INTERNATIONAL JOURNAL OF ELECTRONICS AND COMMUNICATION ENGINEERING & TECHNOLOGY (IJECET)

ISSN 0976 – 6464(Print)
ISSN 0976 – 6472(Online)
Volume 4, Issue 2, March – April, 2013, pp. 264-268
© IAEME: www.iaeme.com/ijecet.asp
Journal Impact Factor (2013): 5.8896 (Calculated by GISI)
www.jifactor.com

IJECET

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FINGERPRINT VERIFICATION USING STEERABLE FILTERS

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ABSTRACT

In this paper, fingerprint verification using steerable filters is presented. The existing fingerprint recognition systems are based on minutiae matching. The common fingerprint matching schemes are Correlation-based matching, Minutiae-based matching and Ridge feature - based matching. The minutiae-based matching systems are the most widely used and popular. The minutiae extraction undergoes very critical steps (like binerization, thinning) and which affects on the overall accuracy of the system. Poor ridge structure and the image processing articrafts may introduce spurious minutiae. A frequency selective as well as orientation selective transform like Gabor transform has been used for extracting the texture features. This paper describes a novel approach based on steerable wedge filter. The proposed method is capable of finding the texture features of fingerprint image irrespective to the image quality in terms of average gray level, clarity in the ridges and comparatively with fewer computations.

Keywords: Feature Extraction Fingerprint, Genuine Acceptance Rate, Steerable Filters.

I. LITERATURE SURVEY

In fingerprint based person authentication systems, minutiae and the texture features are the two important types of features, which have been widely used in fingerprint based person authentication systems. Several methods have been proposed for fingerprint feature extraction by authors in the literature. Minutiae extraction undergoes much time consuming steps like computation of orientation field, region of interest, ridge segmentation, thinning, post processing. This heavily depends on the quality of input fingerprint. Fingerprint is represented as an oriented texture pattern, as it possess a definite ridge pattern in a specific orientation in different parts of fingerprint. The ridge flow pattern could be captured by designing and applying a bank of filters having directional selectivity and frequency localization. Freeman first introduced the concept of steerable filters and a necessary condition of steerability; and some application in [1, 2]. Few applications of steerable filters have been reported in the literature, some of them are listed here. Andrew F. Laine et al [3] have worked on image de-noising by means of wavelet transform using steerable filters. Jerry Jun Yokono et al [5] used the steerable filters for extracting the features for rotation invariant object recognition. J Cai used a 2 - D oriented filer for robust dynamic tone feature extraction [6]. Sharat S. Chikkerur et al used the steerable filter in minutiae verification in fingerprint [4]. They proposed a novel approach based on steerable wedge filter to eliminate false positives resulting from feature extraction. The proposed method is capable of finding the texture features of fingerprint image irrespective to the image quality in terms of average gray level, clarity in the ridges and comparatively with fewer computations.

II. INTRODUCTION

A function is said to be Steerable if it can be represented as a linear combination of rotated versions of itself. A linear combination of a set of basis filters are used to synthesis a steerable filter in a particular orientation. Based on steerability of the transform, image features along specific orientation can be obtained. Once the basis filter responses are known, the response of a filter, which is rotated to an arbitrary angle, can be easily found. The filters are constructed using the first derivative of the Gaussian basis filter. A fingerprint image consists of ridges at specific orientations. It is possible to extract the ridge features using a 2-D steerable filter. A set of 2-D even symmetric steerable filters at eight orientations (0, 22.5, 45, 67.5, 90,112.5, 135,157.5) have been applied to fingerprint to extract the features. Each filtered fingerprint image has been divided into square blocks and their mean has been computed. The experimentation has been carried out on two databases. Experimentation is carried out using k-NN classifier with Euclidean distance metrics. At the values K=1 and 2, for various values of threshold the genuine acceptance rate of 94 percentage have been found out.

III. STEERABLE FILTERS

Oriented filters are used in image processing tasks such as texture analysis, edge extraction. Gaussian derivative filters are known for their selectivity to specific orientation and frequency. The first and second derivatives correspond to extract edge and bar features respectively. A function is said to be Steerable if it can be represented as a linear combination of rotated versions of itself. A linear combination of a set of basis filters have been used to synthesis a steerable filter in a particular orientation. Based on steerability of the transform, image features along specific orientation can be obtained. Once the basis filter responses are known, the response of a filter, which is rotated to an arbitrary angle, can be easily found. The filters are constructed using the first derivative of the Gaussian basis filter. The Gaussian function with scaling and normalizing constant set equal to 1 is defined as,

$$G(x,y) = e^{(x^2+y^2)} \tag{1}$$

The first derivative along x-axis of Gaussian is represented as,

$$G_1^{0^0} = \frac{\partial}{\partial x} = -2xe^{-(x^2+y^2)} \tag{2}$$

The first derivative along y-axis is nothing but the Gaussian function is rotated by 90 degrees and represented as,

$$G_1^{90^0} = \frac{\partial}{\partial x} = -2ye^{-(x^2+y^2)} \tag{3}$$

It is possible to synthesis a filter at an arbitrary orientation θ by taking a linear combination of (2) and (3) as,

$$G_1^{\theta} = k_1 G_1^{0^0} + k_2 G_1^{90^0}$$
(4)

Where,
$k1$=cosθ and $k2$=sinθ are the interpolating functions.

IV. FINGERPRINT FEATURE EXTRACTION

A fingerprint image consists of ridges at specific orientations. It is possible to extract the ridge features using a 2-D steerable filter. The feature extraction aim towards: 1) the algorithm should be capable for deriving fingerprint features irrespective of the image quality without any pre-processing. This is not possible if we consider minutiae features. 2) The performance of the algorithm should not deviate more based on the use of different databases. 3) The algorithm utilizes fewer computations.

Several fingerprint-matching algorithms align the fingerprint images according to the centre point, called the core. This is also referred as image registration. The image registration using core point provides us the invariance with respect to *x, y* displacement i.e. translation invariance. For the fingerprints that do not contain core, the core is usually associated with the point of maximum ridgeline curvature. In the proposed algorithm a point of most curvature in a fingerprint image has been detected and considered as a reference (core) point as proposed by Rao [7]. A properly core point located fingerprint image has been considered for registration.

In this algorithm the area around core point has been used as the area of interest for determining the orientation feature. An image of size 132×132 pixels around the core point has been cropped. The images having the core point location less than 66 pixels away from the image border have been rejected i.e. not used for training or testing.

A set of 2-D even symmetric steerable filters at eight orientations (0, 22.5, 45, 67.5, 90, 112, 5,135,157.5) have been applied to fingerprint to extract the features as shown in Figure 1. The global mean of each filtered fingerprint image can be calculated using,

$$\mu_k = \sum_i \sum_j Z_k\,(i,j) \tag{5}$$

Where
$Z_k = I \oplus G_k$, I is cropped fingerprint image and Gk is steerable filter in direction θ_k.

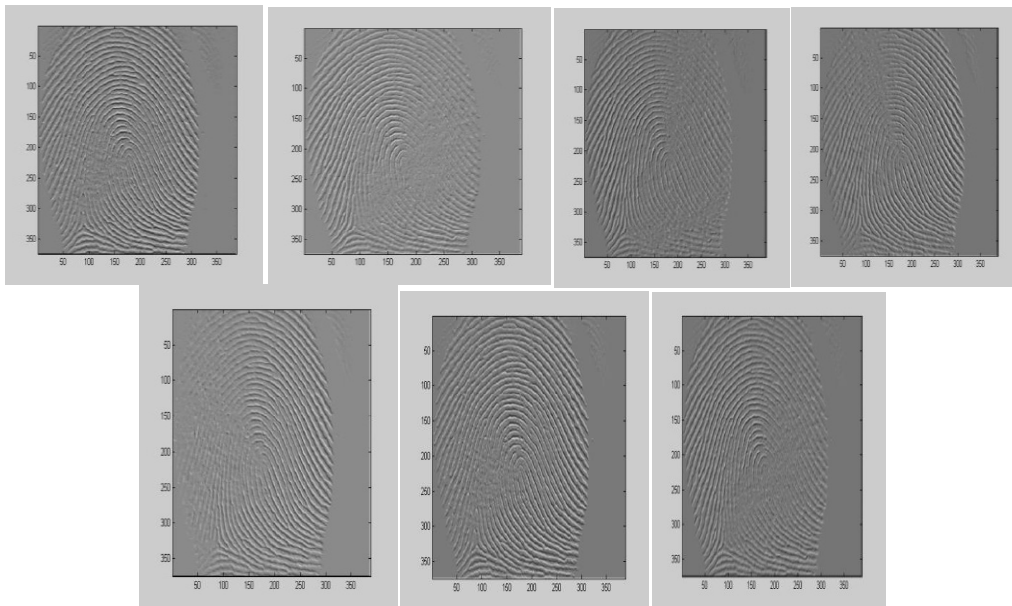

Fig. 1: Filtered fingerprint images using Steerable filters at (00, 22.50, 450, 67.50, 900, 112.50, 1350 and 157.50).

Each filtered fingerprint image has been divided into square blocks and their mean has been computed as,

$$\mu_k(m,n) = \frac{1}{M \times N} \sum_{i=1}^{M} \sum_{j=1}^{N} Z_k\,(i,j) \qquad (6)$$

Where
M=N=16, μk(m,n) is the mean of (m,n)th block of filtered (in orientation k) fingerprint image. The feature matrix is computed as,

$$\sigma_k(m,n) = \frac{1}{\Omega} \sum_m \sum_n (\mu_k\,(m,n) - \mu_k\,)^2 \qquad (7)$$

Where,
Ω is the normalization parameter and σ_k (m, n) is a variance between the global mean and local means of each block of a filtered (in direction k) fingerprint image.
The size of σ_k (m, n) is 8×8. The feature matrix of test fingerprint image has been computed as described. The feature matrices of test and trainee fingerprint have been compared using the Euclidean norm to find a distance vector and the distance.

V. EXPERIMENTAL RESULTS AND CONCLUSIONS

The experimental has been carried out on two different databases made available by University of Bologna. It consists of images of 21 subjects with 8 images of each subject. Total 21×8=168 images have been used for experimentations. Around 80 percent fingerprint images from this database are of good average gray level. The experimentation is carried out using k-NN classifier with Euclidean distance metrics. At the values K=1 and 2, for various values of threshold the genuine acceptance rate have been found out. The Genuine acceptance rate for various thresholds is shown in Table 1.

Table 1: Genuine Acceptance Rate (Gar) For Various Thresholds.

Threshold Value	Genuine Acceptance Rate	
	K=1	K=2
38	79.8	83.75
41	84.3	91.25
42	89.9	93.75
44	91.8	95.87

The proposed algorithm describes the use of 2-D steerable directional filter for fingerprint feature extraction. The *K*-NN classifier has been used to analyze the performance of the feature extracted. As the steerable filters are highly directional it is possible to extract the maximum ridge features of the fingerprint (textural features). The algorithm produces better results compared to the minutiae based algorithm. This algorithm could be effectively used for small size databases.

REFERENCES

Proceedings Papers:

[1] William T. Freeman, and Edward H. Adelson, "Steerable Filters for Early Vision, Image Analysis, and Wavelet Decomposition," Proc. IEEE conf. on ------, 1990, pp. 406-415.

Journal Papers:

[2] Freeman, W. T., and Adelson, E. H., "The Design and use of steerable filters," IEEE Trans. Pattern Anal. Mach. Intell., 1991, 13, pp 891-906.

[3] Andrew F. Laine, and Chun – Ming Chang, "De-noising Via Wavelet Transform using Steerable filers, IEEE Int. Symposium on Circuits and Systems, vol. 3, 1995, pp. 1956-1959.

[4] Sharat S. Chikkerur, Sharat Pankantti, Nalini K. Ratha, Ruud Bolle, and Venu Govindaraju, "Minutiae verification in fingerprint images using steerable filters," IEEE Trans. Pattern Anal. Mach. Intell., 1997, 13, pp 671-679.

[5] Jerry Jun Yokona, and Tomoso Poggio, "Rotation Invariant Object Recognition from Training example," CSAIL, 2004, MIT, Cambridge, (document available on www.csail.mit.edu).

[6] J. Cai, "Robust dynamic tone feature extraction using 2D oriented filters," Electronic Letters, 17th March 2005 vol. 41, no. 6.

[7] Rao A. R., "A Taxonomy for Texture Description and Identification," Springer – Verlag, New York, 1990.

[8] Mr.Lokesh S. Khedekar and Dr.A.S.Alvi, "Advanced Smart Credential Cum Unique Identification and Recognition System. (Ascuirs)", International journal of Computer Engineering & Technology (IJCET), Volume 4, Issue 1, 2013, pp. 97 – 104, ISSN Print: 0976 – 6367, ISSN Online: 0976 – 6375.

[8] Nazrul H. Adnan, Khairunizam Wan, Shariman Ab and Juliana A. Abu Bakar, "Principal Component Analysis for the Classification of Fingers Movement Data Using Dataglove "Glovemap"", International journal of Computer Engineering & Technology (IJCET), Volume 4, Issue 2, 2013, pp. 79 – 93, ISSN Print: 0976 – 6367, ISSN Online: 0976 – 6375.