



## Delaunay Hexangle Based Finger Print Matching Scheme for Authentication

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**Abstract:** *Finger print and its matching technique has its own impact and application in various areas such as authentication, secure identity, secure card manufacturing and many areas where large data and unique identity is required to be maintained. Content based matching techniques such as feature extraction have been implemented by various authors. Feature extraction based on angle based technique to generate security codes using information of angles obtained from quadrangle and pentangle based Delaunay schemes have been used. In this paper, hexangle based Delaunay scheme is proposed and compared with pentangle based Delaunay scheme. Base of false accept rate (FAR), false reject rate (FRR) and equal error rate (EER) have been used as parameter to compare pentangle and hexangle Delaunay based fingerprint matching and it is found the proposed hexangle based scheme guaranteed low FRR = 1.3, FAR = 0 and EER = 0.69 than existing system.*

**Keywords:** *Delaunay triangle, Hex angle scheme, CBIR, feature extraction, Topology code.*

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### I. INTRODUCTION

Finger print authentication is one of the secure techniques used for authentication at many places like banks, passport, cyber security etc. Finger print image data is also available in large tune. Authentication becomes necessary for security reason. CBIR is also used in fingerprint authentication.

Large amount of information in the form of images is available to us. As the amount of data comprising image grows bigger and bigger, it will render itself useless in the absence of any effective method to access and use it. There are many potential problems relating to effective search and navigation that can be solved through the use of efficient information retrieval system.

Content based image retrieval is the process where retrieval is based on the visual features such as color, shapes and texture. The concept of content based image retrieval was first used by Kato to describe his experiment of retrieving image where image was retrieved from the database using the features such as color and shapes. Later the term content based image retrieval or CBIR was widely used to represent the process of retrieving image from the huge collection of image based on their features such as color, texture and shape etc. CBIR based system have become reliable tool for many image database application since then [1]. It demonstrates the various phases involved in order to retrieve the image fingerprint features. Section 2 discusses some of the techniques for fingerprint authentication.

### II. LITERATURE SURVEY

In [2] Natasha Singh et al. proposed identifying fingerprint with the help of minutiae detection and phase spectrum analysis. Algorithm used here represents the fingerprint by calculating Minutiae & their local features, like terminations, bifurcations and Phase spectrum of all minutiae. The phase spectrum is calculated to characterize the minutiae structure in the neighbourhood of a given minutia point. This is very good technique for fingerprint matching as the algorithm gives excellent results. The technique performs fairly an accurate fingerprint matching for minutiae-based verification systems.

In [3] Manjeet Kaur et al. combined many methods to build a minutia extractor and a minutia matcher. By 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. To a great extent this helped are used thinning image to width single pixel deleting more termination, bifurcation and removing false minutia. In another approach to make used minutia points was carried in [4]. Here, new indexing-based approach to fingerprint identification is used where in unique topological structure with the fingerprint minutiae is generated using the Delaunay triangulation. This method allows for choosing more "meaningful" "minutiae groups (i.e., triangles) during indexing. It preserves index selectivity, reduces memory requirements without sacrificing recognition accuracy, and improves recognition time. However, Delaunay triangle suffer from non-linear distortion local structure to overcome this use of Delaunay quadrangle was suggested by Wrenching et al. in [5]. Here Fixed-length and alignment-free feature vectors were extracted from Delaunay quadrangles which are less sensitive to nonlinear distortion and more discriminative than those from Delaunay triangles and can

which be applied to existing template protection directly. This provides a unique topology code from each Delaunay quadrangle. It helps to carry out accurate local registration under distortion, and enhances the security of template data. Delaunay quadrangle-based system with topology code provide better performance and higher security than the Delaunay triangle-based system. Suganya et al. [6] used Delaunay pentangle based method. This method has more attributes and more discriminative abilities than Delaunay quadrangle based structure. Delaunay pentangle system with topology code can achieve better performance and higher security level than Delaunay quadrangle. Section 3 discuss problem identification.

### III. PROBLEM IDENTIFICATION

From last section survey it is observed pentangle based technique is connected with finding minutia point drawing the pentangle and generating the security code. Thus topological codes can be obtained from pentangle for authentication. As the no. of angle from the topology code increases security is enhanced. This motivates us for making the fingerprint authentication system strong by using more number of angles. So, that proposed method as in section 4 suggests use of topological structure with more angles which can provide more number of codes and better security and that the same time reduce non-linear distortion induced effect. In the proposed method in section 4 a hexangle based method is suggested.

### IV. PROPOSED METHODOLOGY

Block diagram for proposed Delaunay hex angles scheme is as shown in fig. no.1. The method is discussed in detail as below.

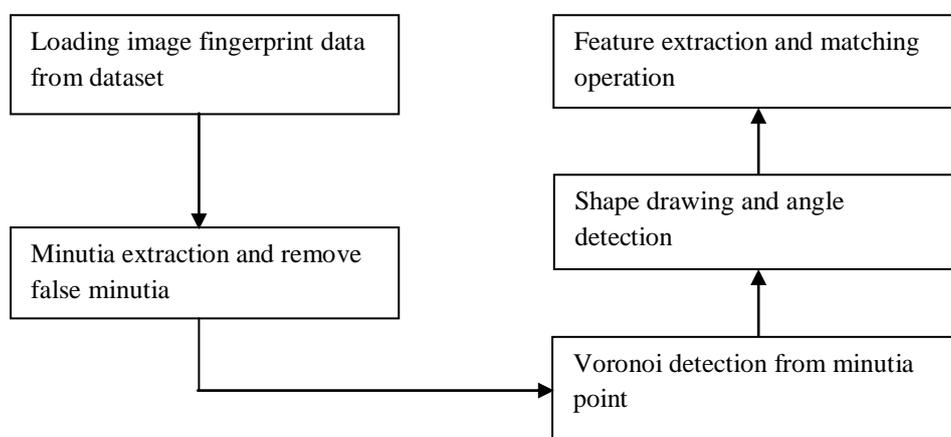


Fig.1 Proposed system flow diagram

A database of fingerprint images is used FVC2002DB1. One of the images from the public database is loaded. As per fig. 1. After loading the fingerprint data, minutia extraction is carried out.

#### 4.1 Minutiae Extractor

Minutiae-based techniques represent the fingerprint by its local features, like terminations and bifurcations. Minutiae extraction steps are explained below-

##### 4.1.1 Fingerprint Image Binarization

In this step, binarization of the above fingerprint is performed in which each pixel is stored as a single bit (0 or 1). Using thresholding. The next step uses thinning operation [2].

##### 4.1.2 Fingerprint Ridge Thinning

Thinning is the process of reducing the thickness of each line of patterns to just a single pixel width. [3] The requirements of a good thinning algorithm with respect to a fingerprint are

- The thinned fingerprint image obtained should be of single pixel width with no discontinuities.
- Each ridge should be thinned to its centre pixel.
- Noise and singular pixels should be eliminated.
- No further removal of pixels should be possible after completion of the thinning process.

##### 4.1.3 Finding Minutia

After the fingerprint ridge thinning, marking minutia points is the next important step. As the number of minutiae detected is more, the probability of accurate results increases. The concept of Crossing Number (CN) is widely used for extracting the minutiae. Rut Ovitiz's definition of crossing number for a pixel P. [2] is given by

$$CN = 0.5 \sum_{i=1}^8 (P_i - P_{i+1}) \quad (4.1) \quad \dots (1)$$

Where  $P_i$  is the binary pixel value in the neighbourhood of P

With  $P_0 = (0 \text{ or } 1)$  and  $P_9 = P_0$ .

However, in the process of finding minutia points, several false minutiae are also detected which need to be removed.

#### 4.1.4 False Minutia Removal

The pre-processing stage does not completely heal the fingerprint image. For example, false ridge breaks due to lacking amount of ink and ridge cross-connections due to over inking are not totally eliminated. We follow the procedure for removing false minutia. The final minutia points so obtained are now portioned using Voronoi diagram

#### 4.2 Voronoi Detection

Voronoi diagram is a partitioning of a plane into regions based on distance to for each seed there is a corresponding region consisting of all points closer to that seed than to any other. These regions are called Voronoi cells.

#### 4.3 Shape Drawing and Angle Detection

We present the implementations of Delaunay hexangle based fingerprint authentication system for enhancing the security level of biometric template data. The two popular eminent minutia are termination and ridge bifurcation. The minutia point are extracted from fingerprints and then Delaunay hexangle structure can be generated from feature points easily.

##### 4.3.1 Topology code

After drawing hexangle or pentangle, we generate the topology code for security purpose.

$$TC = P_1 \times r_1^{5+P_2} \times r_2^{4+P_3} \times r_3^{3+P_4} \times r_4^{2+P_5} \times r_5^{1+P_6} \times r_6^0 \quad (2)$$

Where  $\{r_i\}_{i=1}^6 = 1$  are the quantized angle values of the Delaunay hex angle and  $r_i = \max(p_1, p_2, p_3, p_4, p_5, p_6) + 1$ .

TC is the topology code which is calculated from the angles retrieved from the drawn shape with the finger print input, thus the TC helps to match the image with the existing dataset images. [6]

#### 4.4 Feature extraction and matching operation

We take two sets of minutiae of two fingerprint images thus obtained. The minutia match algorithm determines whether the two minutia sets are from the same finger or not. An alignment-based match algorithm partially derived from used in this work. It includes two consecutive stages: one is alignment stage and the other is match stage. [3]

a) Alignment stage: Given two fingerprint images to be matched, choose any one minutia from each image;

Calculate the similarity of the two ridges associated with the two referenced minutia points. If the similarity is larger than a threshold, transform each set of minutia to a new coordination system whose origin is at the referenced point and whose x-axis is coincident with the direction of the referenced point.

b) Match stage: After the set of transformed minutiae points is derived, the elastic match algorithm is used to count the matched minutia pairs by assuming that two minutia having nearly the same position and direction are identical.

Fingerprint matching techniques can possibly be placed into two categories: minutiae-based and correlation based. However the frequently used technique with minimum FAR and FRR is Minutiae-based techniques. In this process we, first find minutiae points and after that map their relative placement on the finger. However, that there have been so many difficulties while we were using this approach. It truly is difficult to extract the minutiae points accurately when the fingerprint is of low quality. Also this method will not check the worldwide pattern of ridges and furrows. Fingerprint Verification Structure is a system that determines the correspondence in an input fingerprint by having template fingerprint kept in data base.

In order to perform the experiment with the system FVC2002 DB1, DB2 dataset is used to monitor the parameter and output model. In this section 4, we have described the proposed methodology and further have described the application area.

### V. APPLICATION AREA

Allowing the examination of a large number of images in less time, with lower cost and reduced subjectivity than current observer-based techniques.

The possibility to perform automated screening for pathological conditions, such as diabetic retinopathy, in order to reduce the workload required of trained manual graders.

In the above section, we have described the application area. Now, we will observe the some experimental result in next section.

### VI. EXPERIMENTAL RESULT

We have evaluated the proposed system on publicly available databases which are FVC2002 (DB1) having 76 fingerprint images in all have been used for

In this experiment, this work has been implemented on Sony using Matlab 2012b and BMP file with size (16\*16) have been used a GUI for proposed works created in this. First we select the button of load image and then choose image 101 in FVC2002 database. Shows in fig.no.3a. To apply the binarization to convert image into binary form or gray scale as shown in fig. No. 3(b)

Next step is thinning. Thinning is the process of removing selected foreground pixels from the image. It is the process of reducing the thickness of each line of patterns to just a single pixel width. Image after thinning is seen in fig. No 3 ©. And then we find the minutia points from thinned image. For finding minutiae points concept of Crossing Number (CN) is used. Minutia point shown in fig.no.3 (d) To apply the last step then we have get so many false minutia points However false ridge breaks due to insufficient amount of ink and ridge cross-connections due to over inking are not totally eliminated. So we remove the false minutia points with the help of next step and get only true and useful minutia points as shows in fig.no3(e)

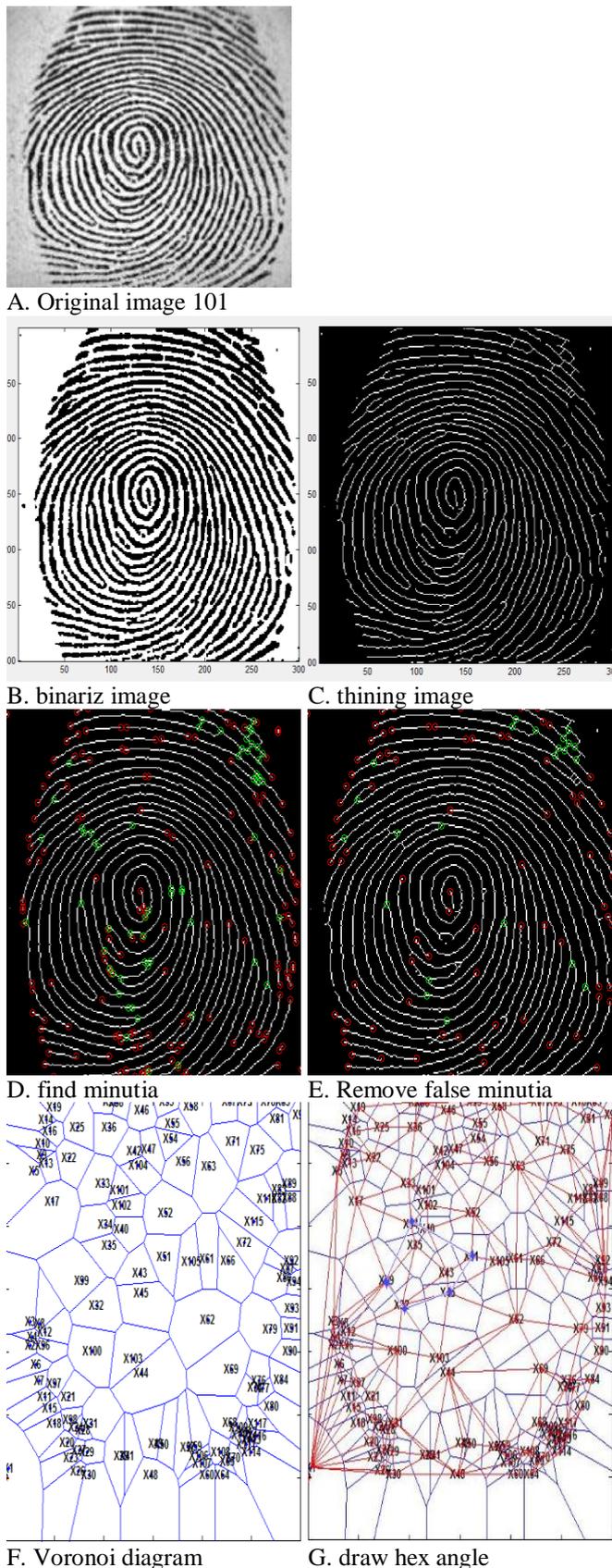


Fig. no.3 (a) Original image ,(b) Binariz image,(c) Thinning image,(d)Find minutia,(e) Remove false minutia, (f)Voronoi diagram ,(g) draw hexangle

Next step is Voronoi detection, Voronoidiagram is partitioning of a plane into regions based on distance to for each seed. To draw the Voronoi diagram we use Delaunay triangle function. With the help of Delaunay function,we join the many triangles .Voronoi cells are those in which each node contains smaller distance to the centroid than the other centroid. This is shown in fig.no. 3(f)

After getting the Voronoidiagram, we apply the hex angle scheme. Hex angle scheme is used to enhance the technique to calculate polygons by using Delaunay triangle as a base. This is shown in fig no.3 (.g.) Then we apply the topology code after this step we come feature extraction and minutiae matching. With help of algorithm of matching minutiae is applied. The process generates a file containing all the match minutiae points. Let us assign a file name name 'ABC' to this file. This file contained all details about bifurcation and termination. These details for image 101 are given below. Along with termination and bifurcation details in this table 1 and 2 respectively

Name: ABC

Date: 2016-05-20

Number of Terminations: 95

Number of Bifurcations: 23

Table 1 Terminations:

X	Y	Angle
3	7	25.00
105	25	124.00
...	...	...
294	157	300.00

Table 2 Bifurcations:

X	Y	Angle1	Angle2	Angle3
38	105	50.00	75.00	66.00
46	78	157.00	88.00	101.00
...	...	...	...	...
256	33	257.00	43.00	266.00

### 5.1 Performance comparison of two different structures

We compared and tested with two different structures. 1. Delaunay pentangle structure 2. Delaunay hexangle in FVC2002DB1 DATABASES

The performance comparison with two different structures is illustrated in fig 7. It can be observed from fig. 7 that the Delaunay hexangle based structure exhibits the better performance compared to Delaunay pentangle as observed from fig. 7 at FRR=0, FAR is reduced with hexangle scheme compared to pentangle scheme. This proves that the Delaunay hexangle is more established than Delaunay pentangle and feature extracted from Delaunay hexangle is more discriminative than Delaunay pentangle because it has richer characteristics.

Values of FAR, FAR and EER obtained with the two schemes with applied to 101 FVC2002 DB1 given in table 3

Table (3) FAR, FRR and EER of pentangle and hex angle based scheme

	FAR	FRR	EER
Hex angle based scheme	1.38	0	0.69
Pentangle based scheme	1.88	0	1.19

Comparative analysis between hexangle and pentangle based scheme

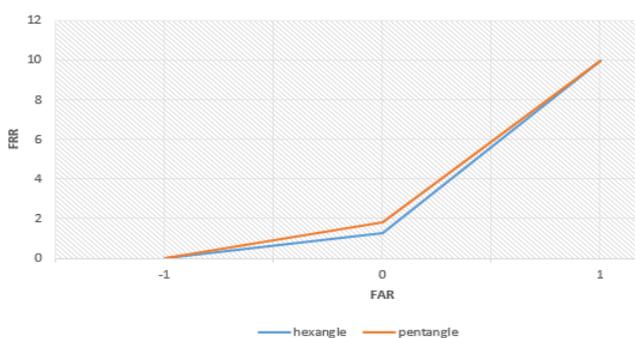


Fig. 2 Comparative analysis of Hex angle and Pentangle based fingerprint matching scheme

## VII. CONCLUSION

Biometric passwords are used to provide enhanced security systems which are used in application where high security is required. However a suitable technique is required to detect these passwords. Fingerprint detection is one of the widely used techniques to authenticate the user and provide access to the system. Thus a system is required to discriminate among the passwords of the various users. In existing techniques a Delaunay pentangle based technique is used to obtain fingerprints of the user. But that technique suffers from some defects like not being able to provide accurate and efficient results which degrades the performance of the whole technique. A hex-angle based technique is presented which is used to provide an enhanced functionality to detect fingerprints. A comparison of existing and proposed techniques is presented in section 4. Proposed techniques are Delaunay hexangle provides better performance to detect fingerprints. FAR=1.38, FAR=0 and EER=0.69

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