BIRZEIT UNIVERSITY

Electrical and Computer Engineering

ENCS4310 |Digital Signal Processing|

Semester 2 / 2023-2024| Project

Filtering a real electrocardiographic signal

We give two files ECG1.xlsx and ECG2.xlsx which need to be low-pass and high-pass filtered for subsequent processing (**peak detection and classification**).

Part 1. Data Visualization

These data are recordings of actual cardiac electrical signals. They are sampled at 360 Hz.

1.1 Insert the real-time column for each signal.

1.2 Display each of these signals (reduce the width of the display lines for better readability).

1.3 What filtering types are necessary to improve the readability of data and make automatic processing possible?

Part 2. Filtering the ECG

We will use two filters, the output of the high-pass filter is $HP(n)$ and the low pass is $LP(n)$. The input is $X(n)$.

2.1 The high-pass filter

$$HP(n) = HP(n-1) - \frac{1}{32}X(n) + X(n-16) - X(n-17) + \frac{1}{32}X(n-32)$$

- ✓ Calculate its transfer function.
- ✓ Find and plot the Frequency response. Don't forget to write the expression of this also
- ✓ Which family does it belong to (FIR, IIR)?
- ✓ Apply this filter to the ECG1 and then ECG2 signal.
- ✓ How to partially resolve the problems occurring at the start of the signal?

2.2 The low-pass filter

$$LP(n) = 2.LP(n-1) - LP(n-2) + X(n) - 2X(n-6) + X(n-12)$$

- ✓ Calculate its transfer function.

- ✓ Find and plot the Frequency response.
- ✓ Which family does it belong to?
- ✓ Apply this filter to the ECG1 then the ECG2 signal.

2.3 Use the output of the high pass filter as the input of the low pass filter and display the result obtained for ECG1 and ECG2. Is there a difference if you reverse the filters?

- Bonus: (5% of project):
  Use adaptive filters for noise removal.

Project Report

- Project report should include an introduction/background, analysis, figures, discussion of the results, and conclusion. Include your code(s) in the Appendix.

Hints:

0. You can use either MATLAB or PYTHON.
1. Writing style and organization are important (Quality not Quantity!)
2. Your serial numbers should be presented on the first page.
3. A group of three students work together and submit one report.
4. You should make your output clear and nice. Use commands like (axis, xlabel, ylabel, title, legend, text)
5. Remember to use (help, lookfor) commands.
6. Allow yourself enough time. Do not work close to the due date.
7. Questions related to the project are most welcomed at most two weeks before the due date. The discussion group remains open. No code is to be shared.
8. Submission is Online through Ritaj (word+ pdf). Any late submission will result in a zero or low grade.

Break up large jobs into smaller ones!