Tutorial 1: Basic Signal Processing

Tutorial 1 teaches basic signal processing by demonstrating how to separate signal from noise using a filter, and how to compute a power spectrum (also known as a "periodogram"). The student creates a time series with time units in years, and with a single frequency sinusoid sampled at time intervals of 0.08333 year (i.e., monthly, 1/12 year). The signal length is 60 years. Gaussian noise with a zero mean and unit variance is added to the signal values. The student examines the time and frequency domain representations of this noisy signal, then filters the signal using an appropriately designed *Filter*, and plots the filtered signal and its power spectrum. This is a preliminary tutorial to demonstrate the use of J-DSP/ESE as described in Ramamurthy et al. (Journal of Geoscience Education, August 2014).

Step 1: Set up the block diagram as in Figure 1. Create a sinusoid sampling at time interval of 0.0834 year (approximately monthly, 1/12 year, but to make sure sample length is 720). The frequency is 0.2 cycles/year, and the amplitude is 0.5.

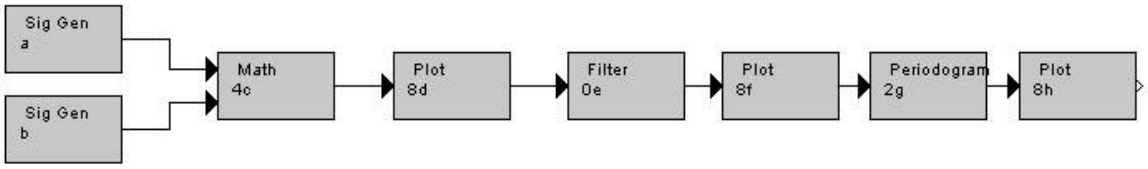

Figure 1. Block diagram for Tutorial 1

Step 2: Create zero-mean, unit variance Gaussian noise. Set the start time to 0 and end time to 60 to get signal length of 60 years. This setting is shown in Figure 2. Plot the noisy signal (Figure 3).

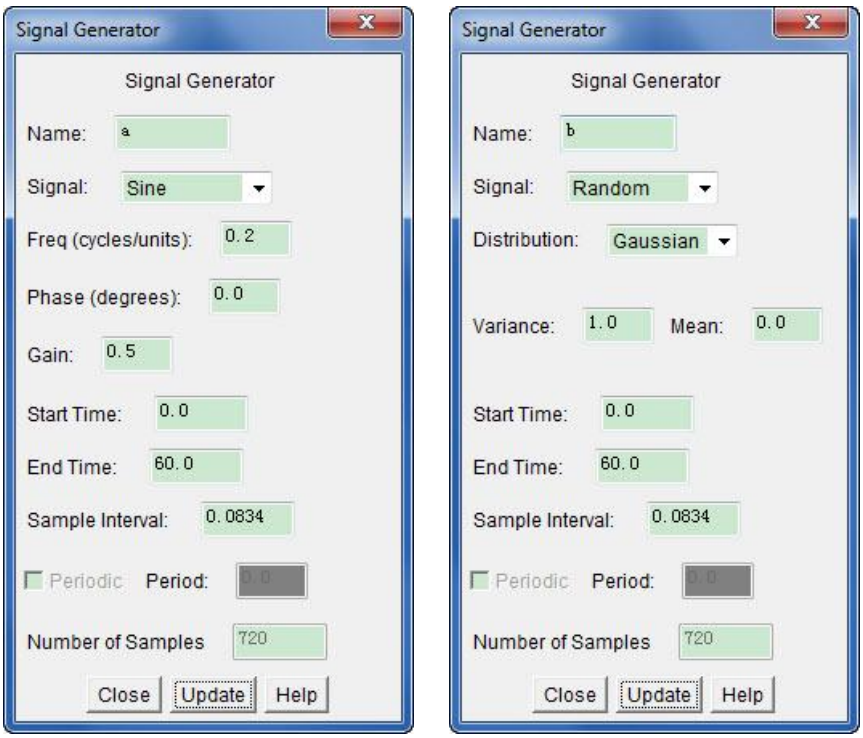

Figure 2. *Signal Generator* parameters

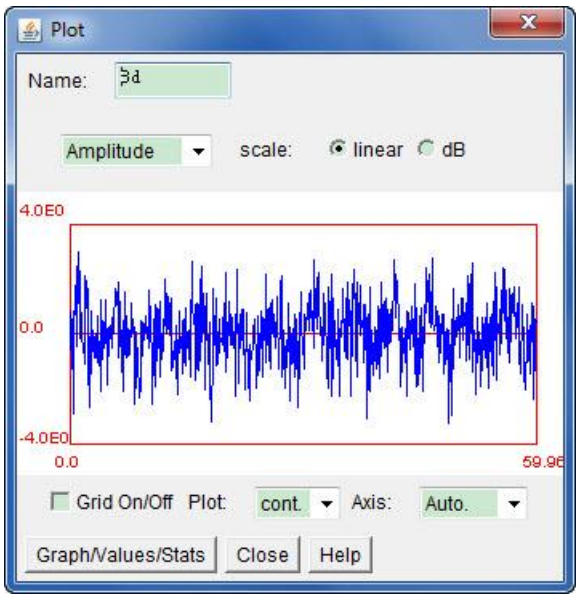

Figure 3. Plot of noisy signal

Step 3: Set up *Taner Filter*. In order to recover the original sinusoid of 0.2 cycles/year, choose a band-pass filter with critical frequencies 0.15, 0.2, 0.25 (Figure 4).

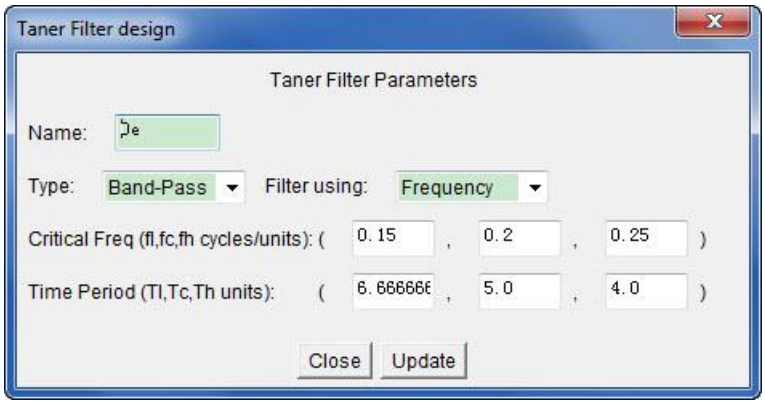

Figure 4. *Taner Filter* Setting

Step 4: Plot the filtered signal (Figure 5).

Step 5: Set up the *Periodogram* (Figure 6).

Step 6: Plot the power spectrum (Figure 7).

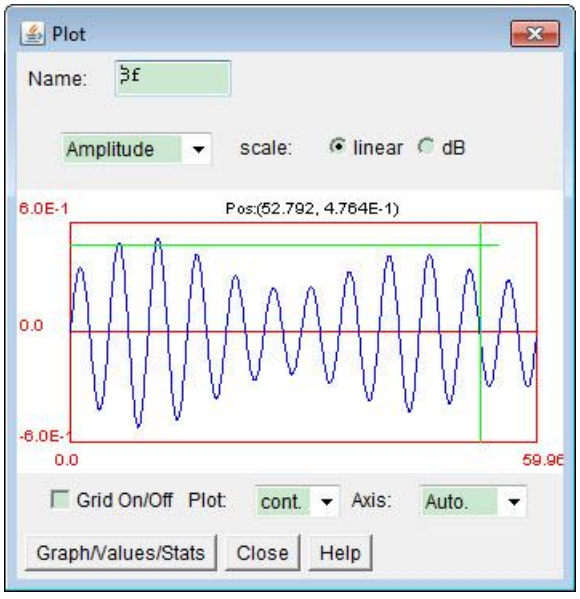

Figure 5. Filtered signal

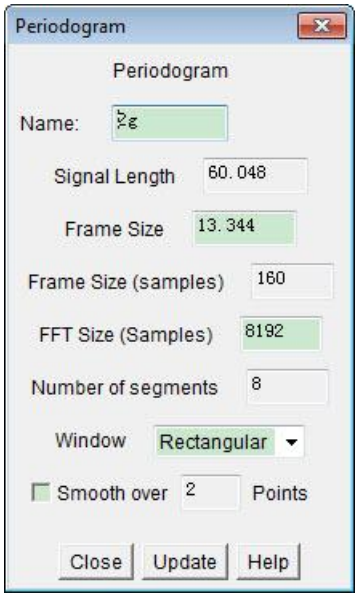

Figure 6. *Periodogram* parameters

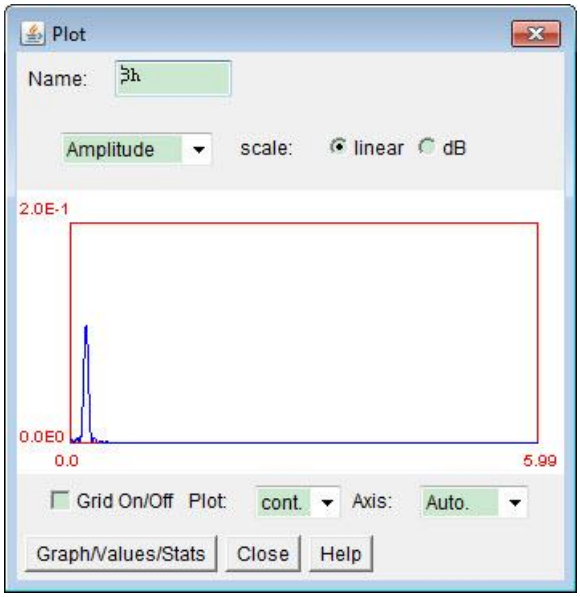

Figure 7. Power spectrum