THE AMERICAN
UNIVERSITY IN CAIRO

CSCE 363/3611 – Digital Signal Processing

Project

(Due on: May 22, 2023 at mid-night)
(Submit on Blackboard as one .zip file)

Project Title: Analyzing ECG Signals using Autocorrelation and Identifying Atrial Fibrillation

This project consists of two parts as follows:

Part 1: Finding Heart Rate using Autocorrelation

One method that can be used to find the heart rate from ECG signals is to use the Autocorrelation of the processed ECG signals. The steps of the method are as follows:

1 – Find the derivative of the ECG signal using the 5-point difference equation provided in Slide 10 of the attached file ECG Processing.pdf

2 – Square the derivative similar to what is explained in Slide 11 of the attached file

3 – Smooth the squared signal using a moving average window of size 31 samples as explained in Slide 12 of the attached file

4 – Compute the Autocorrelation of the obtained signal using the following expression:

$$A(m) = \sum_{i=1}^{n} x(i)x(i-m)$$

where n is the number of samples in the ECG signal and m is the lag. The average time between beats can be obtained as the time at which the autocorrelation achieves its first peak after the peak at 0 lag.

Apply your code to the provided file "Data1.txt". The sampling rate of this ECG signal is 512Hz.

Deliverables:

- Your code
- A figure showing the first 2000 samples of the ECG signal after step 3 above
- A plot of the autocorrelation showing the lag on the x-axis and the autocorrelation value on the y-axis
- The average heart rate as computed from the autocorrelation.

CSCE 363/3611 – Digital Signal Processing

Project

(Due on: May 22, 2023 at mid-night)
(Submit on Blackboard as one .zip file)

Part 2: Detecting Atrial Fibrillation

The ECG of a patient with Atrial Fibrillation is provided in the file "Data2.txt". Apply the function you implemented in Problem 1 to this dataset with a moving average window of size 31 samples.

Deliverables:

- A plot of the autocorrelation showing the lag on the x-axis and the autocorrelation value on the y-axis.

- Your observation about the autocorrelation of this dataset compared to that of the normal ECG of Part 1. Suggest a measure that can be computed from the autocorrelation that increases as the amount of Atrial Fibrillation increases.

- The code you wrote to test the measure you suggested

- The value of the suggested measure for the dataset of this problem and that of Part 1

Submission:

- Your MATLAB or Python code to be submitted on Blackboard on **May 22 at mid-night**

- A report (to be submitted on Blackboard on **May 22 at mid-night**) that includes the following:
    o Description of the approach used
    o Outputs as described in Part 1
    o Outputs as described in Part 2

- Submission of the above items should be done as one .zip file by the deadline

Guidelines:

- This is a group project. A maximum of 3 students per group is allowed.

- Each team must send an e-mail by **Wednesday, May 3 at mid-night** specifying the members of the team.

- **Changing teams will not be allowed**.

- Project evaluation will occur in the class of **May 22.**

- Project grading will be as follows (out of 15):
    o 5 points on the code submitted
    o 5 points on the submitted report
    o 5 points on the evaluation and discussion