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Fingerprint Identification Using Binary Images By Ridge Thinning Method

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Abstract—There are various methods for identification of a fingerprint out of which minutiae based is a challenging task of extracting the minutiae like ridges and bifurcations. So, for that purpose here we are using thinning based method for extracting the features of a binary image. Experimentswere conducted on Fvc2002 databases DB1_1, DB2_1, DB3_1, DB4_1. Experiments were conducted on each data set separately.

Keywords — Identification,Fingerprint, Ridges, Bifurcations, Thinning.

I. INTRODUCTION

Identity establishment is crucial in this immensely interconnected society. The identity of an individual who requests a service can be determined by using an identity recognition system. The intention of such schemes is to ensure that only the authorized user accesses the services and no one else. Biometric recognition refers to the recognition of an individual based on their physiological and/or behavioral traits [1]. Biometrics are used to affirm the identity of an individual based on "who the person is," rather than by "what the person possesses" (e.g., An Identity card) or "what the person knows" (e.g., A unique password). Biometrics are used to prevent illegitimate access to ATMs, safe lockers, secure workstations, internet banking and in automobiles [2].

Kalluri et al., [3-5] proposed palmprint identification algorithms. Kumar et al., [6] proposed face recognition using LDP. Amongst all biometrics, fingerprint identification is one of the most widely used and popular biometrics. Fingerprint identification systems are automated [7]. Sir Francis Galton defined the characteristic points of the fingerprints with which it can be identified and these were referred to as Galton points[8]. The subset of Galton points is used to represent the fingerprint image and these are referred to as minutiae.

The most important thing in fingerprint identification or verification system was feature extraction and matching. Here in this literature we are presented recent approaches that were used for feature extraction and matching. Typically, the original gray scale fingerprint image has a bit depth of 8 bits, and depending on sensor size each such an image will require a few Mbyte of storage. Lossless or irreversible compression methods such as JPEG can be used to compress the image by a factor of 10 or more, but each image will still occupy some memory space. This is one of the reasons why the features of the fingerprint rather than the complete picture is used for matching; digitized features simply require less storage space and even more important, less complicated matching algorithms than should have been needed when using the full image.

Zhixin et al., [9] proposed a Chain code Based Scheme for Fingerprint Feature Extraction. Here the researchers applied some of preprocessing algorithms (image enhancement) Anisotropic Filter on a grayscale image to get a binary image and for better extraction of features from this binary image.and next they applied a chain code method to extract features from this binary image.Jung et al., [10] described minutiae extraction in a binary image based on run-length code.they obtained a binary image by enhancement of gray scale image using Otsu thresholding methods and Gabour filtering and extracted minutiae points using ridge flows in a binary image by using the adjacency runcount method they identify whether the minutiae is ridge ending and ridge bifurcations. Marco et al., [11] Fingerprint local analysis for high-performance Minutiae extraction,A novel approach for fingerprint minutiae extraction in a binary image on the basis of intensity values by using a squared method.this squared method3x3 mask is applied to every pixel on a binary image If the average of masked pixel is lesser than 0.25, it is noticed as a ridge termination minutiae and if the average of masked pixel is greater than 0.75, then it is a bifurcation minutiae.

Khanyile et al., [12] have made a comparative study on four different thinning algorithms and they compared these algorithms in terms of quality and time complexity associated with each method. Zhang and Suen's were taken a less time to skeleton image than that of Guo and Hall's algorithm.the thinning algorithms were also varied based on the application usuage. Feature extraction from this thinning algorithm was also simple by using Crossing Number method or By morphology based methods. Jinxing et al., [13] described a minutiae extraction from a direct gray level image by examining the relationship between the ridges and furrows. The method is based on tracking the relationship between the ridges and furrows in a local neighborhood form a sinusoid-shaped plane wave which has a well-defined frequency and orientation which will extract local features in a fingerprint.

Fingerprint matching is a difficult approach due to quality variations of the fingerprint from the same user in time. These variations are due to changing skin conditions, noise, errors caused during extraction. Here are some of the previous research work done on fingerprint paring algorithms by different authors. Hrushikesh et al., [14] described fingerprint matching of partial fingerprints by using texture based extraction by DWT method.Here they applied this method on a whole fingerprint image used morphological operations. After extraction of features they conducted a mathing on by calculating similarity scores and distance measures. Jiang et al., [15] explained matching of a fingerprint by using local correlation based methods instead of minutiae.They find the neighborhood correlation score and edge correlation score between two minutiae pairs this both scores are used to identify whether the match occurs or not. Marius et al., [16] proposed a method of fingerprint matching based on finding an average ridge pattern around orientation of a circular minutiae.to make a geometrical alignment between two images a greedy algorithm was used here for matching was performed using point patterns. experiment was conducted on public available datasets which given a good results.

Rodrigues et al., [17] proposed a fingerprint matching based on characteristic vector generated from fingerprint minutiae generated by using a triangulation based method for all the minutiae points in a fingerprint image. they compared a characteristic vector between two fingerprint images the experimental results give good results on public databases.Feng et al., [18] here for matching of a two fingerprints they were used pores in which they used sparse technique to identify difference between pores. false pores were removed by using weighted RANSAC algorithm.

The remaining part of the paper is organized as follows: section 2 explains about the fingerprint feature extraction. Section 3 explains about the proposed algorithm for palmprint identification, section 4 explains about experimenatal results. Conclusions are given in section 5.

II. FINGERPRINT FEATURES

Fingerprint features were categorized into three levels based on the type of area we are using and for some applications combination of levels were used.

Level1: level1 features are whole,loops(left loop,right loop),arches we can call these features as patterns which is used to classify the fingerprints. This feature cannot be suitable for identification of an individual separated but were mainly helpful for classification and indexing.Level2:level2 features are Ridge endings,Lakes,Islands,Birfucations,we can call these features as minutiae which were used for better identification of a person.These features can be easily extracted.Level3:level3 features are Pores,Scars,Ridge units,Edgedetail.This gives the intrinsic information in a fingerprint,but they need high resolution sensors.

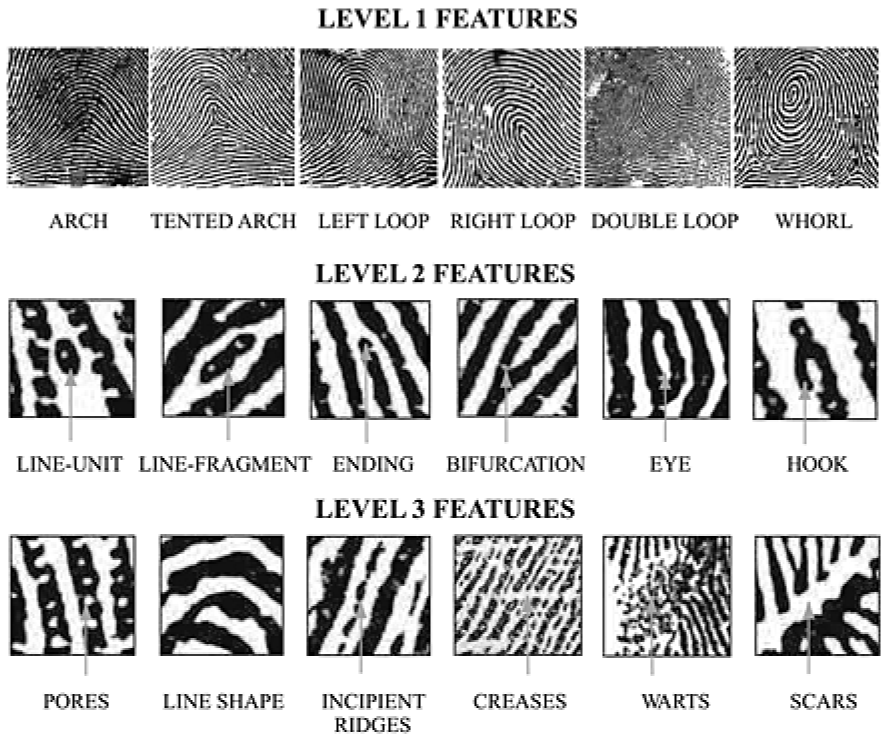

Fig 1 Features at different levels

III. Algorithms used for fingerprint identification and verification

For identification or verification of a fingerprint it needs to undergo different modules 1) Fingerprint Acquisition 2) preprocessing 3) postprocessing 4) Matching 5) Fingerprint verification and identification.

A.Fingerprint Acquisition

This was the first important task in fingerprint identification system, extracting minutiae from a captured fingerprint image. The fingerprint image captured by the device returns an image, usually with 256 grey-levels, which consists of dark (ridges) and bright (valleys) lines.Fingerprint image was captured either one of the following ways.a) Scanning an inked impression of a person's finger,b) Using a live-scan fingerprint scanner.

Fig 2 a)Inked impression on paper b)Live-scanned fingerprint by a sensor

B.Preprocessing

This was the base stage that we will perform on an image before going next modules in our implementation.If the processing steps in this base module would be good, then it will yield a good result in remaining modules.For removing of noise that is present in a fingerprint image we willdo image enhancement like segmentation, ridge frequency estimation, ridge orientation estimation and ridge filtering operations on a Gray scale fingerprint image which were obtained from different sensors.Here on preprocessing stage we will obtain a binary image from the ridge filtering operation.

C.Postprocessing

This was the stage where required features from the fingerprint are extracted and that feature was processed by using postprocessing algorithms.Here we applied crossing number algorithm on a thinned image for specifying features.crossing Number algorithm is one of the best method for extracting the level2 features.

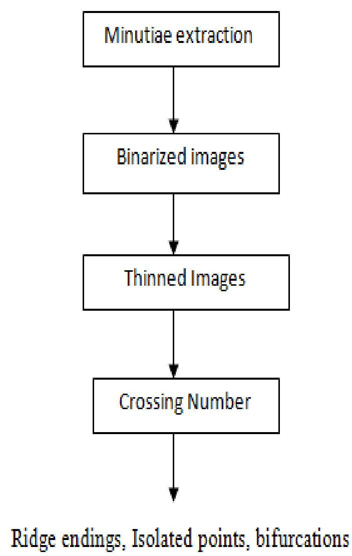

Fig 3 procedure followed in minutiae extraction

1)Thinning operation

To get a thinned image we will apply a morphological operation on a binary image by using bwmorph function which will take input arguments like inverse binary image and thin.it will shrink the ridges until it gets to one pixel wide. This method can be useful to extract the required minutiae from the thinned image.

2) Minutiae Identification

i) We need to first extract the minutiae from a thinned image.

ii) For identifying the minutiae points from the thinned we will apply crossing Number method on that thinned image.

iii) It will apply 3x3 window on the whole image local neighbor pixel and identify CN values by using

$$CN = {}^{1}/_{2} \sum_{i=1}^{8} |P_i - P_{i+1}| \qquad (1)$$

iv)If CN=0 values would isolated point, CN=1 it was ending point CN=2 it would be a connection point one it would be CN=3 was Bifurcation point else CN=4 it was identified as crossing point.

v) Here we will take bifurcation,ridge ending points x,y coordinates and orientation of that minutiae.

3)False Minutiae Removal

Fingerprint matching process maybe effected by a false minutiae.Which were obtained during the thinning process.So,for removing of false minutiae we will use distance measure between two ridge endings,two ridge bifurcations and between one ridge ending and ridge bifurcations**.**

D.Matching

This phase was most important in the decision making whether the two given fingerprints given for matching were correctly matched or not. To find the match between enrolled minutiae and test minutiae we will use the alignment operation to make alignment we will transfer (x,y, theta) with respect to its reference minutiae point.Find the match between both transformed minutiae of enrolled minutiae and test minutiae by using Euclidean distance and also finds similarity scores.If similarity scores >threshold, it will display matched indexes.

E. Fingerprint Verification / Identification

In fingerprint verification query fingerprint is compared with the corresponding finger database fingerprint image. If the similarity score is greater than the specified threshold, then declare the query fingerprint is identified fingerprint otherwise declare the query fingerprint is not genuine. In fingerprint identification, query fingerprint is compared with all the database fingerprintimages. The highest similarity fingerprint is declared as the identified fingerprint.

IV. EXPERIMENTAL RESULTS

Performance evolution rates like FAR,FRR,EER and accuracy were identified by analyzing the feature extraction, matching algorithms on FVC2002 Databases. Here in this database we are having four fingerprint datasets which are collected from different sensors with different resolutions Table1 gives information about datasets collected from sensors, and with what type resolutions they were obtained. Fig 4 shows the images from each dataset.

Database	Sensor Type	Image Size	Set B (wxd)	Resolution
DB1	Optical Sensor	388x374 (142Kpixels)	10x8	500dpi
DB2	Optical Sensor	296x560 (162Kpixels)	10x8	569dpi
DB3	Capacitive Sensor	300x300 (88 pixels)	10x8	500dpi
DB4	SFinGeV2.51	288x384 (108Kpixels)	10x8	about500dpi

Table 1:FVC2002DB_B Sets

Fig 4 Shows images from each dataset

The Same finger impression was collected 8 times with time differences from 10 users. So, in each dataset we are having total 80 images**.**

A.Performance Evaluation Metrics

Here we will analyze the performance of a system by using EER, FAR, FRR.

*1)FAR:*Incorrectly Identify an unauthorized user as a valid user.

$$FAR = \frac{Imposter\ \ Score}{All\ Imposter\ \ Score} \tag{2}$$

Biometric system providing low FAR ensures high security.

*2)FRR:*The system will incorrectly reject an authorized user as an invalid user.

$$FRR = \frac{Genuine\ \ Score\ \ falling\ \ below\ \ threshold}{All\ Genuine\ \ score} \tag{3}$$

*3) EER:*By combining of both FAR and FRR we will get an EER.

4)Accuracy from each dataset were calculated using $Accuracy = \frac{Number\ \ of\ Correctly\ \ Identified}{Total\ Number\ \ of\ Identifications}$

B. Results Obtained From All Data Sets

DB1 consists of 80 fingerprint images of 10 fingers. 10 fingerprint images (for every finger, one fingerprint image) are used for training and the remaining 70 fingerprint images are used for identification. Out of 70 fingerprint images 65 fingerprint images are correctly identified, i.e accuracy obtained is 92.85. In obtaining EER, every query image is compared with the same fingerprint database image to obtain FRR (False rejection rate). i.e 70 comparisons are made for FRR. Every query image is compared with remaining fingerprint database images to obtain FAR (False Acceptance Rate), i.e 630 comparisons are made. FAR& FRR diagram is shown in Fig 5 (a) and obtained EER is 0.05. Similarly for DB2, 65 fingerprint images are correctly identified, i.e accuracy obtained is 92.85. EER obtained for DB2 is 0.07. For DB3, 60 fingerprint images are correctly identified, i.e accuracy obtained is 85. EER obtained for DB3 is 0.17 . For DB4, 67 fingerprint images are correctly identified, i.e accuracy obtained is 95.7. EER obtained for DB3 is 0.17 .

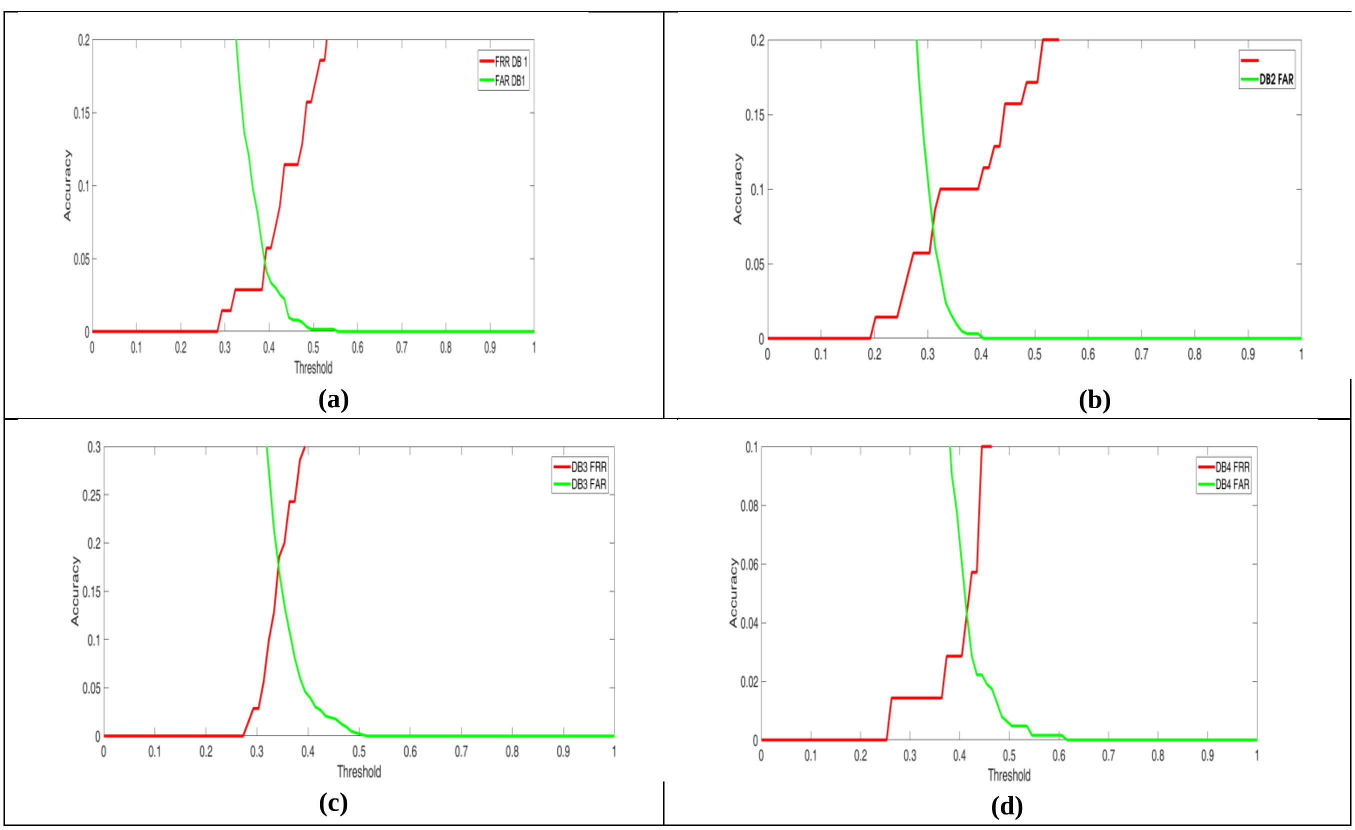

Fig 5. FRR and FAR plots (a) DB1 (b) DB2 (c) DB3 (d) DB4

V. CONCLUSION

Thinning based method applied toobtain minutia points. Later minutia points information used for fingerprint verification and identification. Experiments were conducted on FVC2002 data set. Experimental results show that proposed approach is suitable for fingerprint verification and identification.

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