Noise Removal using MATLAB & Simulink

Project: Noise Removal in Time and Frequency Domain (MATLAB & Simulink)

Designed and simulated a real-time noise reduction system. A dual-frequency sinusoidal signal was contaminated with Gaussian noise and then filtered using a 6th-order Butterworth low-pass filter. Implemented both in MATLAB and Simulink with visualization of frequency spectrum (FFT) and time-domain signal restoration.

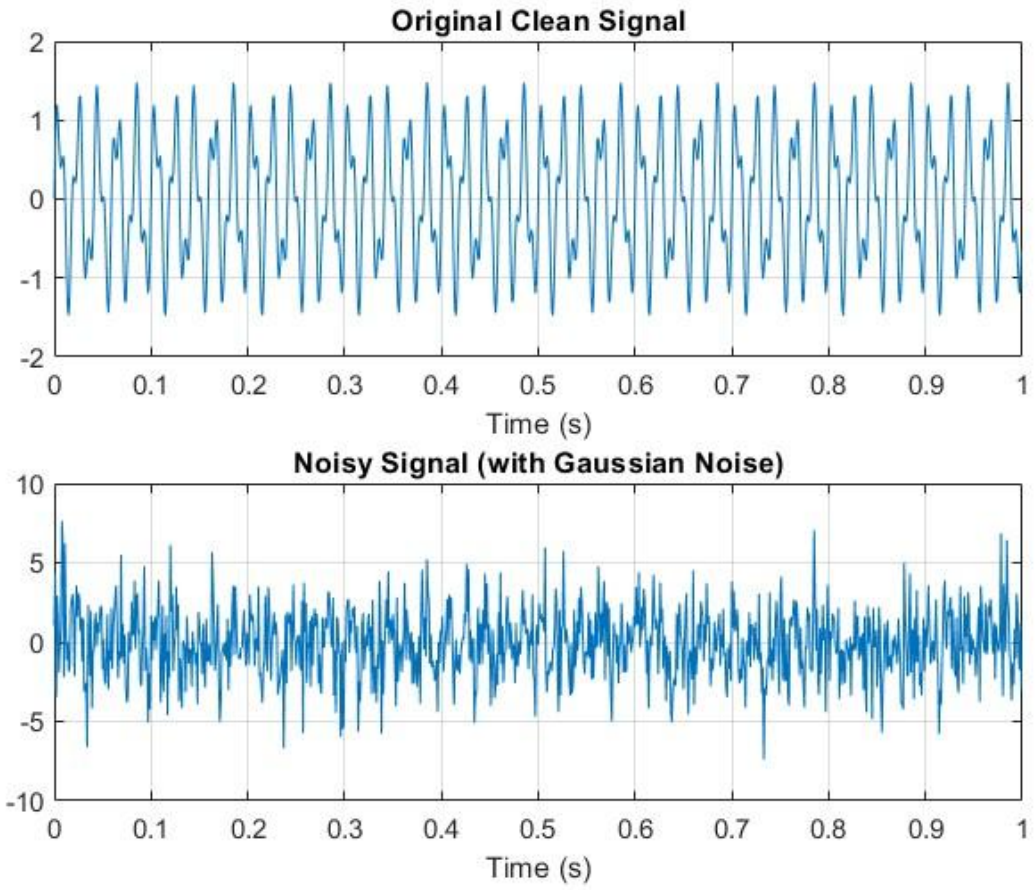

Figure1. The main signal consists of a combination of 50Hz and 120Hz frequencies.

High-intensity random noise has been added to make it realistic.

Two separate graphs show the clean signal and the noisy signal.

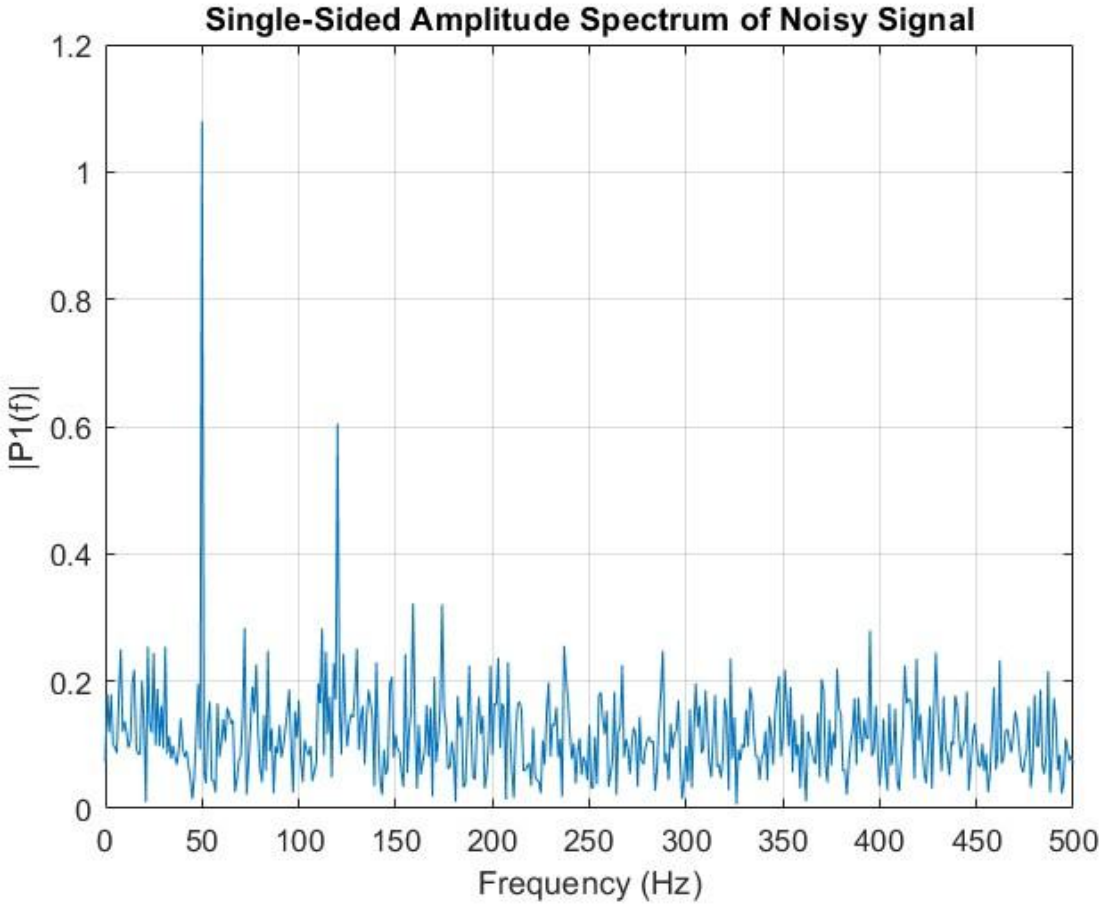

Figure 2. Calculate the Fourier transform of the noisy signal.

We only display the right half of the spectrum (positive frequencies).

In the graph, the frequencies 50Hz and 120Hz should have distinct peaks.

The random frequencies around them are the noise.

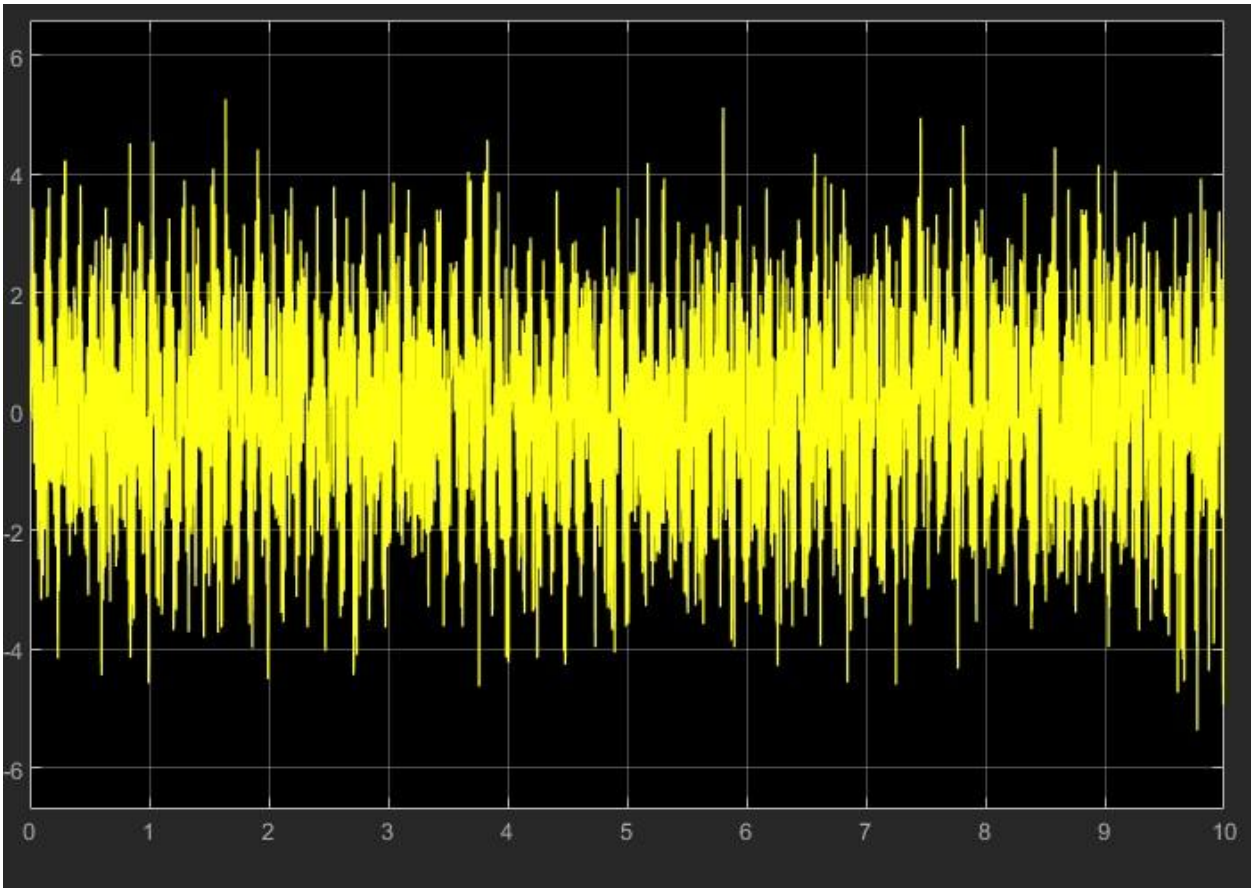

Figure 3. We used the butter() function to create a filter.

With filtfilt(), we filtered the signal forward and backward without phase delay.

The graph below shows that the noise has been significantly reduced, leaving only the main shape of the signal.

Project Overview

This project simulates a real-time noise reduction system in MATLAB and Simulink. It generates a

dual-frequency sinusoidal signal (50Hz and 120Hz), adds Gaussian noise, and applies a 6th-order

Butterworth low-pass filter to remove the noise. Both the time-domain and frequency-domain behaviors of the

signal are visualized.

Tools and Concepts Used

- MATLAB for signal generation, FFT analysis, and filtering
- Simulink for block-based modeling and visualization
- Butterworth low-pass filter
- FFT for frequency spectrum analysis
- Scope for observing signal behavior

Key MATLAB Code Snippet

```
Fs = 1000;
t = 0:1/Fs:1-1/Fs;
x = sin(2*pi*50*t) + sin(2*pi*120*t);
x_noisy = x + 2*randn(size(t));
[b, a] = butter(6, 150/(Fs/2));
x_filtered = filtfilt(b, a, x_noisy);
```

Simulink Model

The Simulink model includes the following blocks:

- Sine Wave: Generates 50Hz sinusoidal signal
- Random Number: Adds Gaussian noise
- Sum: Combines signal and noise
- Lowpass Filter: Filters noise using Butterworth LPF
- Scope: Visualizes noisy and filtered signal

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