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EXTRACTING THE CORE POINT USING LOCAL RIDGE ORIENTATION METHOD IN FINGERPRINT IMAGES

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Abstract - *This paper describes the design and implementation of extracting the core point. This algorithm is concentrated on extracting the core point, since rich minutiae exist close around the core point which is normally used for fingerprint matching and also fingerprint classification is done by using the core point. This feature of extracting core point is essential for fast and robust performance of fingerprint verification / identification. In our algorithm the core point is extracted using the local ridge orientation, which is compared with the Poincare Index method. The system has been tested on a variety of fingerprint images even of very poor quality and the results showed remarkable performance. Experimental results showed that our algorithm is best suited for the verification with high accuracy. The complete fingerprint extraction algorithm takes on an average of about 2 seconds, which is remarkably good.*

Key Words: fingerprint extraction algorithm, *local ridge orientation, Poincare Index method*

1.INTRODUCTION

In modern days, using fingerprints in various systems is getting popular. It has been identified as one of the easiest method for ensuring security in most of the applications. Authentication based on fingerprints is employed in systems such as ID verification, airport security, e-commerce, passports, driving licenses, mobile commerce etc. According to the survey held by AuthenTech (2020- Biometric survey focusing on fingerprint) [1], 69% of the respondents cited online banking as their most important desired application for leveraging the security, convenience and personalization by a fingerprint sensor. Two-thirds of survey respondents see the advantages of fingerprint sensors for online banking and e-commerce and would use the technology today to authorize payments and transactions online. The survey found that the more often an individual conducts online banking [2] and e-commerce, the more likely that person is to perceive the value of using fingerprint sensors and to consider more online activity. Other general perception findings are tabulated and it is shown in Table 1.

Table -1: AuthenTech 2020 biometric survey

General Perception Findings	Yes	No	I don't know
Authentication of one's identity using fingerprint is more secure than using PINs or passwords	66%	14%	20%
Using finger print sensors is much valued and easy	68%	14%	18%
Fingerprint sensors make devices more personal, from PCs and laptops to mobile devices.	65%	14%	21%
Fingerprint sensors makes the system more personalized	97%	3%	-

For fingerprint identification, a set of discriminating features are extracted from the fingerprint images. The uniqueness can be well-defined by the local characteristics in ridge and valley. Core point is one of the ridge characteristics which occur where the local ridge orientation changes very rapidly (i.e. core or delta) the core is the endpoint of the innermost curving ridge while delta is the confluence point of different flow direction. Core extraction is important for further processing of fingerprint identification such as fingerprint classification and matching [3], [4], [5]. So core extraction is the challenging task in the fingerprint identification system. Core point are detected generally based on the poincare index of squared directional fields [4-6]. In this method, as the size of the closed curve is crucial it may lead to spurious detection of singularities or missed singularities. In [7] a ratio of two sines of direction field in two adjacent regions is used to detect singularities

In this paper, a fingerprint core extraction algorithm is developed, which efficiently improves the robustness of complete fingerprint verification . It is possible that there could be images with no delta point [8] or delta point outside the print [9]. Therefore this paper is concentrated on extracting only the core block, as most of the ridge

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characteristics like ridge endings, bifurcations are present in the core block (center).

In this paper, we present in Section II Normalization of input original fingerprint images. After that, in Section III, we compute orientation fields and core point. Then, we compared our proposed algorithm with poincare index method, described in Section IV. Finally, in Section V, we give some experimental results

2. NORMALIZATION

This procedure normalizes the global statistics of the image, by reducing each image to a fixed mean and variance. Although this pixel wise operation does not change the ridge structure, the contrast and brightness of the image are normalized as a result. The normalized image is defined as

$$G(i,j)=\begin{cases} M_0+\sqrt{\dfrac{VAR_0((1-M)^2)}{VAR}}, ifI(i,j)>M \\ M_0+\sqrt{\dfrac{VAR_0((1-M)^2)}{VAR}}, otherwise \end{cases}$$

3. EXTRACTION OF CORE POINT

In this system, the method proposed here is used to estimate the high ridge curvature area. The algorithm is used as follows.

Step (1) Determine the x and y magnitudes of the gradients (Gx and Gy) at each pixel.

Step (2) Apply the 2D Gaussian Low Pass Weiner filter, to reduce noise from the fingerprint image, on the x and y gradients.

Step 3) Divide the input image in to blocks of size w × w

Step 4) Local Orientation Estimation:

There have been several approaches to estimate the orientation image of a fingerprint image. These include the use of filter banks, template comparison, and ridge projection based methods. The orientation estimation obtained by these methods is noisy and have to be smoothened before further use. This algorithm concentrates on using the gradient-based approach by computing the slope orthogonal to the local orientation of each block using the equation

$$\theta(i,j)=\frac{1}{2}\tan^{-1}\left(\frac{\sum_{u=i}^{i+w-1}\sum_{u=i}^{j+w-1}2\delta_x(u,v)\delta_y(u,v)}{\sum_{u=i}^{i+w-1}\sum_{u=i}^{j+w-1}2\delta_x^2(u,v)\delta_y^2(u,v)}\right)+\frac{\Pi}{2}$$

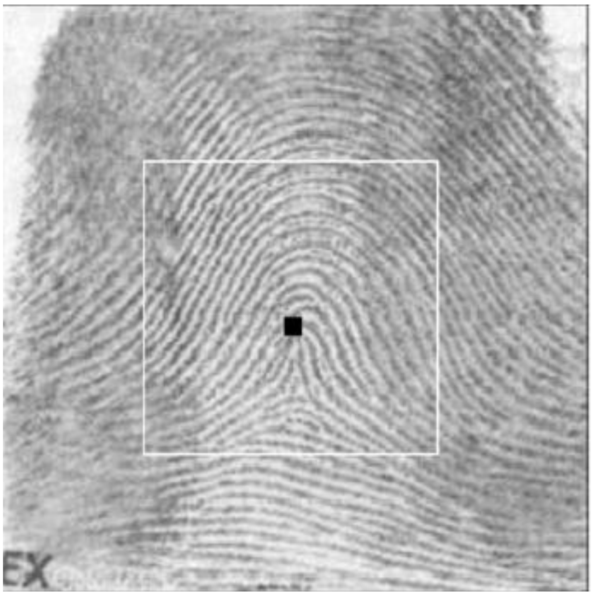
where y ∂ x ∂ (u,v), y ∂ (u,v) represents gradient magnitudes at each pixel in x and y directions respectively. θ (i, j) is the direction of the block centered at pixel (i,j).

Step (5) The blocks with slope values ranging from 0 to Π/2 are located. Then trace a path down until you encounter a slope that is not ranging from 0 to pi/2 and mark that block.

Step (6) The block that has the highest number of marks will compute the slope in the negative y direction and output on x and y position which will the core point.

Step (7) A new core block is formed around the core point which is further enhanced in the next section.

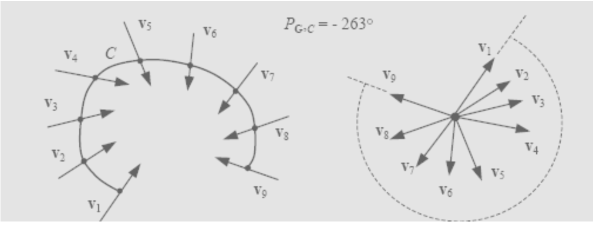
Fig -1: Core Point Extraction



4. POINCARE INDEX METHOD

The orientation Most of the fingerprint-matching algorithm is based on the poincare index method for extracting the core point. Poincaré index was proposed by Kawagoe and Tojo Let G be a vector field and C be a curve immersed in G; then the Poincaré index PG,C is defined as the total rotation of the vectors of G along C

Fig -2: The Poincaré index computed over a curve C



The core point detection algorithm is described below.

Step (1) Estimate and smooth the directional fields of the input fingerprint image.

Step (2) In each block (8X8), we compute the Poincare index. The Poincare index is defined and computed as follows:

$$Poincare(i,j)=\frac{1}{2\Pi}\sum_{k=0}^{N-1}\Delta(k)$$

$$\Delta(k)=\begin{cases}\delta(k), if\delta(k)<\frac{\Pi}{2}\\ \Pi+\delta(k),\ f\delta(k)<\frac{-\Pi}{2}\\ \Pi+\delta(k), otherwise\end{cases}$$

$$\delta(k)=\theta(X(k'),Y(k'))-\theta(X(k),Y(k))$$

$$k'=(k+1)\bmod N$$

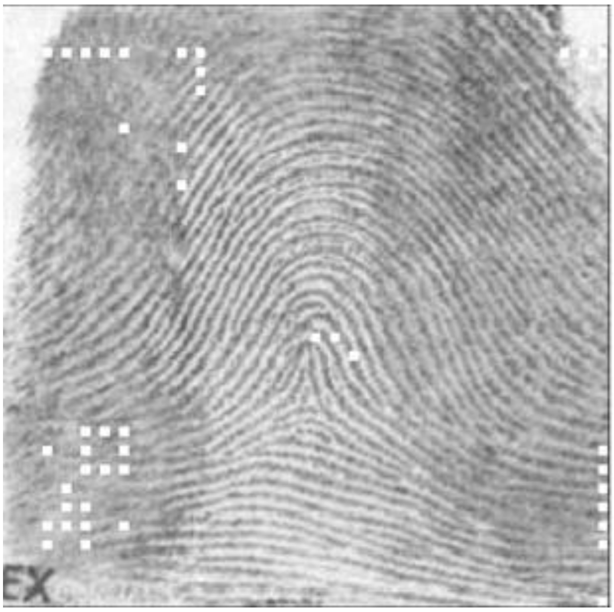
where is the directional field of fingerprint and are the coordinates of the blocks hat are in the closed curve with blocks.

Step (3) If the Poincare index is 1/2, then this block is the core block. The center of this block is the core point. If more than two cores or delta point are detected, go back to Step 1, using a larger smoothing parameter for the directional fields.

5. EXPERIMENTAL RESULTS

We validated the methodology presented here on the FVC database of fingerprint images. We compared the performance of the extraction of high ridge curvature area algorithm presented in section 3 with that of poincare index. The method presented here showed a remarkable performance than the poincare's as shown in figure 1,3. In poincare index method, the smoothening parameter have to be modified for fingerprint images in order to reduce the false detections.

Fig -3: Core Point Extraction using poincare index method



6. SUMMARY AND CONCLUSIONS

The resulting algorithm is shown to extract the high ridge curvature area efficiently and enhance a variety of fingerprints even of poor quality. The probabilities of false detections are considerably reduced. This method of extracting core point in fingerprints could be incorporated further efficiently in the fingerprint verification, identification and classification to ensure robust performance.

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