Title: ECG Signal Simulation and Noise Removal Using MATLAB

1. Introduction

This project demonstrates how to simulate a synthetic ECG signal, contaminate it with noise, and apply a Butterworth low-pass filter for noise removal. It also includes frequency domain analysis using FFT in MATLAB.

2. Objectives

Simulate a clean ECG signal

Add white Gaussian noise

Filter the noisy signal using a Butterworth filter

Analyze signals in both time and frequency domains

3. Tools Used

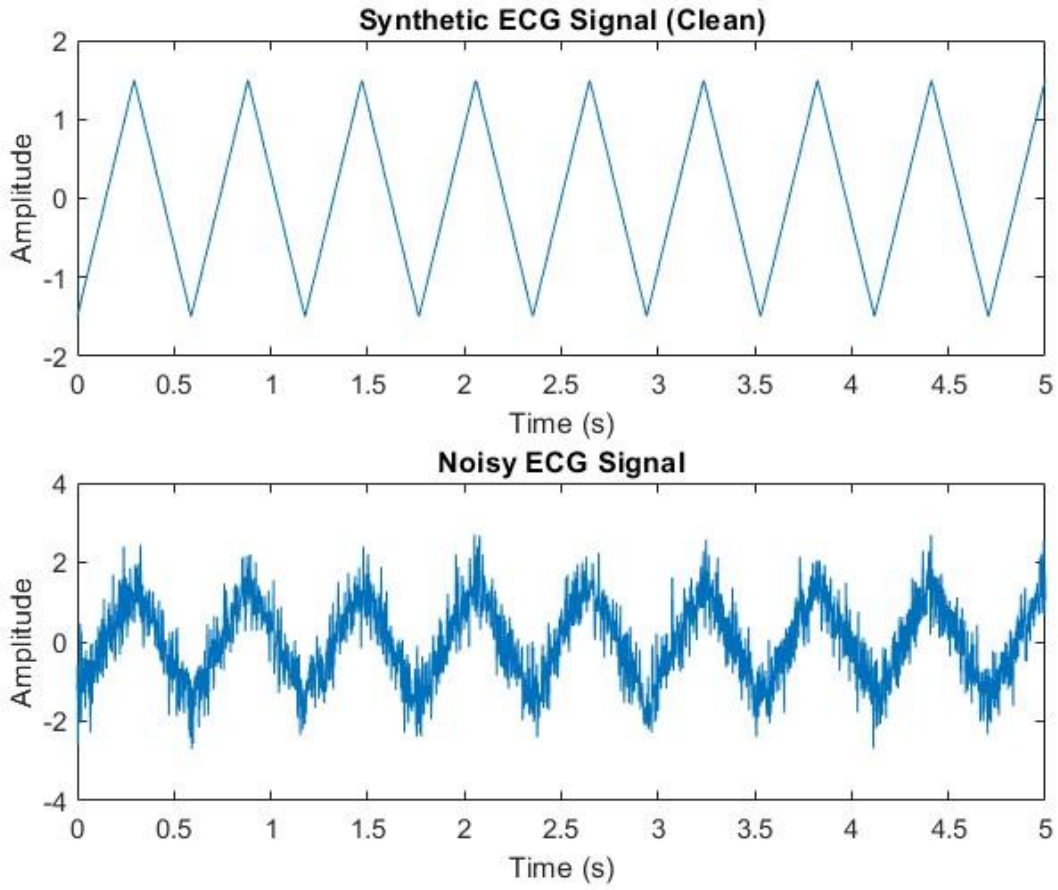
MATLAB R2023a

Signal Processing Toolbox

4. Methodology and Results

Step 1: ECG Signal Generation and Noise Addition

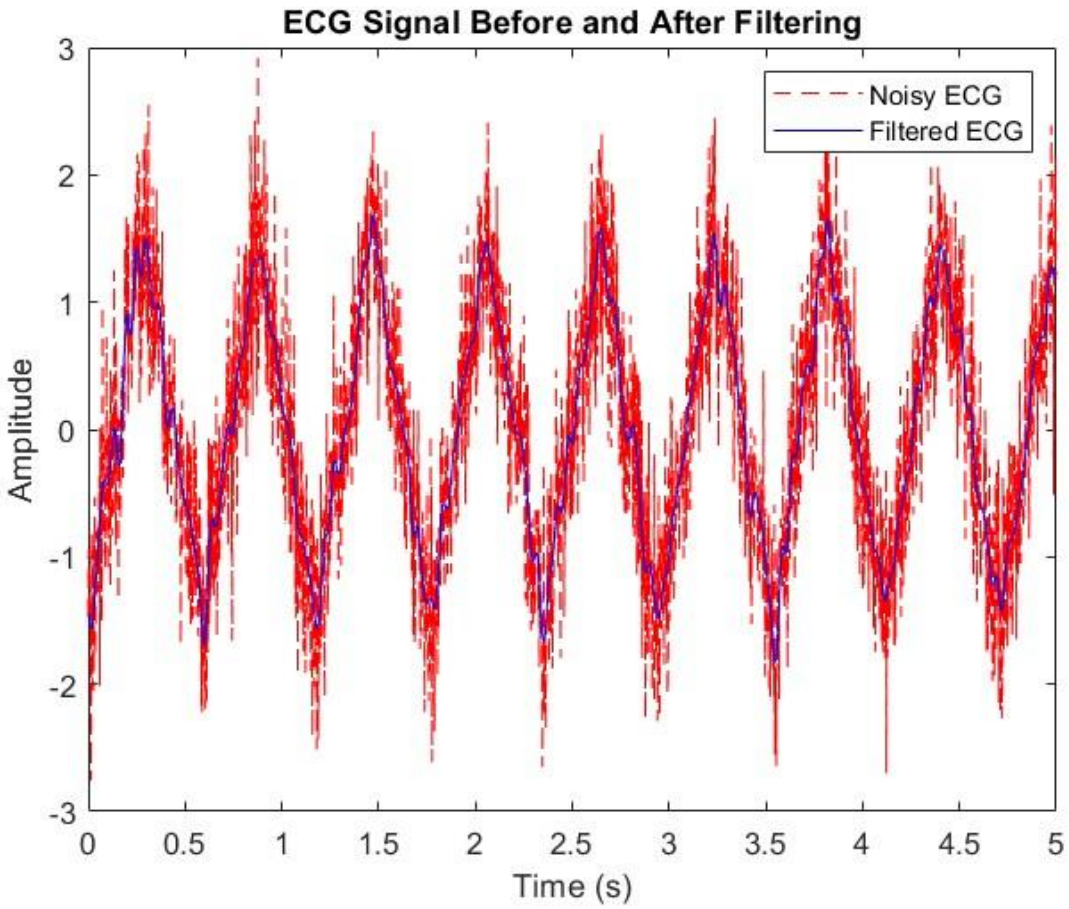
A clean ECG signal is generated and white Gaussian noise is added to simulate real-world conditions.



Comparison of clean ECG signal and noisy ECG signal.

Step 2: Noise Filtering with Butterworth Filter

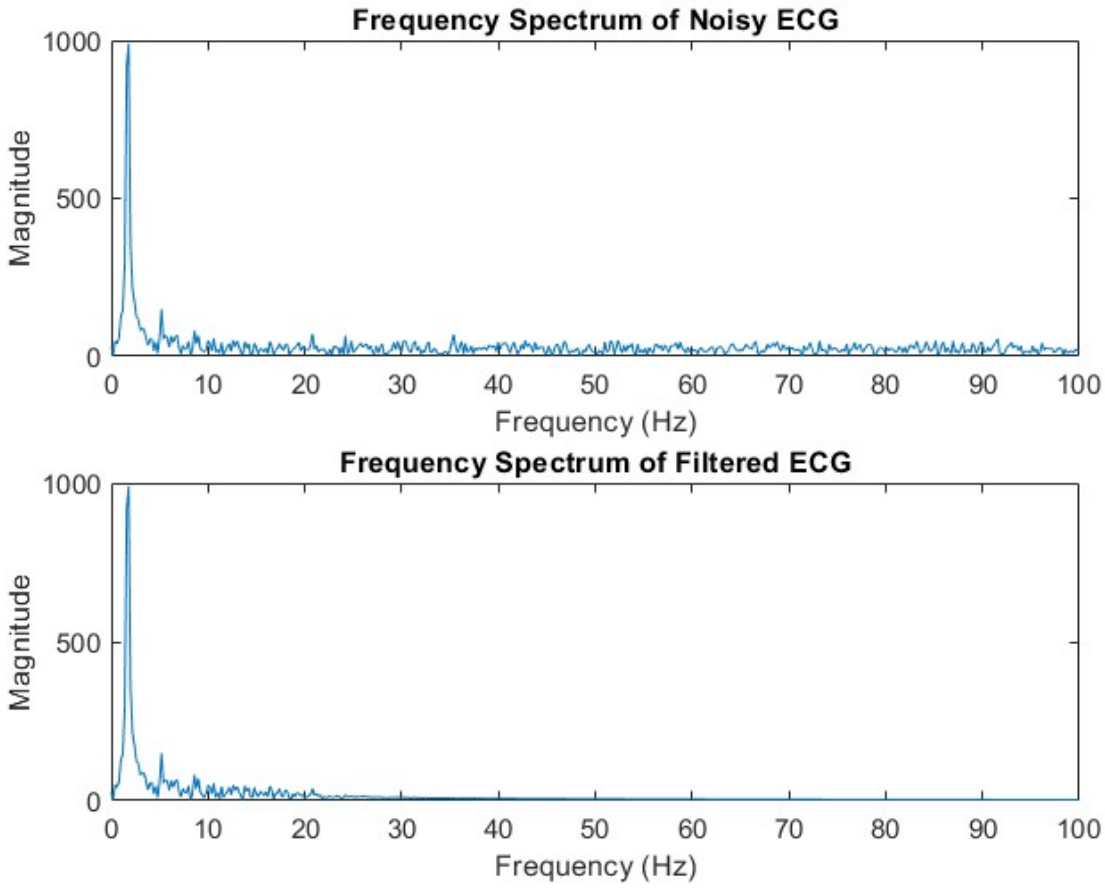
A 4th-order Butterworth low-pass filter is applied to remove high-frequency noise from the noisy signal.



Noisy ECG signal (blue) vs. Filtered ECG signal (red).

Step 3: Frequency Domain Analysis

The frequency components of both the noisy and filtered signals are analyzed using FFT.



Frequency spectrum of noisy ECG vs. filtered ECG.

5. Conclusion

The filtering process effectively reduced high-frequency noise while preserving key features of the ECG waveform. This basic signal processing technique can be further extended for real ECG data and advanced filters.

6. Author

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