# FINGERPRINT RECOGNITION SYSTEM USING MINUTIAE DECTECTION WITH THEIR ORIENTATION

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**ABSTRACT**

*Fingerprint Recognition System, that match a query print against a large database of prints, rely on the pattern of ridges in the query image to narrow their search in the database (fingerprint indexing), and on the minutiae points to determine an exact match (fingerprint matching). Various researches have been done in this field based on minutiae detection. Some researches have been done using the parameter Orientation. But least work has been done by combining these two features viz. minutiae and orientation. Fingerprint Recognition System presented in this paper is based on Minutiae Detection along with a parameter "Orientation" (FPRO). Thus the performance of the system increases with the use of this added parameter. The performance has been measured on the basis of False Acceptance Ratio (FAR).*

***Keywords (11Bold Italic): About Five Key Words In Alphabetical Order, Separated By Comma (10, Times New Roman Italic)***

## I. INTRODUCTION

Humans have used body characteristics like face, voice, finger prints, Iris, etc. to acknowledge one another. Automatic recognition of those characteristics referred to as a biometrics; currently days it's become a full of life analysis space in pattern recognition. Over a decade's fingerprint is one amongst the oldest style of identification due to their individuality, consistency, the intrinsic ease in acquisition, distinctiveness, persistence and high matching accuracy rate. Finger ridge patterns don't amendment throughout the lifetime of a personal. This property makes fingerprint a wonderful biometric symbol and can also be used as rhetorical proof. It has received a lot and a lot of attention throughout the last amount because of the necessity for society. Among the biometric options, the fingerprint is taken into account as one of the sensible ones. Fingerprint recognition needs a lowest effort from the user and provides comparatively sensible performance. Fingerprint recognition refers to the machine-controlled technique of collaborative a match between two human fingerprints. Fingerprints square measure one amongst several kinds of bioscience accustomed establishes people and verifies their identity.

Basically Skin of human fingertips consists of ridges and valleys and that they compounding along type the distinctive patterns. A fingerprint is that the composition of the many ridges and furrows. Fingerprints largely aren't distinguished by their ridges and furrows however square measure distinguished by point that square measure some abnormal points on the ridges. The point is split in to 2 elements such as: termination and

bifurcation. Termination is additionally referred to as ending and bifurcation is additionally referred to as branch.

## II. RELATED WORK

A lot of work has been already done in this fingerprint recognition. Minutiae detection algorithm [1] proposed Fingerprint Recognition by extracting ridge bifurcations and ridge endings and subsequently saving them in the databases. The final ridge structure will be used to generate fingerprint feature vector or minutiae map, which will characterize the fingerprint.

Ratha et al. [2] proposed a unimodal distortion tolerant Fingerprint Authentication technique based on representation of graphs. A weighted graph of minutiae was constructed by employing Fingerprint minutiae features for both reference and query fingerprint. The algorithm proposed by author delivered excellent results tested on a large private database with the use of optical biometric sensor.

S. Mil'shtein et al. [3] proposed a fingerprint recognition algorithm for partial and full fingerprints. In this study, they propose two new algorithms. The first algorithm, called the Spaced Frequency Transformation Algorithm (SFTA), is based on taking the Fast Fourier Transform of the images. The second algorithm, called the Line Scan Algorithm (LSA), was developed to compare partial fingerprints and reduce the time taken to compare full fingerprints. A combination of SFTA and LSA provides a very efficient recognition technique. The most notable advantages of these algorithms are the high accuracy in the case of partial fingerprints.

Prabhakar and Jain [4] showed, in the context of a fingerprint verification system, that combining multiple matchers, multiple enrolment templates, and multiple fingers of a user can significantly improve the accuracy of a fingerprint verification system. They also argue that selecting matchers based on some "goodness" statistic may be necessary to avoid performance degradation when combining multiple biometric modalities. There is a large amount of literature available on the various combination strategies for fusing multiple biometric modalities using the matching scores.

Qijun Zhao et al. [5] have given a pore model for fingerprint pore extraction. Sweat pores have been employed for automated fingerprint identification, in which the pores are extracted by skeletonization method which is expensive as far as computations are considered. This paper shows that it is not always the case that real pores are isotropic. An adaptive and robust anisotropic pore model is proposed whose parameters are adjusted as per fingerprint ridge direction and period. Experiments are performed on a high resolution (1200dpi) fingerprint dataset. Results of the paper shows that the proposed model and method can locate pores more accurately and robustly.

Moheb R. et al. [6] proposed an approach to image extraction and accurate skin detection from web pages. This paper proposes a system to extract images from web pages and then detect the skin colour regions of these images. The performance evaluation of the efficiency of the proposed system in extracting images before and after loading the web page from local host or any server in terms of the number of extracted images is presented. Finally, the results of comparing the two skin detection techniques in terms of the number of pixels detected are presented.

Manvjeet Kaur et al. [7] proposed a fingerprint verification system using minutiae extraction technique. This work has combined many methods to build a minutia extractor and a minutia matcher. Also some novel changes like segmentation using morphological operations, improved thinning, false minutiae removal methods, minutia

marking with special considering the triple branch counting, minutia unification by decomposing a branch into three terminations, and matching in the unified x-y coordinate system after a two-step transformation are used in the work.

Hoi Le et al. [8] proposed online fingerprint identification with a fast and distortion tolerant hashing method. Biometrics such as fingerprint, face, eye retina, and voice offer a more reliable means for authentication. However, due to large biometric database and complicated biometric measures, it is difficult to design both an accurate and fast biometric recognition. Particularly, fast fingerprint indexing is one of the most challenging problems faced in fingerprint authentication system. This proposed work manages and handle the above issues in a well defined manner.

Anil Jain et al. [9] proposed a Pores and Ridges: Fingerprint Matching Using Level 3 (pores and ridge shapes) features. Experimental results on a median-sized database show that Level 3 features carry significant discriminatory information. EER values are reduced (relatively ~20%) when Level 3 features are employed in combination with Level 1 and 2 features.

Mayank Vatsa et al. [10] proposed a combining pores and ridges with minutiae for improved fingerprint verification. They presented a fast fingerprint verification algorithm using level-2 minutiae and level-3 pore and ridge features. The proposed algorithm uses a two-stage process to register fingerprint images. Experimental results and statistical evaluation show that the feature super vector yields discriminatory information and higher accuracy compared to exist ing recognition and fusion algorithms.

Ruud M. Bolle et al. [11] proposed the evaluation techniques for biometrics-based authentication systems (FRR). Biometrics-based authentication is becoming popular because of increasing ease-of-use and reliability. Performance evaluation of such systems is an important issue. Authors have proposed some measures to characterize the data set so that the performance of a given system on different data sets can be compared. This paper also compares the parametric and nonparametric (bootstrap) methods for measuring confidence intervals. They give special attention to false reject rate estimates.

Coetzee and Botha [12] proposed a binarization technique based on the use of edges extracted using Marr-Hilderith operator. The resulting edge image is used in conjunction with the original gray scale image to obtain the binarized image.

Ballan et al. [13] printed a quick machine controlled feature-based technique for classifying fingerprints. The technique extracts the singular points i.e. deltas and cores within the fingerprints supported the directional histograms. It finds the directional pictures by checking the orientations of individual pixels, computes directional histograms exploitation overlapping blocks within the directional image, and classifies the fingerprint into the Wirbel categories whorl and twin loop or the Lasso categories (arch, tented arch, right loop, or left loop). The complexness of the technique is that the order of the quantity of pixels within the fingerprint image. However, it takes abundant time for classification.

Wei Cui et al. [14] proposed the research of edge detection algorithm for fingerprint images. This paper introduces some edge detection operators and compares their characteristics and performances. At last the experiment show that each algorithm has its advantages and disadvantages, and the suitable algorithm should be selected according the characteristic of the images detected, so that it can perform perfectly.

Shunshan li et al. [15] proposed the Image Enhancement Method for Fingerprint Recognition System. In this paper fingerprint image enhancement method, a refined Gabor filter, is presented. This enhancement method can

connect the ridge breaks, ensures the maximal gray values located at the ridge centre and has the ability to compensate for the nonlinear deformations. it includes ridge orientation estimation, a Gabor filter processing and a refined Gabor filter processing. A refined Gabor filter is applied in fingerprint image processing, then a good quality fingerprint image is achieved, and the performance of Fingerprint Recognition System has been improved.

Deepak Kumar Karna et al. [16] proposed normalized cross-correlation based fingerprint matching. Use of correlation-based methods is increasing day-by-day in the field of biometrics as it provides better results. In this paper, they propose normalized cross-correlation technique for fingerprint matching to minimize error rate as well as reduce the computational effort than the minutiae matching method. The EER (Equal Error Rate) obtained from result till now with minutiae matching method is 3%, while that obtained for the method proposed in this paper is approx 2% for all types of fingerprints in combined form.

Asker M. Bazen et al. [17] proposed a correlation-based fingerprint verification system. Unlike the traditional minutiae-based systems, this system directly uses the richer gray-scale information of the fingerprints. Experiments have shown that the performance of this system at the moment is comparable to the performance of many other fingerprint verification systems.

David G. Lowe [18] proposed an approach to distinctive image features from scale-invariant key points. This paper presents a method for extracting distinctive invariant features from images that can be used to perform reliable matching between different views of an object or scene. This paper also describes an approach to using these features for object recognition. The recognition proceeds by matching individual features to a database of features from known objects using a fast nearest-neighbour algorithm, followed by a Hough transformation to identify clusters belonging to a single object, and finally performing verification through least-squares solution for consistent pores parameters. This approach to recognition can robustly identify objects among clutter and occlusion while achieving near real-time performance.

Umut Uludaga et al. [19] proposed a Biometric template selection and update: a case study in fingerprints. In this paper authors have proposed two methods DEND and MDIST to perform automatic template selection where the goal is to select prototype fingerprint templates for a finger from a given set of fingerprint impressions. The Proposed methods have also been utilized to perform automatic template update. Experimental results underscore the importance of these techniques.

Wang Yuan et al. [20] proposed a real time fingerprint recognition system based on novel fingerprint matching strategy. In this paper they present a real time fingerprint recognition system based on a novel fingerprint minutiae matching algorithm. The system is developed to be applicable to today's embedded systems for fingerprint authentication, in which small area sensors are employed. Experiment on FVC database show that the proposed system has a better performance than compared. For the image enhancement and matching techniques they use high efficiency, it can also give a real time identification result with high reliability.

The work done in the area of fingerprint recognition either consider minutiae detection or orientation independently. No work has been done using both parameters together. This paper presents a fingerprint recognition system using minutiae detection using orientation (FPRO) which combines the two parameters in order to enhance the overall performance of the recognition system.

## III. FINGERPRINT RECOGNITION SYSTEM USING MINUTIAE DETECTION WITH THEIR ORIENTATION

The uniqueness of a fingerprint is determined by the topographic relief of its ridge structure and the presence of certain ridge anomalies termed as minutiae points. Typically, the global configuration defined by the ridge structure is used to determine the class of the fingerprint, while the distribution of minutiae points is used to match and establish the similarity between two fingerprints. Minutiae, in fingerprinting terms, are the points of interest in a fingerprint, such as bifurcations (a ridge splitting into two) and ridge endings etc. As shown in Fig. 1.

We propose a simple and effective approach for fingerprint recognition with minutiae extraction based on the frequency and orientation of the local ridges and thereby extracting correct minutiae as shown in Fig. 2. Various steps which are used in FPRO are given and discussed below.

ALGORITHM: FPRO

**Step 1**: Load the original image[Table 1.1].

**Step 2**: Binarization of original image: A threshold value is set and the pixel having value greater than the threshold is set to 1 and the ones lower than the threshold is et to 0[Table 1.2].

**Step 3**: Thinning of binarized image: Ridge thining is done on the binarized image to eliminate the redundant pixels of ridges till the ridges are just one pixel wide.This is done by using the following Matlab's Thinning function[Table 1.3].

bwmorph(binary image,'thin','inf');

**Step 4**: Extracting Minutiae points from processed image: We filter the thinned ridged map using nlfilter to compute the number of minutiae i.e. endings and bifurcations on the thinned image.

After completion of fingerprint ridge thinning, minutiae marking is done by using 3 x3 pixel window as follows. In case of minutia marking the concept of Crossing Number (CN) is mainly used.

- Termination

  In 3 x 3 windows if the central pixel is 1 and has only 1 one-value neighbour, then the central pixel is a ridge ending or termination. i.e Cn(p)=1 for a pixel "p" [Table 1.4].
- Bifurcation

  In 3 x 3 windows if the central pixel is 1 and has exactly 3 one-value neighbours, then the central pixel is a ridge branch or bifurcation. i.e Cn(p)=3 for a pixel "p" [Table 1.5].

We have a lot of spurious minutae and we are going to process them. Let D be some threshold value and we find the distance using Matlab function DEuclid( ) [Table 1.6].

**Process 1:** if the distance between a termination and a bifurcation is smaller than D, we remove this minutiae. DEuclid(Centroid of Bifurcation,Centroid of Termination)

**Process 2:** if the distance between two bifurcations is smaller than D, we remove this minutiae. DEuclid(Centroid of Bifurcation)

**Process 3:** if the distance between two terminations is smaller than D, we remove this minutiae. DEuclid(Centroid of Termination)

**Step 5**: ROI: The unnecessary outline of the thinned image is discarded by finding the Region of Interest by applying closing and erosion. We suppress the minutiae external to this ROI. ROI extraction can be done using

two Morphological methods those are CLOSING and OPENING. By using the OPENING operation we can enhance images and remove the peaks caused by background noise and we use CLOSING operation to shrink the images and to eliminate the small cavities [Table 1.7].

**Step 6**: Determining Orientation of minutiae: We have orientation of each minutiae [Table 1.8].

We know one type of minutia can be change to other type easily, coming in contact with the different types of data acquisition conditions. So we have to save them in some form of representation that is both for termination and bifurcation. So each minutia is completely characterized by the following parameters at last:

1) x-coordinate

2) y-coordinate

3) Orientation

4) Associated ridge

Actually a bifurcation can be broken down to three terminations each having their own x-y coordinates, orientation and an associated ridge.

The orientation for each termination (tx, ty) is estimated by using the following method.

a) First of all we have to track a ridge segment, whose starting point must be the termination and length is D.

b) Then sum up all the x-coordinates of points present in that particular ridge segment.

c) After that to get sx we have to divide the above summation with D and sequentially we get sy using the same technique.

### 3.1 Matching Algorithm

The algorithm is used to match the X and Y co-ordinates of both the Termination points as well as the bifurcations. We also match their orientations to ensure a perfect match if found. On discovery of a proper match, the match count is raised by one at the end of the matching. The match score is calculated as the total number of matches divided by the total number of samples matched as given :

$$\text{Match Score} = \frac{number\ of\ total\ matched\ minutiae\ pairs}{number\ of\ minutiae\ of\ the\ template\ fingerprint}$$

After calculating the match score its percentage is calculated and further it is compared with a pre-specified threshold value which is taken as 60 because it depicts a high probability that the user is genuine.

## IV. PERFORMANCE PARAMETERS

1. **False rejection rate (FRR):** The rate at which the system falsely rejects a registered user compared to the total number of trials.
2. **False acceptance rate (FAR):** The rate at which the system falsely accepts a nonregistered (or another registered) user as a registered one compared to the total number of trials. The FAR is in this report used in the identification version, as a contrast to verification procedures, where it measures if a user is accepted under a false claimed identity.
3. **Equal error rate (EER):** The common value of the FAR and FRR when the FAR equals the FRR. This is the value where both the FAR and FRR are kept as low as possible at the same time (see Fig. 3). A low EER value indicates a high accuracy of the system.

This paper presents that the value of FAR and EER decreases with the added orientation parameter in the fingerprint recognition system.

## V. FIGURES AND TABLES

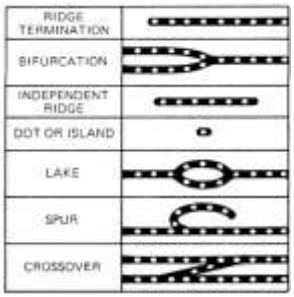



**Fig.1 Types of Ridges**

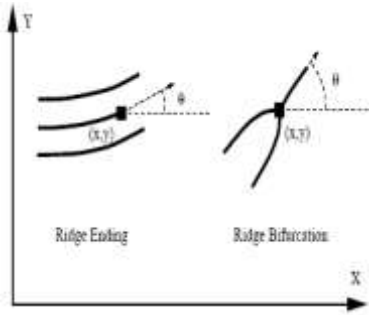



**Fig.2 Measuring Ridges angles**

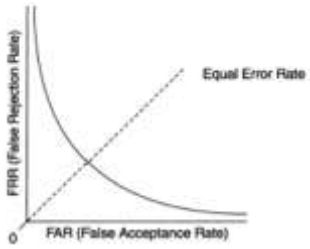
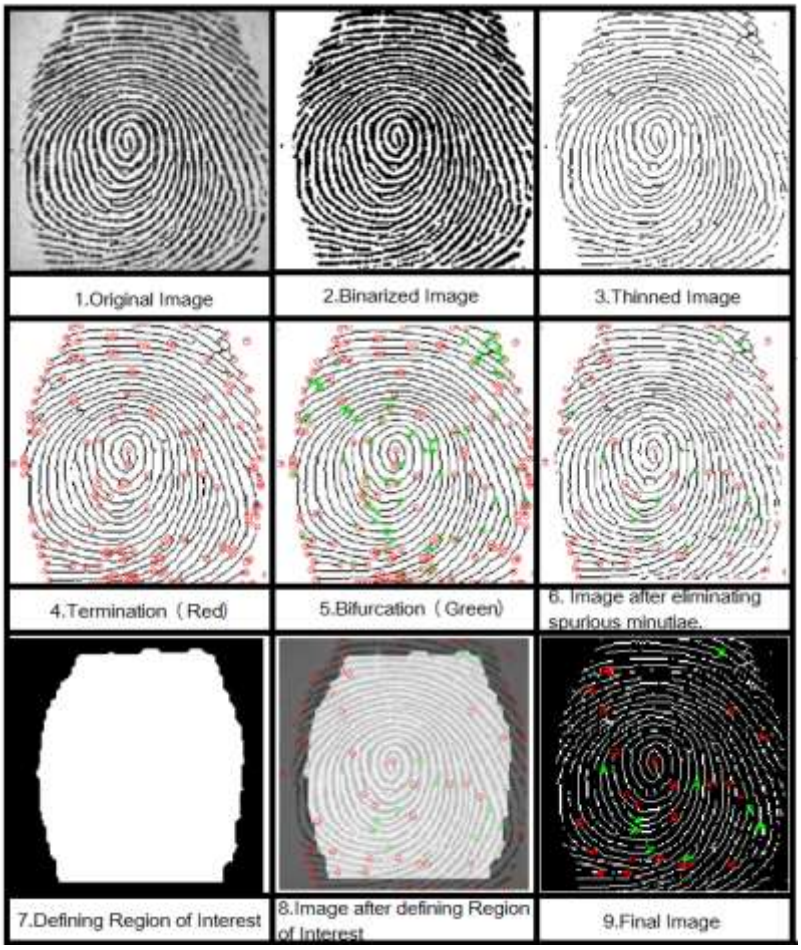



**Fig. 3.Relationship between FAR, FRR & EER**

**TABLE I Steps of Fingerprint Recognition**



## VI. CONCLUSION

This paper presents the Fingerprint matching algorithm using Minutiae detection along with their Orientation. It helps in enhancing the accuracy of the algorithm. This paper presents matching of fingerprint on the basis of frequency and orientation for which we binarize, eliminate the redundant pixels, and then subsequently find out the Region of Interest. Finally, we analyze the extracted minutiae points on the basis of orientation.

## REFERENCES

This heading is not assigned a number. A reference list **MUST** be included using the following information as a guide. Only cited text references are included. Each reference is referred to in the text by a number enclosed in a square bracket (i.e., [3]). References must be numbered and ordered according to where they are first mentioned in the paper, NOT alphabetically.

**Examples follow**

**Journal Papers**

**[1]** M Ozaki, Y. Adachi, Y. Iwahori, and N. Ishii, Application of fuzzy theory to writer recognition of Chinese characters, International Journal of Modelling and Simulation, 18(2), 1998, 112-116. Note that the journal title, in italics

**Books: [2]** R.E. Moore, Interval analysis (Englewood Cliffs, NJ: Prentice-Hall, 1966). Note that the title of the book is in lower case letters and italicized. There is no comma following the title. Place of publication and publisher are given.

**Theses: [3]** D.S. Chan, Theory and implementation of multidimensional discrete systems for signal processing, doctoral diss., Massachusetts Institute of Technology, Cambridge, MA, 1978. Note that thesis title is set in italics and the university that granted the degree is listed along with location information

**Proceedings Papers:**

**[4]** W.J. Book, Modeling design and control of flexible manipulator arms: A tutorial review, Proc. 29th IEEE Conf. on Decision and Control, San Francisco, CA, 1990, 500-506 **(10,**