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CORE-POINT, RIDGE-FREQUENCY, AND RIDGE-ORIENTATION DENSITY ROLES IN SELECTING REGION OF INTEREST OF FINGERPRINT

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ABSTRACT: in fingerprint recognition technology, ridge-frequency and –orientation step are utilized to identify trait pattern of ridge/valley features of the fingerprint by separating foreground and background of the fingerprint image and specifying the directional pattern of the ridges and valleys. The ability to determine the patterns help us as well to select a particular area to be utilized forth. Meanwhile, core-point is needed as a reference point in region of interest (RoI) cropping process. For example, if a desired region is a square-form area, core-point can be as a central of the RoI. Thus, we just need to lay down two diagonal side of the selecting area. In conclusion, it is obvious that the superiority of these three steps can be exploited in RoI step.

Keywords: RoI, Core-Point, Ridge-Frequency, Ridge-Orientation, Fingerprint

1. INTRODUCTION

Selecting a particular region of image is needed to specify a desired working area and to focus either the processing or analysis on part of the image. The image processing step is able to associate, extract, erase, and transform the current selected region from and into an image window. In biometric, this processing step is needed to select as much as possible an accurate trait of biometric but less of unnecessary objects. For instance, normally a fingerprint image is obtained as a scanned fingerprint. It means that on one received fingerprint, not only fingerprint exists as foreground but it is surrounded by noises as the background.

Therefore, this selection procedure, known as Region of Interest (RoI), requires a special willingness in its implementation. The willingness is about how to understand which determination is used as reference to choose an appropriate required region. For example in several cases of fingerprint, a fully fingerprint recognition used as a foreground is not required in fact. That is only core-point and delta appearance on fingerprint as shown in fig.1 needed to classify the fingerprint.

RoI is obviously demanded as well when the field work domain is in matrix form [1]. As it's globally known, working in matrices field usually require a square-form image. Meanwhile, a fingerprint recognition input is mostly available in non-square form. Thus, demanding of RoI step is decisive to be implemented.

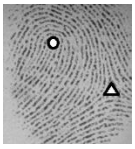


Figure.1. Fingerprint and Its Core-point (circle) and Delta (triangle)

This paper is outlined firstly by introduction several previous researches in RoI field continued by offering a proposed RoI method in the next two sub-chapters. Afterward, the result of RoI implemented into three different fingerprint databases will be shown to exemplify result and advantage of RoI process into fingerprint. Lastly, conclusion and future work will summarize this paper and illustrate an interesting further research related to RoI field.

2. RELATED WORKS

Region of Interest (RoI) process is required to select a particular area to certain objection and has been implemented in several different applications. For example, in [2], it proposes a new image-based fingerprint matching method for various rotations and translation of fingerprint input. This approach combines direction of ridges as a prominent feature component and describes fingerprint as directional energies. The region of a particular radius around a detected reference point is used as region of interest for feature extraction.

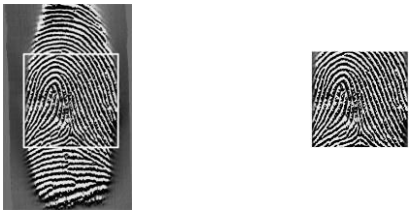
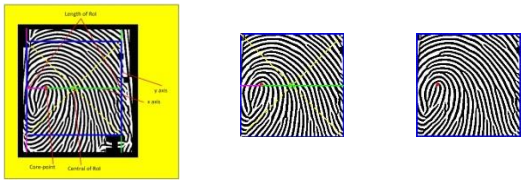


Fig. 2. Region of interest step

Another application of RoI is for accurate object detection proposes [3]. In this research, it is discussing about an approaching to determine an object location by selecting and grouping the importance area of the main object. Moreover, it also discuss about establishing a target area based on its likeness and spatial neighborhood citations.

3. PROPOSED METHOD

In this research, Region of Interest procedure is utilized to select a full-information area of fingerprint by positioning the core-point as a reference point to cover all features existed in fingerprint image as following pictures.

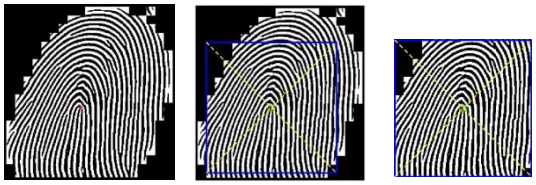


(a) (b) (c)

Figure 3. RoI procedures for fingerprint image un-centred core-point

Region of interest (RoI) selection procedure is based on several criterion requirements as follow:

a. Core-point is as a reference point for RoI. Still, core-point is not always as a centered point for fingerprint image.
b. Suppose fingerprint size is x by y. If $x > y$, create a horizontal line throwing the core point.
c. Made a vertical line at the right side of the core to find the densest ridge/valley in there based on ridge frequency value resulted along the vertical line.
d. A similar procedure is implemented to the other side of the core-point
e. Stretch the horizontal line till both vertical lines.
f. This horizontal line will be the length of a square RoI.
g. Create two horizontal lines in above and beneath of the core-point and do the same procedure like in step c and d.
h. Place the square RoI in the middle of these two vertical lines and two horizontal lines.
i. So then, this is the RoI of the fingerprint.



(a) (b) (c)

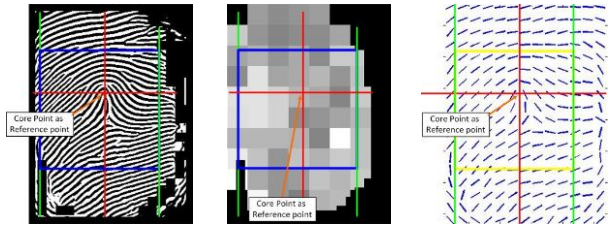
Figure 4. Another RoI result;
(a) Fingerprint after core-point detection step;
(b) Selection a specific region with core-point as a reference point;
(c) Fingerprint with new region of interest

4. UTILIZING RIDGE FREQUENCY AND ORIENTATION IN CHOOSING REGION OF INTEREST

This research, the stage to implement RoI is after core-point detected as a reference point when a region as a certain working area should be chosen to either extract the fingerprint features or generate a cancellable fingerprint.

As mentioned in the afore chapter, region of interest (RoI) aims to select a particular area of the fingerprint to avoid noises and to support generating cancellable fingerprint process which is required an square form of matrix/image. From figure 2 and 3., it is obvious that RoI process reduce coverage area of the fingerprint. And it means that RoI stage can omit several features of the fingerprint. However, the RoI experiment and two previous experiments; fingerprint enhancement and core-point detection, show that selecting a certain and particular region of the fingerprint is precious to reduce an unimportant image or feature of the fingerprint. By using core point as a reference point of RoI process, it ensures that requirement for the next steps; fingerprint classification (the needed of core-point and delta) and cancellable fingerprint (square form input image) are available.

In this RoI stage, this research proposed a new approach to select a particular region. As aforementioned, core-point is utilized as a reference point. Starting from this point, a horizontal or vertical line is stretched to the end of the most densely of ridges-frequency and -orientation. This line is a length of the square form area of the fingerprint. The step process is shown as following figure.



(a) (b) (c)

Figure 5. Step process of RoI;
(a) Enhanced fingerprint with core-point
(b) Ridge frequency
(c) Ridge orientation

In figure 5, it is seen that the red line is a line crossing throw the core-point of the fingerprint. These lines, vertical or horizontal, will find an area fulfilled with ridge using ridge-frequency and -orientation step result. Meanwhile, the green lines are end-area with contain the most dense ridges. These both green lines will be a length of the square RoI, as illustrated by blue square rectangle.

5. RESULTS

This RoI approach is implemented into three different fingerprint databases i.e. FVC2002 (Fingerprint Verification Contest in 2002) [4], FVC 2004 [5], and BRC (Biometric Research Centre in Hongkong) [6]. FVC 2002 database provides four different types of fingerprint from three different scanners and the SFinGE synthetic generator to collect fingerprint data as following table.

Table 1 FVC 2002 Scanners/Technologies for Each Database

Database	Technology Used	Scanner Used	Image Size (Resolution)
DB1	Optical	Identix TouchView II	388x374 (500 dpi)
DB2	Optical	Biometrika FX2000	296x560 (569 dpi)
DB3	Capacitive	Precise Biometrics 100 SC	300x300 (500 dpi)
DB4	Synthetic	SFinGE v2.51	288x384 (500 dpi)

In FVC2002, each database has 10 different fingerprints which for each fingerprint consist of eight different acquisition processes. Two requirements are implemented along collection process to manage a similarity result for every volunteer i.e. maximum rotation not more than 35 degrees and non-null overlap between any two impressions of the same finger.

Table 2 Results for RoI Process of Fingerprint images of FVC2002 database

	Original Image	RoI
DB1 101_1		
DB2 106_3		
DB3 107_6		
DB4 103_1		

Similarly with FVC2002, FVC2004 database has four types of database as well. These databases are collected using three commercially available scanners and a synthetic generator SFinGe.

Table 3 FVC 2004 Scanners/Technologies for Each Database

Data base	Technology Used	Scanner Used	Image Size (Resolution)	Fingerprint Condition
DB1	Optical	CrossMatch V300	600x480 (500 dpi)	Dried
DB2	Optical	Digital Persona U.are.U 4000	328x364 (500 dpi)	Dried
DB3	Thermal Sweeping	Atmel FingerChip	300x480 (512 dpi)	Moistened
DB4	Synthetic Generator	SFinGE v3.0	288x384 (about 500 dpi)	Moistened

Still, the same processing steps with FVC2002 are implemented into this database. The results of those fingerprint processes are as follows.

Table 4 Results for RoI Process of Fingerprint images of FVC2004 database

	Original Image	RoI
DB1 101_2		
DB2 103_5		
DB3 105_4		
DB4 107_5		

BRC database contain of two databases i.e. DBI and DBII. DBI consist of a small training dataset and a large test dataset. The following table gives the detailed information of the databases.

Table 5 BRC database detail information

Database	Resolution	Image Size	#Fingers	#Images per finger per session	#Images
DBI: Training	~1,200 dpi	320x240	35	3	210
DBI: Test	~1,200 dpi	320x240	148	5	1,480
DBII	~1,200 dpi	640x480	148	5	1,480

The DB1 database has image size smaller that the two previous databases. Thus, several images do not exhibit core point and tented arch in the same appearance of the image.

Table 6 Results for RoI Process of Fingerprint images of BRC databases

	Original Image	RoI
DBI Test 16_2_1		
DBI Training 307_1_3		
DBII 3_2_1		

6. CONCLUSION

In the afore tables, it can be seen that selecting a particular area in RoI step is useful to accommodate the needs of a square input form for any fingerprint processes that is demanding a square area of fingerprint and the needs to omit an unimportant area for minutiae extraction step. Notwithstanding RoI stage reduce the area of the fingerprint, this step is certainly required to discard noises in the fingerprint image.

7. FUTURE WORKS

In fact, not only core-point, ridge-orientation and –frequency of fingerprint can be exploited to select a demanding area of fingerprints or images correctly and precisely. We can apply neighborhood similarity of pattern of the image to precisely identify and border a desired region. This approach can be supported by implementing supervised and unsupervised identification of pattern to omit an error in region selecting process.

8. ACKNOWLEDGEMENTS

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