# Fingerprint Indexing using Extended Set Delaunay Triangulation

C.Vamshi Krishna, Dr. M.V.N.K Prasad
Institute Of Development and Research in Banking Technology, Hyderabad

## Abstract

- Fingerprint indexing is a key technique in automatic fingerprint identification systems (AFIS). However, handling fingerprint distortion is a major problem. We have proposed a new algorithm for fingerprint indexing, which is based on minutia triplets, and it is very tolerant to missing and spurious minutiae. In this sense, a novel representation for fingerprints is proposed by defining a triangle set based on extensions of Delaunay triangulations. Moreover, a set of robust features is used to build indices. Finally, a method based on calculating the score using a similarity function between the formed triangles is used. Our proposal was tested on benchmark databases and it was shown that it is better than the existing methods especially under conditions of distortions.

## Indexing Approach

- Any indexing based approach can be divided into two phases: Preprocessing (building the database by enrolling the templates) and fingerprint verification. During preprocessing features that are robust, that are abundantly available in the template and that uniquely represent a fingerprint are used to form indices. These indexed locations are filled with entries containing reference to the template. During the verification step, the same features are extracted from the query templates and are used to from the indices. The references to the templates that are present in the indexed entries are retrieved and the similarity between the templates is computed and finally a potential list of candidates called the candidate list is produced

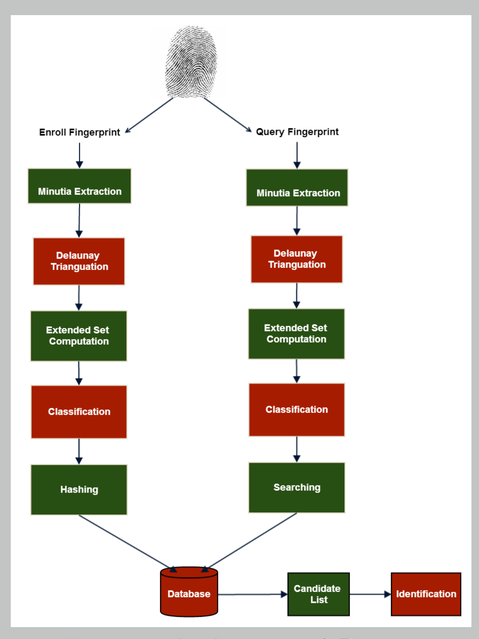


Figure : Architectural Design

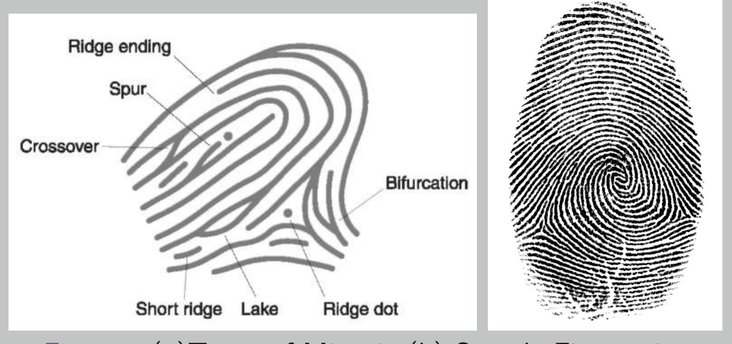


Figure : (a)Types of Minutia (b) Sample Fingerprint

## Delaunay Vs Extended Set Triangulation

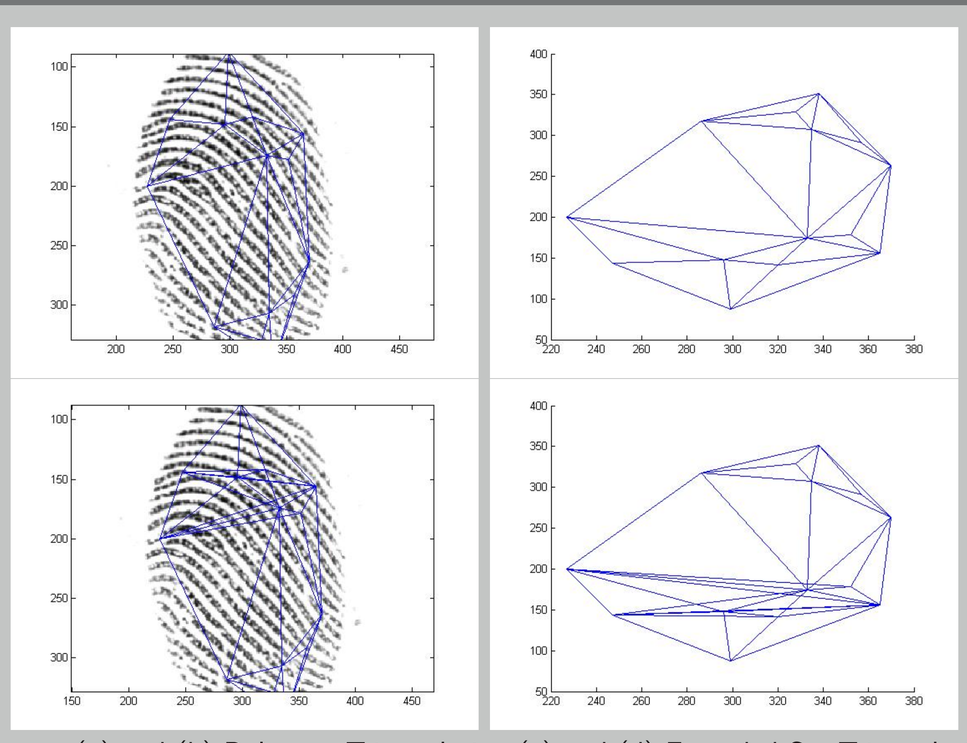

Figure : (a) and (b) Delaunay Triangulation (c) and (d) Extended Set Triangulation

## Proposed Approach

Each minutia can be represented uniquely by using its co-ordinates m(x, y).Let t be any triangle in the representation and let it be represented by minutia triplet $m^1 = \{x1, y1\}$ $m^2 = \{x2, y2\}$ $m^3 = \{x3, y3\}$ which are sorted in increasing order according to the length of the opposite side.
The triangle class $t_c$ is defined by the binary integer $m_t^1 m_t^2 m_t^3$ i.e., if $m^1$ is an end point ($m_t^1$=0), $m^2$ an bifurcation ($m_t^2 = 1$) and $m^3$ an end point ($m_t^3$=0), then the triangle class $t_c$ is denoted by 010 i.e 2.
Let $m_\theta^i$ be the orientation of the minutia point with respect to x axis. Let the sides of the triangles be represented by $m^1m^2$, $m^2m^3$, $m^3m^1$. The angles that $m_\theta^1$ makes with $m^1m^2$ is denoted by $\theta_1$ and the angle that $m_\theta^2$ makes with $m^2m^3$ is denoted by $\theta_2$.
A 3D index X = $(t_c,\theta_1,\theta_2)$ is formed for each triplet in the fingerprint image. We use the $(t_c,\theta_1,\theta_2)$ of the triplet as an index into the 3D hash table A, of size 8x180x180. The fingerprint ID and the lengths of sides of triagnles have been stored as entries in the index inside the hash table.

$$A(t_c, \theta_1, \theta_2) = (f_{id}, l_1, l_2, l_3)$$

where $f_{id}$ represents the fingerprint identity to which the triplet belongs and $l_1$, $l_2$,$l_3$ are the lengths of sides of triangle.The same procedure is repeated for every triangle in S and the so obtained hash table is used for identification of authenticity of a user.

## Results: Figure

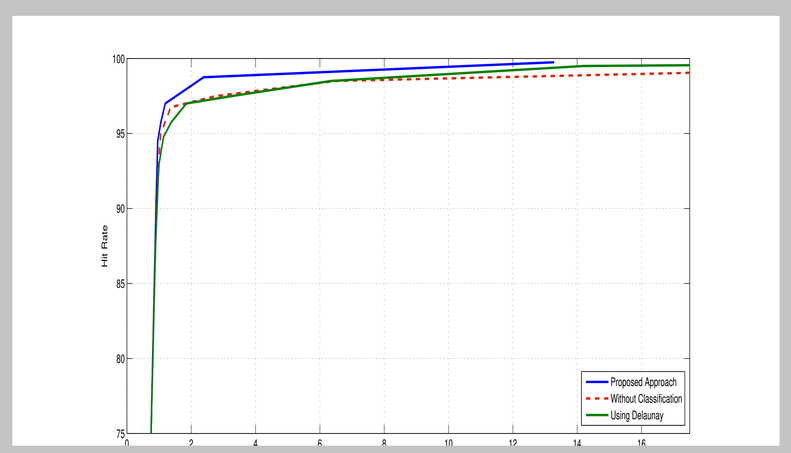


Figure : Results on FVC-2002 DB1

## Conclusion

- In this project, a new fingerprint indexing approach based on minutia triangulation is proposed.The proposed approach uses a very robust triplet representation of minutia in its approach. Experimental results show that it can greatly reduce the number of candidate hypotheses for further verification.The obtained results shows that our approach outperforms the present state of art fingerprint appriaches.
- 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

## References

1. Xuefeng Liang, Arijit Bishnu, and Tetsuo Asano ,"Distorted Fingerprint Indexing Using Minutia Detail and Delaunay Triangle", Voronoi Diagrams in Science and Engineering, 2006. ISVD '06. 3rd International Symposium, IEEE, pg: 217 - 223.
2. Andres Gago-Alonso, Jose Hernandez-Palancar, Ernesto Rodrguez-Reina, Alfredo Munoz-Briseno, "Indexing and retrieving in fingerprint databases under structural distortions", Elsevier, Expert Systems with Applications 40 (2013) 2858-2871.
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