Assignment - 6
Multirate Signal Processing

March 11, 2018

Task 1

Consider the transfer function of a notch filter:

$$H(z) = \frac{1+a}{2}\frac{(z - e^{+j\omega_n})(z - e^{-j\omega_n})}{(z - ae^{+j\omega_n})(z - ae^{-j\omega_n})},$$

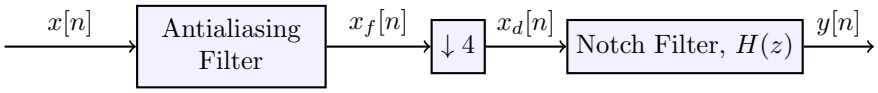
where ω_n is the frequency to be stopped. F_s is the sampling rate of the input (and of course the output) of the system. Note that the system has two zeros corresponding to ω_n and $-\omega_n$.

Questions

1. Read the uploaded Jack Sparrow's wave file `almostcaught_high.wav` and examine using DTFT to figure out the frequency of the tone present in the audio.
2. Design a notch filter using above-mentioned transfer function and remove the tone.
3. How many multiplications and additions are required per unit time for the filter?

Task 2

Consider the system below: In this task, we will redo task 1 but on a decimated



version of input signal.

1. Read the documentation of MATLAB's command `fir1`. Desing a lowpass FIR filter using the command for antialiasing. The length of the filter should be 23.

2. Plot the impulse response as well as the frequency response of the lowpass FIR filter. Do you recognize the impulse response? Which function does it resemble and why?

3. Implement the above system in MATLAB. How many additions and multiplications are required for the above system per unit time?

4. Implement an equivalent polyphase decomposition based decimation system for the system above. How many additions and multiplications are required per unit time?

5. Do you see any gains in number of computations?