Designing and Using Digital Filters in MATLAB using FDAtool

DSP Lab 10

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1 Objective

Use Filter Design and Analysis tool from Matlab for quick filter design and evaluation.

2 Theoretical notions

Digital filters are a key tool in many fields, including engineering, science, and economics. They are used to process and analyze signals, and can perform a wide range of tasks, such as noise reduction, echo cancellation, and system identification. In this paper, we will discuss the use of FDAtool in MATLAB for designing digital filters.

FDATool, or the Filter Design and Analysis Toolbox, is a graphical user interface (GUI) that allows users to easily design and implement digital filters in MATLAB. It provides a convenient and user-friendly way to design and analyze filters, and generate code for implementation in other programs.

To use FDATool, users first need to launch it from the MATLAB command window by typing `fdatool` and pressing enter. This will open the FDATool GUI, which consists of three main windows: the Filter Design and Analysis Tool, the Filter Visualization Tool, and the Filter Implementation Tool.

3 Exercises

3.1 Exercise 1: Designing a Low-Pass Filter

In this exercise, we will use FDATool to design a low-pass filter. A low-pass filter allows low-frequency signals to pass through, while attenuating high-frequency signals. This is useful for removing noise from a signal, or for smoothing out a signal that has sharp changes.

1. Launch FDATool from the MATLAB command window by typing `fdatool` and pressing enter.
2. In the Filter Design and Analysis Tool, select the type of filter you want to use. For this exercise, we will use a Butterworth filter.
3. Design a Low-Pass filter of order 3, IIR, with cutoff frequency 0.1 (or 500 Hz for a sampling frequency of 5000Hz), and other parameters as desired.
4. In the Filter Visualization Tool, visualize the frequency response of the filter. This will show you how the filter will behave at different frequencies.
5. Visualize the pole-zero plot of the system function $H(z)$
6. Visualize the filter coefficients.
7. Export the filter coefficients to Matlab's workspace

3.2 Exercise 2: Designing a High-Pass Filter

In this exercise, we will use FDATool to design a high-pass filter. A high-pass filter allows high-frequency signals to pass through, while attenuating low-frequency signals. This is useful for removing DC offsets from a signal, or for emphasizing high-frequency components of a signal.

Repeat the steps in exercise 1, to design a high-pass Chebyshev filter of order 5, IIR, with cutoff frequency 0.25 (or 2500 Hz for a sampling frequency of 5000Hz), and other parameters as desired.

3.3 Exercise 3: Designing a Band-Pass Filter

Repeat the steps in exercise 1, to design a band-pass elliptic filter of order 4, IIR, with cutoff frequency 0.25 (or 2500 Hz for a sampling frequency of 5000Hz), and other parameters as desired.

3.4 Exercise 4: Filtering a Signal

In this exercise, we will use the filters designed in the previous exercises to filter a signal.

1. Generate a 300-long periodic square signal, composed of 30 values of 1 followed by 30 values of 0, repeated for 5 times.
2. Filter the signal with the filter obtained in Exercise 1.
3. Filter the signal with the filter obtained in Exercise 2.
4. Filter the signal with the filter obtained in Exercise 3.
5. Visualize the filtered signals and compare them to the original signal.