- Faculty of Computer and Information Sciences –

- AIN Shams University -

HCI - SC

ECG-BASED-AUTHENTICATION-INTERFACE

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Main idea

Ecg-Based-Authentication-Interface that can recognize Authorized Persons from its ECG After result from Classifier based on fiducial and non-fiducial features extracted from Signal ..

ECG signals have 11 main points differ from person to each other ..

Dataset

We used ECG-ID Database The ECG-ID Database is a set of 310 ECGs from 90 volunteers, created and contributed to PhysioBank by Tatiana Lugovaya and Published: March 6, 2014.

The records were obtained from volunteers (44 men and 46 women aged from 13 to 75 years who were students, colleagues, and friends of the author). The number of records for each person varies from 2 (collected during one day) to 20 (collected periodically over 6 months).
The raw ECG signals are rather noisy and contain both high and low frequency noise components. Each record includes both raw and filtered signals:

- Signal 0: ECG I (raw signal)
- Signal 1: ECG I filtered (filtered signal)

In Our Project we selected Raw signal [PERSON_01,PERSON_02,PERSON_52 and PERSON_72 " lot numbers of records "] with noise to can apply Filters and Preprocessing to remove Noises from it as required before Feature Extraction.
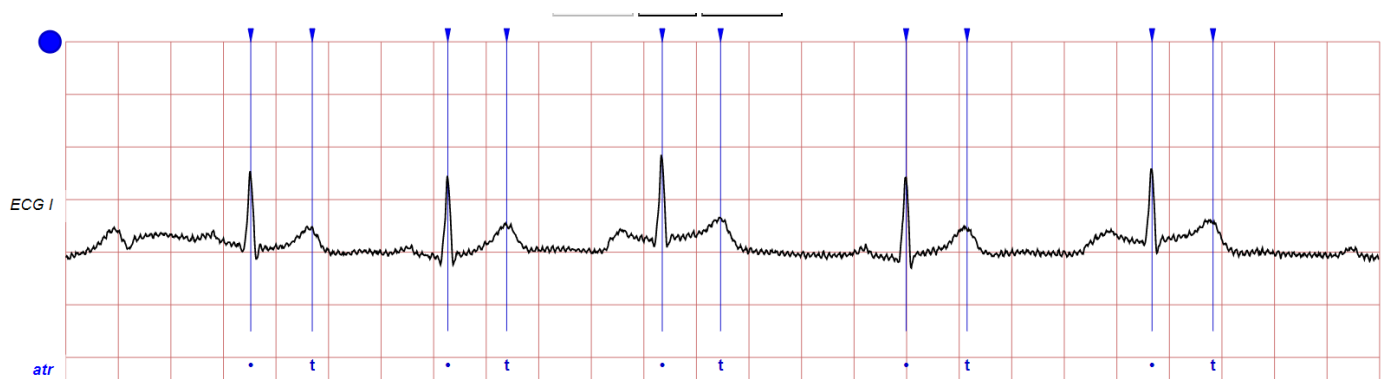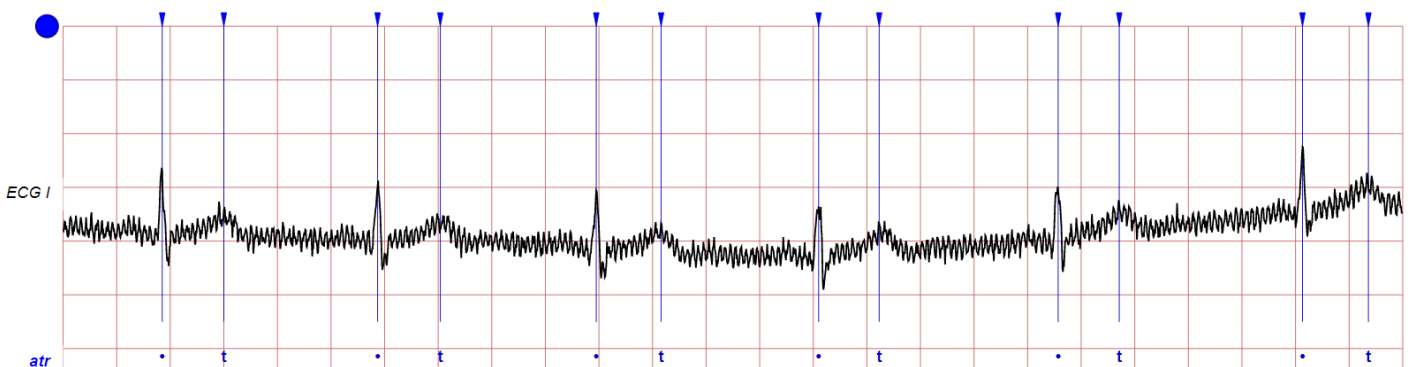

Figure 1 - PERSON1 RECORD 1

Figure 2 - PERSON2 RECORD 11

Data preparation

READ DATA:

Records was in types of ".atr , .dat , .hea", so we used **wfdb.rdsamp** method in **wfdb** library that take location of all signals and range of samples from 0 to "Specific Range=1500" and number of channels " in case our data [0:"raw",1:"filitered"] "

And we when read data we take Label of all signals to can Encoding it before submit to classifier.

Before Classifying, we split data into 80% Training and 20% Testing.

PREPROCESSING:

due to noise in raw signals

1- Non fiducial features: Firstly using butter bandpass filter with parameters
   - low cutoff:1.0 Hz , High cutoff:40.0 Hz , samplingRate = 500.0 and order = 4
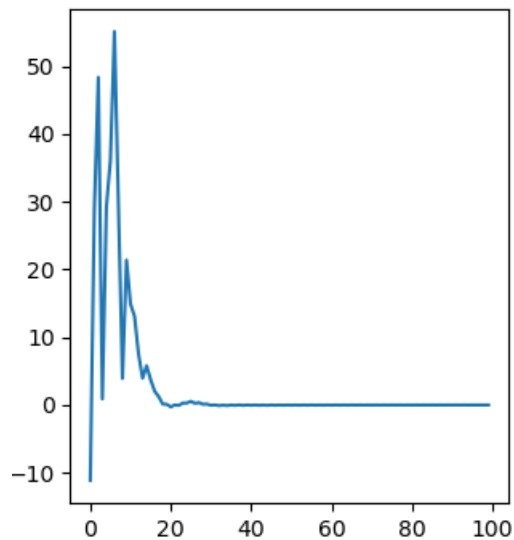   - smoothing signal
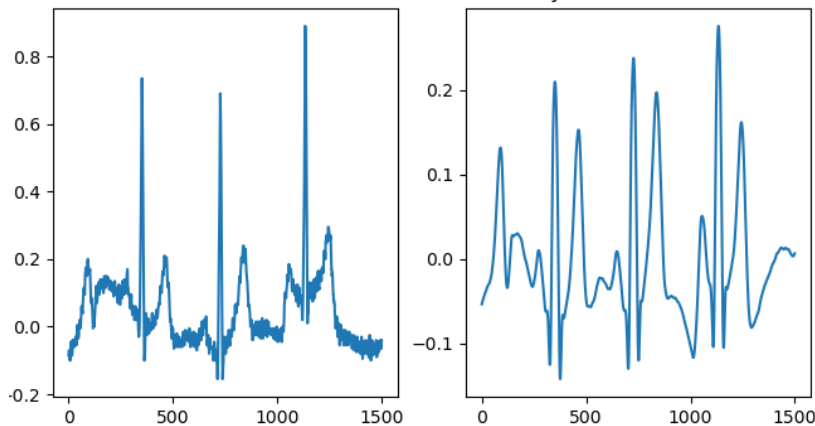
2- Fiducial Features: must apply butter bandpass filter in steps of Pan and Tompkins with parameters
   - low cutoff:1.0 Hz , High cutoff:40.0 Hz , samplingRate = 500.0 and order = 1
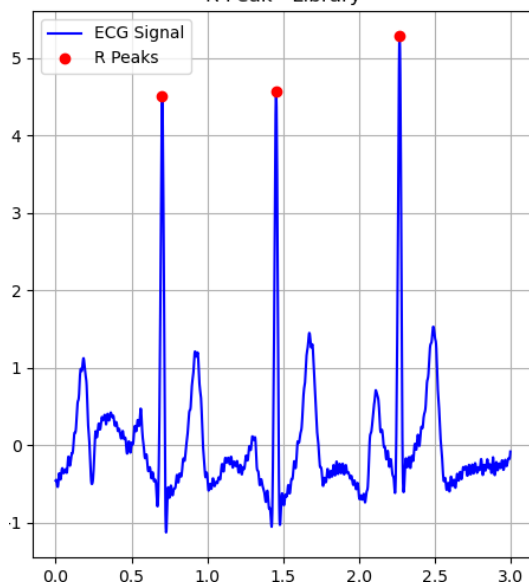
Feature Extraction

1- **Non-fiducial:**

   Applying Autocorrelation to get segments and then apply DCT to reduce Dimension of signal

   300 samples as segment from AC because another is aliasing to first Heartbeat ,then take first 100 features from DCT to Classifier to train .

2- **Fiducial:**

   we need to extract main 11 points from each heartbeat, so we applied Pan and Tompkins that first search for R Peaks
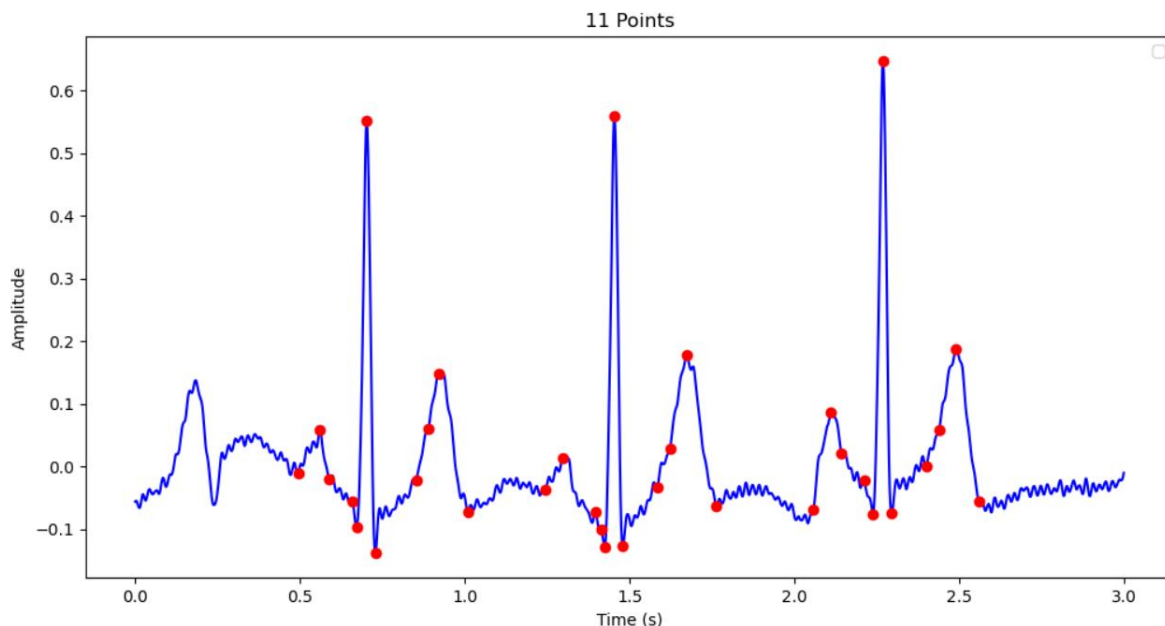
   and from each R peaks we search for P,Q,S,T local Maximum and minimum windows before and after everyone + **specific Range we entered=50** and for onset or offset for each Point, we used get_point_with_max_area() function in Helpers to find point with max Area in **specific Range we entered.**

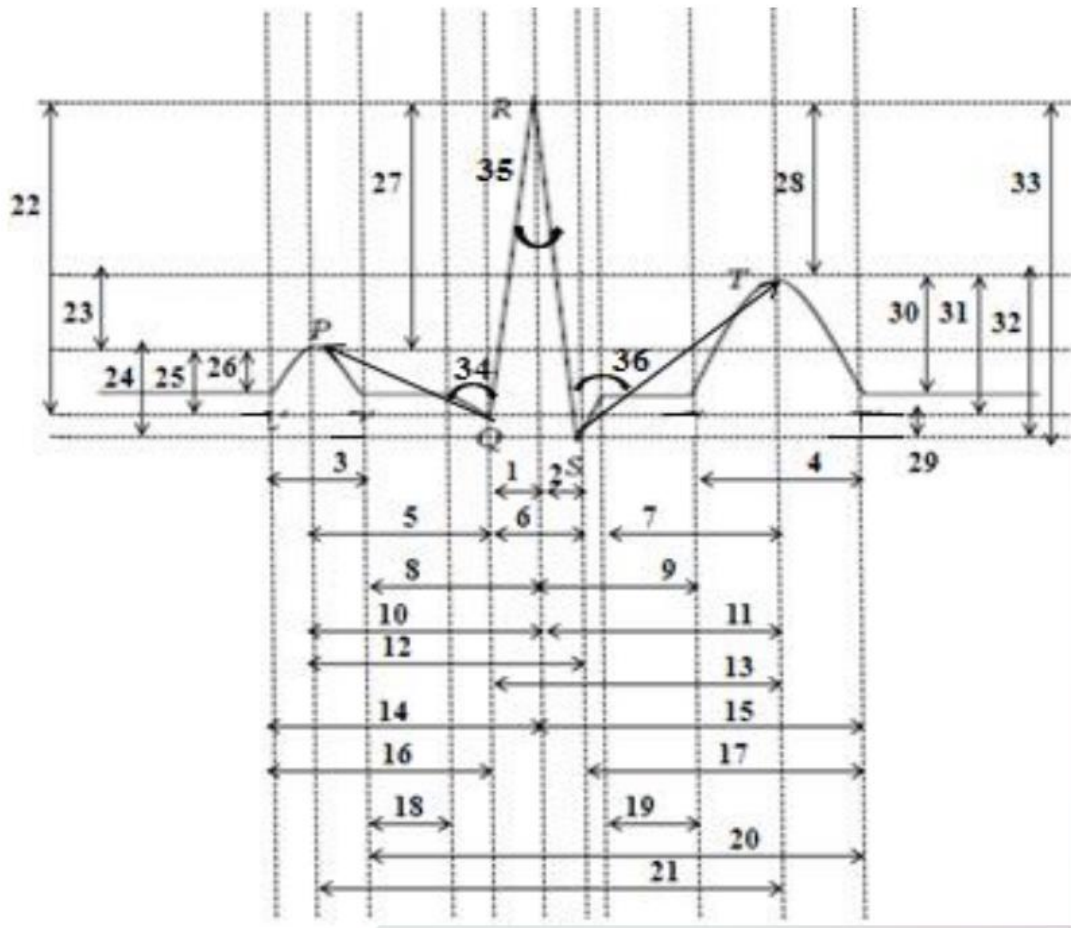**Calculating 21 Features From Extracted Points**

Figure 3 - Features From 1 to 21

Classification

We Used SVM Classifier with Parameters   *clf = svm.SVC(kernel='poly',degree=3, C=1)*
after training we Get Good Results from it that lead to not change parameters

TYPES OF FEATUERS	NO. OF INPUT FEATUERS	ACCURACY
Non-Fiducial	Array of 100	100.00%
Fiducial	Array of 42	91.66%

```
C:\Users\khale\anaconda3\python.exe C:\Users\khale\PycharmProjects\ECG-based-authentication-interface\main.py
prediction: [0 0 1 1 0 1 2 1 1 3 1 0]
True: [1, 0, 1, 1, 0, 1, 2, 1, 1, 3, 1, 0]
Accuracy : 0.9166666666666666
```

Figure 4 – Fiducial

```
"C:\Users\Ahmed Tarek\.conda\envs\HCI_env\python.exe" "D:/faculty 4th yrear 2nd term/HCI/ECG-based-authentication-interface/main.py"
prediction: [1 1 2 0 1 0 0 2 0 1 0 0 2]
True: [1 1 2 0 1 0 0 2 0 1 0 0 2]
Accuracy : 1.0
```
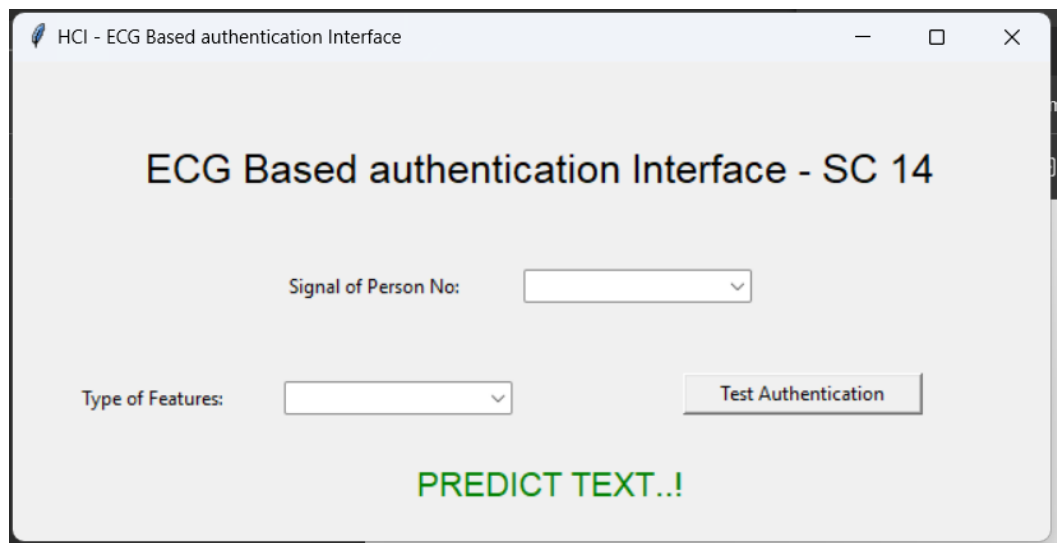
Figure 5 – non – Fiducial

Interface

From interface we take

- Signal from Persons Authorized and not authorized,

  PERSON_01, PERSON_02 → Authorized

  PERSON_03, PERSON_10 → Not Authorized

- Type of Features which need to test using it.

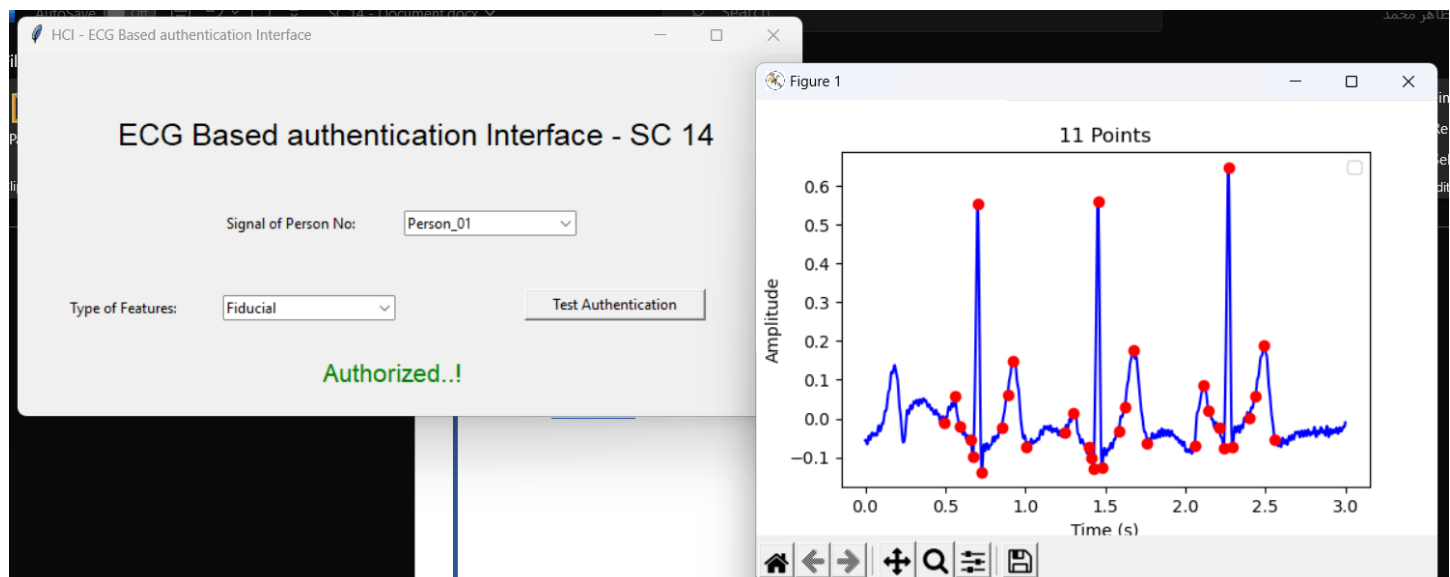And display if Person Authorized or not authorized and Accuracy of Model Trained Before..

First State – Waiting information from User.

If there empty information, Console will print `YOU MUST CHOOSE FROM COMBOBOX........!`

IN CASE " Fiducial "

IN CASE " Non - Fiducial "