SSY130 - Hand-in 2

FIR Differentiator Design

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**Question 1:**

In code 1 as shown below we designed low pass FIR filter using the given specifications as cutoff frequency of 0.05 and blocking frequency of 0.01 in order to eliminate noise effects

The matlab command *firmpm* have three inputs: 1st one is normalized frequency ranging from 0 to 1, which can be obtained by dividing it with sampling frequency . The 2nd input corresponds to the filter amplitude within the pass band region is directly related to where is without normalized frequency in rad/s. Similarly, the last command “differentiator” forced the filter output to be with constant phase of 90 degree which the demand is asked to fulfil.

**Question 2**

The figures 1 and 2 represent designed filter response and a comparison among ideal and the designed FIR filter using firmpm command respectively.



**Figure 1:** FIR differentiator filter impulse response



**Figure 2:** FIR differentiator filter frequency response

**Question 3**

The firpm command uses Parks-McClellan algorithm in order to design FIR filter with constant linear phase. In our case, we pick filter order 60 by picking 61 samples which means our filter order will always be N-1 where N= filter coefficients. Since our filter is symmetric and in order to make it causal the algorithm adds some delay of (N-1)/2= 30 samples, which in time corresponds to .

**Question 4**

Figures 3a and 3b represent Euler and designed FIR filter for true and noisy data. The delay effect is completely removed by using offline delay compensation factor. However, we face another problem of high peak values, this is due to the convolutional effect. A convolution will give us a final output values with M+N-1, where M is length of signal and N is length of filter coefficients. Since we convert M length into M+N-1 by adding N-1 zeros. This sharp increase is maybe be due to the large last value of the signal which ultimately creates huge position displacement and turns our velocity humongous. That’s why we always asked us to remove the last sample.

**Question 5**

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**Question 6**

In order to calculate vehicle speed accurately we must have tp device our system in such a way that it completely remove noise however the noise is still present in figure 3a. In order to remove noise we need to sharpen our filter more by choosing low cut off (0.01) and stop band (0.02) frequencies and plus enhancing the filter order (300), which ultimately lower ripple magnitudes which means lower noise from the stop band. However, we have to pay in the form of more delay.

cut\_frequency = 0.01;%0.05; % Hz

stop\_frequency = 0.02;%0.1; % Hz

N = 300; % FIR filter order

The maximum speed can be achieved around 180 km/h since time equals 600-N/2=450s.

