Biometric Identification
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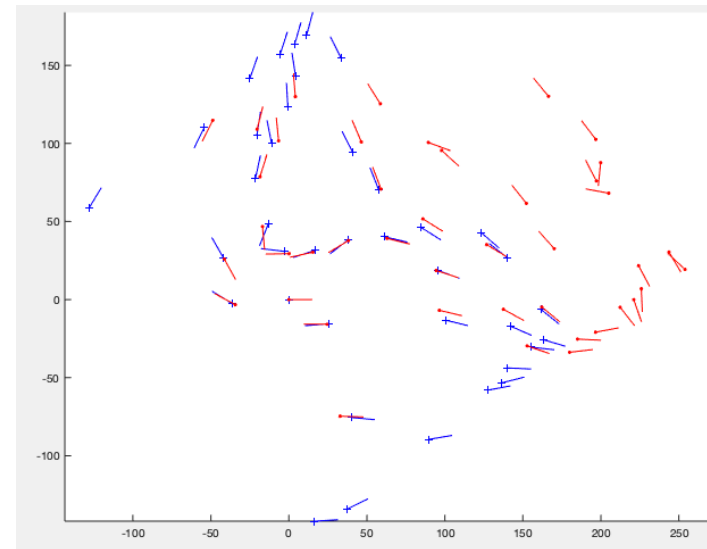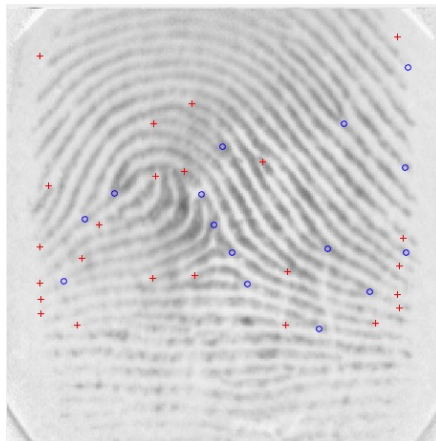
Fingerprint matching in Matlab

MESIIA – Master's Degree in Computer Security Engineering and Artificial Intelligence

Run_Match_Fingerprints

12_2
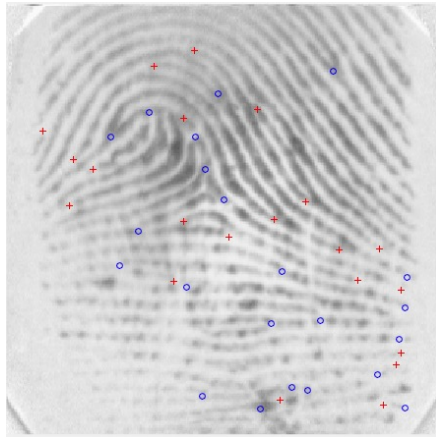
12_3

DeltaX = 4

DeltaY = 7

DeltaAngle = 0

Run_Match_Fingerprints

```matlab
clear;
clc;
close all;
addpath(genpath(pwd));

[filename1,~]=uigetfile('*.tif','Fingerprint 1');
[filename2,~]=uigetfile('*.tif','Fingerprint 2');

flag =1; % Show images. 0 if don't show
Extract_Features(filename1,flag);
ff1=load(strcat(filename1(1:end-3),'txt'));
Extract_Features(filename2,flag);
ff2=load(strcat(filename2(1:end-3),'txt'));
[ff1_aligned,ff2_aligned,DeltaX,DeltaY,DeltaAngle] = Transform_fingerprints(ff1,ff2,flag);
Distance=Match_fingerprints(ff1_aligned,ff2_aligned);   ← Function to be implemented

display(Distance,'Distance');
display(DeltaX,'DeltaX');
display(DeltaY,'DeltaY');
display(DeltaAngle,'DeltaAngle');
```

Extract Features

```matlab
function Extract_Features(filename,flag)
img1 = imread(filename);
if ndims(img1) == 3; img1 = rgb2gray(img1); end  % Color Images
disp(['Extracting features from ' filename ' ...']);
fir=ext_finger(img1,0);
fir=fir(fir(:,3)<5,:);
if flag ==1
    figure;
    imshow(img1);
    hold on
    fir1=find(fir(:,3)==1);
    fir3=find(fir(:,3)==3);
    plot(fir(fir1,1),fir(fir1,2),'r+');
    plot(fir(fir3,1),fir(fir3,2),'bo');
end
filename2=filename; filename2(end-1)='x'; filename2(end)='t';
save(filename2,'fir','-ascii');
end
```
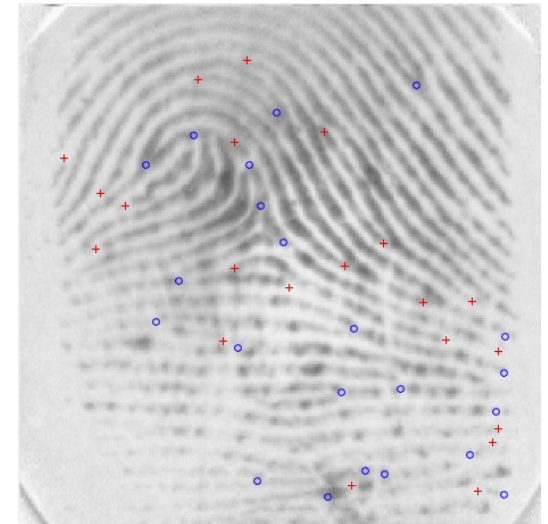
Transform Fingerprints

$$\Delta_x, \Delta_y, \theta$$

```
function [T1,T2,bi,bj,ba] = Transform_fingerprints( M1, M2,display_flag )
    [bi,bj,ba] = Transform_parameters( M1, M2);
    T2=transform(M2,bj);
    T2=transform2(T2,ba*pi/360);
    T1=transform(M1,bi);
    if display_flag==1
        plot_data(T1,1);
        plot_data(T2,2);
    end
end
```

Match Fingerprints

```
% FINGERPRINT MATCHING SCORE
% Argument:   ff1 -  First transformed Fingerprint
%             ff2 -  Second transformed Fingerprint
% Returns:    Distance


function Distance = Match_fingerprints(ff1,ff2)
%%TO DO

%% END TO DO
end
```

Match Fingerprints

- Assume that the correlation parameters <u>are known</u>: $(\Delta_x, \Delta_y, \theta)$

- For each i:1..m

  Set P(i)=j if

      a) mm(m''$_j$,m$_i$)=1

      b) D(m''$_j$,m$_i$) is the minimum given the NON previously mapped m''

  Otherwise P(i)=Null

- D_match = (sum $D(\mathbf{m}''_j, m_i)$) +K · max(nm'', nm))/(num_m''+num_m)

Where: nm'', nm: Non matched minutiae of both fingerprints

K: Constant, usualy the maximum value of D

$$D(\mathbf{m}''_j, m_i) = \alpha \cdot sd(\mathbf{m}''_j, m_i) + \beta \cdot dd(\mathbf{m}''_j, m_i)$$

$$mm(\mathbf{m}''_j, \mathbf{m}_i) = \begin{cases} 1 & sd(\mathbf{m}''_j, \mathbf{m}_i) \le r_0 \quad \text{and} \quad dd(\mathbf{m}''_j, \mathbf{m}_i) \le \theta_0 \quad \text{and the same Type (Terminal/Bifurcation)} \\ 0 & \text{otherwise.} \end{cases}$$
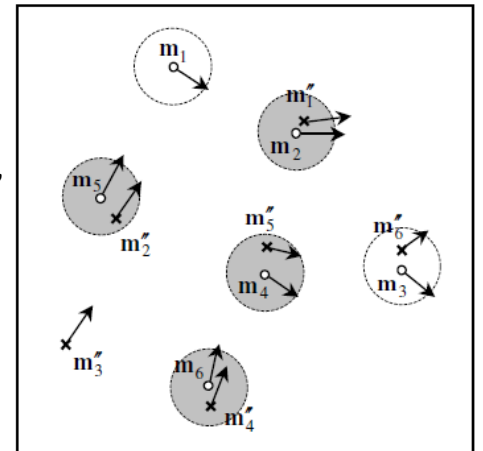
Fingerprint recognition

Practical Exercise:

- What does "Run_match_fingerprints.m" compute? Explain the format of the data. Give an example.

- What does "Transform_parameters.m" compute?

- Implement "Match_fingerprints.m"

- Fill a table with the distances between all combinations of the four fingerprints

Fingerprint matching

- **Practical Exercise Submission:**
  - Upload a pdf file that contains the comments and answers of the exercise:
    - Maximum 2 pages.