

Team 26
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Digital Filters for Real-Time ECG Signal Processing Using Microprocessors

Objectives -

- > To understand various digital filtering algorithms
- > To implement these digital filters to conduct signal conditioning of electrocardiograms.
- > To appropriately select and implement certain filtering algorithms in a particular sequence to conduct the desired filtration task.

Summary -

Filters studied in report include:

Adaptive filter -

Task: Removal of Interference

Due to various causes of power line interference, unwanted 60-Hz interference often appears in ECG signals. We can use the adaptive filter to remove this interference without removing 60-Hz components of the signal. By treating the original signal as transient noise superimposed on 60-Hz signal and using previous samples, we can estimate the amount to be subtracted from the total signal so that we are eventually left with just the transient part of the signal.

Hanning filter -

Task: Smoothing

Hanning filters are low-pass filters which use a weighted moving-average algorithm to smoothen out signals and suppress noise. We get the scaled average of 3 continuous points as our output. Thus, it also tends to suppress the higher frequencies.

Low pass filter -

Task: Removal of high interference signals

ECG signals may also face high frequency interferences like EMG noise which can be eliminated using low-pass filters with steeper reductions of gain. Higher order filters can be used to reduce the magnitude of sidelobes obtained.

Elimination of Offset filter -

Task: Elimination of DC offset using a high pass filter.

We can eliminate DC offset from ECG signals using a high pass filter implemented by removing the result of low pass filter from the actual signal.

Turning point data reduction -

Task: Data reduction while conserving data points necessary to preserve ECG features.

For utilizing some other filters, sampling rate may need to be decreased which will reduce the accuracy of the signal we are sampling. The turning point algorithm is used to compare the trends from different samples and retain the more essential ones to make sure that the important samples are not removed while reducing the total number of samples.

Band-Pass Filter -

Task: QRS detection

QRS type structures can be detected in ECG signals using special band-pass filters with evenly spaced zeroes and pair of complex conjugate poles on unit circle.

Sum of derivatives -

Task: QRS detection

QRS type structures can be detected more efficiently using the first and second order derivatives of the original signals and processing them appropriately such that they give us a peak in the output when QRS type structures are present.

References -

1. Digital Filters for Real-Time ECG Signal Processing Using Microprocessors
by- M. L. AHLSTROM AND W. J. TOMPKINS
2. Adaptive noise cancelling: Principles and applications
by- B. Widrow, J. R. Glover, J. M. McCool, J. Kaunitz