Department of Electrical Engineering

Indian Institute of Technology Kharagpur
Signal Processing and Systems Design Laboratory
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Experiment 4: Biomedical Signal Processing on PCG dataset using different type of filters

1 Objective of the Experiment

The aim of this experiment is to implement different type of filters such that Running Mean Filter, Butterworth Filter, Gaussian Filter, FIR Filter and Median Filter design tecniques for denoisining the biomedical signals such as PCG signal and measure Reconstruction Signal-to-Noise Ratio(RSNR) to estimate how much similarities between the original and filtered signals.

2 Assignments to Solve and Report

Write all the codes for the following tasks in a '.ipynb' file, including all visualizations, and submit the executed file. Submit also a separate PDF of your report on this experiment. This report should describe your observations and reasoning while executing these experiments.

i. Plot the PCG signal from the given Dataset. The link of the dataset had been given in the references. Download PCG Data.zip and extraxt the HeartSoundData.mat and for PCG dataset and take the first column of the dataset as the columns indicates PCG Recording from different subjects and row indicates the time samples. The Data had been recoreded with sampling frequency of 2 kHz. Now plot the clean PCG signal $x(t)$ and create a White Gaussian Noise $w(t)$ and generate noisy signal $y(t)$ by adding $x(t)$ and $w(t)$. Before that, ensure whether the dataset is having spike type of noise or not. If there are spike noises in that given dataset, then after taking some threshold value, apply median filtering for removing the spikes.

ii. Apply Running Mean Filter to the noisy signal $y(t)$. Take different values of k and plot the filtered signal which will be denoted by $filtsig$ and compare the filtered output of different values of k. Take $k = 5, 10, 15, 20$ to compare your output.

iii. Apply Gaussian Filter to the noisy signal $y(t)$. Take different values of *sigma* and plot the filtered signal which will be denoted by *smoothsignal* and compare the filtered output of different values of *sigma*. Take $sigma = 4, 6, 8, 10$ to observe the performance of Gaussian Filter.

iv. Apply Median Filter to the noisy signal $y(t)$. Take different values of order n and plot the filtered signal which will be denoted by *cleansignal* and compare the filtered output of different values of n. Take $n = 11, 21, 31, 41$ to compare your output.

v. Apply a bandpass FIR filter of order 50 to the noisy signal $y(t)$ of different window type hamming, hann, blackman and bartlett and compare the filtered signal output and take the frequency range of 20 Hz to 500 Hz.

vi. Apply a zero phase shift butterworth bandpass filter to the noisy signal $y(t)$ and plot the filtered signal. Take the orders $o = 4, 6, 8, 10$

vii. Repeat all the steps with different values of SNR. Take SNR=5, 10, 15 dB.

vii. Calculate Reconstruction Signal-to-Noise Ratio (RSNR) in each of the cases between the original and the reconstructed signal(filtered signal) to assess the accuracy of reconstruction.

References

[1] Dataset is available here `https://github.com/mathworks/physionet_phonocardiogram/blob/main/PCG_Data.zip`

[2] Rangaraj M, Rangayyan, *Biomedical Signal Analysis* Second Edition, Wiley.

[3] Proakis and Manolakis, *Digital Signal Processing Principles, Algorihtms and Applications*, 4th Edition, Pearson Education India