ISSN : 2278 – 1021

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 1, Issue 5, July 2012

Improving Accuracy of Pattern Matching Technique with Polar Harmonic Transform for Poroscopy

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ABSTRACT— ***Accuracy of the object classification is depend upon the feature vector of the object. Poroscopy is the method of pattern matching of the fingerprint images based upon pores. Pores of the fingerprint image are extracted by using Marker Controlled Watershed Segmentation. The features of the pores are extracted by various methods which are rotation variant. To improve the accuracy of the pattern matching we propose an technique based upon PHT (polar harmonic transform) which is an rotation invariant transform that provide many numerical stable features. The kernel functions of PHTs consist of sinusoidal functions that are inherently computation intensive. The proposed Method will reduce the FAR and FRR.***

***Keywords*—Poroscopy, Fingerprint images, Marker Controlled Watershed Segmentation, Polar Harmonic Transform, False Acceptance rate, False Rejection Rate.**

I. INTRODUCTION

Poroscopy is the method of personal identification of impression left by the sweat pores of fingers to check or support fingerprint evidence. The information that are collected from fingerprint image can be categorized as Level1-archs, loop and whorl, Level2 –minutiae and Level 3 –pores and ridges[1,2].Sweat pores and other extended fingerprint features have gained increasing attention from researchers and practitioners working on automatic fingerprint recognition system(ARFS)[3].They have been proven to be very useful for improving the accuracy of existing minutiae based AFRS. In 1912, Locard introduced the science of poroscopy, the comparison of sweat pores for the purpose of personal identification. It was observed that the number of pores along a centimeter of ridge varies from 9 to 18, or 23 to 45 pores per inch and 20 to 40 pores should be sufficient to determine the identity of a person [4].
A problem of such pore matching method is that the matching of pores depends upon the feature vector which is rotation variant. In this paper we will focus on the rotation in Variant technique which is PHT (Polar Harmonic Transform).

II. BACKGROUND STUDY

Some researchers have been paying more and more attention in using Level3 features in AFRS. The state-of-heart pore matching method was recently proposed by Jain et al. [1]. In this method, the fingerprint images were first aligned based on the minutia features on them by using a string-matching. Then they were matched by using the iterative closest point (ICP) algorithm which is capable to handle sets of points with different numbers of points and can compensate for non-linear deformation between them. .M .Ray et al. [5] proposed a minimum square error approach for finding the region where the probability of the pore is more and then extracts the pore from those regions. It is very efficient method of pore extraction and capable of obtaining good results for images of 500 dpi. Qijun Zhao et al. [6] proposed an adaptive pore model (APM) based on the observation on real pore appearances and then determines the correspondences between pores based on their local features. It then uses the RANSAC (Random Sample Consensus) algorithm to refine the pore correspondences obtained S. Malathi et al.[7] proposed a local binary pattern based technique for partial fingerprint recognition. Extract pores from the partial image. Pores act as anchors points and a sub-window (32*32) is formed surrounding the pores. The rotation invariant histogram obtained from surrounding window .Finally chi square formula is used to calculate the minimum distance for matching. Q. Zhao et al.[8] proposed a pore valley based method for fingerprint matching. Pores are extracted from the fingerprint image by using a difference of

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Gaussian Filtering approach. After it a pore valley descriptor is made to characterize pores based on their locations and orientation, location and valley structure around them. A PVD based coarse to fine matching algorithm used to locate pore correspondence. After it alignment transformation between two partial fingerprints can be estimated.

A. *Polar Harmonic Transform*

In this paper we use polar harmonic transform (PHT) which can be used to generate rotation – invariant features. The computation of the PHT kernels is significantly simpler compared with that of ZMs and PZMs and hence can be performed at a much higher speed [9]. With PHTs, there is also no numerical instability issue, as with ZM and PZMs which often limits their practical usefulness. A large part of the computation of the PHT kernels can be recomputed and stored. In the end, for each pixel, as little as three multiplications, one addition operation, and one cosine and/or sine evaluation are needed to obtain the final kernel value. In this paper, three different transforms will be introduced, namely, Polar Complex Exponential Transform (PCET), Polar Cosine Transform (PCT), and Polar Sine Transform (PST). We have grouped them under the name Polar Harmonic Transform as the kernels of these transforms are harmonic in nature, that is, they are basic waves.

III. PROPOSED METHOD

In this paper firstly pores of the fingerprint mage are extracted with Marker controlled Watershed algorithm. The feature vector of these pores is taken with Polar Harmonic Transform. After that Chi square formula is used for matching the feature vector.

A. *Pore Extraction*

Pores are extracted from fingerprint image by using Marker Controlled Watershed Segmentation method proposed by S. Malathi et al. [10].The algorithm created foreground and background markers using Morphological image reconstructions. Watershed transform of the marker-modified gradient fingerprint image is computed. After superimposing the watershed ridge lines on the original fingerprint image, pores are extracted from the image.

Algorithm:

1. Read the gray-scale image.
2. Develop gradient fingerprint images using appropriate edge detection function.
3. Compute the watershed transform of the gradient fingerprint image without any other processing
4. Calculating the regional minima to obtain the good forward markers
5. Superimpose the foreground marker image on binarised fingerprint image.
6. Clean the edges of the markers using edge reconstruction.
7. Compute the background markers
8. Compute the watershed transform of the function

B. *PHT Feature Extraction*

For a square-integral function $f(x,y)$, a transform order $(p,q) \in \mathbb{Z}^2$ with respect to the basis function $\psi_{p,q}(x,y)$, generating the transform coefficients $M_{p,q}$ can be defined as:

$$M_{p,q} = \int_x \int_y \psi^*_{p,q}(x,y)\, f(x,y)\, dx\, dy, \quad (1.1)$$

where the superscript *denotes the complex conjugate. The basis functions are typically designed to have some properties that are useful for the task at hand. Moments, for instance, can yield representations that are invariant to rotation, scaling and translation of $f(x,y)$. For digital images defined on a discrete domain, equation (1.1) can be discretized and written in the form

$$M_{p,q} = \Sigma_x \Sigma_y\, \psi^*_{p,q}(x,y) f(x,y) \Delta x \Delta y \quad (1.2)$$

If the set of basic functions is complete, the image can be completely characterized by the corresponding set of transform coefficients $\{Mp,q\}$

To appreciate the rotation invariance of a transform, it is helpful to express the transform in polar coordinates (r, φ), where $r = \sqrt{x^2 + y^2}$ is the radius of a circle with (0, 0) as its origin and (x,y)as one of its points, and $\varphi = \arctan(y/x)$ is the angle between the line joining the origin and the point (x, y) and the x-axis. The basis function $\psi_{p,q}(x,y)$ and the image function $f(x,y)$can be written as $\psi_{p,q}(x,y) = \psi_{p,q}(r\cos\varphi, r\sin\varphi) \equiv \psi_{p,q}'(r,\varphi)$ and $f(x,y) = f(r\cos\varphi, r\sin\varphi) \equiv f'(r,\varphi)$, respectively.

IV. MATCHING

The algorithm for matching feature vectors is based on distance between two pht feature histograms. Minimum distance corresponds to best match. To get distance between two histograms, chi-square formula is used. Distance between two istogram S,M can be defined as

$$\chi^2(S,M) = \sum_{i-1}^{n} \frac{(S_i - M_i)}{S_I + M_i}$$

Where n is the number of elements in the histogram. Chi square formula is an effective measurement of similarity between two histogram, hence it is suitable for pair of nearest neighbour.

V. CONCLUSION

The proposed method has been evaluated in NIST SD3 dual resolution database.This will reduce the FAR (False Acceptance Rate) and FRR (False Rejection Rate).The Polar Harmonic Transform will provide more accuracy in pattern matching technique.

ACKNOWLEDGEMENT

The authors would like to thank the anonymous reviewer for their valuable comments.

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