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Course: ECE 5210

Subject: Lab 4, Decimation and 60 Hz Noise

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1 Introduction

In this lab, we explore the implementation and analysis of decimation and interpolation on STM32F769I development boards, a foundational tool in digital signal processing. Through theoretical insights and practical experimentation, we aim to understand the behavior of the filter and its performance in real-time signal processing applications. To demonstrate the use of this filter we will process an ECG signal that has been corrupted by 60 Hz noise.

We will be implementing the system using C and using the oscilloscope to plot the phase and magnitude of the frequency response by performing a frequency sweep. We can then compare the measured frequency response with the numerical and analytical solutions

2 Theory

This lab required the calculation of the coefficients for this filter. Fortunately we solved this analytically both in class and in homework. Solving for the coefficients yields

$$h[n] = [1, -2cos(\frac{\pi}{4}), 1] \tag{1}$$

3 Results

The results for this lab can be seen in Fig.1 and Fig.2. Fig.1 shows the noise removal using my filter, we can see that the vast majority of the noise is removed and it looks much more like the generated ECG wave than in the pass-through channel. Not all noise is removed however which is why the figure still shows some wiggle after being processed.

In Fig.2 there are two subplots, each containing two lines. One line corresponds to the measured data and one to the analytical solution. Both of the plots line up pretty well but not perfectly like they have in previous labs. Towards the end of each plot the difference between the measured and analytical plots grows.

4 Discussion and Conclusions

This lab was really cool to implement just as the previous labs have been. The noise removal worked way better in this lab compared to the last lab. This was the first lab where my phase required a phase correction. I'm not sure why previous lab did not require a phase correct but this one did. This is also the first lab were my measured data did not match exactly with the analytical solution. I would assume this is due to our inability to implement a low pass filter perfectly.

Trying to filter the data without downsampling fails to work because we are sampling so fast that we miss the low frequency signal that we are interested in. The measured frequency response and the DTFT of

our filter match for the most part. Both exhibit the same trends although they do not line up exactly. As the frequency increases the data lines up less and less. The weird result at the end of the plots is due our upsampling and downsampling.

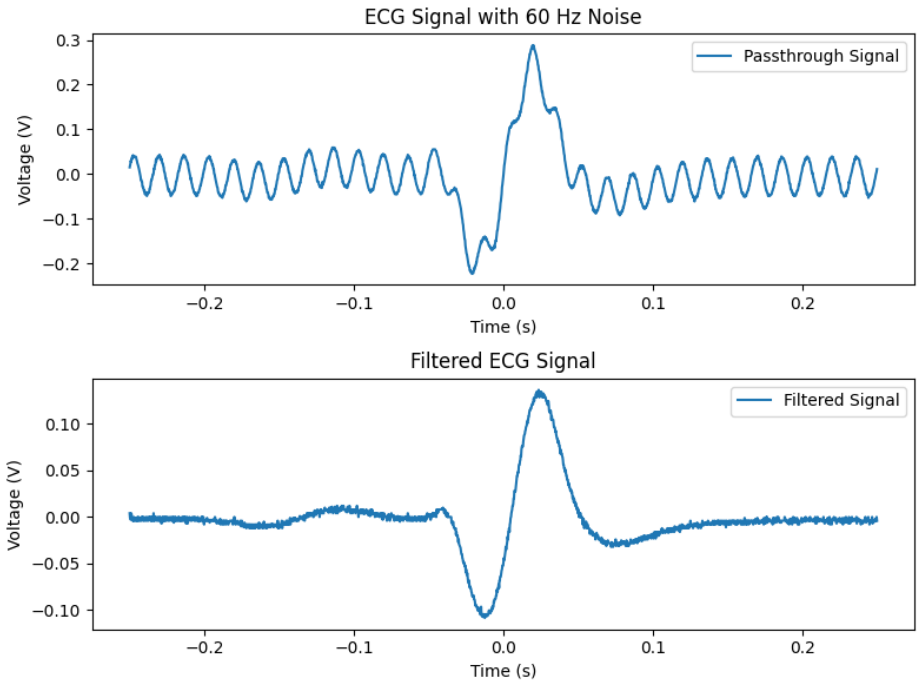

Figure 1: Noise removal of a 60 Hz ECG signal using upsampling and downsampling as well as interpolation

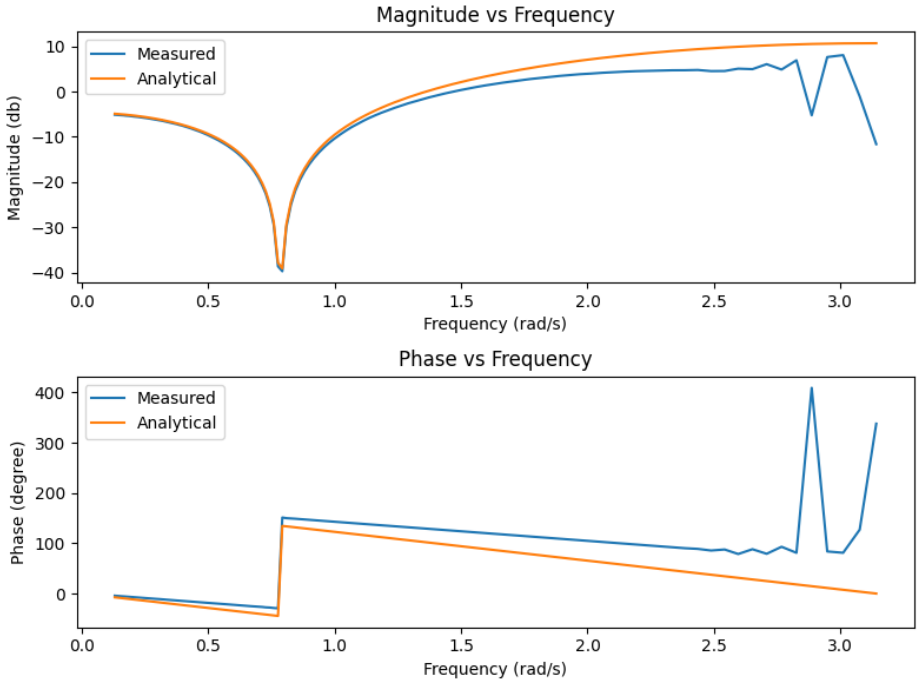

Figure 2: Magnitude and phase of the frequency response using measured and analytical data