FINGERPRINT RECOGNITION AND EVALUATION SYSTEMS

Sapienza University of Rome

Biometric Systems 2016-2017 Term Project

Prof. Maria De Marsico

Students: Farid Yusifli , Huseyn Mammadov , Tahmasib Asgarli

INTRODUCTION

- History

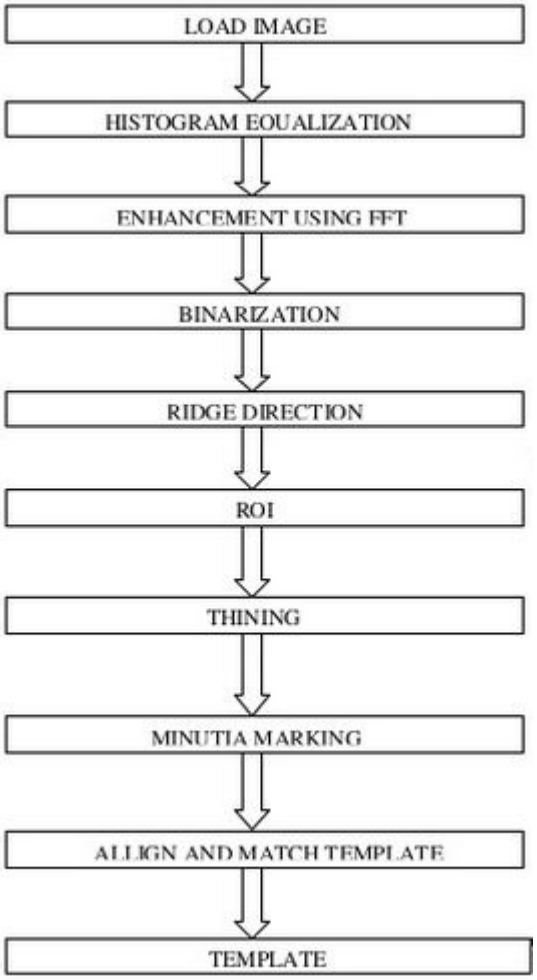
  - The characteristics of fingerprints were studied as early as the 1600s.

- Details

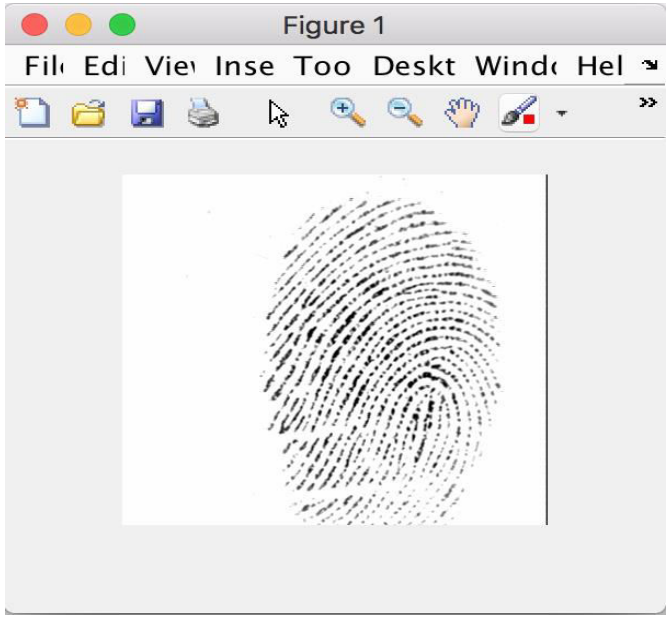
  -Unique for everyone

  -A fingerprint pattern is comprised of a sequence of ridges and valleys which together forms distinctive pattern

STEPS IN FINGERPRINT RECOGNITION SYSTEMS



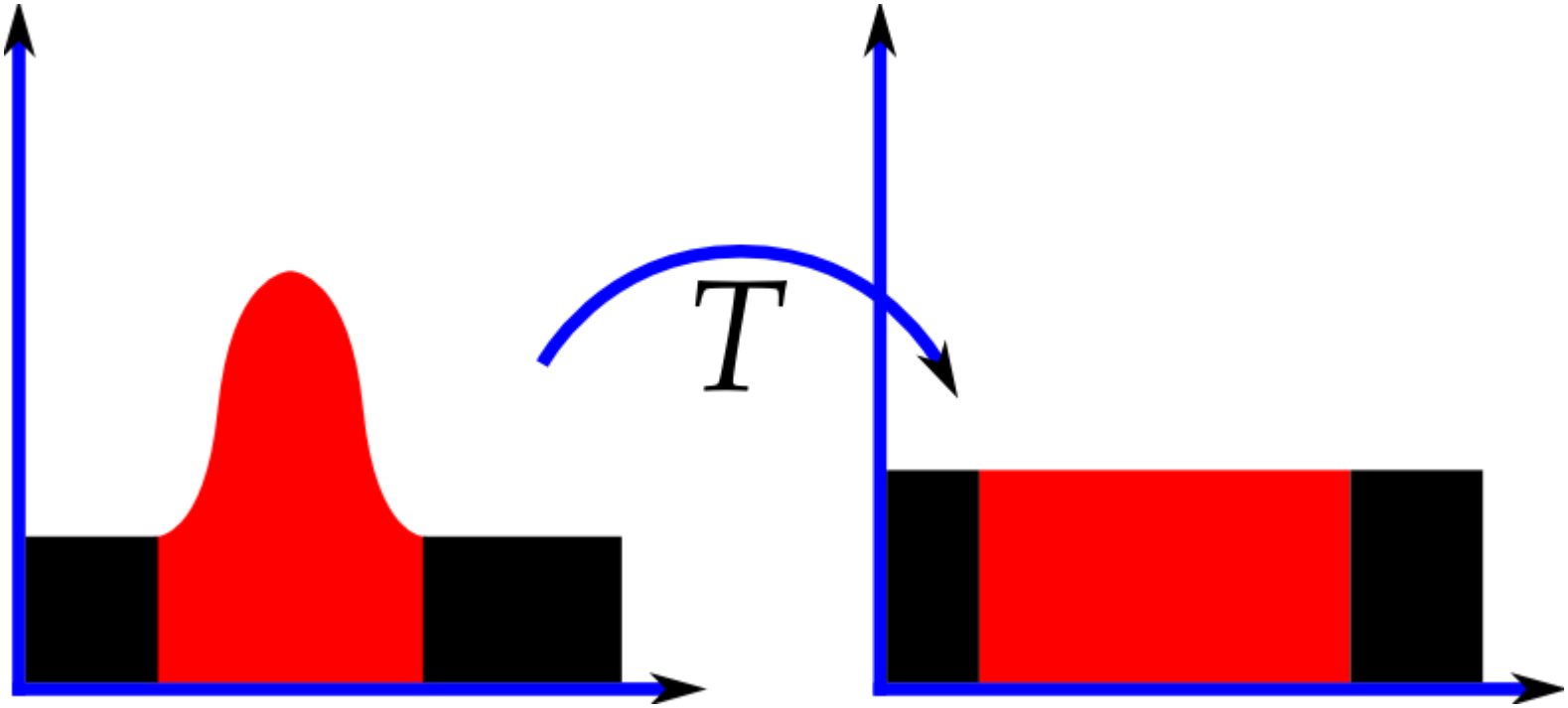
Gray Scale Image



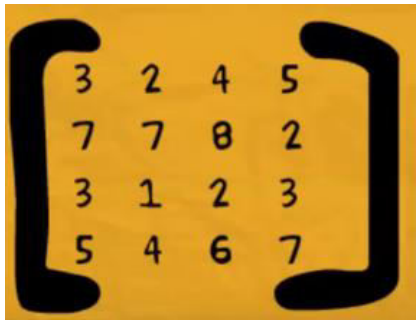
After person's fingerprint taken, we need to convert original fingerprint in greyscale image which is also known as black and white image and each pixel has only one value which is the intensity of the pixel the value may range from 0 to 255.

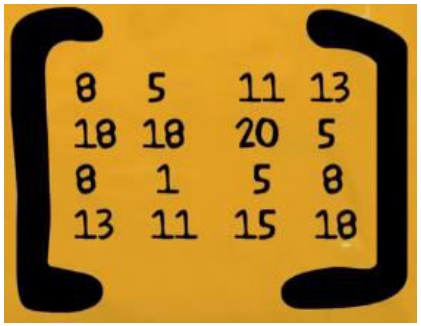
Histogram Equalization

- Histogram equalization is a general process used to enhance the contrast of images by transforming its intensity values.



Histogram Equalization





Pixel Intensity	1	2	3	4	5	6	7	8	9	10
No. of pixels	1	3	3	2	2	1	3	1	0	0
Probability	.0625	.1875	.1875	.125	.125	.0625	.1875	.0625	0	0
Cumulative probability	.0625	.25	.4375	.5625	.6875	.75	.9375	1	1	1
C.P * 20	1.25	5	8.75	11.25	13.75	15	18.75	20	20	20
Floor Rounding	1	5	8	11	13	15	18	20	20	20

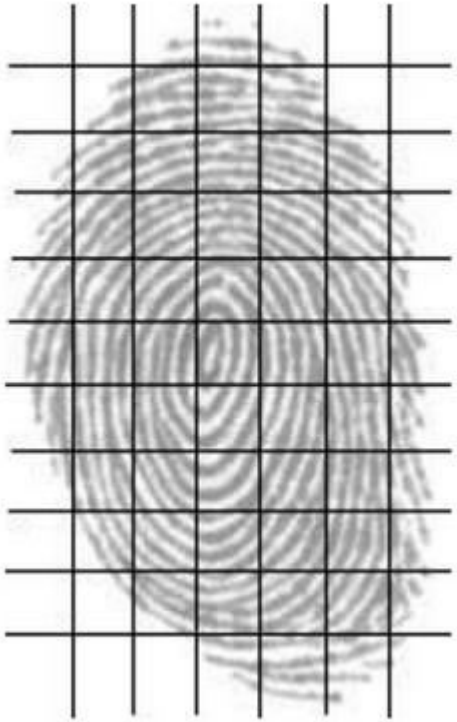
(https://www.youtube.com/watch?v=PD5d7EKYLcA)

Histogram Equalization

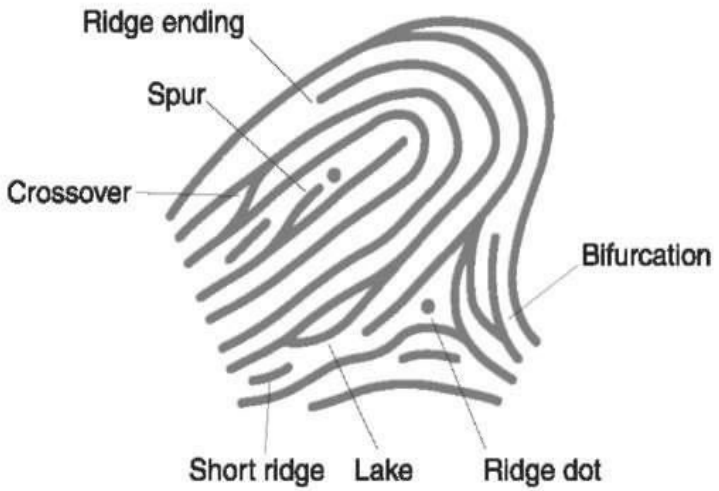
Original fingerprint

After histogram equalization

USEFUL FEATURES TO IDENTIFY FINGERPRINT RIDGES



Blocksize x Blocksize



Fingerprint Ridges

Enhancement Using Fourier Transform

The image after FFT enhancement has the improvements to connect some falsely broken points on ridges and to remove some false connections between ridges.

Binarization and Thinning

- Binarization

  -Transforms the image from a 256-level to a 2-level image. Typically, a finger pixel is a value of 1 while a background pixel is 0.

- Thinning

  -Elimination of the redundant pixels of ridges till the ridges are just one pixel wide.

  -An iterative, parallel thinning algorithm is used.

Binarization and Thinning

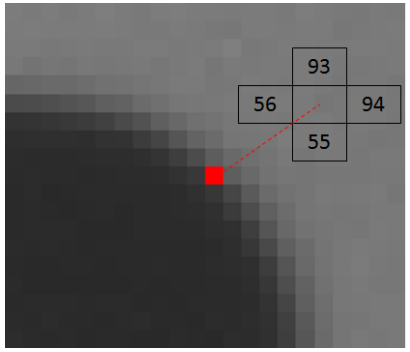
original image

binary image

thinned image

Ridge Orientation

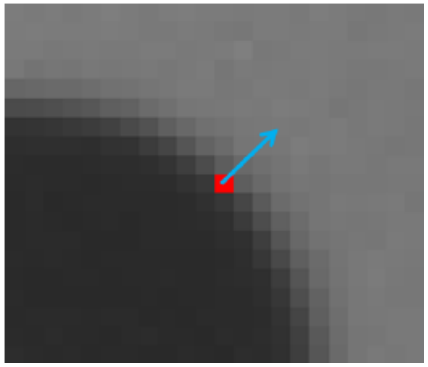
The most popular method for ridge orientation estimation is the **gradient-based** method. It computes the gradient vector at each pixel.



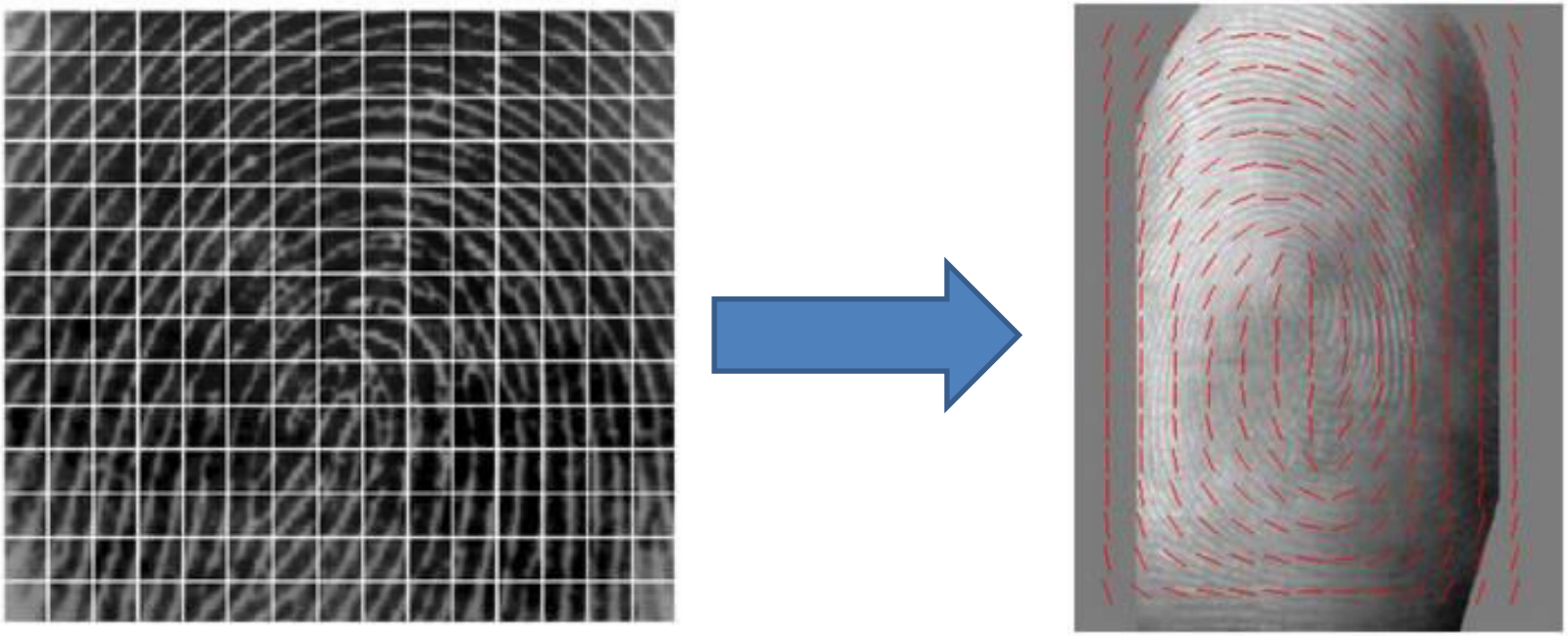
$$\text{Magnitude} = \sqrt{(38)^2+(38)^2} = 53.74$$

$$\text{Angle} = \arctan\left(\frac{38}{38}\right) = 0.785 \text{ rads}$$

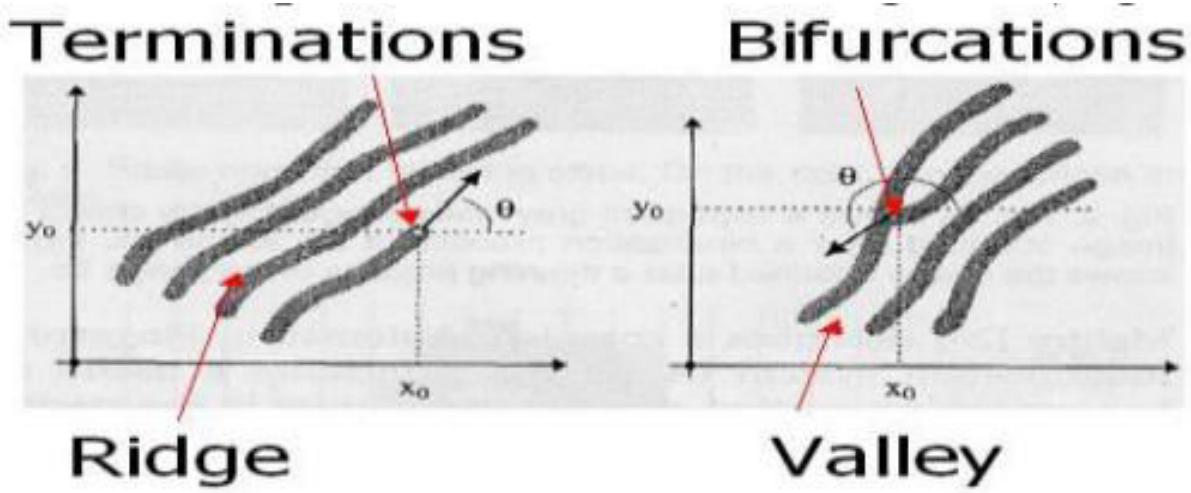
$$= 45 \text{ degrees}$$



Ridge Orientation Result



Minutiae Features



After the fingerprint ridge thinning, marking minutia points is relatively easy. In general, for each 3x3 window, if the central pixel is 1 and has exactly 3 one-value neighbours, then the central pixel is a ridge branch

Minutiae Features

0	1	0
0	1	0
1	0	1

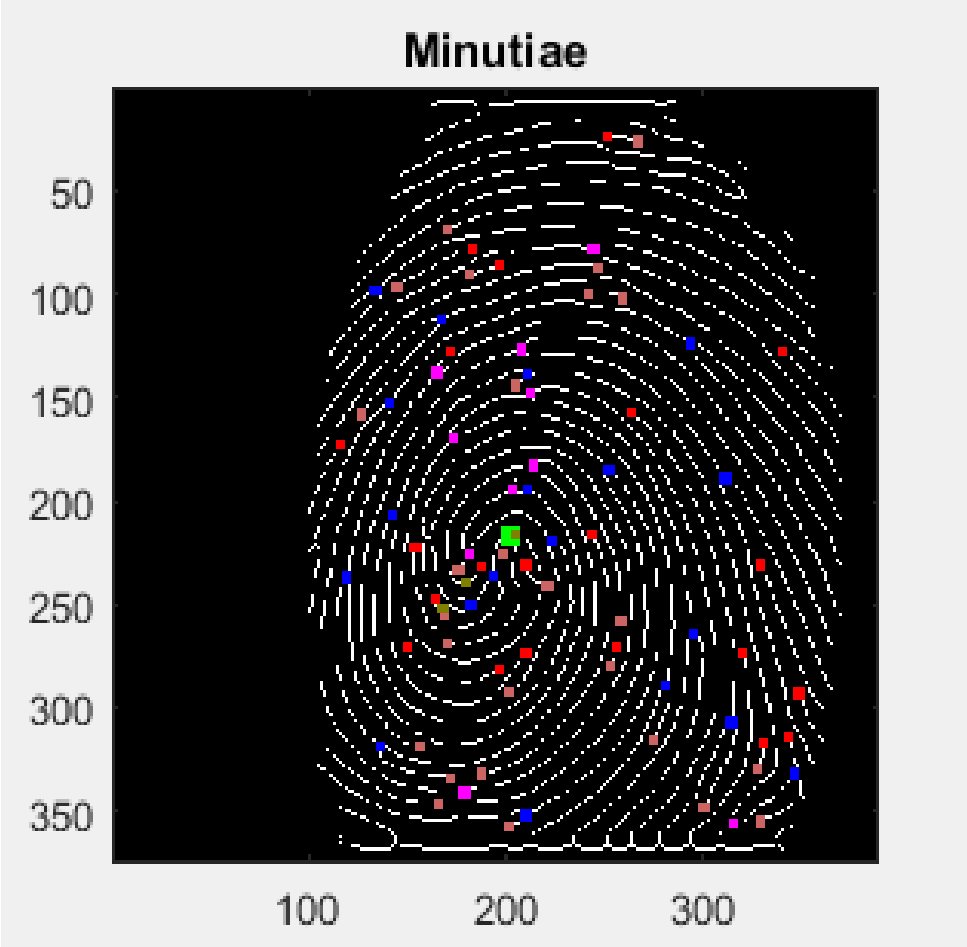
Bifurcation

0	0	0
0	1	0
0	0	1

Termination

0	1	0
0	1	1
1	0	0

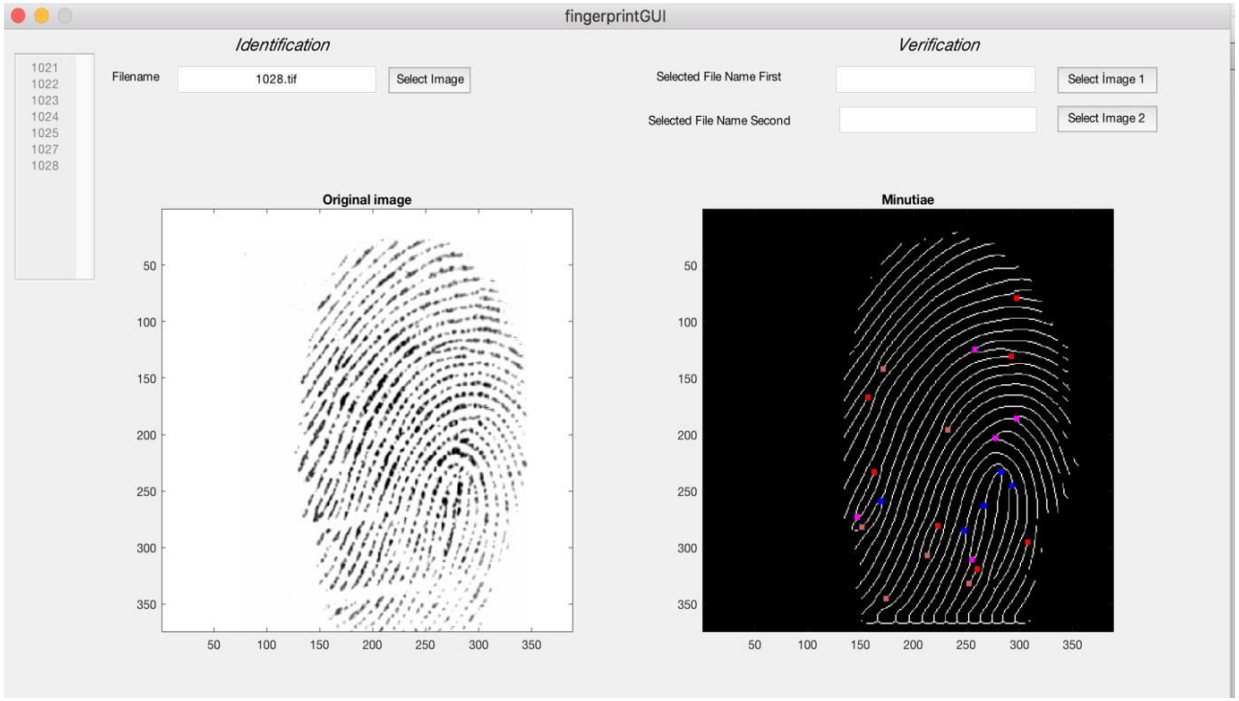
Triple counting branch



Fingerprint Recognition and Evaluation System

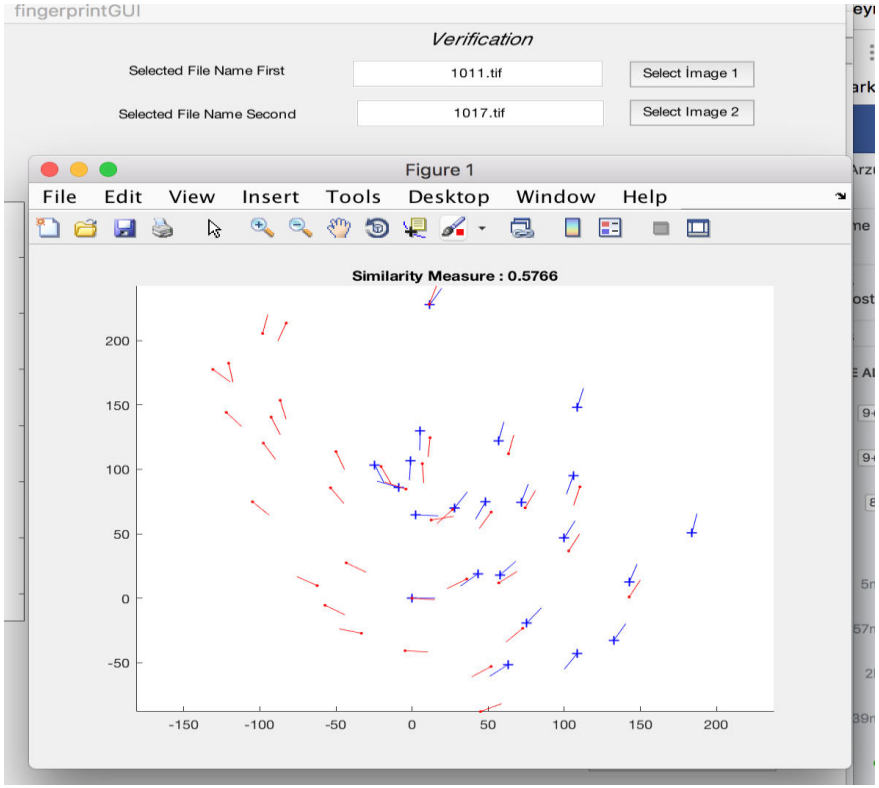
Identification

- Compare similarity of the one fingerprint through all fingerprints which is include in database then it will show fingerprint which is above the certain threshold.(1 to N)



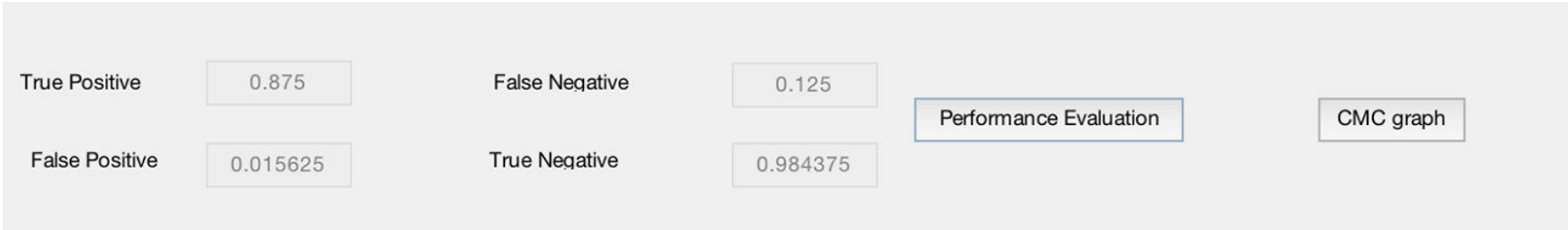
Verification

- The system performs a one-to-one comparison of a captured biometric with a specific fingerprint stored in a database in order to verify the individual is the person they claim to be (1 to 1)



Performance Evaluation

- A perfect biometric system would always make correct decisions, but in reality this is not possible.
- **TP** =Number of positive fingerprints of our application **/** Number of pictures' one fingerprint
- **TN** = Negative result of application **/** exact number of negatives
- **FP**=Number of negative that is shown as positive by application **/** exact number of negatives
- **FN** = (Number of pictures' one fingerprint - Number of positive fingerprints of our application) **/** Number of pictures' one fingerprint



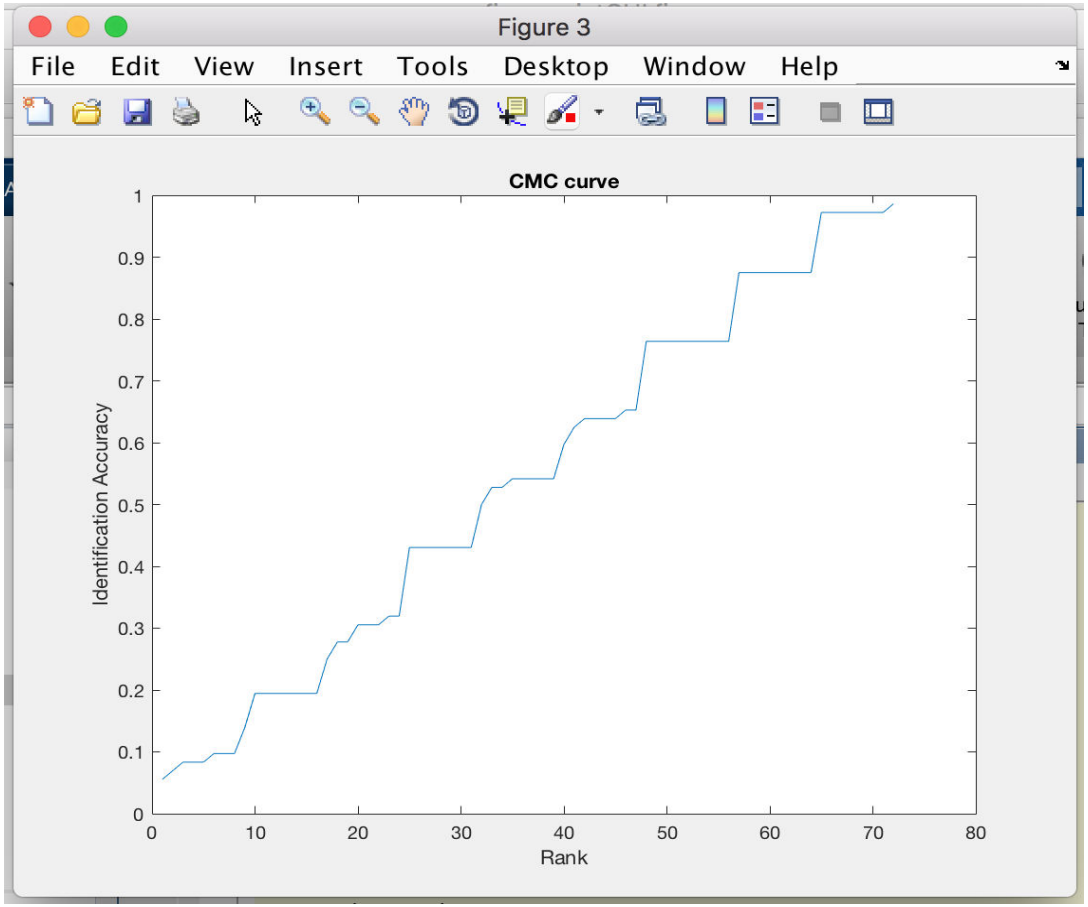
Cumulative Match Characteristic Graph

- In our system we focus on the closed-set problem, so for that reason we use Cumulative Match Characteristic

- Each probe biometric sample is compared against all gallery samples. The resulting scores are sorted and ranked. After that we only determine the rank at which a true match occurs.

- True Positive Identification Rate (y axis) which is the probability of observing the correct fingerprint within the top K ranks (x axis)

Cumulative Match Characteristic Graph



Output of Cumulative Match Characteristic in our application