RECOGNITION OF HUMAN IDENTITIES USING ENHANCED KNUCKLE PATTERN FEATURES

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Abstract: This paper introduces to recognize the human identities using finger knuckle image. The texture pattern of the finger knuckle is highly unique and makes the surface an idiosyncratic biometric identifier. In our proposed system gets the major finger knuckle and minor finger knuckle images and combines these two images by addition pixels of images. The use of combined major and minor knuckle image employs to improve the performance over usual finger knuckle identification. The major and minor finger knuckle patterns are formed on the surface joining proximal phalanx, middle phalanx and distal phalanx. This biometric identification is extended with region of interest segmentation, image enhancement and feature extraction then matching. The feasibility of this approach is thoroughly evaluated on a publically available finger dorsal database from several subjects and achieves highly accurate results.

Keywords: Major finger knuckle, Minor finger knuckle, Addition, Biometrics, Finger dorsal image.

1. INTRODUCTION

The rapid growth of technology into the daily life requires consistent user identification for effective and protected access control. Biometrics authentication is to identify the individuals using physiological or behavioral characteristics. It provides better security and greater convenience than other authentication. This paper is focusing on the development of an automated method for extracting finger knuckle features from the finger dorsal image (shown in Fig.1) and using it for personal identification. This paper investigates automated biometric authentication using knuckle pattern in finger dorsal image which is the back surface of the finger. In this authentication, the combined form of major and minor finger knuckle patterns are used as a biometric identifier. The major and minor finger knuckle patterns are combined by adding these two images. The skin pattern on the finger-knuckle contains highly unique texture formation due to skin folds and creases. Major Finger Minor finger Knuckle

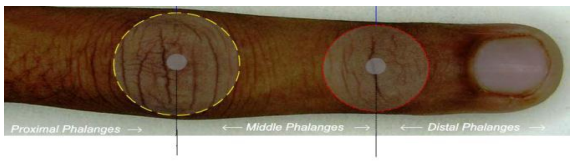


Figure 1: Finger Dorsal Image

Further, advantages of using finger knuckle patterns include unique texture features, easily accessible, independent to emotions and other behavioural aspects such as tiredness and high social acceptability. It is increasingly mapped to new civilian applications for commercial use. It also used in large scale user authentication. In forensic department, it is one of the evidences available to identify the suspects. No information is obtained regarding fingerprint or any other biometrics is present in the available photographs. But, the finger knuckle image in the photograph is used to identify the suspects. In each finger in human hand consists of 3 bone segments and 3 joints except thumb. The thumb finger has 2 bone segments and 2 joints. These segments are called as phalanges (Plural form of phalanx). The fore finger and little finger have very high mobility and agility. The ring finger is the stiffest one. Even though peg free imaging; it is highly inconvenient to users. The middle finger consists of high surface area and stability. It provides best performance when compared to other fingers. Previously biometric identification is done using minor finger knuckle pattern which provides better recognition accuracy. Even though, it gives better results, combined major and minor finger knuckle pattern employed to improve the performance and accuracy of conventional major or minor finger knuckle based biometric identification.

Woodard and Flynn [1] established the use of 3D finger dorsal images for personal identification. The local curvature patterns on the finger dorsal surface divided into various shape indexes for the consistent matching. In this identification different edge detection technique is used to detect the weak edges in the knuckle image. Several publications exploited the usefulness of finger knuckle patterns using contactless imaging [1], [2], [4], [5]. These references are oppressed major finger knuckle images which are formed by joining proximal phalanx and middle phalanx bones. Kumar [6] successfully demonstrated the use of minor finger knuckle pattern which is formed on the finger back surface joining distal phalanx and middle phalanx bones in the finger back surface. In our knowledge, no one used the combined image of major and minor finger knuckle pattern for personal identification.

1.1 Proposed System

Our proposed exploits the finger knuckle pattern for authentication. In the existing system iris, voice, face, gait etc., are used for biometric identification. Each and every biometric identifier has interference during identification. The finger knuckle pattern has no interference. Based on accuracy, cost, social acceptability the knuckle biometric identifier is compared with existing biometric identifiers and the results shown the knuckle biometric key gives promising results. The block diagram of proposed system is given below.

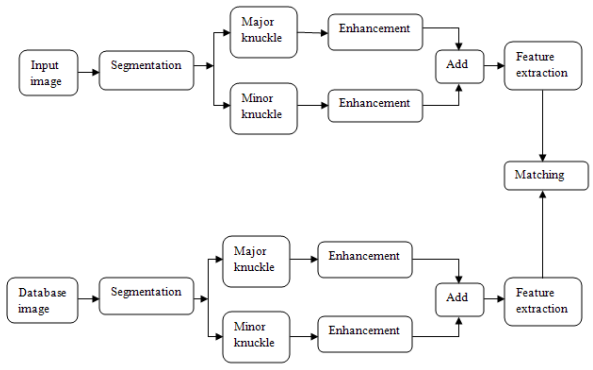
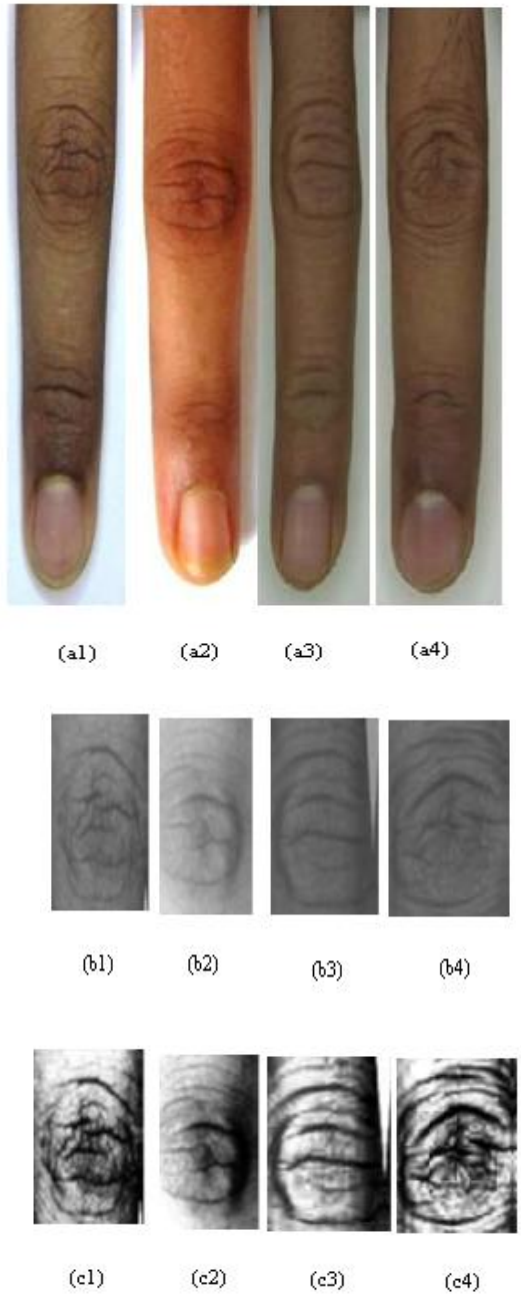


Figure 2: Block diagram of proposed scheme

2. SEGMENTATION AND ENHANCEMENT:

Image segmentation is the process of partitioning an image into many parts of images which contains groups of pixels. Those groups are uniform with respect to some criterion. Region of interest segmentation is used to split the image into set of regions. Regions in an image are a group of connected pixels with similar properties. The segments obtained by this segmentation have a relatively large no of pixels. It offers several advantages over conventional segmentation techniques.



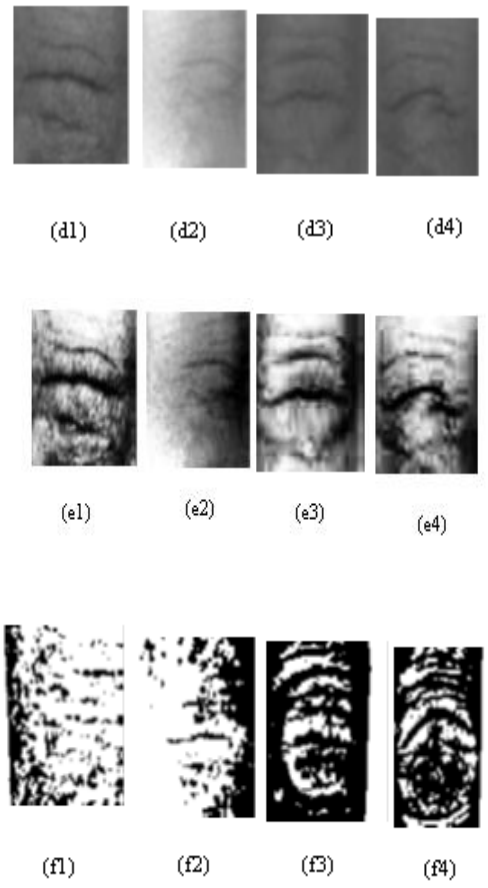


Figure 3: Finger dorsal images in (a1-a4), corresponding segmented major finger knuckle images in (b1-b4) and enhanced images in (c1-c4), segmented minor finger knuckle images in (d1-d4) and enhanced images in (e1-e4), combined major and minor finger knuckle images in (f1-f4).

The borders and regions found by this method are perfectly thin and connected. The algorithm is very stable with respect to noise. It is also simple one and is applicable with respect to multiple criterions. The region of interest is the region which has maximum knuckle creases. Region of interest segmentation is used to segment the fixed size of images with respect to given size. Using this segmentation technique, the ROI set is cropped from the original image automatically for reliable feature extraction and matching. The major and minor finger knuckle patterns are extracted from the finger dorsal image. The segmented major and minor finger knuckle is shown in figure.2 (b1-b4) and (d1-d4) respectively.

2.1 Image Enhancement

Enhancement is the image processing technique which is used to improve the contrast in the image. The finger surface is the 3D surface consists of creases and curves. The curves in the image produce uneven illumination and reflections (which generate shadows) in the image. To normalize that image enhancement techniques are used. An enhancement algorithm is used to get a better quality image and is employed to emphasis, sharpen or smoothen image features for display and analysis. Adaptive histogram equalization is used to improve the visual quality of the image. The illumination is eliminated by redistribute the lightness in the image. After enhancement technique, the enhanced major and minor finger knuckle patterns are obtained and are shown in fig.2 (c1-c4) and (e1-e4).

2.2 Thresholding

Thresholding is used to partition the foreground from the background. The enhanced knuckle image contains curved lines and creases which are used for feature matching. Otsu's thresholding technique is used to extract the curved lines and creases from the enhanced image.

2.3 Combining major and minor knuckles

The major and minor knuckle image is fused by adding corresponding pixels in the two images. Adding two images is simpler and straightforward computation. The size of the major finger knuckle and minor finger knuckle is different. The minor finger knuckle resized with respect to major finger knuckle. The combined image of major and minor finger knuckle pattern gives high matching performance when compared to either using major or minor finger knuckle pattern. The combined image of major and minor finger knuckle pattern is shown in fig.2 (f1-f4). The combined image is obtained using the following equation,

$$C(i, j) = \sum_{i=0}^{n} \sum_{j=0}^{n} (Pma + Pmi)$$

Where C (i, j) is the combined image, Pma and Pmi are major and minor pixel value respectively.

3. FEATURE EXTRACTION

Feature extraction is transformed the input data into set of features. The required features are extracted from the input image for reliable matching. Several features are available in feature extraction. Features extracted from the combined image is the following

3.1 Local Binary Patterns

Local binary pattern is one of the efficient texture operators which represent the multi scale texture in the knuckle pattern. The centre pixel and neighbouring pixel is represented as Pc and Pn respectively. The binary pattern computed as,

$$h(z) = \begin{cases} 1, & Pc > Pn \\ 0, & Pc <= Pn \end{cases}$$

Using the binary pattern the mean value is computed by the following equation,

$$LBP\ (mean) = \sum_{l=0}^{L-1} h(z) 2^{l}$$

Where L is the total number of pixels in a local region and l = 0, 1, 2... L − 1. The LBP knuckle images are used to generate LBP descriptors using local histograms. From each local region, the histogram information is obtained that is concatenated to extract the LBP descriptors.

3.2 Gabor filter

The local phase information is extracted from the enhanced knuckle image. In Gabor filter the impulse response is calculated by using convolution of its harmonic function and Fourier transform of Gaussian function. The knuckle features extracted without using any pre-processing steps in Gabor filter. The mean value is computed by using the following equation,

$$G(x, y) = e^{\left(-\frac{x^2+y^2}{\delta^2}\right)} * k$$

K= Where δ is the filter size.

4. MATCHING AND RESULTS

Features are extracted from the knuckle image using above feature extraction. Matching is done using features which are extracted from the input image and database image. The knuckle image gives the information which contains local and global features.

The features are same in the authorized knuckle images and are unequal in the unauthorized knuckle image. The advantage of using local binary pattern and Gabor filter are used to improve the matching performance. The features extracted from the minor knuckle, major knuckle and combined of these two images in a finger dorsal surface are shown in table.1

Table 1: Features value of a single finger dorsal image

Finger Surface	LBP Features	Gab or Filter
Major Knuckle	107.091	68.147
Minor Knuckle	95.772	73.657
Combined Image	17.271	0.372

5. CONCLUSION

This paper has investigated the new approach of biometric authentication using finger knuckle pattern. It also employs combined major and minor finger knuckle image as biometric identifier. The simultaneous use of major and minor finger knuckle gives high matching accuracy.

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