ECE-GY 6113 (DSP 1)
Ivan Selesnick

Fourth-Order Notch Filter Exercise

In the class demo ("notch_filter_demo.zip"), we used a second-order recursive notch filter to reduce a tonal noise in a speech signal (file "noisy.wav"). The output signal is given in the file "output_IIR.wav". But if you listen carefully, you can still hear some of the tonal noise (500 Hz) in the signal. The noise was not completely removed. We need a better notch filter.

In this exercise, design a 4th-order recursive notch filter with the aim of completely removing the 500 Hz signal while otherwise preserving the signal.

As a suggestion: Design a 4th-order notch filter where the zeros on the unit circle have multiplicity 2. They are 'double zeros'. As before, your filter should be designed to remove 500 Hz when operating at a sampling rate of 8000 samples/second.

Compare your 4th-order notch filter to the second-order notch filter in class demo ("notch_filter_demo.zip"). How is the frequency response different? How is the impulse response different?

Use your 4th-order to reduce the tonal noise of the noisy speech signal. Can you completely remove the 500 Hz tonal noise? Can you still the noise in the output signal?

To submit:
1) Plots of your filter (frequency response, pole-zero diagram, impulse response)
2) Wave file (.wav) of your output signal
3) Matlab program that reproduces your result (creates your filter, applies it to the signal, saves the output signal to a wave file).