

A Multi-Stage Fingerprint Recognition Method for Payment Verification System

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Abstract

This thesis is on fingerprint recognition method and system, more in detail, the layered fingerprint recognition method and system to compare not only the minutiae or singular point, but also compare the images of detailed area for making prompt and accurate comparison of fingerprint. Through the experiment that applies this theory, we have confirmed that there is a great improvement of verification rate and erroneous recognition rate of other person's fingerprint. In the world security market, the size of the biometric industry is gradually increasing, of which the fingerprint verification is recognized of its superiority and marketability in terms of relatively low cost, light weight and uneasiness to input bio-information, compared to other biometric methods. This paper proposes a method to utilize the strengths of the Multi-Stage Fingerprint Recognition Method for Fingerprint Payment Verification System. The example of the utilization of the credit card payment is the model business of fingerprint verification credit card payment applied for three months in large domestic marts, to discuss the possibility to settle the non-medium credit trading by the biometric technology and the applicability to the financial services.

Keywords: *fingerprint, recognition, core point, delta point, verification system*

1. Introduction

The process of verification by using fingerprint is largely divided into the classification of several fingerprints into different shapes and the procedure of matching for the subject person. In addition, such an individual verification system of fingerprint is further divided into the identification system of one to multiple number to distinguish the inputted fingerprint from the registered fingerprint and the verification system that contrast and distinguish the inputted fingerprint with the registered fingerprint on one to one basis [1-3].

Analyzing the fingerprint used for such a fingerprint recognition system, fingerprint exists in many number of singular point area on top of the normal area made up in fingerprint ridge with the accurate direction. From such a singular point, the point that progresses with the ridge but disconnected is called as ending point the point where the ridge is divided is called as bifurcation, and this is collectively referred to as the minutiae.

Also, for fingerprint, there is singular point such as the core point, the center point of the flow of fingerprint ridge, and the delta point that the vertical ridge and the horizontal ridge are met and generated [4-8].

In general, there are approximately 100-150 minutiae on a finger and each person has different type, location and direction. Therefore, this type of location and direction of minutia may be used as a way of deciding for fingerprint [5].

However, the previous fingerprint recognition method that used the singular point or the minutiae was the method using the coefficient relationship between the minutiae adjacent or the position that was dispersed in space between the minutiae that depended completely on the extraction of the minutiae that the rate of error in recognition became larger when the minutiae was mistakenly extracted or having similar patterns.

In other words, in most of fingerprint recognition system, the type of information for minutiae and the ending point and bifurcation due to the error arising during the filtering process of the image that, in actuality like Figure 1, it is frequent cases of erroneous verification of different fingerprint to recognized as the same fingerprint.

This thesis is on the fingerprint comparison method that it not only compares the generally used minutiae but also is a Multi-Stage fingerprint recognition method that may compare the prompt and accurate comparison of fingerprint under the foundation of image foundation comparison of the detailed area.

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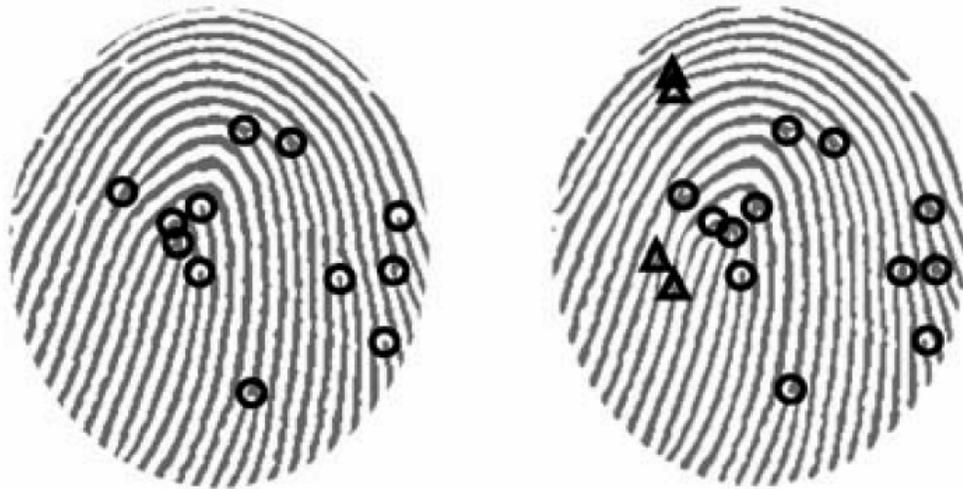


Figure 1. Actual Example of Fingerprint Image Matched in Similar Pattern

2. Image Processing

In most systems, the two fingerprints are deemed to be the same person since the type information of minutiae in the ending point and bifurcation due to the error arising from the filtering process of the image. However, looking into the detailed area, the minutiae patterns of these two images are different, particularly, the ridge pattern of the center area is different. This thesis calculates the relativity between the minutiae and extracts certain area for the standard on similar patterns in measuring the similarity that

it provides effective identification on the consistency on fingerprint with similar minutiae and fingerprint with prompt and rotation in fabric.

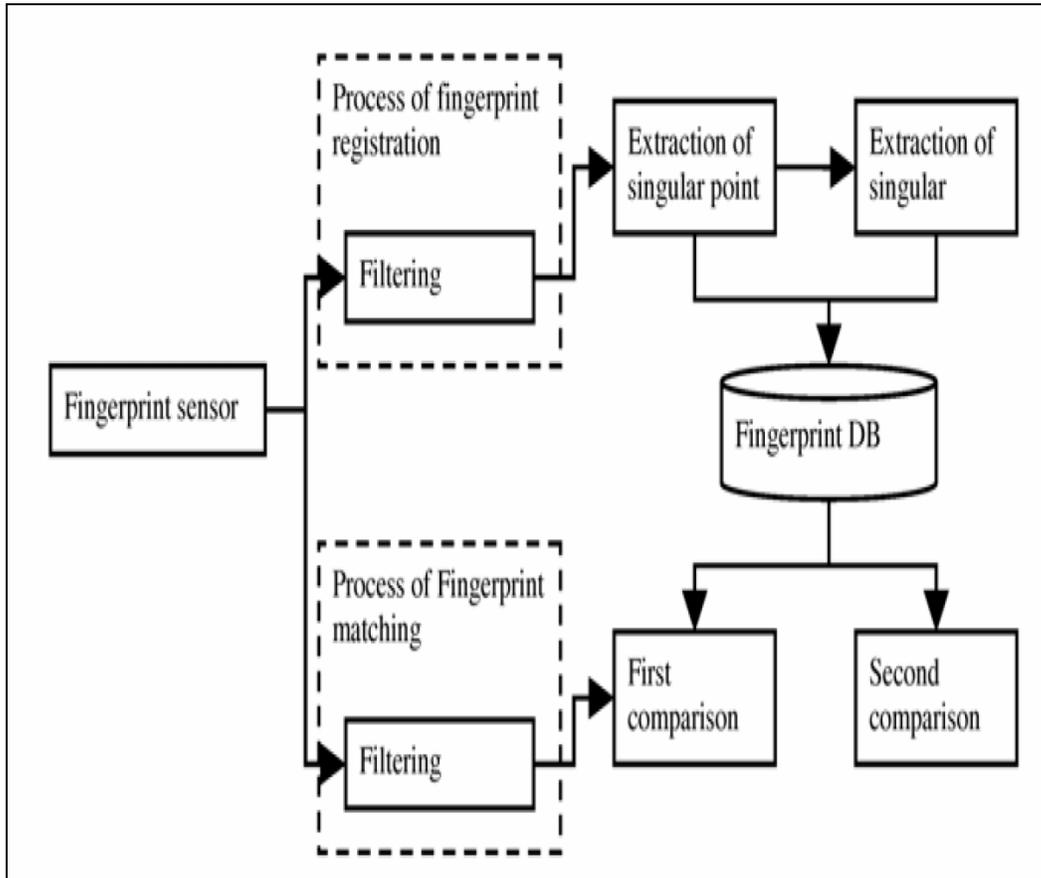


Figure 2. The Fingerprint Matching Process of the Fingerprint Recognition System

The fingerprint matching process of the fingerprint recognition system under this thesis is shown on Figure 2.

First, the fingerprint image is extracted from the fingerprint sensor. For a sensor that captures the image, there are optical method and semiconductor type area sensor and optical method and thermal sensitive type linear sensor.

The quality of fingerprint image captured from the fingerprint sensor may have a significant difference for gender, age and skin composition of individual depending on the sensor. Therefore, there is a need of filtering process to make entire quality of image consistent and restructuring the part with disconnected ridge or crushed part by using the direction of the ridge. The output of this process is the B/W image.

The next stage is the minutiae extraction stage that the layered extraction of singular point information is made. This information is used as the information of layer comparison in the process of the fingerprint matching.

In the extraction stage for singular point and minutiae, the core point, the center of flow for fingerprint ridge and the delta point where the vertical ridge and the horizontal ridge are met and generated.

This chapter explains the interface device and its method between POS(POS: Point-of-sale) system and fingerprint identification system and the credit dealing system made by it.

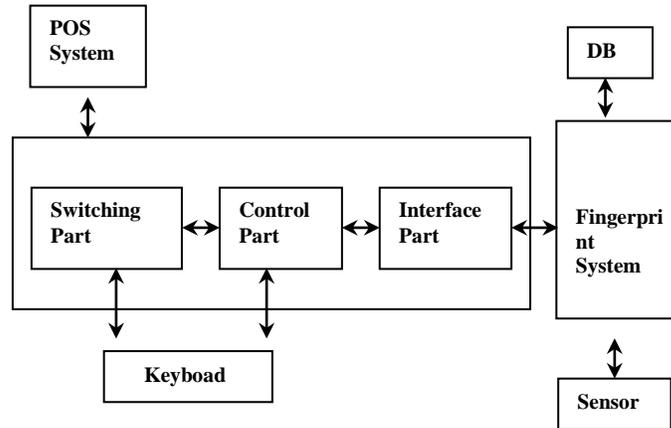


Figure 3. Interface Device between POS and Fingerprint Identification System

This device is composed of the switching part which transfers to the POS system the input signal from the keyboard of POS system, or ignores the input signal of the keyboard and transfers to the POS system the input signal from the fingerprint identification system, the control part which prints out the input signal from the keyboard to the fingerprint identification system, or when a signal is input from the fingerprint identification system, controls the switching part and transfers to the switching part the input signal from the fingerprint identification system, and the interface part for the signal transfer between the control part and the fingerprint identification system. Therefore, it is possible to integrate the fingerprint identification system to the existing POS system to enable the data transfer between them with only one keyboard. By using this device, it is possible to graft the biometric system without changing the existing POS system.

By using this interface device, it is configured not to change the existing POS program and its operating system, with grafting the fingerprint identification system to the existing system without possibility of an error in financial dealings, so as to permit the consumers to more easily utilize the non-medium payment.

The followings are the operating method. First, assuming that a fingerprint has already been registered, if the user inputs his or her fingerprint without showing the credit card, the interface device sends this to the local verification device, and then if the authorization is made, it transfers to the POS system the customer's card information saved in the database in the same manner to read the card. Since it transfers the already-registered card number, a clerk who is not familiar to the credit card can more easily make billing and also the consumer is not required to show up the card from the wallet, resulting higher security and convenience of the card.

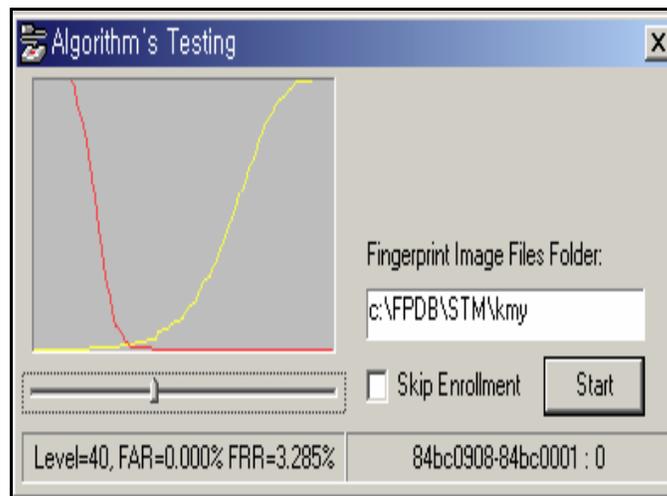
And the strong point of this system is the possibility to register also the point card of a discount store, so as to enable the point accumulation only with one input of the fingerprint, meaning that it will be very properly and usefully utilized in the discount stores which require shorter dealing time.

3. Experiments

The result of the fingerprint DB test (compare to the before and after the algorithm improvement) is as follows. * EER is the equal error rate with the average figure of FAR and FRR that it measures the degree of error for algorithm. In the actual system, choose the threshold value of FAR=0, rather than selecting the threshold value with the minimum figure of EER in a way of minimizing the erroneous recognition rate.

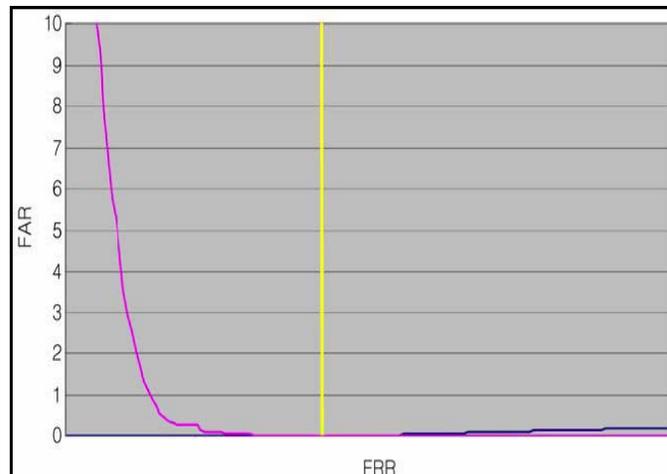
1) Previous algorithm

- EER = 1.216 %
(when FAR = 0.608% and FRR = 1.825%)



2) Improved algorithm

- EER = 0.0039%
(when FAR = 0.0% and FRR = 0.0077%)



The credit dealing system in the past has used POS system to make the calculation of the sales in a member store and to make payment with cash or credit card.

For the payment by a credit card, they use the card reader of POS system to read the credit card, to request the authorization of the card company or the bank, and as authorized, to receive the authorization results.

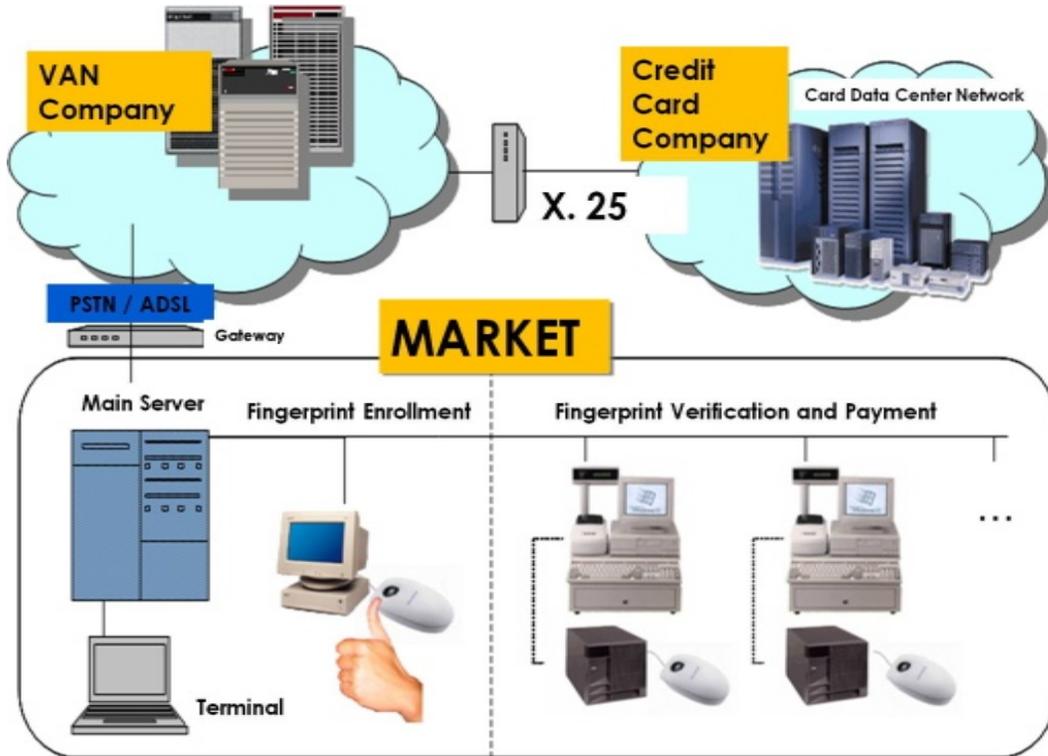


Figure 4. System Configuration

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Therefore, it is possible to integrate the fingerprint identification system to the existing POS system to enable the data transfer between them with only one keyboard. By using this device, it is possible to graft the biometric system without changing the existing POS system.

By using this interface device, it is configured not to change the existing POS program and its operating system, with grafting the fingerprint identification system to the existing system without possibility of an error in financial dealings, so as to permit the consumers to more easily utilize the non-medium payment.

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- 1) Fingerprint Verification Server Installation within Store
 - Info to be saved: group number, fingerprint template, residential number, name, credit card info and bonus card information.
 - Use of the network within store, permitting cross verification of many stores (One server can combine many stores)
- 2) 1:1 relation between respective POS within store and Fingerprint Verification Memory Pack
 - Info saved in Memory Pack: group number, fingerprint template, credit card info and bonus card information.
 - Designed to allow fingerprint payment despite troubled communication with fingerprint verification server.

Table 1. Operating Result

Item	Results	Remarks
Number of persons who registered fingerprint	- Totally 5,341 persons - Average 137 persons per day	- This number decreases as time goes by - Now average 80 persons per day
Number of payment cases by fingerprint	- Totally 5,062 cases - Average 130 cases per day	- This number increases as time goes by - Now average 170 cases per day
Payment amount by fingerprint	- Totally 230 million won paid - Average 5.9 million won per day	- This number increases as time goes by - Now average 7.7 million won per day
Number of users & payment per customer	- Totally 2,389 users - Average 45 thousand won per customer	- 45% of the fingerprint-registered persons - The payment per customer hardly changes as time goes by

There is no solution for mutual compatibility from the fingerprint registration since the verification servers is installed respectively for each brand store. Limitation to expand the service because it requires the members to respectively register for each brand store and to be granted with different group number (5,000 fingerprints classified as one group for preventing from false acceptance)

There is a possibility to drain out the member information because the verification server is installed within a store. Necessary to make solutions for the security of the input fingerprint and the member information

Table 2. Analysis of Result

Item	Results	Remarks
Number of persons who registered	- 5,341 persons registered	- Members of Songpa branch bonus card (70 thousand), monthly average number of uses of the Company (20.5 thousand) - 7.6% of bonus card members, 26.1% of
Number of persons who used	- 2,389 users	- 3.4% of bonus card members, 11.7% of the uses of the Company
Number of fingerprint use cases	- 5,062 cases (May: 4,136 cases)	- 7.5% of the Company's card uses in May (55,191 cases)

4. Conclusions

In the comparison of the existing algorithm and the improved algorithm, we can see clearly better result.

The test fingerprint DB is 80 images from the thumb to the little finger that have been used for actual verification, and the previous algorithm showed a drop in the verification rate for the little finger, but the improved algorithm show a great result in the fingerprint DB even for the ones that included the little finger.

In conclusion, considering the fact that the capability difference of the two algorithms under the ST Bench Marking Test was low while the EER of algorithm that are highly ranked in test results of companies from the fingerprint verification competition (FVC) is around 1-2%, the improved algorithm can be commercialized.

In addition, a marked improvement has been made compared with the previous algorithm.

For non-medium transaction, the input is Multi-Stage inputs the fingerprint, and the fingerprint data is composed as follows for optimizing performance of the algorithm of the fingerprint verification system.

Fingerprint data are saved as one unit in order to reduce FNMR rate which was heightened as the FMR was adjusted as 0% under the characteristics of the credit dealing authorization system. By this, having reached 3.86%, the FNMR rate is reduced to 0.1% (FMR=0).

The fingerprint matching is classified as 1:1 matching and 1:N matching, and this system applies 1:N matching[7, 8].

Because compared to 1:1 matching, the 1:N matching requires shorter time to match the input templates with all the saved fingerprint templates, the Classification & Search Method which is developed on the basis of the actual user data affects the swiftness and accuracy of the matching results[5, 6, 11].

The algorithm used in this paper optimized the classification and search technology on the basis of the actual fingerprint data of about ten thousand customers of a mart.

Definition of Acceptance Error is classified as false acceptance and false rejection.

- False Acceptance: it misidentifies him or her as another registered one (processing fingerprint A as fingerprint B)
- False Rejection: it rejects a registered user (not recognizing fingerprint A as the registered A)

Both are in inverse proportion, while the minimization of false acceptance is more important for maintaining the high performance.

The probability of false acceptance in fingerprint verification is about one millionth, but it is necessary to make preventive solutions and ex post facto measures.

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