EE 115 Lab 1: Matlab and Communication

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Date Submitted	October 17, 2013
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1 Abstract

This lab teaches basic MATLAB and Simulink functions as well as introducing filter design within MATLAB. First, a walk through of basic MATLAB functions are introduced to help acquaint users with the program. Then a Fourier Synthesizer is created with a Simulink model. This model is then further used to help design a Butterworth Filter also within Simulink.

2 Procedure and Analysis

2.1 Simulink Walkthrough

The first part of the lab walks through creating a Simulink model. Simulink is loaded by typing in the command `simulink` into the MATLAB prompt. A Signal Generator and a Scope are attached to each other. The parameters are then edited to have a max. step size of 0.01. The simulation is then ran several times with different parameters to observe its effect on the model. Finally, with a 1 Hz sine wave, the scope's sampling time is varied between 0 and 0.1. The simulation is then rerun and observed.

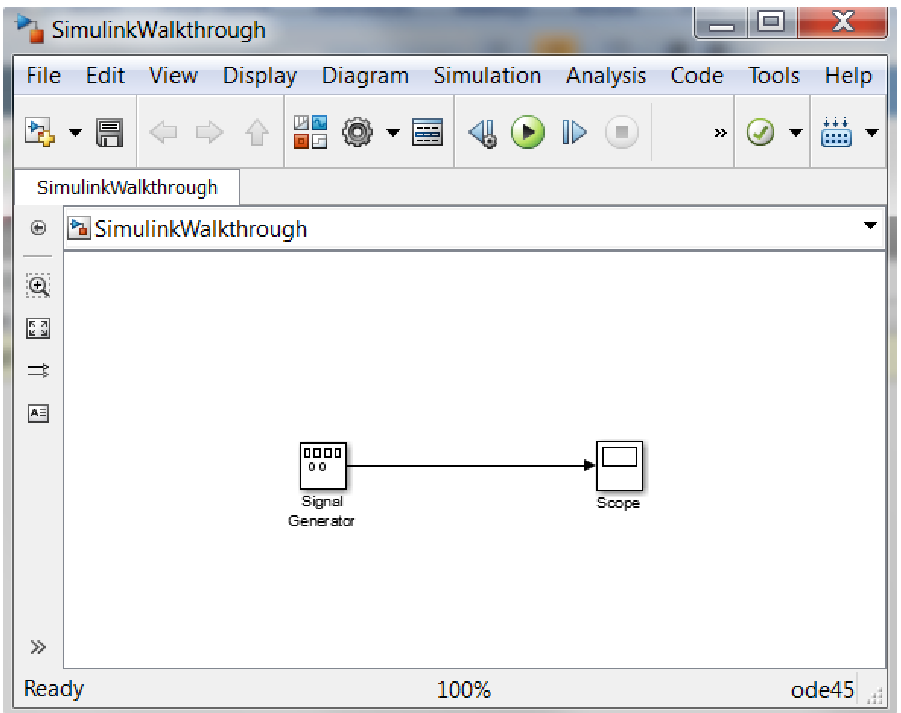

Figure 1: This is a picture of the simulink model.

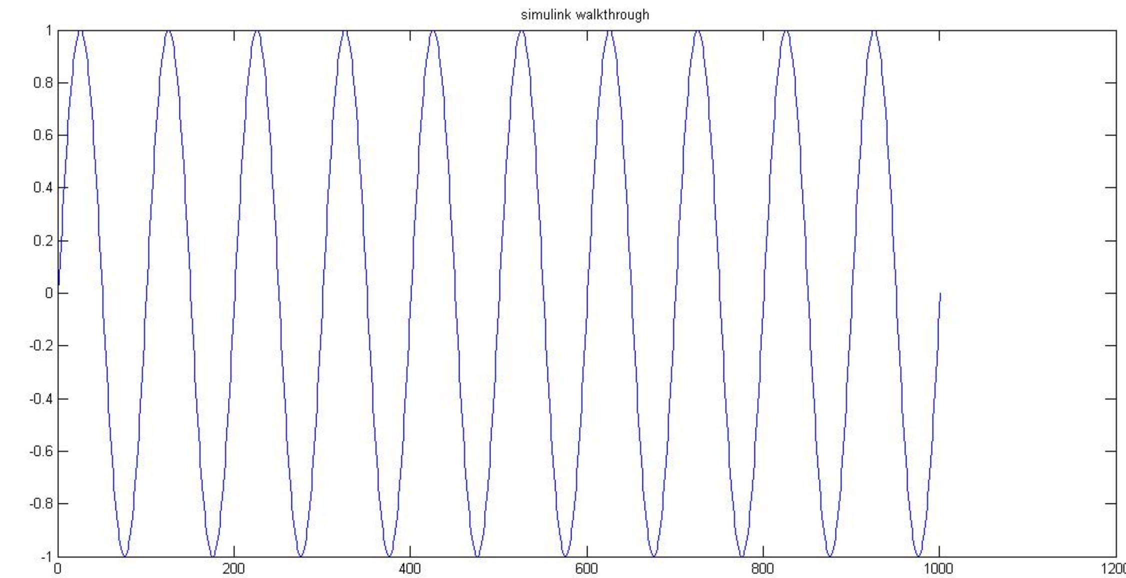

Figure 2: This is a picture of a view from the scope when running through different parameters.

2.2 Fourier Synthesizer

In this exercise a Fourier theory synthesizer is created using a simulink model. The model is constructed using Sine Wave, Sum, Scope, and Power Spectral Density blocks. Up to the 9th harmonic is added to the system one at a time. This was achieved by adding a + to the Sum block. A square wave and the harmonic scope are then superimposed and compared for accuracy.

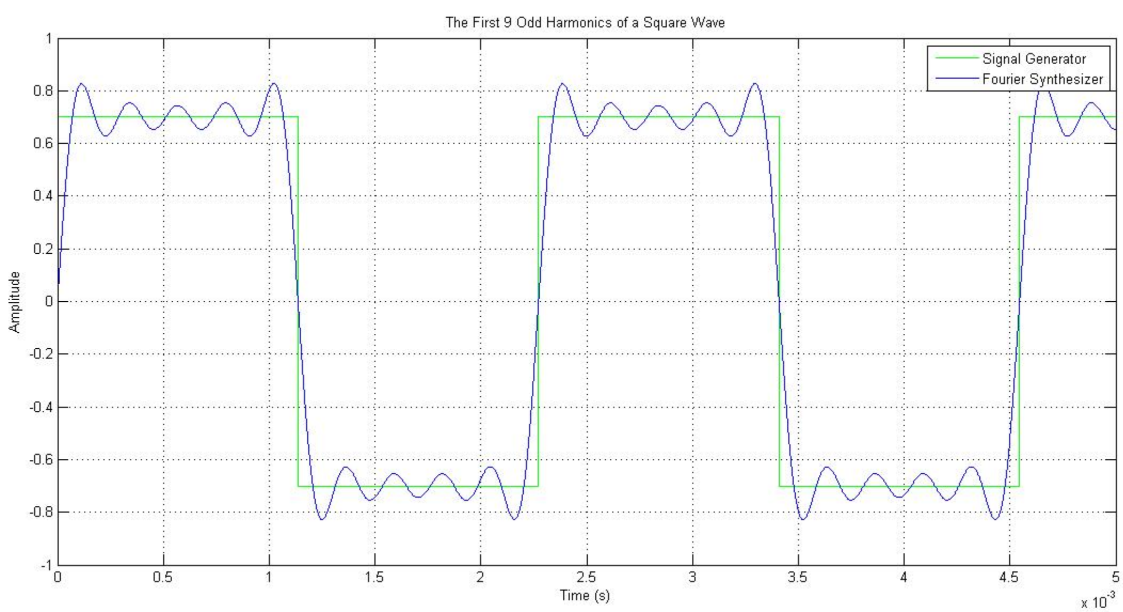

Figure 3: This is a picture of the first 9 harmonics of the system superimposed with a square wave.

As shown above, the waveform is consistent with the square wave. The more harmonics added, the more accurate the waveform would be. This discovery is consistent with the preparation and with the spectrum we had observed.

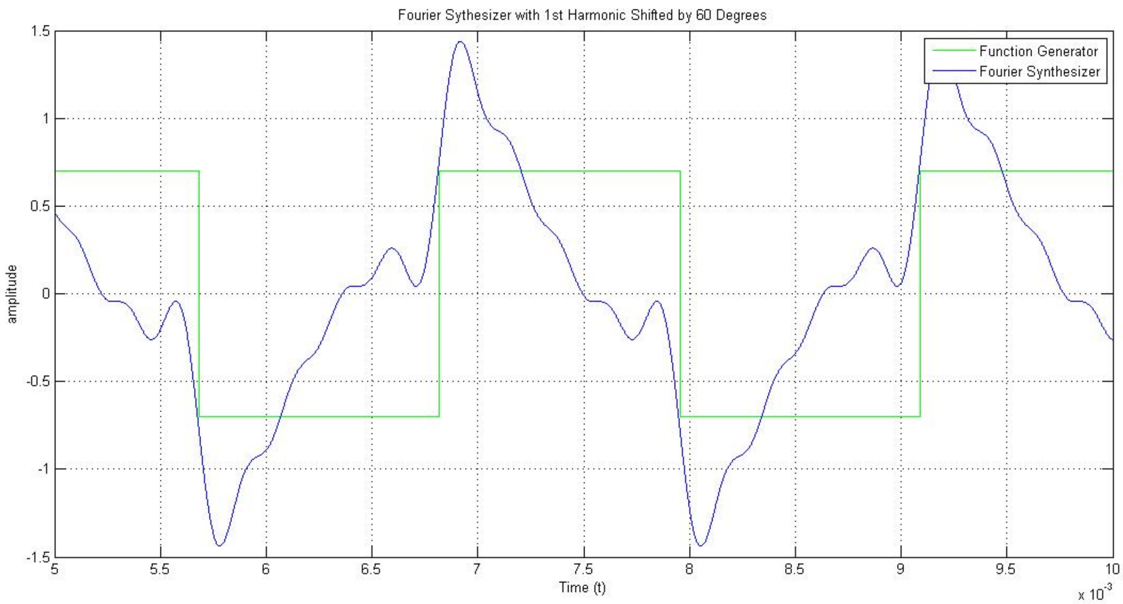

Figure 4

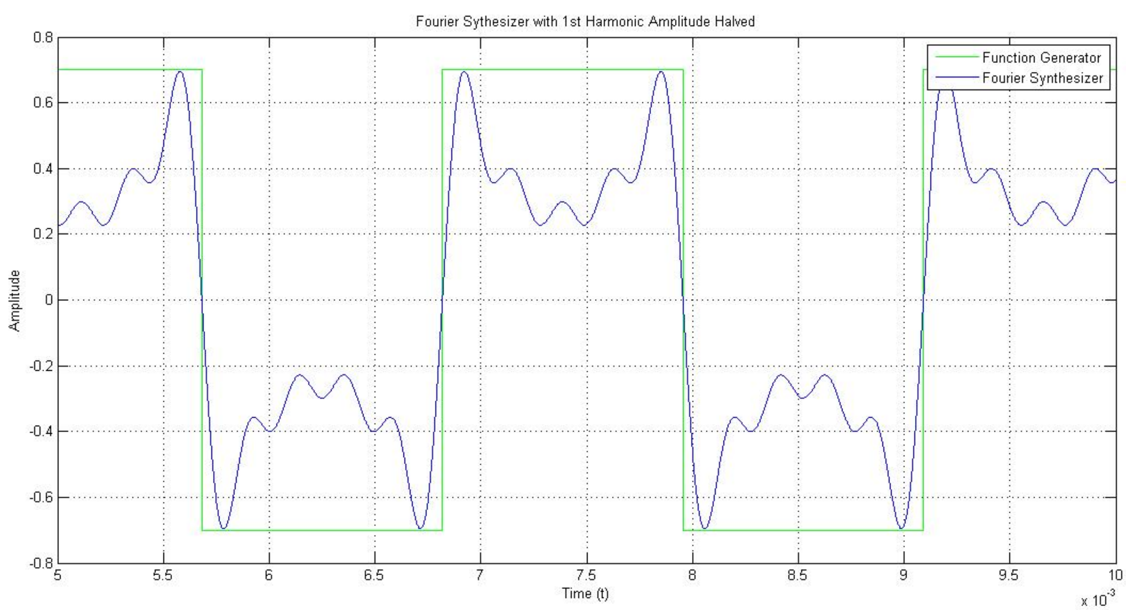

Figure 5

2.3 Filter Design

In this section, an Butterworth low pass filter with a frequency higher than the 9th harmonic of the synthesized square wave is created. The Analog LP Filter block sets the cutoff frequency. A Sine wave, scope, and mux block are also needed. The Fourier Synthesizer square wave output is used as the input to this filter. The filter is then run and the input and output, which is filtered, are compared. These steps are repeated for the cutoff equal to the 6th and 2nd harmonics. Then, a bandpass filter is with a cutoff equal to the 2nd harmonic is created and repeated for the center frequency equal to the 9th harmonic, then the 6th, then finally the 3rd harmonic. A high pass filter is created and the cuttoff is equal to the 3rd harmonic. All of these are tested and compared to eachother to see the differences the Butterworth filters make on the input signal.

The significance of doing various filter designs is to create a nicer signal to noise ratio (S/N). When a certain frequency (or frequencies) of a signal need to be obtained, a filter can easily do the job. Sometimes the noise will be from the lower end of the spectrum so a high pass filter will be needed. A highpass fiolter will block out any lower frequency noise below a certain threshold but pass through the frequencies higher than the threshold. Other times, frequencies too high and too low are carried in the signal and aren't needed. A bandpass filter will help achieve getting the correct frequencies (in between the high and low thresholds) in the output. Still other times frequencies may be too high on the signal and a lowpass filter will help block them out in order to clean up the signal with the lower frequencies needed.

3 Conclusion

With simulink, Filter Design and simulation can easily be reproduced without any real hardware. This is useful for analyzing a system and easily testing a system before it is created to wipe out and errors created during the design phase.