Minutiae Extraction and Variation of Fast Fourier Transform on Fingerprint Recognition

Amandeep Kaur[1], Ameeta[2], Babita[3]

[1]Department of ECE, PCET, Lalru Mandi. PTU Jalandhar, Punjab

[2]Asst. Professor, Department of ECE, PCET, Lalru Mandi. PTU Jalandhar, Punjab

[3] Asst. Professor,Department of Computer Science and Engineering , PCET, Lalru Mandi PTU Jalandhar, Punjab

Email:-amankaurpcet@gmail.com

Abstract—A fingerprint is the feature pattern of one finger. It is believed with strong evidences that each fingerprint is unique. Each person has his own fingerprints with the permanent uniqueness. So fingerprints have being used for identification and forensic investigation for a long time. The fingerprint recognition problem can be grouped into two sub-domains: one is fingerprint verification and the other is fingerprint identification In addition, different from the manual approach for fingerprint recognition by experts, the fingerprint recognition here is referred as AFRS (Automatic Fingerprint Recognition System), which is program-based. This paper presents the variation of Fast Fourier Transform on finger print recognition by fast fingerprint minutiae extraction and recognition algorithm which improves the clarity of the ridge and valley structures of the input finger print images based on the frequency and orientation of the local ridges and thereby extracting correct minutiae .This research work has combined many methods to build a minutia extractor and a minutia matcher. Simulation results are obtained with MATLAB going through all the stages of the fingerprint recognition is built. It is helpful to understand the procedures of fingerprint recognition. And demonstrate the key issues of fingerprint recognition

Keywords— Region of Interest (ROI); Fast Fourier Transform (FFT).FFR, FAR , SMCBA ,OCR,FKP

I. INTRODUCTION

Biometric templates are unique to an individual. Unlike password, pin number, or smart card, they cannot be forgotten, misplaced lost or stolen. The person trying to access is identified by his real id (represented by his unique biometric signature). Fingerprint scanning has a high accuracy rate when users know how to use the system. Fingerprint authentication is a good choice for in house systems where training can be provided to users and where the device is operated in a controlled environment. Small size of fingerprint scanners, ease of integration can be easily adapted for appliances (keyboards, cell phones, etc). Relatively low costs make it an affordable, simple choice for workplace access security. Fingerprint identification is the oldest method among all the biometric techniques, and has been used in various applications. Every person has unique, fingerprints which can be used for identification. Steps for fingerprint identification are: scanning (capture, acquisition), extraction (process), comparison, and final match/non-match decision. A series of ridges and furrows on the surface of the finger made a fingerprint. We create pattern of ridges and furrows as well as the minutiae points to get unique fingerprint. Fingerprint based identification has been one of the most successful biometric techniques used for personal identification. Each individual has unique fingerprints. A fingerprint is the pattern of ridges and valleys on the finger tip. A fingerprint is thus defined by the uniqueness of the local ridge characteristics and their relationships. Minutiae points are these local ridge characteristics that occur either at a ridge ending or a ridge bifurcation. A ridge ending is defined as the point where the ridge ends abruptly and the ridge bifurcation is the point where the ridge splits into two or more branches. Automatic minutiae detection becomes a difficult task in low quality fingerprint images where noise and contrast deficiency result in pixel configurations similar to that of minutiae. This is an important aspect that has been taken into consideration in this project for extraction of the minutiae with a minimum error in a particular location.

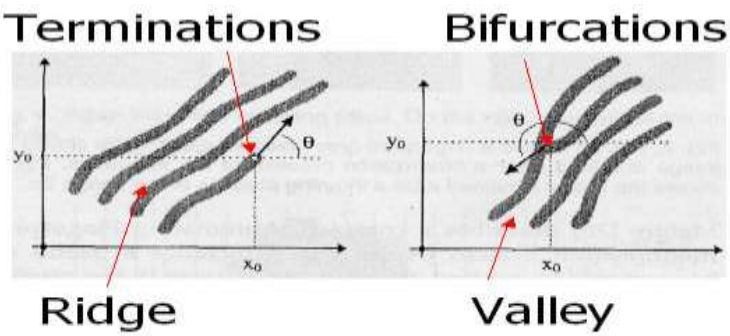


Fig. 1: Ridge Endings and Bifurcations

II. LITERATURE REVIEW

I. Al Rassan, I et al. 2013. Securing Mobile Cloud Computing Using Biometric Authentication (SMCBA). This paper proposes and implements a new user authentication mechanism of mobile cloud computing using fingerprint recognition system to enhance mobile cloud computing resources

II. Baris Coskun et a.l 2014 "Recognition of Hand-Printed Characters on Mobile Devices "This paper explores the challenges of performing this character identification and presents a novel scale/rotational invariant algorithm applied to the recognition of these hand-drawn letters. The results of the algorithm are compared to those obtained using a popular Optical Character Recognition (OCR) application, Tesseract, that is often integrated with iPhone Apps for this purpose

III R. Wildes I.et al. 2014 " Biometric Authentication Using Kekre's Wavelet Transform"

This paper proposes an enhanced method for personal authentication based on finger Knuckle Print using Kekre's wavelet transform (KWT). Finger-knuckle-print (FKP) is the inherent skin patterns of the outer surface around the phalangeal joint of one's finger. It is highly discriminable and unique which makes it an emerging promising biometric identifier. Kekre's wavelet transform is constructed from Kekre's transform. The proposed system is evaluated on prepared FKP database that involves all categories of FKP. The total database of 500 samples of FKP. This paper focuses the different image enhancement techniques for the pre-processing of the captured images

IV J. G. Daugman.et al 2014 " Finger-knuckle-print verification based on vector consistency of corresponding interest points"

This paper proposes a novel finger-knuckle-print (FKP) verification method based on vector consistency among corresponding interest points (CIPs) detected from aligned finger images.. Experimental results show that the proposed approach is effective in FKP verification.

III. OBJECTIVE:- The objective of this Paper is to investigate the current techniques for fingerprint recognition. This target can be mainly decomposed into image pre-processing, feature extraction and feature match. For each sub-task, some classical and up-to-date methods in literatures are analyzed. Based on the analysis, an integrated solution for fingerprint recognition is developed for demonstration. For the program, some optimization at coding level and algorithm level are proposed to improve the performance of fingerprint recognition system with the variation of FFT on stored images. These performance enhancements with the variation of FFT are analyzed and shown by experimental results conducted upon a variety of fingerprint images

IV. AN OVERVIEW OF THE METHOD/METHODOLOGY:-

ISSN 2091-2730

1. System Design (System Level Design & Algorithm Level Design)

2. Fingerprint Image Preprocessing (Fingerprint Image Enhancement, Binarization & Image Segmentation)

3. Minutia Extraction (Fingerprint Ridge Thinning & Minutia Marking)

4 .Minutia Post-processing (False Minutia Remove & Unify Minutia Representation Feature Vectors)

5. Minutia Match (Alignment Stage &Match Stage)

6. Experimentation Results

Evaluation Indexes

Experiment Analysis

1. System Design:-

System Level Design:-A fingerprint recognition system constitutes of fingerprint acquiring device, minutia extractor and minutia matcher as shown in figure

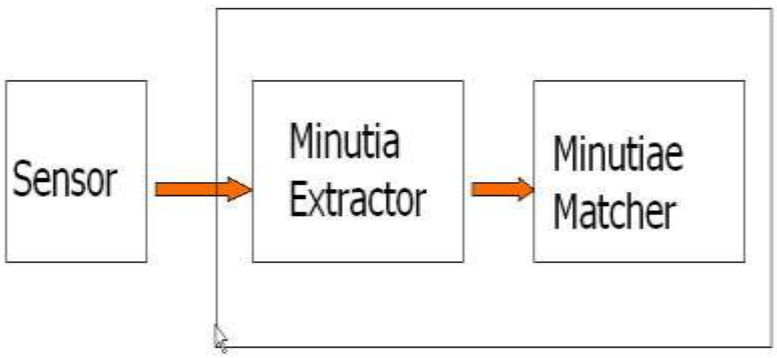


Figure 2: Simplified Fingerprint Recognition System

Algorithm Level Design:-To implement a minutia extractor, a three-stage approach is widely used by researchers. They are pre-processing, minutia extraction and post-processing stage

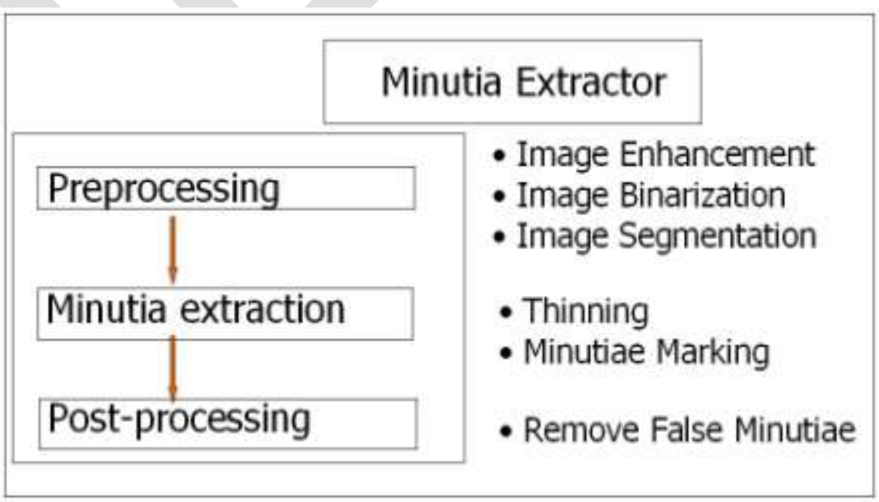


Figure 3:Minutia Extractor

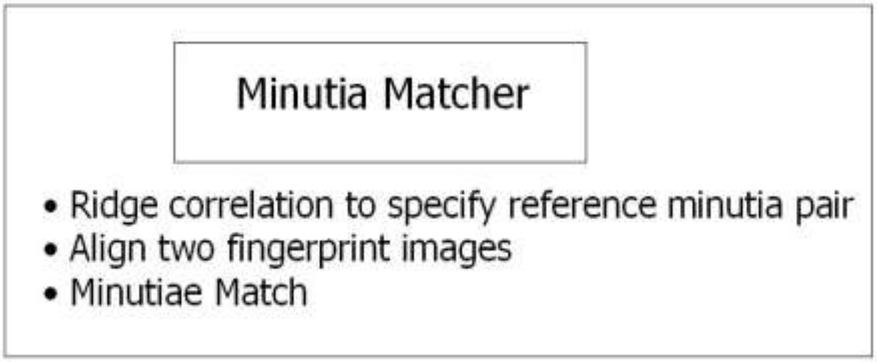


Figure 4: Minutia Matcher

The minutia matcher chooses any two minutia as a reference minutia pair and then match their associated ridges first. If the ridges match well, two fingerprint images are aligned and matching is conducted for all remaining minutia.

Fingerprint Image Enhancement:- Fingerprint Image enhancement is to make the image clearer for easy further operations. Since the fingerprint images acquired from sensors or other media are not assured with perfect quality, those enhancement methods, for increasing the contrast between ridges and furrows and for connecting the false broken points of ridges due to insufficient amount of ink, are very useful for keep a higher accuracy to fingerprint recognition .Two Methods are adopted in my fingerprint recognition system: the first one is Histogram Equalization; the next one is Fourier Transform.

V. ANALYSING FINGERPRINT PARAMETERS AND RESULTS

1.Finger print Image Pre-processing 2.Fingerprint Image Binarization 3.Fingerprint Image Segmentation

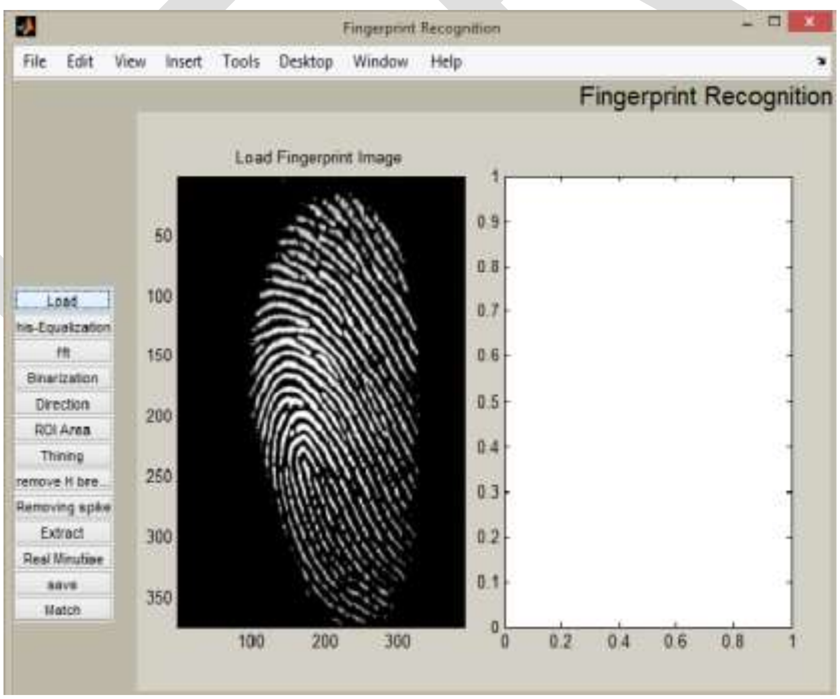


Figure 5: Finger Print Loading

Fingerprint scanning is the recognition and identification first step to record different characteristics for identification purposes. This process identifies an individual person through quantifiable physiological characteristics. There are two types of finger-scanning technology.

1. First is an optical method, which starts with a visual image of a finger.
2. The second uses a semiconductor generated electric field to image a finger.

Fingerprint image enhancement is done using histogram equalization.

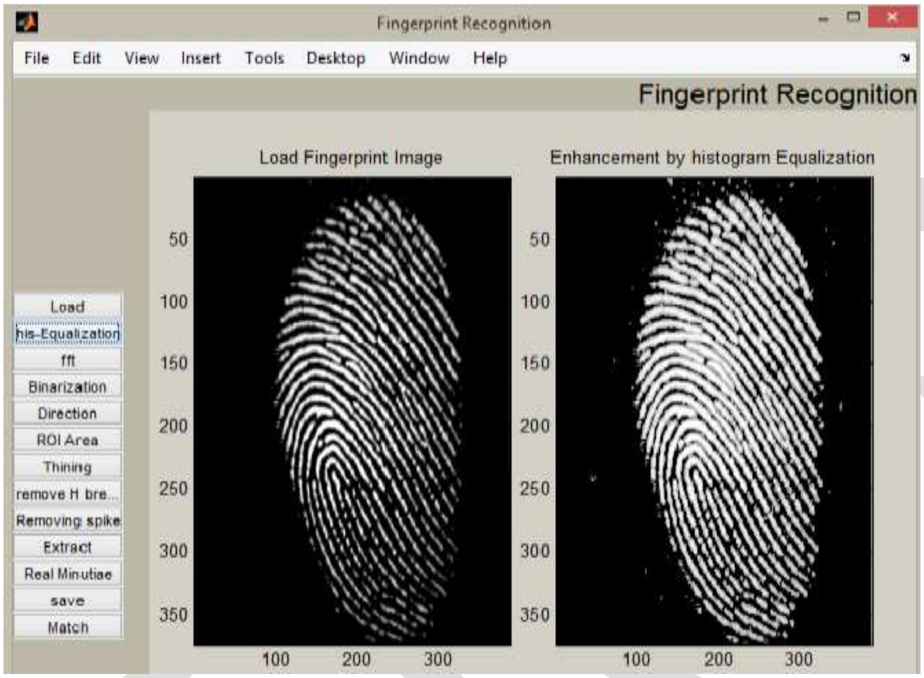


Figure 6: Histogram Equalization

Fast Fourier Transform:- A **fast Fourier transform** (**FFT**) is an algorithm to compute the discrete Fourier transform (DFT) and its inverse. Fourier analysis converts time (or space) to frequency and vice versa; an FFT rapidly computes such transformations by factorizing the DFT matrix into a product of sparse (mostly zero) factors. As a result, fast Fourier transforms are widely used for many applications in engineering, science, and mathematics .FFT at different levels can be applied for 0.1 to 0.9.and percentage for finger print matching will be calculated for each finger. Different tables are maintained for each finger with three images and applied FFT from 0.1 to 0.9 levels.

Fingerprint Enhancement by Fourier Transform:We divide the image into small processing blocks (32 by 32 pixels) and perform the Fourier transform according to:

$$F(u,v) = \sum_{x=0}^{M-1}\sum_{y=0}^{N-1} f(x,y) \times \exp\left\{-j2\pi \times \left(\frac{ux}{M}+\frac{vy}{N}\right)\right\} \quad (1)$$

for u = 0, 1, 2, ..., 31 and v = 0, 1, 2, ..., 31.

In order to enhance a specific block by its dominant frequencies, we multiply the FFT of the block by its magnitude a set of times. Where the magnitude of the original FFT = abs(F(u,v)) = |F(u,v)|.

Get the enhanced block according to

$$g(x,y) = F^{-1}\left\{F(u,v) \times |F(u,v)|^{K}\right\} \quad (2),$$

where $F^{-1}(F(u,v))$ is done by:

$$f(x,y) = \frac{1}{MN} \sum_{x=0}^{M-1} \sum_{y=0}^{N-1} F(u,v) \times \exp\left\{ j2\pi \times \left(\frac{ux}{M} + \frac{vy}{N} \right) \right\} \quad (3)$$

for x = 0, 1, 2, ..., 31 and y = 0, 1, 2, ..., 31.

The k in formula (2) is an experimentally determined constant, which we choose k=0.45 to calculate. While having a higher "k" improves the appearance of the ridges, filling up small holes in ridges, having too high a "k" can result in false joining of ridges. Thus a termination might become a bifurcation. Figure 3.1.2.1 presents the image after FFT enhancement.

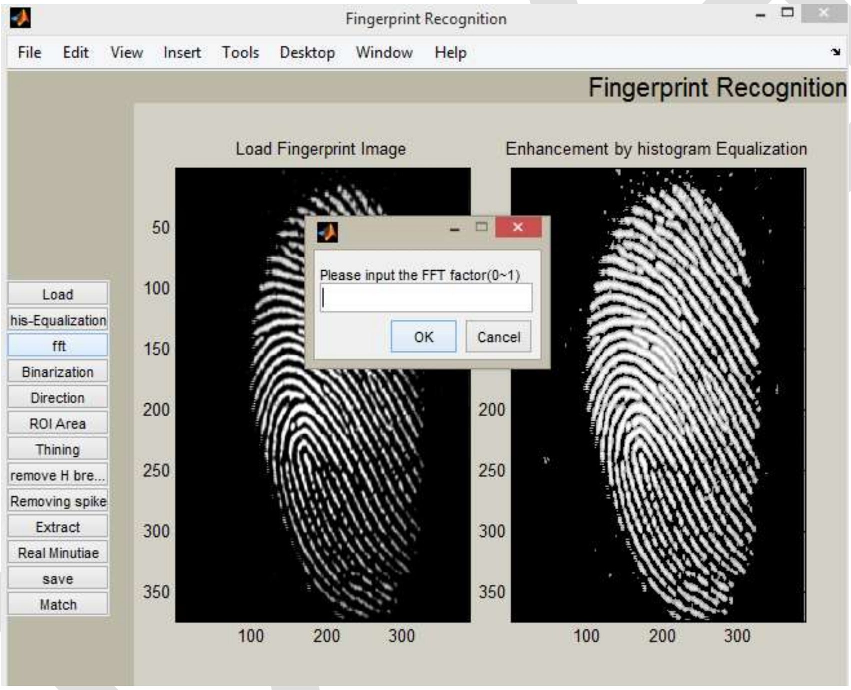


Figure 7:Binarization enhancement by histogram equalization of adaptive binarization after FFT.

International Journal of Engineering Research and General Science Volume 2, Issue 6, October-November, 2014
ISSN 2091-2730

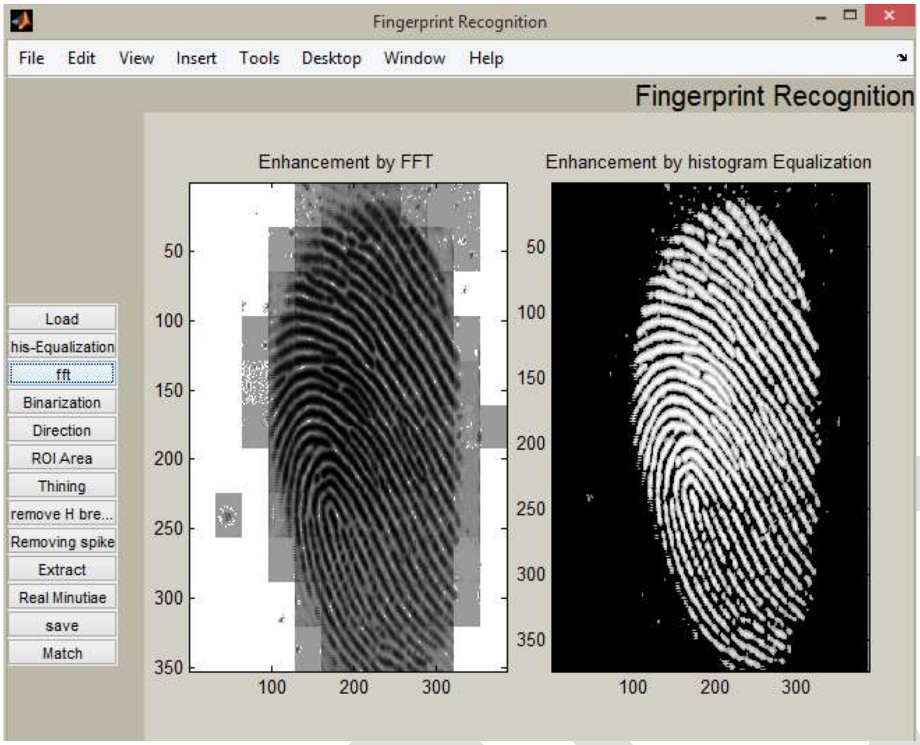


Figure 8:Enhancement by FFT

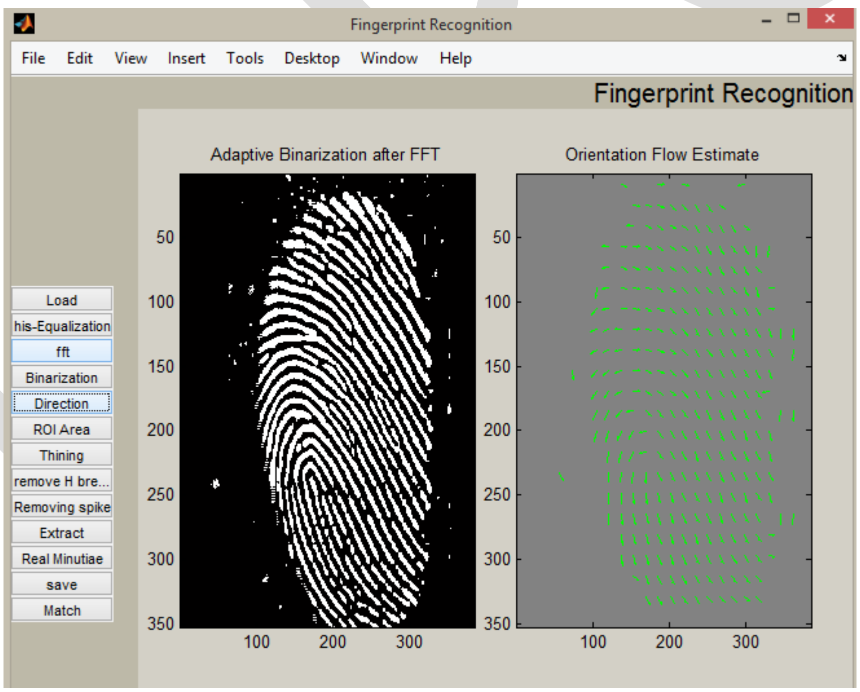


Figure 9: Orientation Flow Estimate

Direction calculates the local flow orientation in each local window with size (block size x block size) direction (gray scale fingerprint image, block size, graphical show disable flag) return p ROI bound return z ROI area.

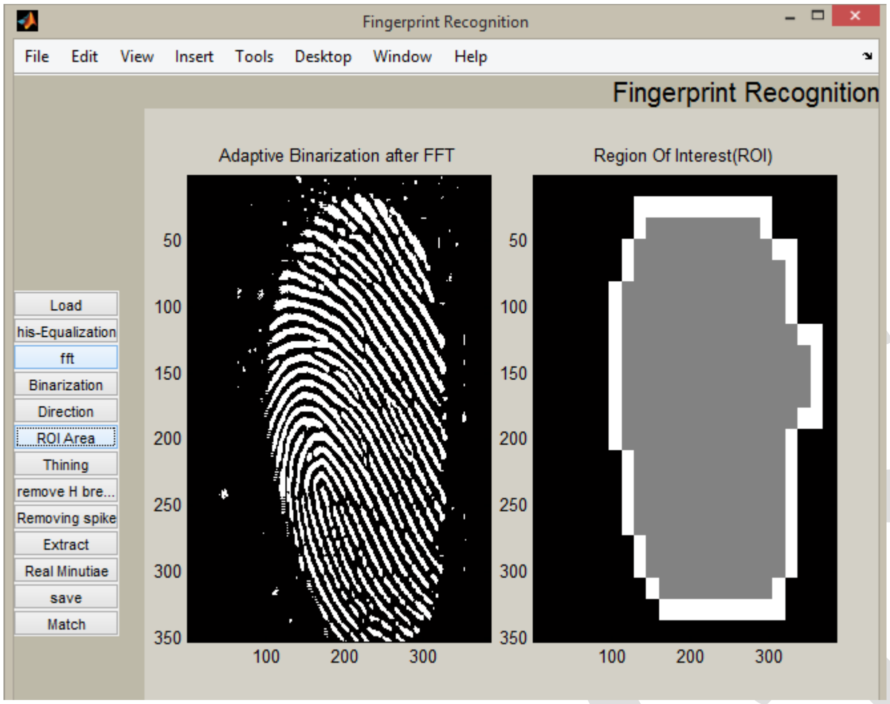


Figure 10: Region of Interest

H breaks of adaptive binarization is done after FFT. Fingerprint shown in figure remove H breaks between curves and generate clear fingerprint image after this step.

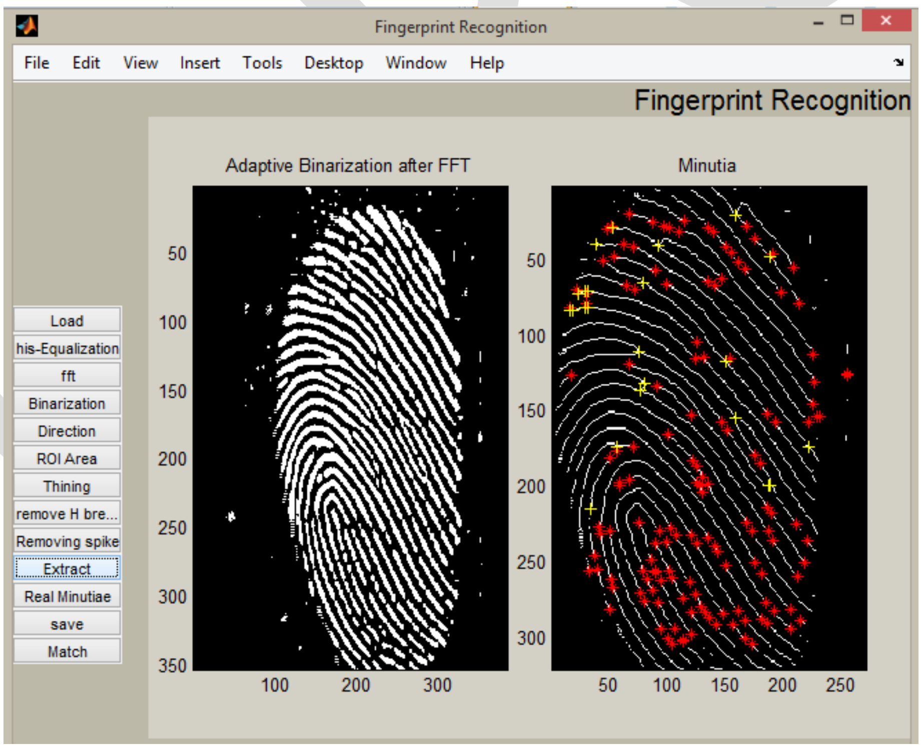


Figure 11: Minutie Extraction

The performance of minutiae extraction algorithm relies heavily on the quality of the input fingerprint images. Fingerprint matching techniques:-There are two categories for fingerprint matching techniques:

Minutiae based: In this category first find minutiae points and then map their relative placement on the finger. It is difficult to extract the minutiae points accurately when the fingerprint is of low quality .Also this method does not take into account the global pattern of ridges and furrows and correlation based.

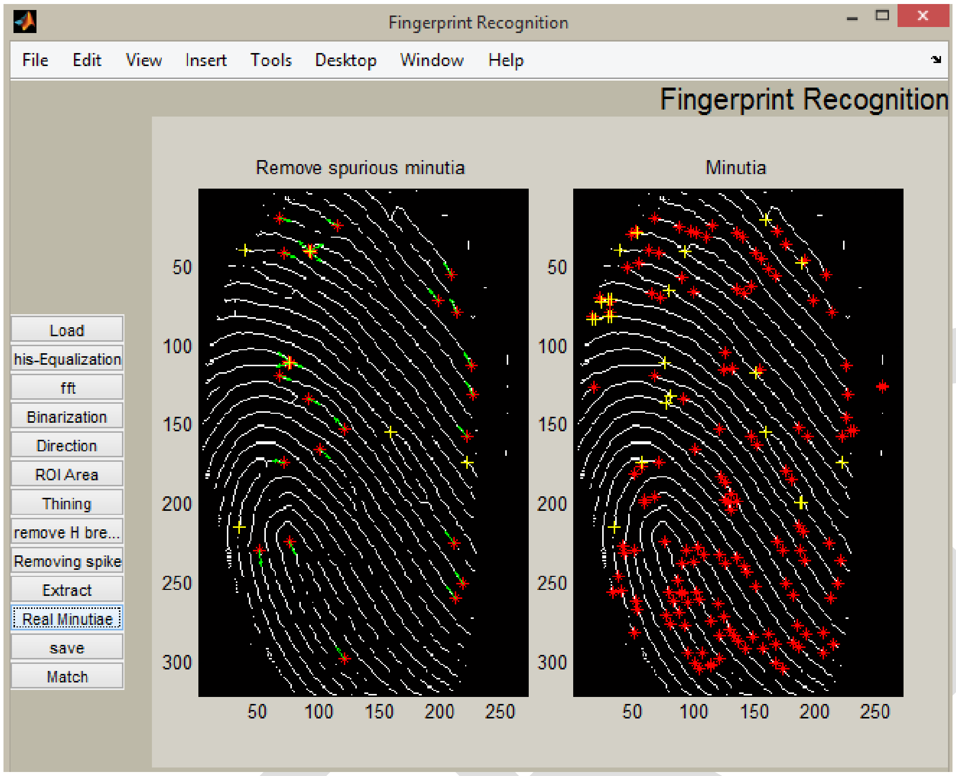


Figure 12: Remove spurious minutia

2. Correlation based: This technique affected by fingerprint image translation and rotation and require the precise location of a registration point. This method is able to overcome some of the difficulties of the minutiae based approach.

FINGERPRINT MATCHING

Fingerprint algorithms consist of two main phases, enrolment and identification or verification. The enrolment phase, first determines the global pattern of the print, so it can be categorized in a large bucket during improve matching performance, the minutia points are then transformed by a, typically proprietary, algorithm into a template. The template is stored and used for future identification. An additional step in the enrolment process could be to search for existing matches. This leads to an interesting advantage fingerprint authentication has over password authentication. As well as being proof of being a particular person, fingerprint identification can also be used prove somebody is not a particular person or persons, such as on a terrorist watch list, or previously having applied a benefit. Finger Print sample recognition process:-The recognition process at real time application. In this figure left fingerprint is at real time and right fingerprint is stored in database. This figure shows the different vector position at different points on finger. If the pattern stored in database match with the real time pattern then it will recognize otherwise it will not recognize the person. The identification phase, first determines a pattern bucket, and then submits the minutia or template, depending on the design, which can be compared to the saved template. The comparison is done with a statistical analysis, since an exact match is not expected. Matches may be found by rotating or translating the image, to compensate for the finger not being placed in an identical location on each use. Evaluation indexes for fingerprint recognition:-Two indexes are well accepted to determine the performance of a fingerprint recognition system: one is FRR (false rejection rate) and the other is FAR (false acceptance rate).

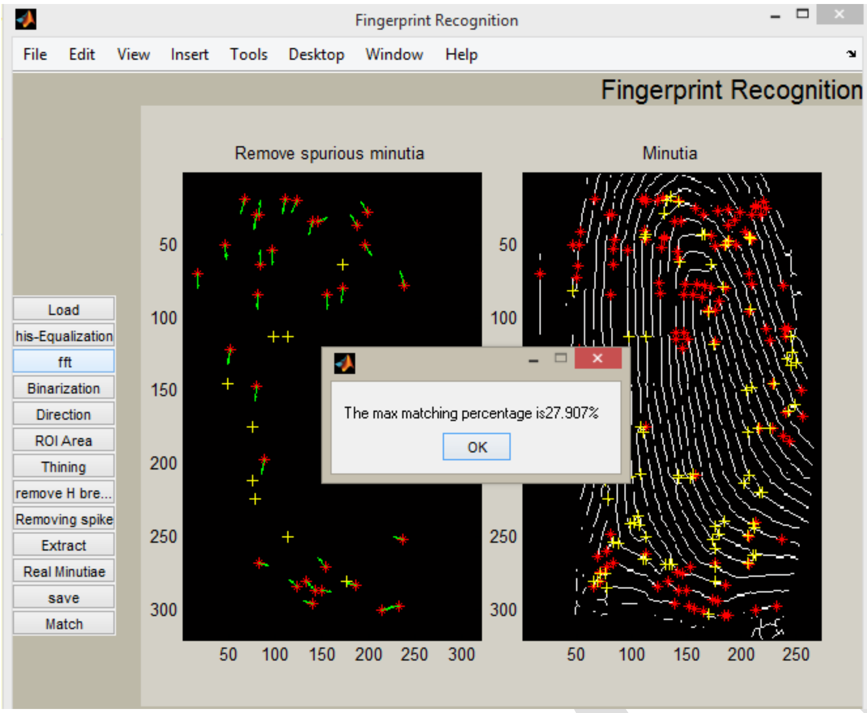
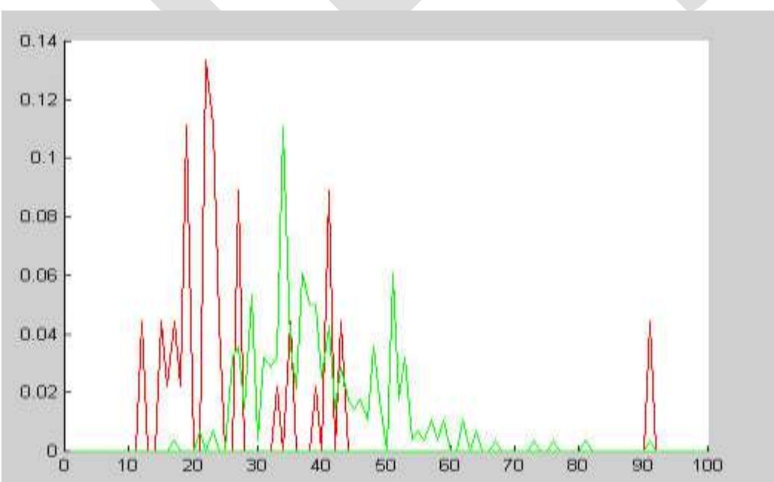


Figure 13: Fingerprint matching

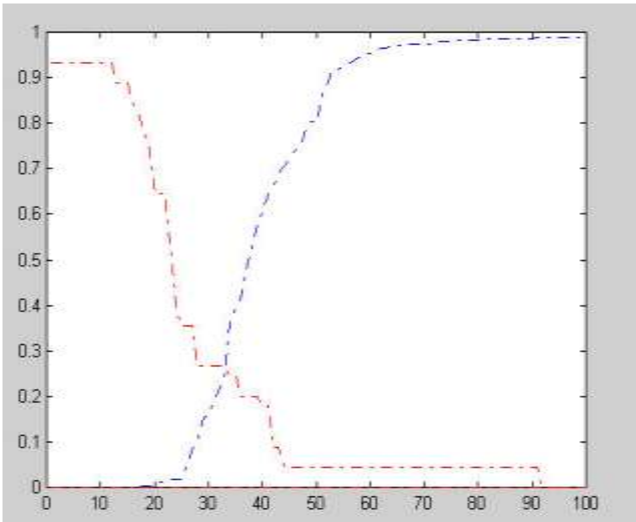
For an image database, each sample is matched against the remaining samples of the same finger to compute the False Rejection Rate. If the matching *g* against *h* is performed, the symmetric one (i.e., *h* against *g*) is not executed to avoid correlation. All the scores for such matches are composed into a series of Correct Score. Also the first sample of each finger in the database is matched against the first sample of the remaining fingers to compute the False Acceptance Rate. If the matching *g* against *h* is performed, the symmetric one (i.e., *h* against *g*) is not executed to avoid correlation. All the scores from such matches are composed into a series of Incorrect Score.A fingerprint database is used to test the experiment performance. Here is the diagram for Correct Score and Incorrect Score distribution:



Red line: Incorrect Score
Green line: Correct

Figure 14: Fingerprint matching

It can be seen from the above figure that there exist two partially overlapped distributions. The Red curve whose peaks are mainly located at the left part means the average incorrect match score is 25. The green curve whose peaks are mainly located on the right side of red curve means the average correct match score is 35. This indicates the algorithm is capable of differentiate fingerprints at a good correct rate by setting an appropriate threshold value.



Blue dot line: FRR curve

Red dot line: FAR curve

Figure 15: FAR and FRR curve

The above diagram shows the FRR and FAR curves. At the equal error rate 25%, the separating score 33 will falsely reject 25% genuine minutia pairs and falsely accept 25% imposturous minutia pairs and has 75% verification rate. The high incorrect acceptance and false rejection are due to some fingerprint images with bad quality and the vulnerable minutia match algorithm.

Fast Fourier Transform variation: Three samples of each finger are taken first. Each sample is passed through all the verification stage and minutiae extraction with the variation of FFT.

Step 1:- FFT is set to 0.1 first and matching percentage results of all the first finger samples   are calculated. Then again with FFT 0.1 matching percentage of second finger are calculated. This process is carried out for all the samples of ten finger and matching percentage is calculated.

Step 2:- FFT is set to 0.2 and matching percentage is calculated. Similarly FFT is varied from 0.2 to 0.9 and results are calculated. It is observed that with the variation of FFT on samples, more accurate results are obtained i.e more matching precision results are obtained.

Few Sample percentage are shown in table and graph is also plotted for finger 1 with FFT 0.1to 0.9 .Some matching percentage is selected for authentication of user. Same procedure is repeated for all fingers, matching percentage is calculated and corresponding graphs are plotted.

International Journal of Engineering Research and General Science Volume 2, Issue 6, October-November, 2014
ISSN 2091-2730

Table1. *FFT and Percentage Matching Table for First Finger*

FFT	F1F2(%)	F1F3(%)	F2F3(%)	F1F1(%)
0.1	31.2	67.2	67.6	100
0.2	29.3	34.4	66.5	100
0.3	31.1	56.3	54.5	100
0.4	33	35.7	78.8	100
0.5	23.4	77.3	47.7	100
0.6	45.5	50.5	45.3	100
0.7	45	34.2	62.7	100
0.8	55.5	38.9	34.5	100
0.9	38.6	54.3	70.9	100

FFT: Fast Fourier Transform

F1,F2,F3: Samples of Finger

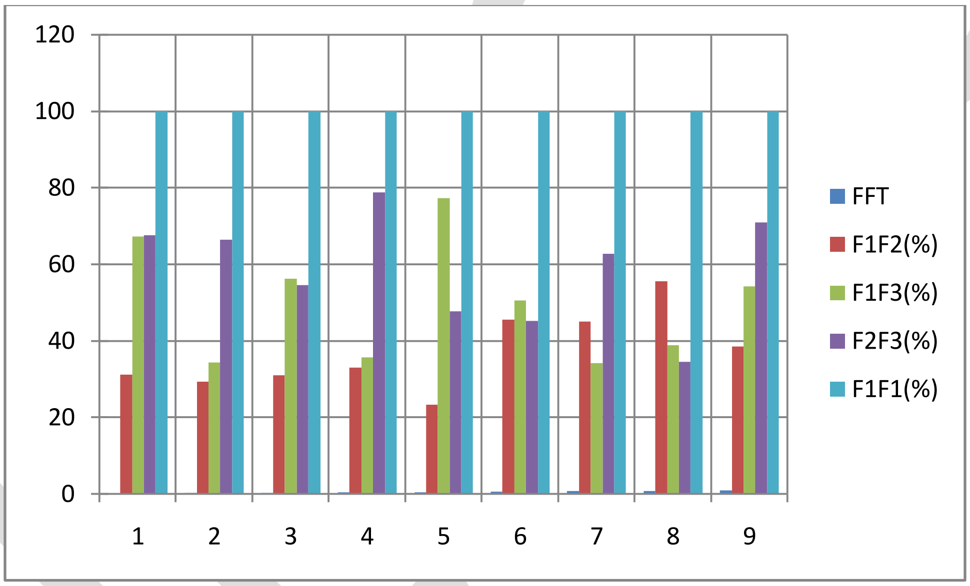


Figure 16: Matching Percentage of Finger First

Table2. FFT and Percentage Matching Table for Second Finger

FFT	F1F2(%)	F1F3(%)	F2F3(%)	F1F1(%)
0.1	31.2	67.2	67.6	100
0.2	29.3	34.4	66.5	100
0.3	31.1	56.3	54.5	100
0.4	33	35.7	78.8	100
0.5	23.4	77.3	47.7	100
0.6	45.5	50.5	45.3	100
0.7	45	34.2	62.7	100
0.8	55.5	38.9	34.5	100
0.9	38.6	54.3	70.9	100

FFT: Fast Fourier Transform

F1,F2,F3: Samples of Finger

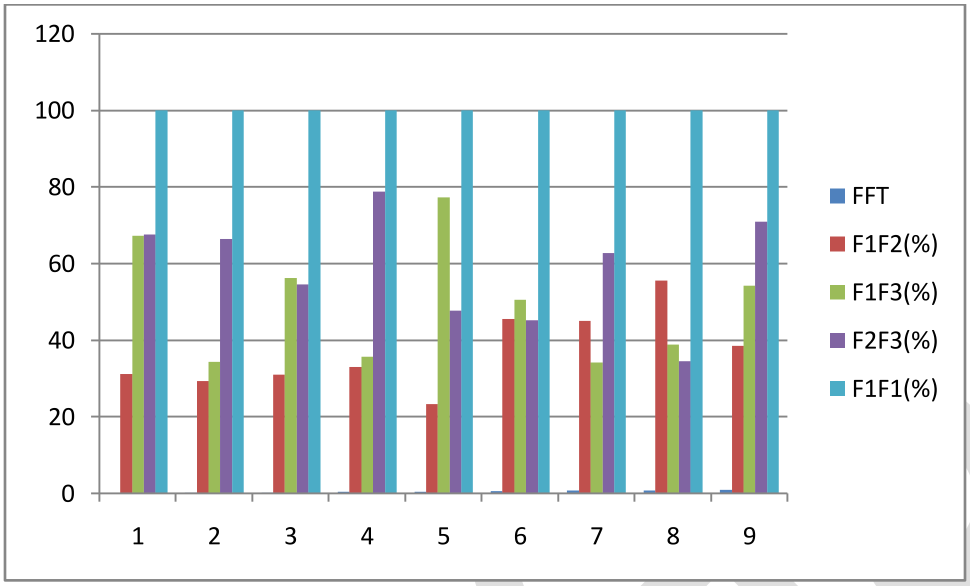


Figure 17: Matching Percentage of Finger Second

VI. CONCLUSSION AND FUTUREWORK

We have presented the overview of the finger print technology which includes primarily the scanner, the classification of fingerprint image in the database, the matching algorithms. Fingerprint recognition is used in various industries for its attendance and security purposes. Variation of FFT value on samples produces more accurate results. This application can be implemented in any of security concern areas. If done correctly it can be a very powerful method of identification.

REFERENCES

[1] Lin Hong, Yifei Wan and Anil Jain. Fingerprint Image Enhancement Algorithm and Performance Evaluation. East Lansing, Michigan.

[2] Fingerprint Minutiae Extraction, Department of Computer Science National Tsing Hua University Hsinchu, Taiwan 30043

[3] Handbook of Fingerprint Recognition by David Maltoni (Editor), Dario Maio, Anil K. Jain, Salil Prabhakar

[4] L. Hong, A. Jain, S. Pankanti and R. Bolle, Fingerprint Enhancement, Pattern Recognition, 202-207, 1996 **ICRTEDC-2014 246**

[5] A. K. Jain, L. Hong, S. Pantanki and R. Bolle, An Identity Authentication System Using Fingerprints, Proc of the IEEE, vol, 85, no.9,1365-1388, 1997

[6] A. Ross, & A. K. Jain, Information Fusion in Biometrics, Pattern Recognition Letters, 24(13), 2003, 2115-2125.

[7] W. Yunhong, T. Tan, & A. K. Jain, Combining Face and Iris Biometrics for Identity Verification, Proceedings of Fourth International Conference on AVBPA, Guildford, UK, 2003, 805-813.

[8] S. C. Dass, K. Nandakumar, & A. K. Jain, A Principled Approach to Score Level Fusion in Multimodal Biometric Systems, Proc. of Audio- and Video-based Biometric Person Authentication (AVBPA), Rye Brook, NY, 2005.

[9] G. Feng, K. Dong, D. Hu, & D. Zhang, When Faces Are Combined with Palmprints: A Novel Biometric Fusion Strategy, International Conference on Bioinformatics and its

Applications, Hong Kong, China, 2004, 701-707.

[10] J. G. Daugman, High confidence visual recognition of persons by a test of statistical independence, IEEE Transactions on Pattern Analysis and Machine Intelligence, 15(11), 1993, 1148–1161