Fingerprint Indexing Using Extended Set Delaunay Triangulation

Guide : Dr.M.V.N.K Prasad
Student : C.Vamshi Krishna

B-Tech (III) - DAIICT

chennavamshi@gmail.com

July 1, 2014

Overview

- Why Biometrics?
- What is Biometric Recognition?
- What is Indexing?
- Why Fingerprint?
- Features in Fingerprint?
- What is Delauanay Triangulation?
- Why Extended Set?
- Proposed Approach?
- Testing Technique?
- Results?

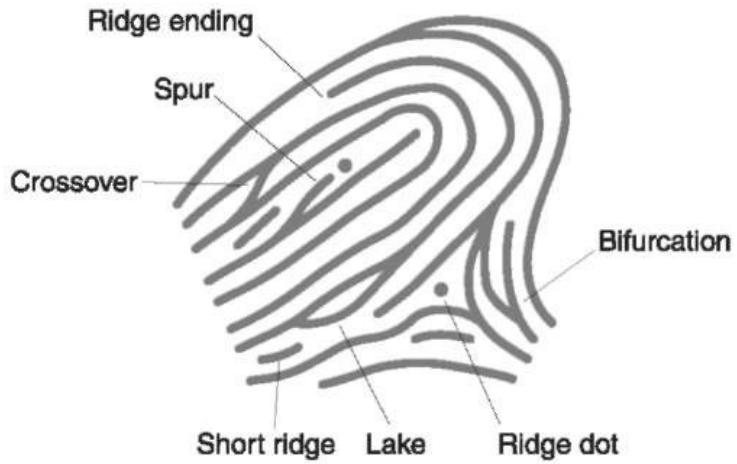
Introduction

- Biometric Recognition is the use of physiological characteristics such as fingerprint, faces, iris, palm etc. and behavioral characteristics such as gait, voice for recognizing the identity of individual.
- Biometric Recognition is of two types :
  - Verification
  - Identification
- Accuracy and Efficiency are the defining factors for any Biometric Recognition System.

Fingerprint Recognition

- Fingerprint Identification can be classified into three types:
  - Naive Approach.
  - Classification.
  - Indexing.

(a) Sample Fingerprint



(b) Types of Minutia

Figure : Fingerprint Images

Defination

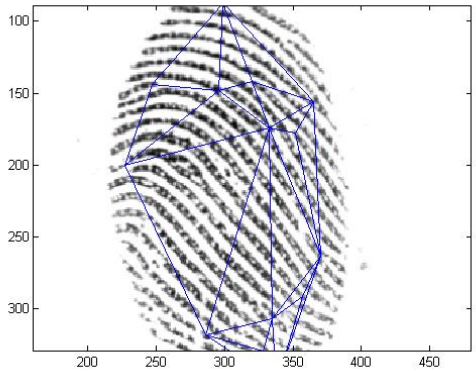
Delaunay Triangulation

Let P = $\{p_1, p_2, ..., p_n\}$ be a set of points in the plane. A triangulation P is said to be a Delaunay Triangulation if and only if for every triangle in T, it satisfies a property that its circumcircle contains no other point of P.

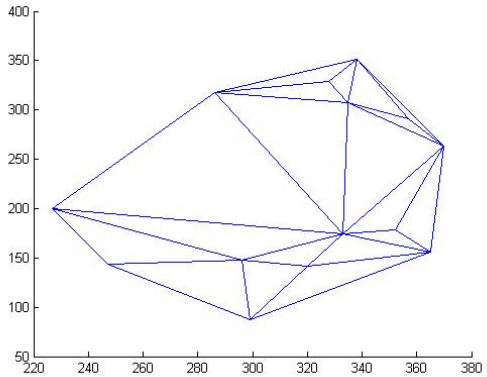
Extended Set Triangulation

Delaunay Triangulation is formed for every vertex with its adjecent vertices in the Delaunay Triangulation of the whole set . The union of all such Delaunay Triangulations is called Extended Set Triangulation.

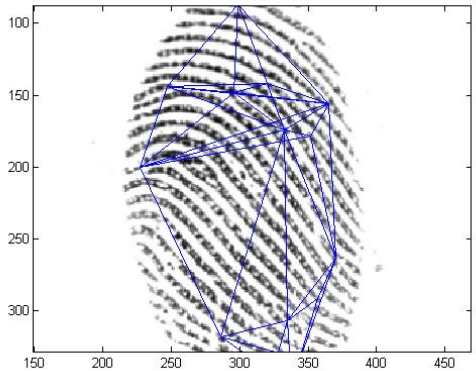
Extended Set Vs Delaunay Triangulation



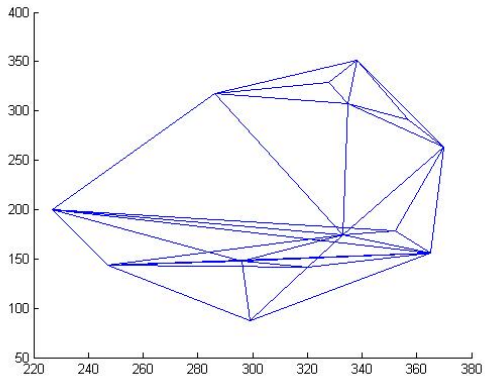
(a) Delaunay Triangulation with Image



(b) Delaunay Triangulation



(c) Extended Set with Image



(d) Extended Set

Proposed Approach

- Extended set Triangulation S{P,E} is formed with the extracted minutia for each fingerprint.
- Let t be any triangle in S and let it be represented by minutia triplet $m_1 = \{x1, y1\}$ $m_2 = \{x2, y2\}$ $m_3 = \{x3, y3\}$.
- The triangle class t_c is defined by the binary integer $m_1^t m_2^t m_3^t$.
- The angles that m_1^θ makes with $m_1 m_2$ is denoted by θ_1 and the angle that m_2^θ makes with $m_2 m_3$ is denoted by θ_2.
- Hashing is done into a hash table based on the triplet $(t_c, \theta_1, \theta_2)$. The fingerprint ID and the lengths i.e., the quadruplets (f_{id}, l_1, l_2, l_3) have been stored as entries in the index inside the hash table.

During Verification

- Let D represent the entry in the hash table corresponding to index $\{t_c, \theta_1, \theta_2\}$.
- Now, for each quadruplet $q_i\{f_{ID}, l_1, l_2, l_3\}$ present in D, we find the similarity between the triangle represented by q_i and the triangle being considered.
- Similarity between two triangles: Two triangles represented by (l_1^1, l_2^1, l_3^1) and (l_1^2, l_2^2, l_3^2) are said to be similar if and only if the maximum difference between the corresponding lengths of the triangles lie within a certain threshold th i.e., th $\geq$ max $(l_1^1\text{-}l_1^2, l_2^1\text{-}l_2^2, l_3^1\text{-}l_3^2)$.
- A vote based statergy is used to accumulate the votes and the template with the maximum votes is said to be the most similar image to the query fingerprint.

Some Definations

Penetration Rate

It denotes the average length of the candidate list retrieved for each probe. It is defined as

$$P_r = \frac{1}{Q} \sum_{i=1}^{Q} \frac{d_i}{N},$$

Hit Rate

It denotes the fraction of the probes for which candidate list contains the correct identity as the query probe. It is defined as

$$H_r = \frac{X}{Q} * 100\%,$$

where X is the number of probes for which correct identity has been retrieved and Q denotes the size of the number of queries made.

Testing Technique and Results

Testing Technique

1. FVC Database.
2. 800 Images
3. 8 Impressions per template, 100 templates.

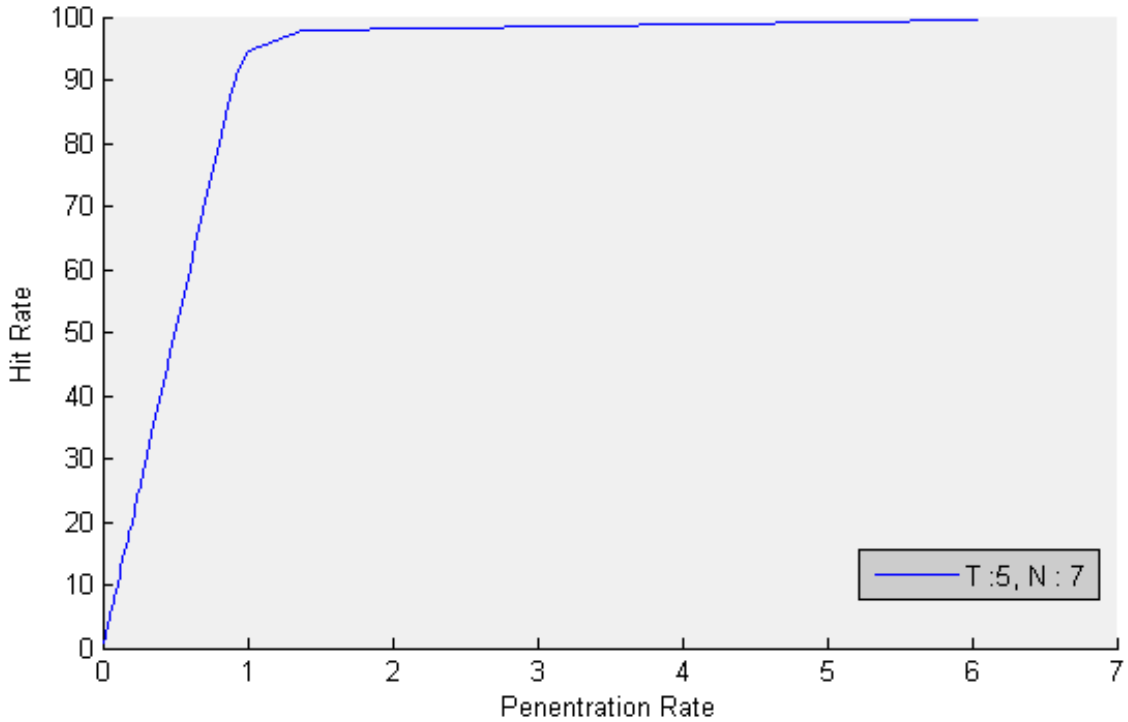


Figure : Result on FVC 2002 DB1.

Comparision with other approaches :

Approach	**Hit Rate**	**Penetration Rate**
R.Capelli et al,2011	99.5	15.5
A.Gago et al,2013	99.75	10
Our Approach	99.5	6.0325

Table : Comparision for FVC-2002DB1

Where we are making Difference

1. Extended Set - Captures the local similarity of the fingerprint images.
2. Relative Angles - does not change under distortions.
3. Triagnle class and Triangle lengths - reduce the amount of candidates drastically.

The End