CMSC 465 Signal Project

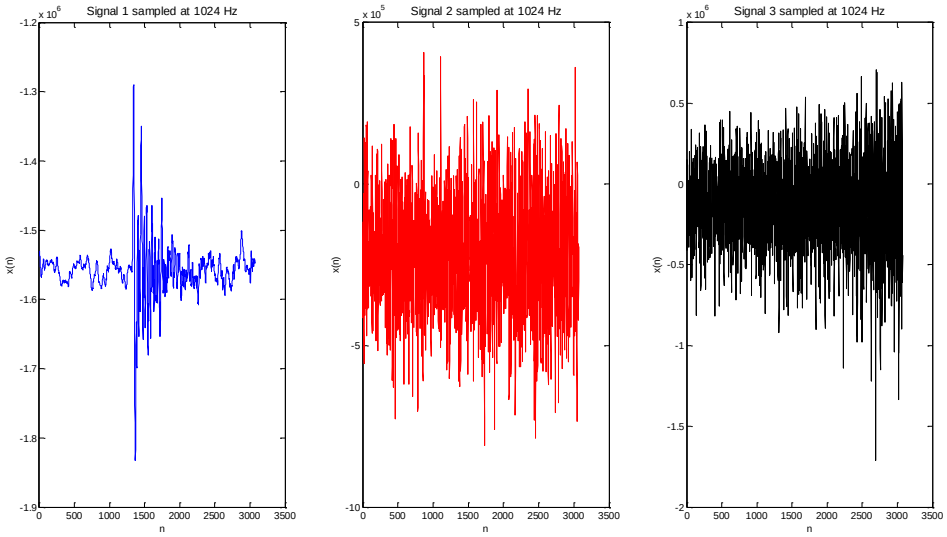

Figure 1. Plot of the input signals

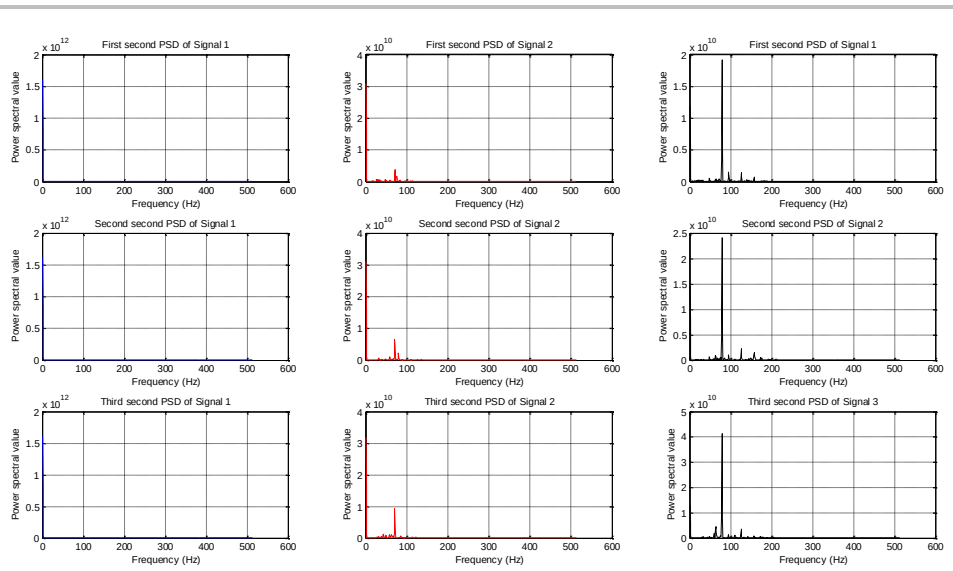

Figure 2. Power spectra for each second of data using Welch's method and a Hanning window with 50% overlap.

Greater signal resolution was obtained by using Matlab's `zoom` function. Zooming in on the *y*-axes of the PSDs of Signal 1 (Figure 2), which begins with very low frequency activity, reveals that most of the spectral components are contained in the second second of the sample, which correlates with the plot of Signal 1 in Figure 1.

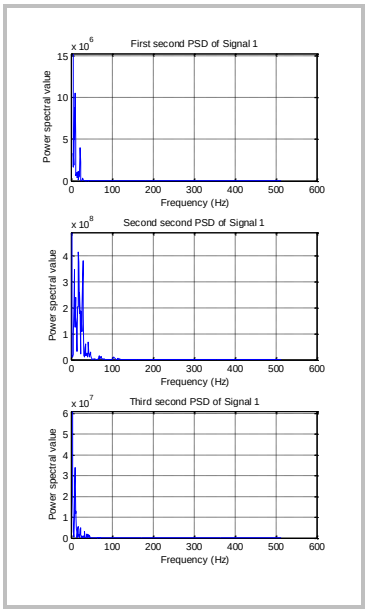

Figure 3. Zooming in on the y-axes of the PSD plots of Signal 1.

Changing to a stem plot, as shown in Figure 4 makes it easier to identify the power of component signals in each of the three sample periods.

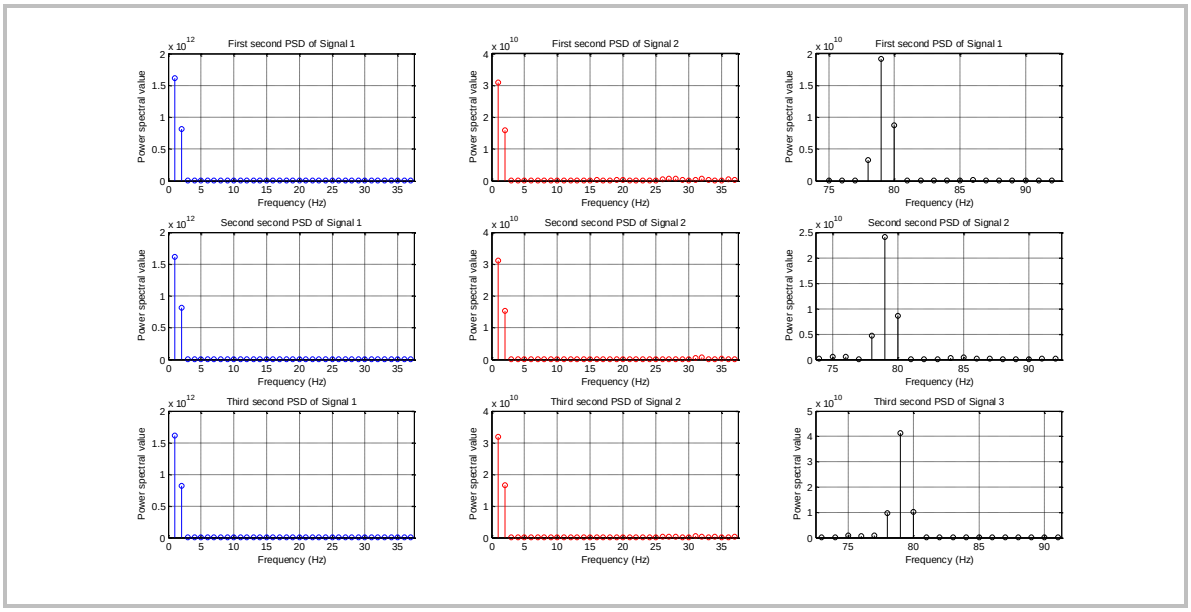

Figure 4. Stem plots of the PSDs.

Here, the highest peaks in the PDSs were focused in on. Although the appearance of their input signals differ significantly, both Signals 1 and 2 have the most spectral power coming from a 1 Hz frequency. Signal 3 has the most spectral power coming from a 79 Hz frequency.

PSD analysis was also conducted by varying the sizes of the Hanning window. The results of this analysis are shown in Tables 1 to 3.

Table 1

Signal 1 power spectrum density (PSD) using Welch's method

Hanning size	1st second (Hz)	2nd second (Hz)	3rd second (Hz)	Average (Hz)
8	1	1	1	1.0
16	1	1	1	1.0
32	-----	-----	-----	0.0
64	-----	-----	-----	0.0
128	-----	-----	-----	0.0
256	-----	-----	-----	0.0
512	-----	-----	-----	0.0
1024	-----	-----	-----	0.0

Table 2

Signal 2 power density spectrum (PSD) peaks using Welch's method

Hanning size	1st second (Hz)	2nd second (Hz)	3rd second (Hz)	Average (Hz)
8	1	1	1	1.0
16	1	1	2	1.33
32	-----	-----	-----	0.0
64	6	5	5	5.33
128	10	10	10	10.0
256	19	18	18	18.33
512	36	36	36	36.0
1024	72	71	71	71.33

Table 3

Signal 3 power density spectrum (PSD) using Welch's method

Hanning size	1st second (Hz)	2nd second (Hz)	3rd second (Hz)	Average (Hz)
8	2	2	2	2.0
16	2	2	2	2.0
32	3	3	3	3.0
64	6	6	6	6.0
128	11	11	11	11.0
256	20	21	20	20.33
512	40	40	40	40.0
1024	79	79	79	79.0

For Signal 1, only the smaller sized windows could detect the 2 Hz frequency component.

The FFT plots in Figure 5 support the results obtained in Tables 1 through 3.

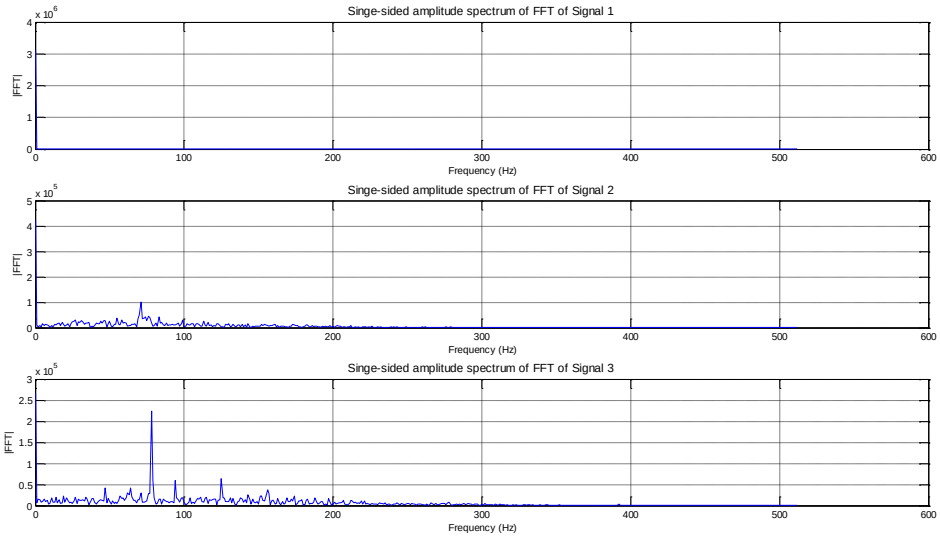

Figure 5. Comparison plot of PSD results for each signal.

Figure 5 shows a comparison of the PSD results for each signal and each time period. The 'First second' comparison shows that Signals 2 and 3 have similar frequency profile. Signal 3, however, possess more frequencies in certain ranges. For example, in the 0-50 Hz and the 150+ Hz ranges (approximations), Signal 3 has more powerful, tightly bound frequencies. The 'Second second' comparison shows the same trend continuing with the frequency densities beginning to dissipate. Here also, Signal 1 shows its strongest frequency components. The 'Third second' comparison shows Signal 3 having the most frequency components. There still remain many overlapping frequencies below about 150 Hz.

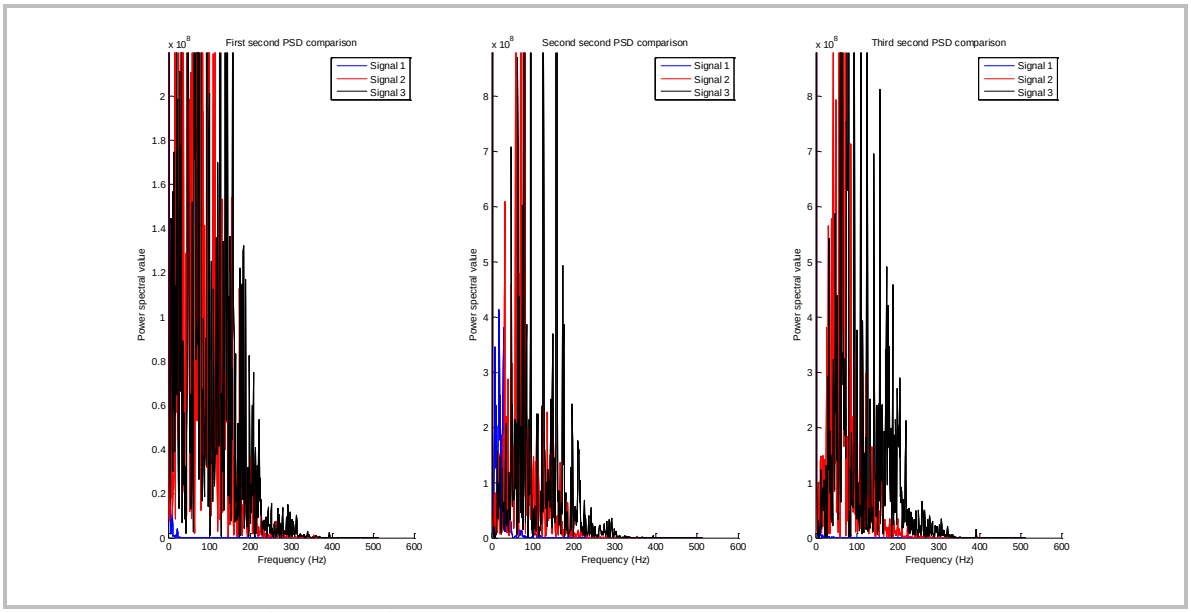

Figure 6. Comparison plot of PSD results for each signal.

The magnitude comparison shown in Figure 6 also shows that Signal 3 possess more tightly bound frequencies with greater power.

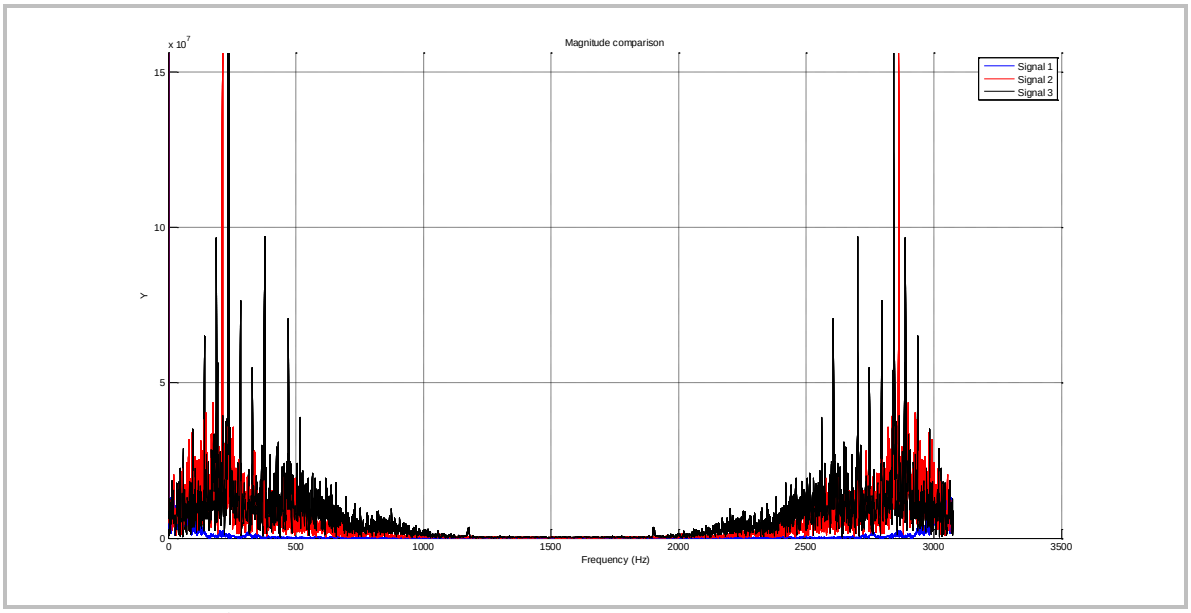

Figure 7. Magnitudes of input signals.

The magnitude of Signal 1 shows the highest peaks occurring at 8 Hz and 3066 Hz

The magnitude of Signal 2 shows the highest peaks occurring at 212 Hz and 2862 Hz.

The magnitude of Signal 3 shows the highest peaks occurring at 236 Hz and 2842 Hz