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Finger Knuckle Feature Extraction using Radon like Features

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ABSTRACT

It has been observed that texture pattern produced by finger knuckle surface is highly distinctive and can be used as new biometric identifier .Also the use of finger back knuckle surface image for personal identification has shown promising results in last few years. In this paper, a new approach for extracting knuckle features using Radon like features (RLF) is proposed. Radon-Like features, allows for aggregation of spatially distributed image statistics into compact feature descriptors. Radon like features impart on the casting 2D line segments across the image plane, Radon-like features are more general and aggregate image statistics (geometric or textural) along a segment. In the proposed work RLF method is employed to enhance the input knuckle images. Experiment is carried out using IIT Delhi finger knuckle database version 1.0.Features extracted using the above technique may further be used for classification of knuckle images.

Keywords

Biometrics, Radon like Feature (RLF), Knuckle, Edge Based Contrast Measurement (EBCM)

1. INTRODUCTION

Biometrics is the discipline of recognizing a person's identity based on their physical or bevavioural characteristics, has attracted much attention in the recent decade due to its numerous applications. Researchers have broad scope in searching new kinds of biometric identifiers. Hand-based biometrics has attracted lot of attention for personal identification by using palm print, hand geometry, 3-D finger geometry and hand vein. But these systems have certain drawbacks. Palm print recognition systems have not yet been deployed for civilian applications (e.g., access control), because of its large physical size. The hand geometry systems also have large physical size, so they cannot be easily embedded in existing security systems. The pattern of blood vessels hidden underneath the skin is quite distinct in individuals, even among identical twins and stable over long period of time. But this could not be primarily used because it is very expensive system compared to other biometric systems. Also it is not adopted due to lack of large scale studies on vein individuality and stability [1]. Although fingerprint-based recognition has been the longest serving, most successful and popular method for person identification, it has some hygienic issues. Touching the finger to the same scanner repetitively by many users may cause skin problems. This problem may occur with other biometric system that uses touched sensors. Also the earlier approaches achieved the results by constraining the position and posture of hands by using pegs. However, such approaches are inconvenient and difficult for some user groups, especially for the children and old persons. Therefore, a lot of emphasis has been laid on contact free and peg-free image acquisition .The peg-free imaging, although highly convenient to users, generates images with more scale and rotational variations. Therefore, efforts are further required to get better results and to improve the reported performance [2].

The finger back surface, also known as the dorsum of the hand, can be highly useful in user identification and has attracted less attention of researchers. The image-pattern formed from the finger-knuckle bending is highly unique and makes this finger knuckle surface a distinctive biometric identifier. Finger geometry features can be acquired from the same image, at the same time, and integrated to improve the performance of the system. The peg-free imaging of the finger back surface is highly convenient and user friendly. Such images can be acquired online and used to extract scale, translation, and rotational-invariant knuckle features for user identification. The contact free imaging of the finger back surface is highly beneficial to users [2]. 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. Various advantages of using Finger Knuckle Print (FKP) include rich in texture features, easily accessible, contact-less image acquisition, invariant to emotions and other behavioral aspects such as tiredness, stable features and acceptability in the society [3]. Literature survey of related work has been discussed in detail in the papers [4] [5] [6]. Kumar A et al [2] use PCA, LDA, ICA subspace techniques for feature extraction. The Principal Component Analysis (PCA) determines the basis vectors for spanning an optimal subspace such that the mean square error between the projections of the training images onto this subspace and the original images is reduced. Independent Component Analysis (ICA) is the subspace techniques that can create spatially localized features. Linear Discriminant

Analysis (LDA) finds vectors in the underlying space that are the best discriminates among classes. Nigam et al [3] extracted knuckle features using scale invariant feature transform (SIFT) and the speeded up robust features (SURF), which are used to extract the local features from a FKP image. Both of these methods determine scale invariant key-points and describe these key-points by means of local patterns around key-points. Kumar et al [7] [15] exploits the orientation features from the random knuckle lines using Finite Radon Transform. Z. Lin [8] applied feature extraction scheme that combines orientation and magnitude information extracted by Gabor filtering. Z Lin [9] applied competitive coding scheme, which uses 2D Gabor filters to extract the image local orientation information to represent the FKP features.

2. RADON LIKE FEATURES

The knuckle image mainly consists of curved lines and creases. Therefore the feature extraction approaches that are highly successful in the characterization of such random textured biometric traits (*e.g.*, iris, palm, *etc.*) deserve investigation. The feature extraction approach is mainly focused on the detection and characterization of curved knuckle lines The Radon transform can effectively accentuate such line features by summation of image pixels along several directions and is highly computationally efficient. The Radon Transform (RT) is a technique used extensively in tomography applications. It is defined by the integrated function $I(x, y)$ on a line l that is characterized by an intercept m and a slope z:

Furthermore, for each intercept and slope in space, the Radon back-projection is used to reconstruct the original input image. Kumar et al [10] propose an other approach based on Radon Transform called Radon Like Features (RLF). RLF retains the central idea from the Radon Transform i.e. processing an image (a 2D function I(x,y)) along a line (l , parameterized by t, i.e. l(t)=(x(t),y(t))).But instead of collapsing I(x,y) along line l into a scalar value via integration (as in equation 1), RLF distribute some desired information derived from I(x,y) among various line segments along l. In our paper numbers of lines are thirty six. The line segments can be defined by the set of principal points along line l. The set of principal points along line l is given as (t_1,t_2…….tn) , value of RLF at a point P along a line l between (x (ti) ,y(ti)) and (x (t_{i+1}) ,y (t $_{i+1}$)) is given by equation-2 :

In this equation T can be any desired function called extraction function. Each line has been associated with some direction. Here angle θ is used in association with each line where $\theta \in (\theta, 2\pi)$ whose tangent gives its slop. RLF is intended to redistribute the statistical input image in the compact feature descriptors and to improve the cell boundary from image. In this paper knuckle images are enhanced using RLF. The main idea behind the use RLF in knuckle image is to enhance the line and creases in an image. Knuckle image can be enhanced using Radon Like Features as shown in figure2.

3. KNUCKLE FEATURE EXTRACTION USING RLF

RLF of knuckle images are computed using thirty six line segments. For experiment publicly available "IIT Delhi finger knuckle database version 1.0" [11] is used. This database has been acquired from 158 users in IIT Delhi campus using digital camera .All the subjects in the database are in the age group 16 to 55 years. Images are in bitmap format. Resolution of these images is 80 × 100 pixels. Sample knuckle images are as shown in figure 1. Figure 2 represents the enhanced Knuckle images using RLF technique. It has been observed that edges are more visible in Figure 2 as compared to original image.

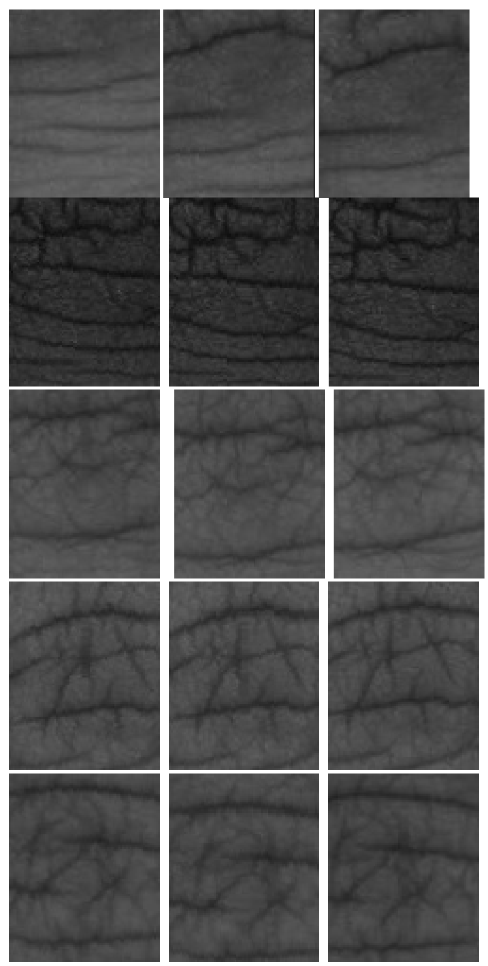

Figure 1. Sample finger knuckle images of five persons

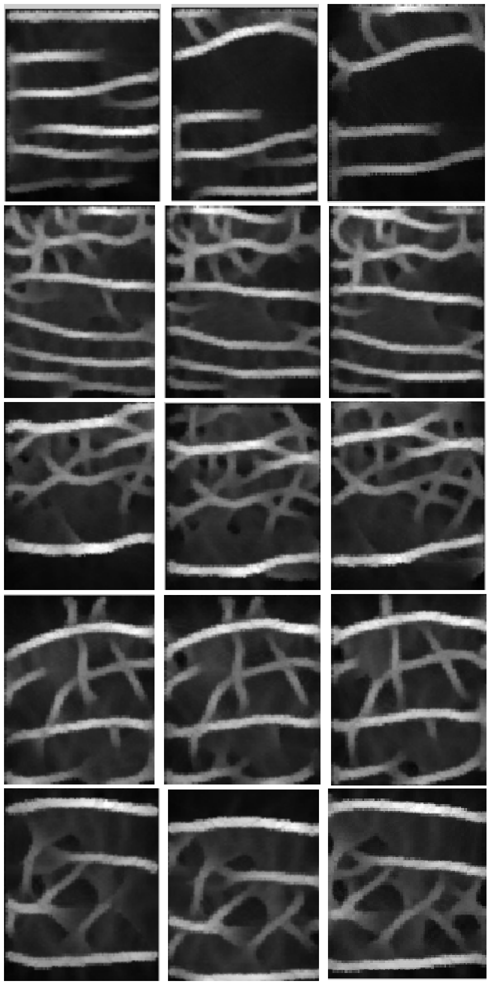

Figure 2. Corresponding enhanced knuckle images using RLF .

Features are extracted along multiple scan lines and mesh representation of RLF for sample image is as shown in figure 3.

4. ENHANCEMENT PERFORMANCE MEASUREMENT

Edge Based Contrast Measurement technique is used to measure the performance of RLF. It is a known fact that human beings are more sensitive to edges/creases (contours) of knuckle image. It is expected that an enhanced knuckle image should have more edge pixels than the original image and this parameter of Edge Based Contrast Measurement does measure the intensity of edge pixels in small windows of the image [12]. Statistical values of contrast for original knuckle images using EBCM technique is given in the table 1. Statistical value of contrast for various Enhanced knuckle images is recorded in the table 2 given below. From the experiment it has been observed that Statistical value of contrast is greatly increased in enhanced knuckle image.

Original Image	Knuckle image_1	Knuckle image_2	Knuckle image_3
Person 1	5.12	5.97	6.54
Person 2	18.78	19.09	19.18
Person 3	5.82	6.31	5.66
Person 4	8.15	7.59	7.84
Person 5	5.57	5.56	5.90

Table 1 EBCM Statistical value of contrast for original images

Enhanced Image	Knuckle image_1	Knuckle image_2	Knuckle image_3
Person 1	30.53	31.18	30.08
Person 2	27.15	27.88	27.98
Person 3	25.99	24.75	25.52
Person 4	23.36	24.36	25.32
Person 5	24.67	25.26	26.56

Table 2 EBCM Statistical value of contrast for enhanced images

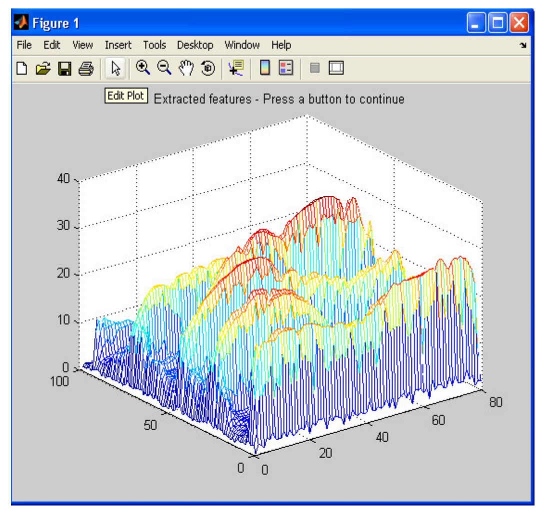

Figure 3. Extracted features using RLF for sample knuckle image.

5. CONCLUSION

This paper presented a new approach for feature extraction of two dimensional finger knuckle image using Radon Like Feature (RLF). It is more effective as compared to simple Radon Transform as features has been extracted along multiple scan lines with different angles. It is very suitable technique for knuckle image enhancement because knuckle images contain lines or creases. Result obtained by RLF is better as compared to previous feature extraction method .Extracted features of various knuckle images may further be used for classification purpose.

6. REFERENCES

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