free imaging of the finger back surface is highly convenient to users. Such images can be acquired online and used to extract scale, translation and rotational invariant knuckle features for user identification [1].It is reported that the skin pattern on the finger-knuckle is highly rich in texture due to skin folds and creases, and hence, can be considered as a biometric identifier. Further, advantages of using Finger Knuckle Print (FKP) include rich in texture features, easily accessible, contact-less image acquisition, invariant to emotions and other behavioural aspects such as tiredness, stable features and acceptability in the society. Despite of these characteristics and advantages of using FKP as biometric identifier, limited work has been reported in the literature [2]. The usage of finger knuckle for personal identification has shown promising results and generated lot of interest in biometrics. However, the research efforts to investigate the utility of finger knuckle patterns for personal identification have been very limited. As a result; there is no known use of knuckle pattern in commercial or civilian applications [14]. The user acceptance for employing finger knuckle in human identification is expected to be very high as there is no stigma of personal information (such as life-line, heart-line, head-line associated with palm surface) associated with finger knuckle lines/creases [17].Proposed work is focusing on the development of an automated method for extracting finger knuckle print and knuckle features from the finger back surface and using it for personal identification purpose.

II. Literature Survey

The finger surface posses unique patterns that have been utilized in the personal identification. Woodard and Flynn (2005) [3] have examined the fine features of finger surface for its use in the biometric system. Authors have presented promising results by using curvature and a shape-based index from finger surface features extracted from finger images. For hand data collection the Minolta 900/910 sensor was used by author. However, the work detailed in [3] does not exploit the texture information that can be simultaneously extracted from the intensity images of hands. Ribaric and Fratric (2005) [4] employed appearance based features from the finger and palm surface images for personal identification. However, the authors in [4] have employed a scanner for imaging which is very slow and, hence, not suitable for online user authentication. S. Malassiotis (2006) combines finger geometry features and color information to authenticate user hands in the cluttered background. The finger shape information is generally believed to be less discriminative and only suitable for small-scale user identification [1]. Michael K.O. Goh and Connie Tee (2009) [5] employed a bimodal palm and knuckle print recognition system using inner surface of palm and finger knuckle. Authors presented a palm print and knuckle print tracking approach to automatically detect and capture these features from low resolution video stream. No constraint is imposed and the subject can place his/her hand naturally on top of the input sensor without touching any device. The palm print and knuckle print features are extracted using Wavelet Gabor Competitive Code and Ridget Transform methods. Several decision-level fusion rules are used to consolidate the scores output by the palm print and knuckle print. The work, detailed in [4] and [5] is promising but it relies on crease and wrinkle details on the palm side (inner surface) of the fingers which are quite limited. Ajay Kumar and Ravikanth (2009) [1] [18] investigates a new approach for personal authentication using finger back surface imaging. Author uses texture pattern produced by the finger knuckle bending for identification as it is highly unique and makes the surface a distinctive biometric identifier. Finger geometry features are also extracted from the same image at the same time and integrated to further improve the user-identification accuracy of such a system.

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Ajay Kumar, Yingbo Zhou (2009)[14] [17]investigate a new approach for efficient and effective personal identification using Knuckle Codes. The enhanced knuckle images are employed to generate Knuckle Codes using Localized Radon Transform that can efficiently characterize random curved lines and creases. The similarity between two Knuckle Codes is computed from the minimum matching distance that can account for the variations resulting from translation and positioning of fingers. Lin Zhang, Lei Zhang and David Zhang (2009) [6] [16] [19] constructed data acquisition device to capture the Finger Knuckle Print images, and then an efficient FKP recognition algorithm is presented to process the acquired data .The local convex direction map of the FKP image is extracted based on which a coordinate system is defined to align the images and a Region of Interest (ROI) is cropped for feature extraction. A competitive coding scheme, which uses 2D Gabor filters to extract the image local orientation information, is employed to extract and represent the FKP features. To match two FKPs, they present a Band-Limited Phase-Only Correlation (BLPOC) based method to register the images and further to evaluate their similarity. An FKP database was established to examine the performance of the proposed system. Rui Zhao (2009) [7] presents an approach which use single knuckle-print image only to implement personal identification. Unlike most previous work, there is no need to collect a large amount of images to train the classifier. Michal Choras and R.Kazil (2010) [15] evaluated texture-based knuckle features using IIT Delhi knuckle image database. G S Badrinath, Aditya Nigam and Phalguni Gupta (2011) [2] presented an Efficient Finger-knuckle-print based Recognition System Fusing SIFT (Scale Invariant Feature Transform) and SURF (Speeded up Robust Features) Matching Scores. Corresponding features of the enrolled and the query FKPs are matched using nearest-neighbour-ratio method and then the derived SIFT and SURF matching scores are fused using weighted sum rule. Lin Zhang, Lei Zhang, David Zhang, Hailong Zhu (2011) [8] proposed Ensemble of local and global information for finger–knuckle-print recognition. Shoichiro Aoyama, Koichi Ito and Takafumi Aoki (2011) [9] proposed Finger-Knuckle-Print (FKP) recognition algorithm using Band-Limited Phase-Only Correlation (BLPOC)-based local block matching. The phase information obtained from 2D Discrete Fourier Transform (DFT) of images contains important information of image representation. The phase-based image matching, especially BLPOC-based image matching is successfully applied to image recognition tasks for biometric authentication applications.

To calculate the matching score, the proposed algorithm corrects the global and local distortion between FKP images using the BLPOC-based local block matching. Zhao Rui, Lv Tao, Hou Shunyan, Shi Jianying (2011) [10] proposed a novel approach of Personal Identification based on the Fusion of Multifinger knuckle prints. Author's research work involves extracting and matching the knuckle print's line feature, fusing of the matching scores of the multi-finger knuckle prints to get the total matching score and then certifying the identity of the user.

III. PROPOSED METHODOLOGY

Figure 1 represents work flow diagram for proposed Knuckle Surface Identification.

a) Finger image acquisition

The backside of finger is to be acquired using digital camera.

b) Localization of Region of Interest (ROI)

Each of these images requires localization of region of interest for the feature extraction. The region of interest is the region having maximum knuckle creases. It is necessary to construct a local coordinate system for each FKP image. With such a coordinate system, an ROI can be cropped from the original image for reliable feature extraction and matching.

c) Extracting Segmented Finger Knuckle Image

The Region of Interest is to be automatically extracted using the edge detection based approach. This gives segmented finger knuckle image.

d) Knuckle Image Enhancement

The finger surface is highly curved and results in uneven reflection which also generates shadow. The knuckle images therefore have low contrast and uneven illuminations. These undesirable effects are to be reduced using image enhancement techniques.

e) Knuckle Feature Extraction

The enhanced knuckle image mainly consists of curved lines and creases. Knuckle curved lines and creases are to be detected. Knuckle features are then extracted.

f) Database Establishment

In order to evaluate the proposed FKP identification an FKP database is to be established by collecting finger back images of various users.

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g) Feature Matching

Algorithms are to be employed for the matching of two knuckle features.

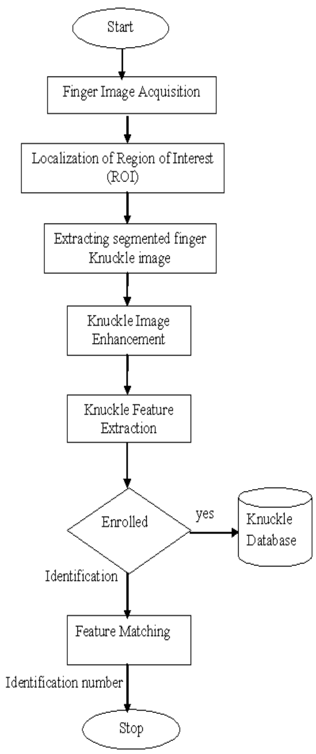

Figure 1. Flowchart for proposed research work

IV. Image Acquisition And Edge Detection

Finger back image is acquired using inbuilt web camera. Then Sobel, Canny, Robert edge detection methods are applied on finger back image. Result of edge detection is as given in Figure 3, 4 and 5. Canny edge detection is found suitable to recognize weak edges of finger back surface. This edge information will further be used to extract Region of Interest.

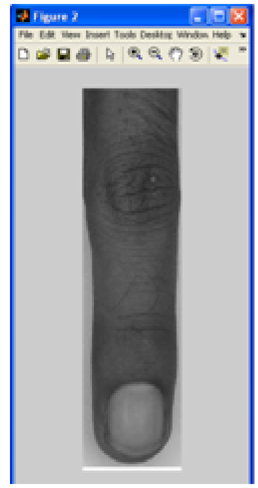

Figure 2. Finger Back Image

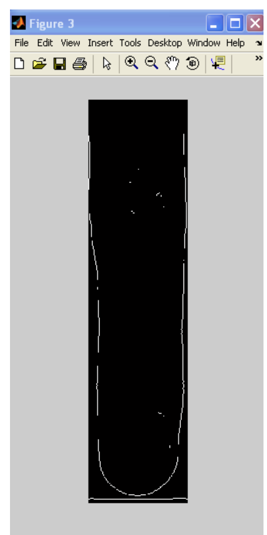

Figure 3. Edge Detection using Sobel

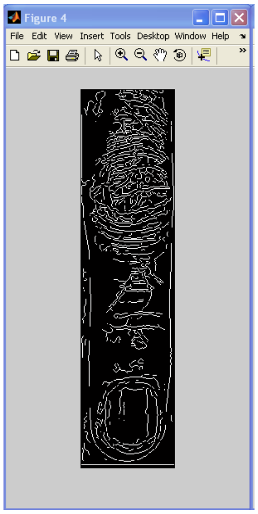

Figure 4. Edge Detection using Canny

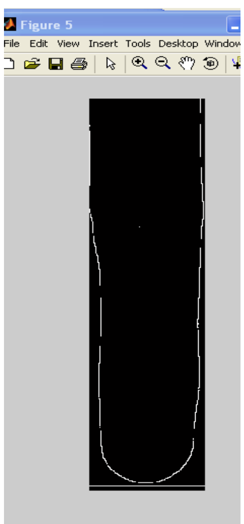

Figure 5. Edge Detection using Robert

V. CONCLUSION

This paper proposes contactless, cost effective and user friendly finger knuckle surface based biometric identifier for personal identification. Unlike most previous work, this approach uses single knuckle print image and it need not require collecting large amount of knuckle images. It is efficient approach as it requires less computation and processing time.

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