EE 513 HW2

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1 Problem 2.1

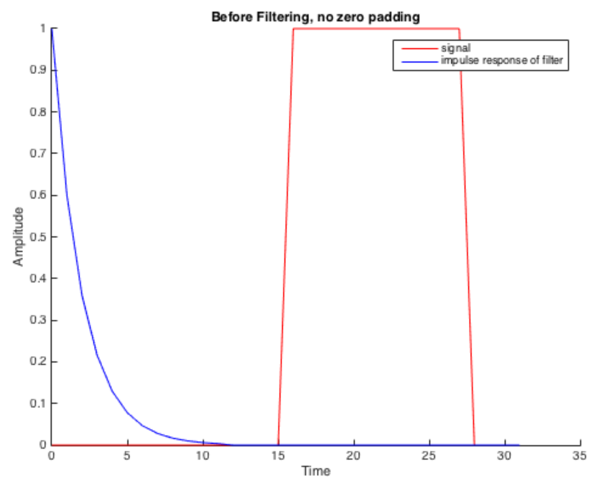

Figure 1: The signal, `s[n]`, in red, and the impulse response, `h[n]`, in blue, before filtering.

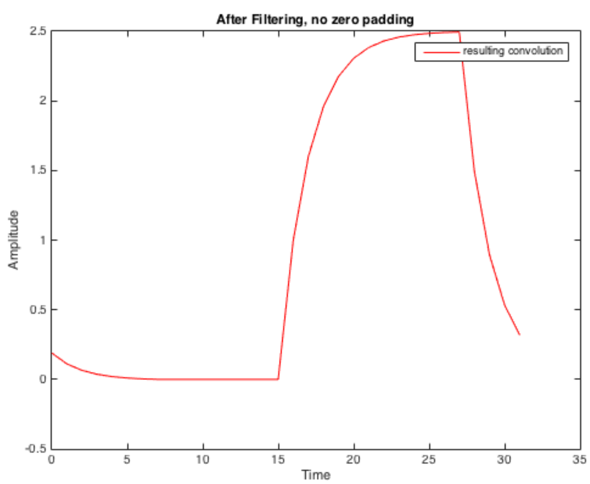

Figure 2: The result of filtering `s[n]` and `h[n]`. Notice the effects of circular convolution on the beginning of the resulting signal.

1.1 Part b

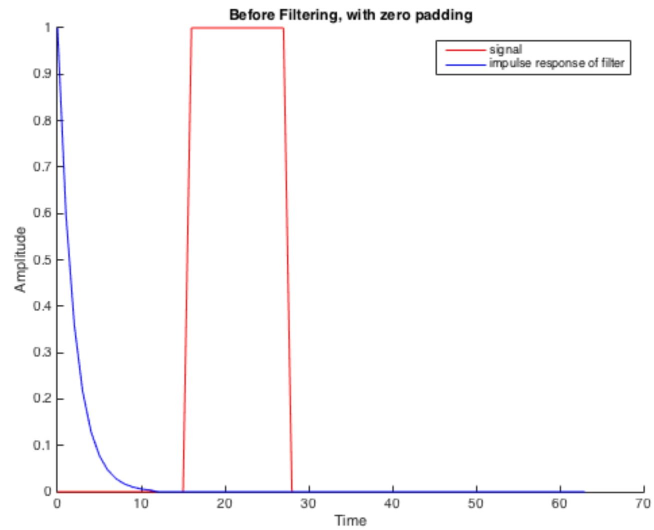

Figure 3: Zero padded versions of the signal, `s[n]`, in red, and the impulse response, `h[n]`, in blue, before filtering.

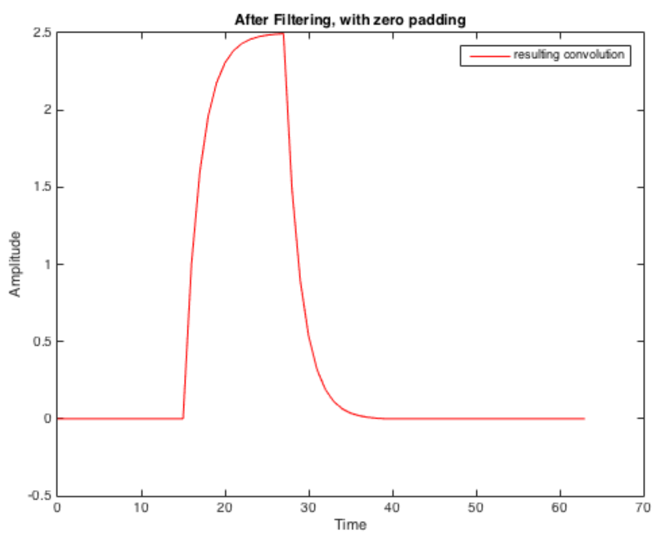

Figure 4: The result of filtering `s[n]` and `h[n]`, with zero padding. Notice how adding 'space' to the end of the signal eliminated the wrap-around effect.

2 2.2

When a signal length is short, relative to the sampling rate, a large enough window length may not be feasible to achieve the desired frequency resolution.

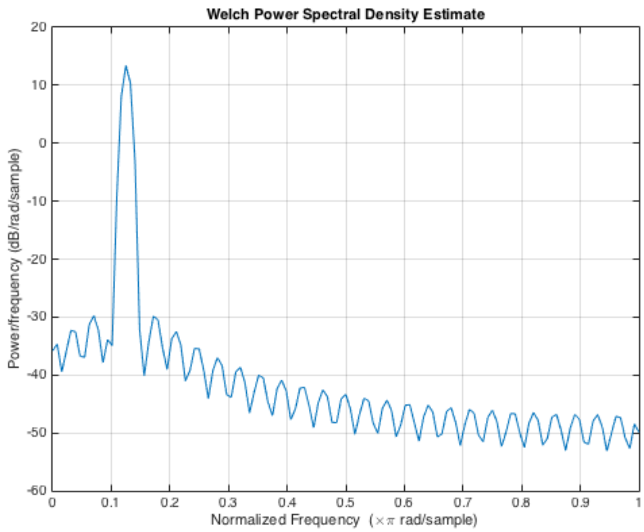

Figure 5: The PSD of the signal without zero padding, 0.05s window length.

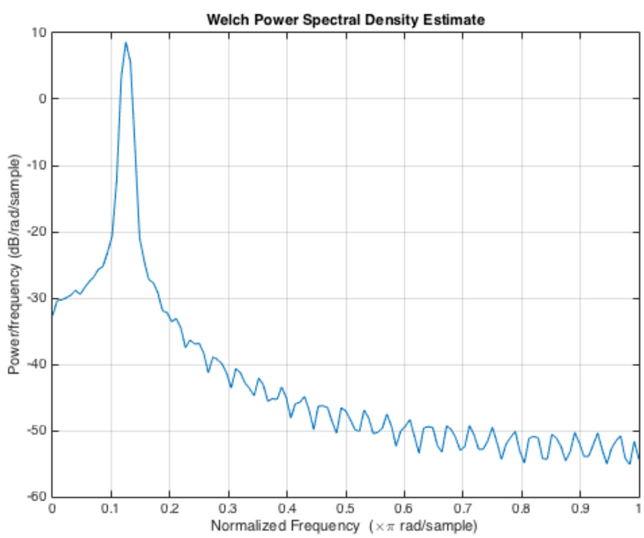

Figure 6: The PSD of the signal with zero padding, 0.05s window length. Slight suppression of sidelobes.

Zero padding a signal in order to visualize the frequency distribution is useful for applying a longer window length analysis. Through higher frequency resolution is not actually achieved, it does allow finer discernment in shorter signals.

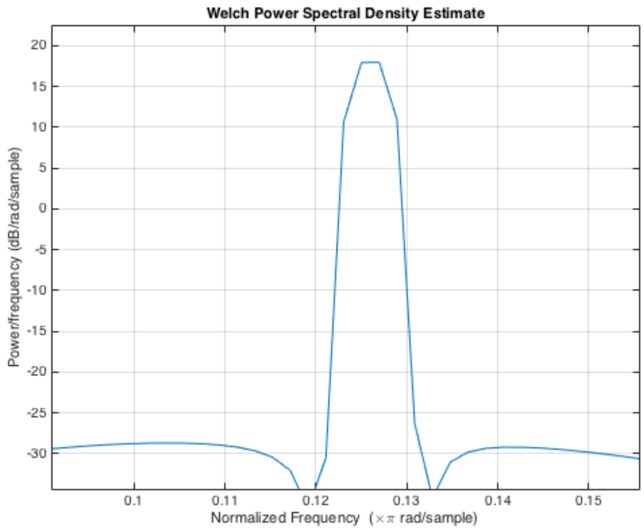

Figure 7: The PSD of the signal without zero padding, 0.25s window length.

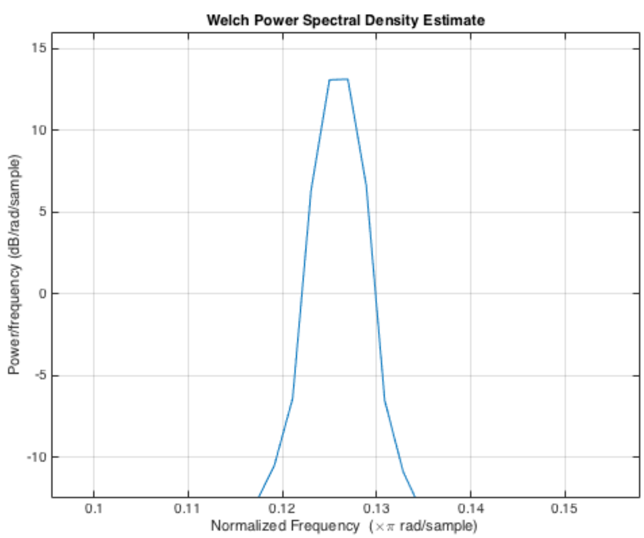

Figure 8: The PSD of the signal with zero padding, 0.25s window length. More suppression of sidelobes.

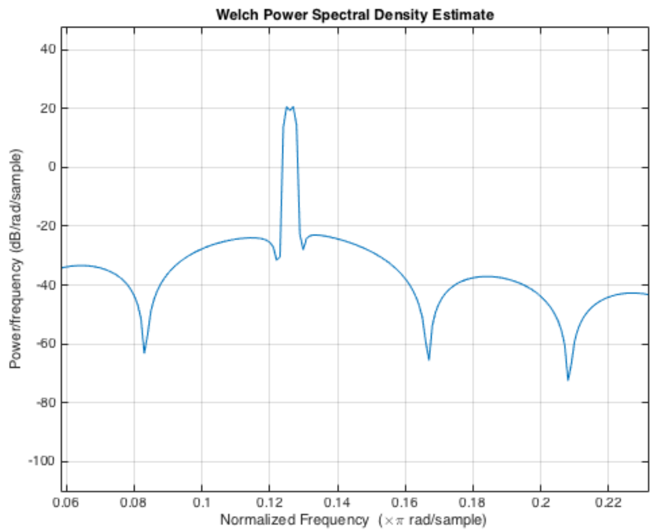

Figure 9: The PSD of the signal without zero padding, 0.5s window length.

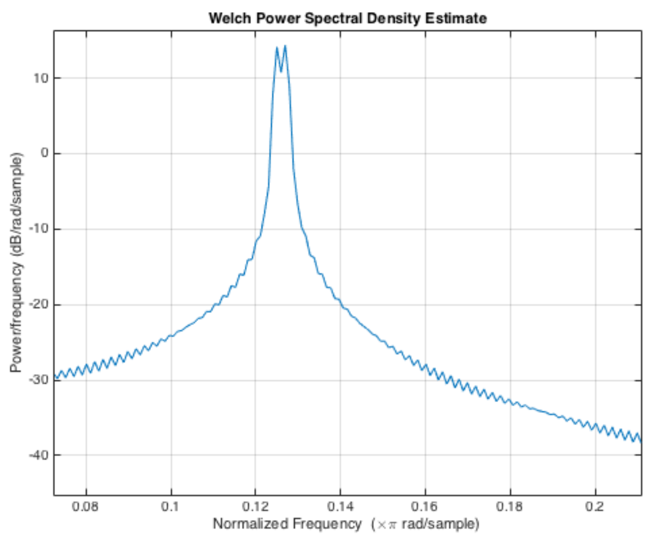

Figure 10: The PSD of the signal with zero padding, 0.5s window length. More separation of individual peaks now

3 2.3

Increasing the number of FFT points by a factor of 4 made more of the signal energy appear in sidelobes for each note, and decreased the energy seen as spectral smearing during the transitions between notes. Figures 11 and 12 show the spectrogram before and after quadrupling the number of FFT points.

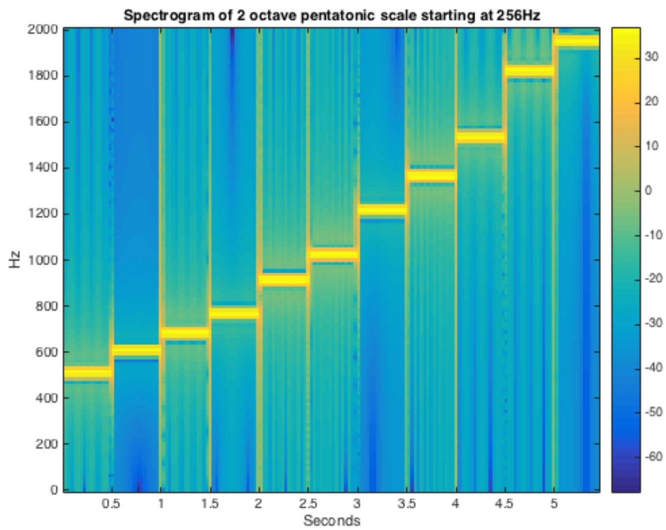

Figure 11: Spectrogram of the 2 octave sequence before quadrupling the number of FFT points.

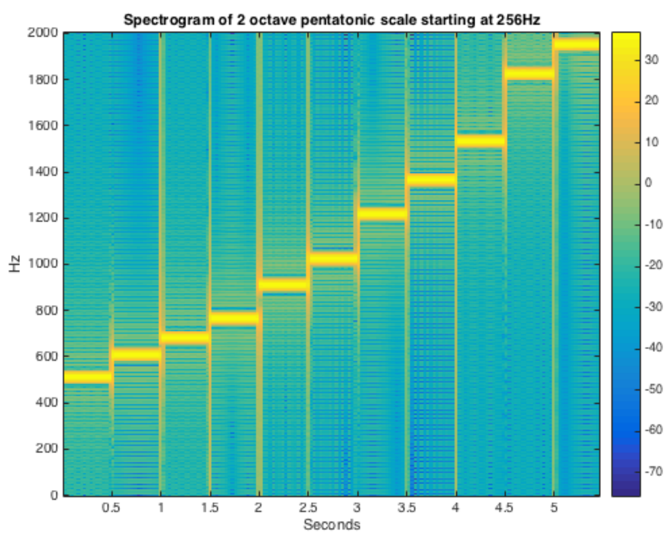

Figure 12: Spectrogram of the 2 octave sequence after quadrupling the number of FFT points, notice the horizontal stripes now distinguishable.

4 2.4

4.1 Part A

After filtering the white noise, to create pink noise, the resultant PSD is expected, and the resultant shape is representative of the filters transfer function. PSD of colored noise in Fig. 13.

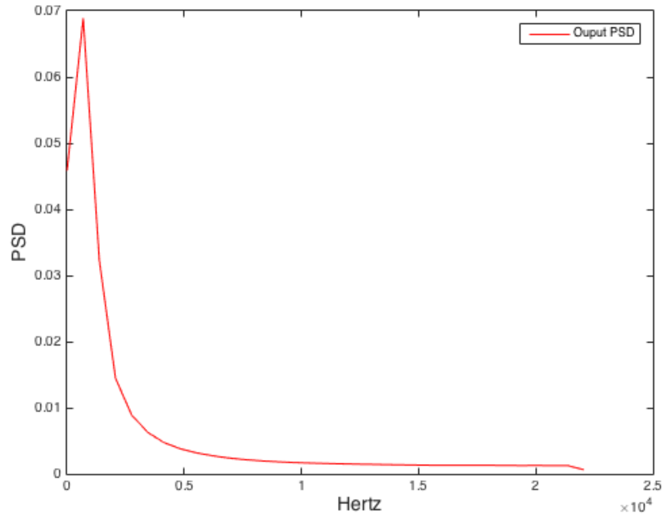

Figure 13: PSD of filtered white noise

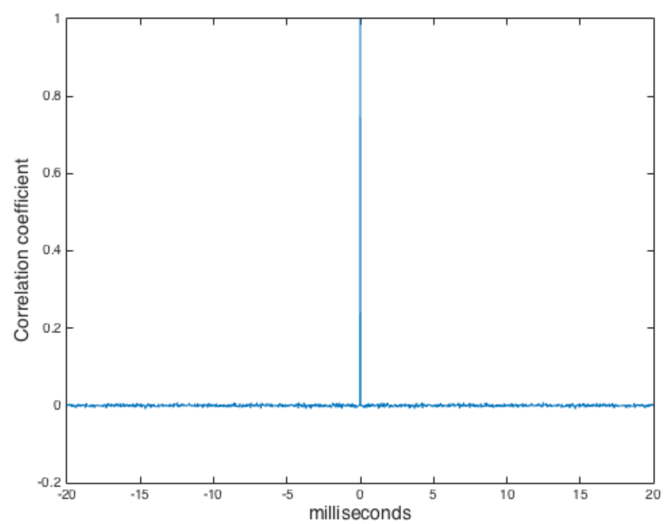

Figure 14: Autocorrelation of the white noise with itself. An effective delta appears at maximum overlap.

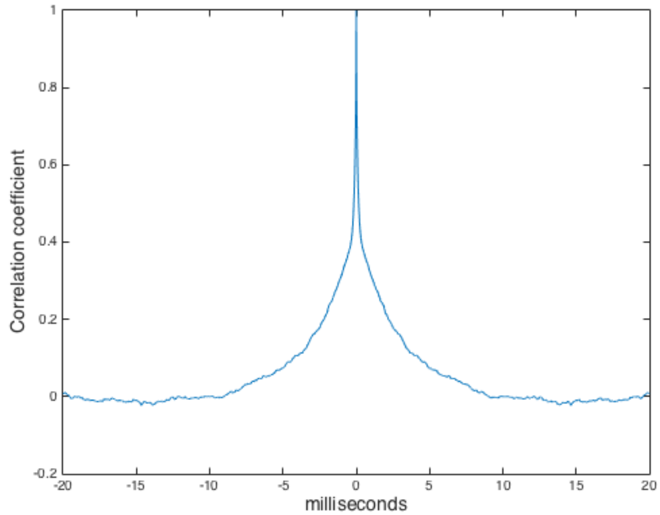

Figure 15: Autocorrelation of the pink noise and white noise. The original direct correlation at t=0 is no longer present.

4.2 Part B

Here, a sinusoid at 440Hz is added to the filtered pink noise before the PSD and autocorrelation are preformed. Since the sinusoid is relatively close to the peak in the filter's passband, not much difference appears in the PSD plot seen in Fig. 16. The self autocorrelation is similar, as expected (Fig. 17). However the pink noise autocorrelation, seen in Fig. 18 shows the repetitive nature of the introduced sinusoid, giving a higher correlative value for periodic overlaps.

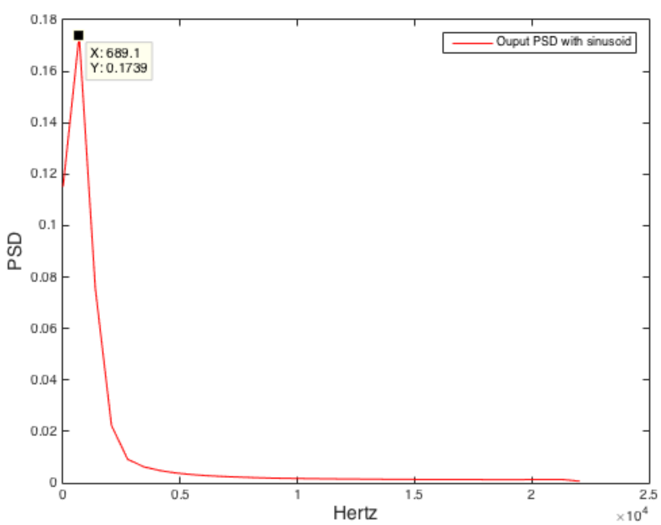

Figure 16

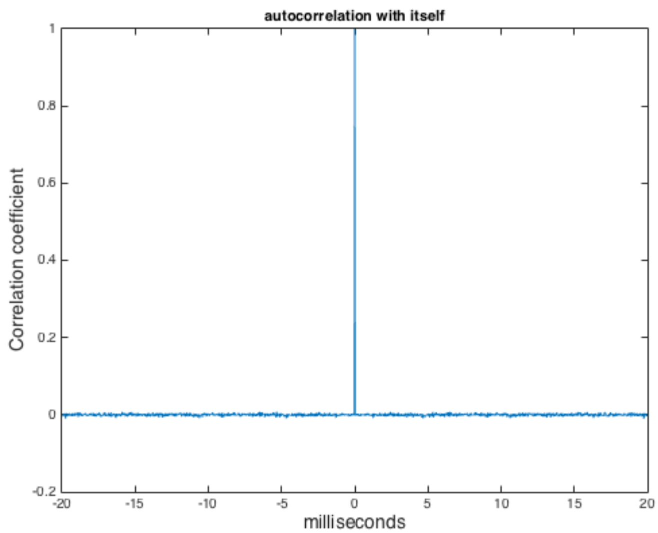

Figure 17

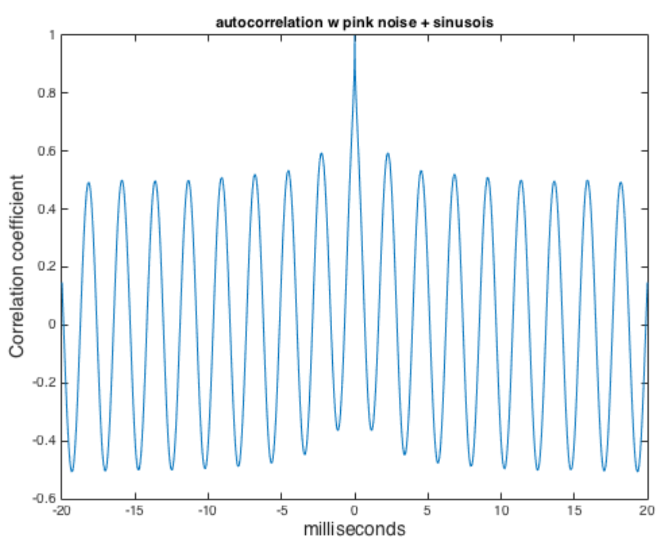

Figure 18