Verifying Human Identities using Major and Minor Finger Knuckle Pattern

Shubhada Jaywant Sonawane
Student, Computer Science and Engineering,
G.H.Raisoni Institute of Engineering and Management,
Jalgaon, India.

Prof. Ganesh Dhanokar
Assistant Professor, Computer Science and Engineering,
G.H.Raisoni Institute of Engineering and Management,
Jalgaon, India.

Abstract: This paper investigates a new approach for personal authentication using fingerback surface imaging. The texture pattern produced by the finger knuckle bending is highly unique and makes the surface a distinctive biometric identifier. The finger geometry features can be simultaneously acquired from the same image at the same time and integrated to further improve the user-identification accuracy of such a system. The fingerback surface images from each user are normalized to minimize the scale, translation, and rotational variations in the knuckle images. This paper details the development of such an approach using peg-free imaging. The experimental results from the proposed approach are promising and confirm the usefulness of such an approach for personal authentication.

Keywords: Finger Biometric, Finger Knuckle Methodology, Pattern Recognition Algorithm, Finger Knuckle

I.　INTRODUCTION

Personal authentication is a common concern to both industries and academic research due to its numerous applications. Biometrics can be used to distinguish between individuals based on their inherent physical and behavioral characteristics and hence can serve as an ideal solution to this problem. In the past three decades, many biometric characteristics have been investigated, including fingerprint, face, iris, retina, palm-print, hand geometry, voice, gait and signature, etc [1].

Recently, it has been noticed that the textures in the outer finger surface has the potential to do personal authentication. Woodward et al. [2] used the 3D range image of the hand to calculate the curvature surface representation of the index, middle, and ring fingers for similarity comparison. In [3], Ravikanth et al. applied the subspace analysis methods to the finger-back surface images for feature extraction and person classification. The above works made a good effort to validate the uniqueness of biometric features in the outer finger surface; however, they did not provide a practical solution to establishing an efficient system using the outer finger surface features. In addition, the method [2] mainly exploits the 3D shape information of finger back surface but does not fully use the texture information; while the subspace analysis methods used in [3] may not be able to effectively extract the distinctive line and junction features in finger back surface. In palm print recognition, the features used for matching are the principal lines and wrinkles. Actually, the outer surfaces of finger joints have even more obvious line features than the palm surface, while they have much smaller area than the palm surface. This motivates us to propose a new biometric technique — the finger-knuckle print (FKP), which refers to the image of the outer surface of the finger phalangeal joint. Using ten fingers and two iris images unique identification of ~1.2 billion population is ambitious project. Among the many authentication systems that have been proposed and implemented, finger knuckle biometrics is emerging as the full proof method of automated personal identification. Similar to fingerprint, these dermal patterns are formed at birth and they will not change throughout the life of a person. These line features are reliable and they can serve as unique personal identifier. Moreover, these line textures are clearly visible on the hand's upper surface and they can be captured using relatively inexpensive low-resolution device.

Shubhada et.at., *International Journal of Science Technology Management and Research*
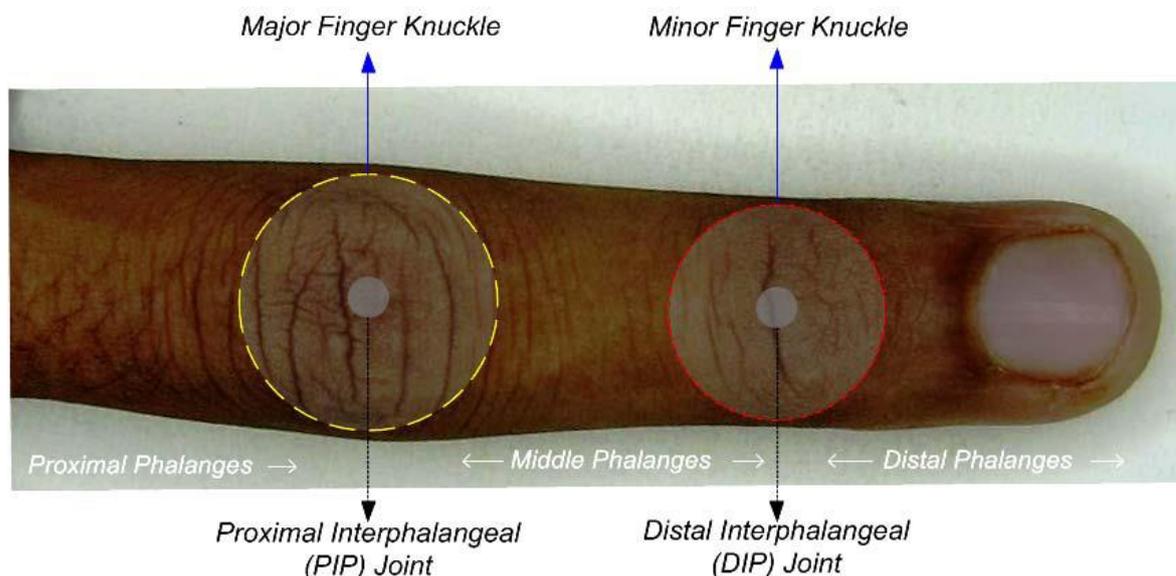*Volume 1 , Issue 4 , July 2016*
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Fig.1 Sample knuckle image

Accurate identification of finger knuckle patterns can be beneficial for several applications involving forensic and convert identification of suspects. There are several classes of forensic images in which the finger knuckle patterns are the only piece of evidence available to identify the suspects. There are some examples like kidnapping, sexual/physical assault where the cameras are unable to track the face/finger print of the suspect, in that case the finger knuckle pattern is the only or major source of information available to scientifically ascertain the identity of individuals.

II. NEED OF SYSTEM

There are many different types of Biometrics, these are, IRIS Identification, Retinal Identification, Face Recognition, Voice Recognition, Fingerprint, Hand/Finger Geometry, Signature verification, Keystroke Dynamics, and other esoteric biometrics. Hand-based biometrics, such as fingerprint and hand geometry, is the most prevalent biometric system in the marketplace.

However, fingerprint suffers from a major drawback, which is its proneness to anti-security threats, such as the reproduction of fingerprints left on surfaces to deceive the system. On the other hand, the hand geometry features are not descriptive enough for identification when the number of users grows larger. Problem related to other identifiers are as human voice and signature can be copied, duplicates are available so face recognition will not be foolproof identifier.

Palm print and finger print can be simultaneous extracted from the palm side which can give better performance improvement, but size of finger knuckle is very small as compared to palm print and offers more attractive alternative as it requires less processing as compared to palm print. These biometric identifier systems can cause problem in children and adults.

Many concepts are proposed to explore an alternative way to utilize the major knuckle print for human identification. This biometric system implementation is contactless and peg-free and free from factors like tiredness etc. which causes problem in other biometric identifiers. But in some humans the major knuckle pattern of finger can be occluded by hair and there are some cases where only the minor knuckle portions are visible in forensic images. By considering this problem, now need to utilize the major and minor portions simultaneously.

III. PATTEREN RECOGNITION METHODS

There have been several promising efforts in the literature to exploit finger knuckle image pattern images for the automated personal identification. This paper deals with recognition of the system, which involves the finger knuckle extraction and recognition of the knuckle surface by using artificial neural network. Biometrics authentication is an effective method for automatically recognizing a person's identity. There are many different approaches and algorithms in implementing for finger knuckle print identification system. In this work, the process for FKP identification system can be divided into the following different stages:
• Image acquisition
• Feature extraction
• Database Establishment
• Identification
In this system, there are two main parts: Registration and Identification.

Shubhada et.at.,　　　　*International Journal of Science Technology Management and Research*
Volume 1 , Issue 4 , July 2016
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A. Image Segmentation and Normalization

Accurate personal identification using minor finger knuckle patterns will require accurate segmentation of region of interest images. The segmentation approach should be able to generate normalized and fixed size region of interest images from the finger dorsal images of subjects under varying age group. In absence of any fixation pegs or the finger docking frame, the acquired finger dorsal images illustrate fingers with varying poses, locations and scale changes. In addition, the varying length of fingers, finger-widths, finger-nails, skin pigmentation and location of distal interphalangeal points, poses severe challenges to exploit any anatomical characteristics of fingers for robust minor finger knuckle segmentation. Figure 2 illustrates simplified block diagram for the finger knuckle segmentation strategy attempted in this work to segment fixed size minor finger knuckle images. Each of the acquired images is firstly subjected to binarization[8] using Otsu's thresholding. The resulting images are cleaned (denoised) by automatically removing the isolated regions/pixels (< 100 pixels) so that the longest object representing finger is only retained. The binarized finger shape is used to estimate the location of finger-tip from the convex hull of the images. The location of finger-tip is utilized to eliminate the background image above the finger-tip. The orientation of fingers is then estimated from this binarized image using the methods of moment, similar to as also employed in [5]. This step is followed by the coarse segmentation which segments a small portion of acquired finger images that can include minor finger knuckle region while excluding major knuckle region and major part of finger nail. Such segmentation strategy requires some crude assumptions for the maximum ratio of nail length to the finger length and assumption that the major finger knuckle region is located somewhere in the middle of the acquired finger dorsal image. The resulting coarsely segmented image is further subjected to nail check and removal steps which consist of segmenting the image and locating the bonding box region for smaller parts and removing them. The width of the resulting image is computed and used to estimate the scale factor for the scale normalization. The edge detection of resulting image is used to locate the center of minor finger knuckle image. This is achieved by estimating the location of the centroid for the resulting edge detected image and segmenting a fixed size region (160×180 pixels) that represents minor finger knuckle region for the finger dorsal image.

B. Feature Extraction and Matching

The finger knuckle images after enhancement typically represent some random texture pattern which appears to be quite unique in different fingers. Therefore a variety of spatial and spectral domain feature extraction strategies can be pursued to ascertain the matching accuracy from the minor finger knuckle images. The experimental results in this paper have employed local binary patterns [4], improved local binary patterns [5], band limited phase only correlation [8] and 1D log-Gabor filter based matchers [6], [7] for the performance evaluation. These matchers are briefly described in the following.

Local Binary Patterns

The local binary patterns (LBP) encoding can acquire local knuckle patterns and also represent multi-scale texture appearances.
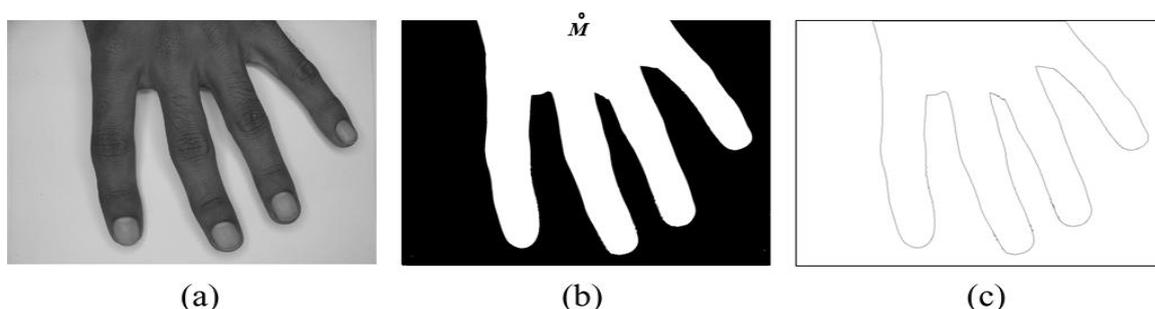

Fig. 2 Acquired image in (a), binarized image in (b), and the extracted contour image in (c).

The contour pixels, as shown in Fig. 2 (c), from the shape boundary are stored in a vector called (border pixel vector). The midpoint of the palm-wrist is marked as [Fig. 2 (b)] and used for image normalization. The Euclidean distances between the points and are computed and the resulting distance distribution diagram is illustrated in Fig. 3. The pattern in the distance distribution (Fig.3) is quite similar to the shape of the hand. The local minima correspond to the valleys of the hand. The extreme base points of the hands, shown as and in Fig. 4, are located from the shortest distance of the pixel in the contour of the image from the adjacent valley points. Therefore, the point is located by calculating the shortest distance from (located from the contour distance in Fig. 3) among the first few points. Similarly, the point is located by using the initial dip points are computed as the midpoint of these valley points. Thus, for the middle finger shown in Fig. 4, the initial dip point is estimated as the midpoint of and (marked as a dot).

Shubhada et.at.,

International Journal of Science Technology Management and Research
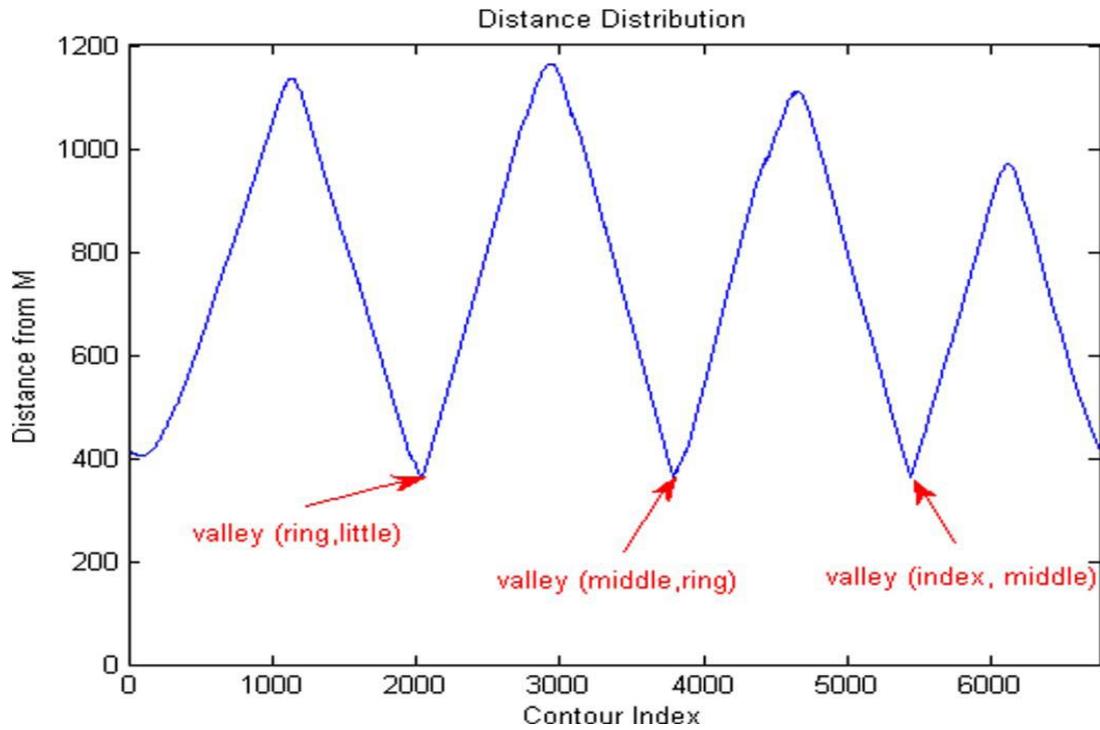*Volume 1 , Issue 4 , July 2016*
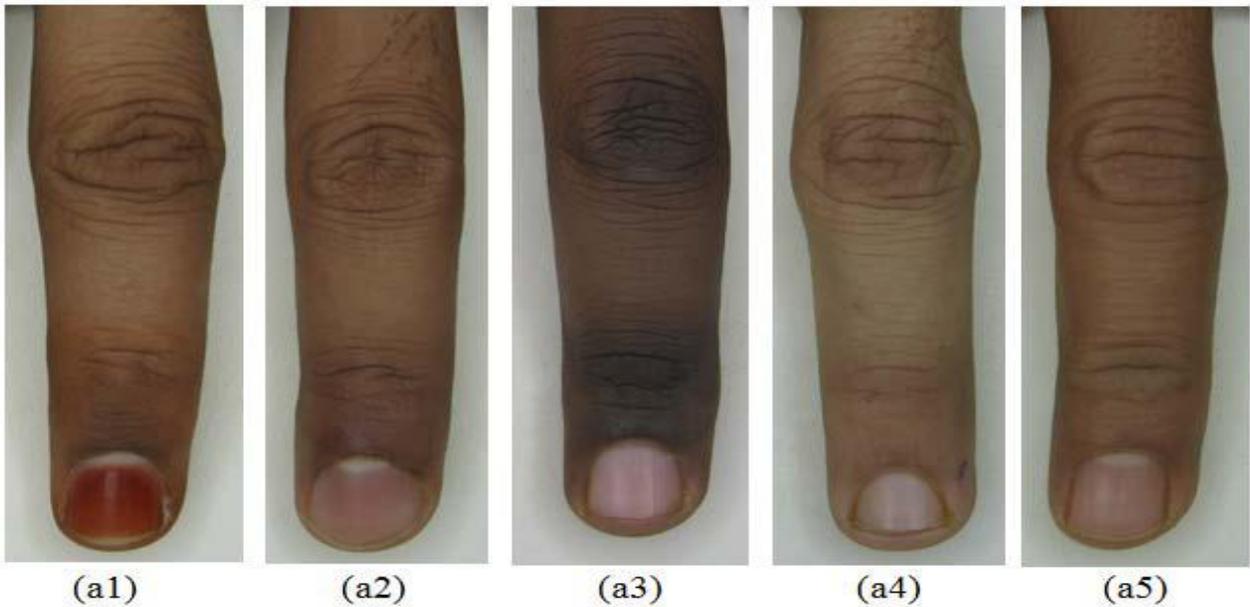**www.ijstmr.com**

Fig. 3. Distribution of the contour distances from the center point.

Next, the base points of each finger (and) are determined from the points of which are at a minimum distance from the initial dip point of that corresponding finger. The dip point of the finger is updated as the midpoint of the base points of the finger and shown as DIP in Fig. 4 for the middle finger. Next, the contour pixels between the base points of the finger are divided into six parts for the calculation of widths. The midpoint of the base points along the border of the finger is marked as the finger tip.

(a1) (a2) (a3) (a4) (a5)

Shubhada et.at.,

International Journal of Science Technology Management and Research
Volume 1 , Issue 4 , July 2016
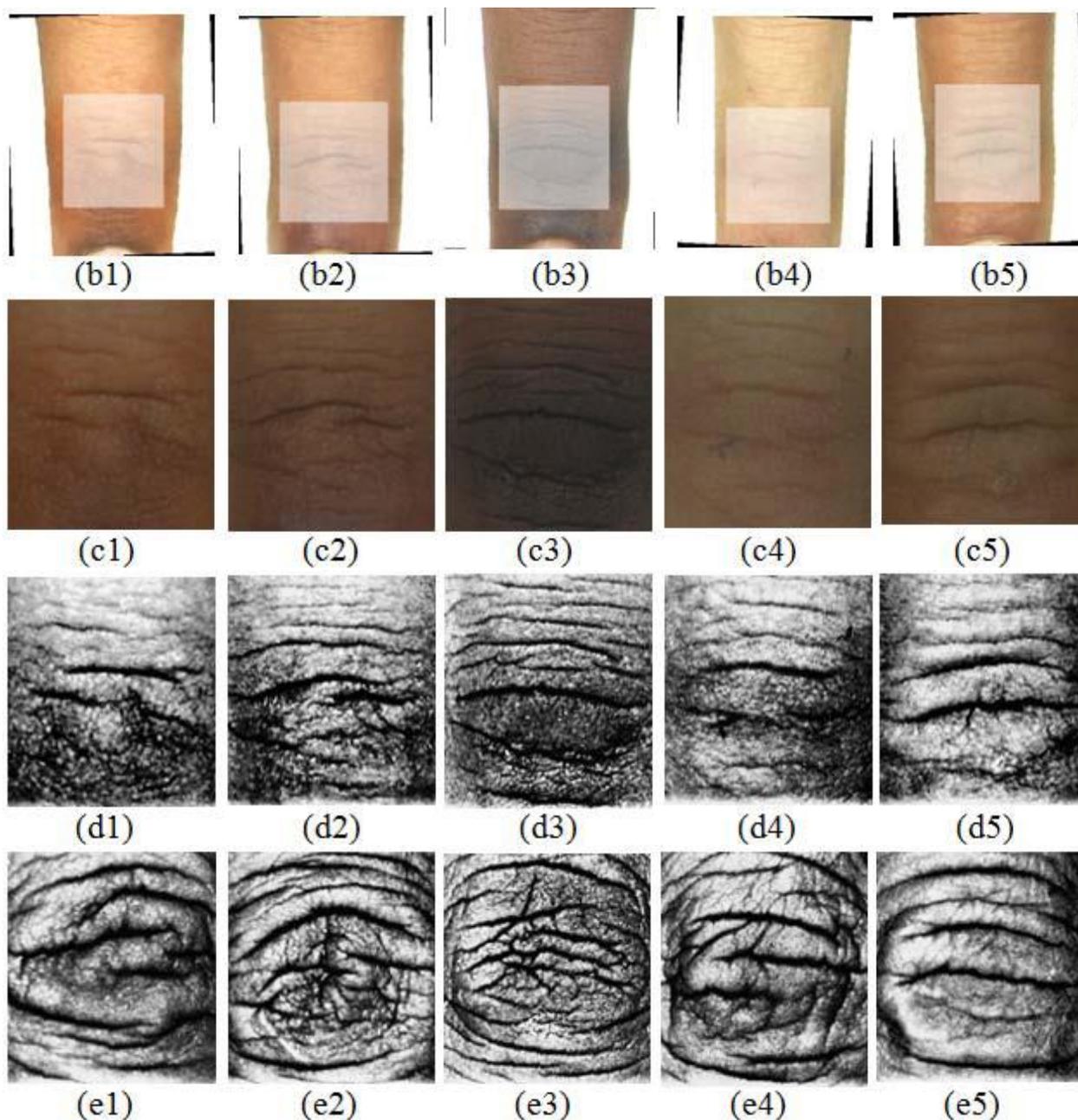**www.ijstmr.com**

Fig.4. Finger dorsal images in (a1)–(a5), corresponding minor finger knuckle region identified for segmentation during fine segmentation in (b1)–(b5), segmented minor finger knuckle images in (c1)–(c5), images after enhancement in (d1)–(d5), respective segmented and enhanced major finger knuckle images in (e1)–(e5).

Image Enhancement

The finger dorsal surface is a 3D curved surface and such curves can result in uneven illumination reflections and shadows. Therefore the segmented minor finger knuckle images often have low contrast and illumination variations. The enhancement steps are essentially required to normalize such illumination variations. The illumination normalization approach used in this work is same as also used in. This approach firstly estimates the average background illumination in the 16×16 pixels sub-blocks of the segmented knuckle images. The estimated illumination is then subtracted from the original knuckle image to remove the uneven illuminations. The resulting image is then subjected to the histogram equalization operation which generates enhanced minor finger knuckle image for the feature extraction stage.

Shubhada et.at.,

International Journal of Science Technology Management and Research
Volume 1 , Issue 4 , July 2016
www.ijstmr.com

IV. PROPOSED SYSTEM

The use of finger knuckle images for the biometric identification has generated increasingly interest in the literature. The unidirectional bending of fingers is primarily responsible for generating skin pattern alterations on the finger dorsal surface joining the four phalanx bones. The minor knuckle patterns of finger are formed on the surface joining distal phalanx and middle phalanx bones and can also be quite distinctive for biometric identification. We proposed this project to examine biometric identification capability for humans using such minor knuckle of finger images and will apply an effective algorithm for the automated segmentation of region of interest, image normalization, enhancement and robust matching to accommodate inherent image variations.

We proposed to investigate the possibility of using minor knuckle patterns of finger for human identification. This idea aims to develop a completely automated scheme to simultaneously segment minor and major knuckle images of finger from contactless finger dorsal images. We can achieve significant improvement in performance by using combination of simultaneously acquired minor knuckle pattern of finger and major knuckle pattern of finger image, which is not possible by using major knuckle images of finger alone finger-tip.

The orientation of fingers is then estimated from this binarized image using the methods of moment. Then coarse segmentation is done in which segments a small portion of acquired finger images that can include finger knuckle region major part of finger nail. Such segmentation strategy requires some assumptions for the maximum ratio of nail length to the finger length and assumption that the major finger knuckle region is located somewhere in the middle of the acquired finger dorsal image. Then nail check and removal steps are done with resulting image which consist of segmenting the image and locating the bonding box region for smaller parts and removing them. The width of the resulting image is computed and used to estimate the scale factor for the scale normalization. The edge detection of resulting image is used to locate the center of minor finger knuckle image.

In addition with this the different length, width of fingers, finger-nails, skin color and location of distal interphalangeal points, poses severe challenges to exploit any anatomical characteristics of fingers for robust minor finger knuckle segmentation. Each of the acquired images is firstly subjected to binarization using thresholding. The resulting images are cleaned (denoised) by automatically removing the isolated regions/pixels so that the longest object representing finger is only retained. The binarized finger shape is used to estimate the location of finger-tip from the convex hull of the images.

(a) This knuckle identification investigates the possibility of using minor finger knuckle patterns for human identification. A completely automated scheme to simultaneously segment minor and major finger knuckle images from contactless finger dorsal images is developed. Combination of simultaneously acquired minor finger knuckle pattern and major finger knuckle pattern images can achieve significant improvement in performance, which is not possible by using major finger knuckle images alone as in the literature.

(b) Lack of any systematic study to ascertain stability of knuckle patterns raises several questions on the possible use of finger knuckle patterns in image forensics for law enforcement and civilian applications. This paper therefore also presents a/first study (also publicly providing such images for further investigation) to ascertain the stability of knuckle pattern in finger dorsal images acquired over the interval of over 6 years. Such study is especially important for forensic analysis of those images in which finger knuckle is the only piece of evidence available to identify the suspects.

(c) This provides first publicly available database on minor knuckle images (also major finger knuckle images), from 503 different subjects. In the best of our knowledge this will be largest subject's database available to-date in public domain and help to advance further research efforts in this area.

FKP and finger vein which is actually provide high level security to identifier. Finger-knuckle-print (FKP), the image pattern of skin present on the back surface of finger. Compared with fingerprint, FKP is not so popular.
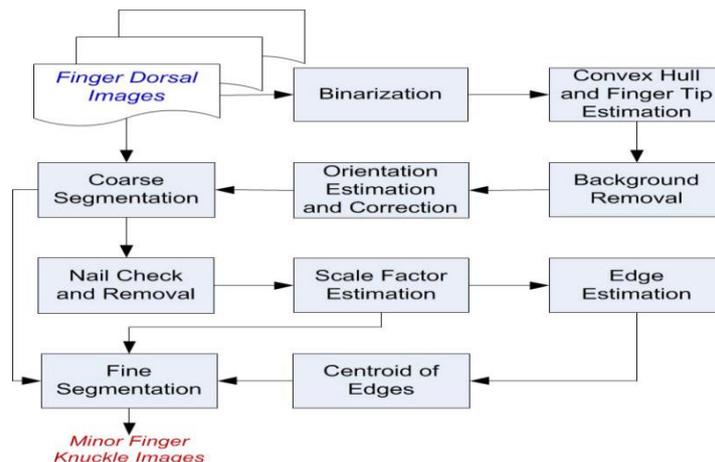

Fig. 5 Block Diagram of proposed work

Shubhada et.at.,   *International Journal of Science Technology Management and Research*
Volume 1 , Issue 4 , July 2016
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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. The proposed method improves security and improved efficiency in comparison traditionally used biometric identification.

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