Design of FIR Filter Based on MATLAB

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Abstract

With the advancement of social economy and the continuous development of science and technology, the advantages of digital filters make them widely used in different fields. In this paper, a self-determined FIR filter is designed based on MATLAB, and the spectral characteristics of the signal are analyzed.

Keywords

FIR filter, MATLAB, Window function design.

1. Introduction

In the process of continuous development of digital technology, digital filters have attracted people's attention and are widely used in many fields, such as automatic control, aerospace, military and so on. The digital filter is reliable, with high precision and flexibility, but when designing a traditional digital filter, the complexity is high, the amount of calculation in the working process is large, and the characteristic adjustment is difficult, which restricts the development of the digital filter. Therefore, this paper designs a FIR filter based on MATLAB.

2. Digital filter design requirements

2.1 Digital filter design requirements

(1) Design a self-determined FIR filter;

• Select window function;

• Determine the filter order.

(2) Customize an input signal and analyze the spectral characteristics of the signal;

The input signal should include the passband frequency, stopband frequency, and transition band frequency of the designed FIR filter.

(3) Pass the input signal through the designed FIR filter;

Think about how to pass the input signal through the designed filter.

(4) Analyze the spectral characteristics of the output signal.

The characteristics of the passband, stopband and transition band signals in the output signal are analyzed separately.

2.2 Digital filter design

Digital filter design must go through three steps :

(1) Identification of indicators: In the design of a filter, there must be some indicators. These indicators should be determined on the basis of the application. In many practical applications, digital filters are often used to achieve the frequency operation. Therefore, indicators in the form of general jurisdiction given frequency range and phase response. Margins key indicators given in two ways. The first is absolute indicators. It provides a function to respond to the demands of the general application of FIR filter design. The second indicator is the relative indicators. Its value in the form of answers to decibels. In engineering practice, the most popular of such indicators. For phase response indicators It is often desirable for the system to have a linear phase in the passband.

Using linear phase filter design with the following response to the indicators strengths：

①it only contains a few algorithms, no plural operations；

②there is delay distortion, only a fixed amount of delay;

③the filter length N (number of bands for N-1), the volume calculation for N/2 magnitude.

(2) Model approach : Once identified indicators can use a previous study of the basic principles and relationships, a filter model to be closer to the target system.

(3) Achieved : the results of the above two filters, usually by differential equations, system function or pulse response to describe. According to this description of hardware or software used to achieve it.

3. Design process content

3.1 Define the input signal and analyze the spectral characteristics.

Define the sampling frequency and time series. Draw the original signal and spectrum

The Input signal is:

s1=2*cos(2*pi*150*t+pi/4)+4*cos(2*pi*250*t+pi/2)+3*cos(2*pi*300*t);

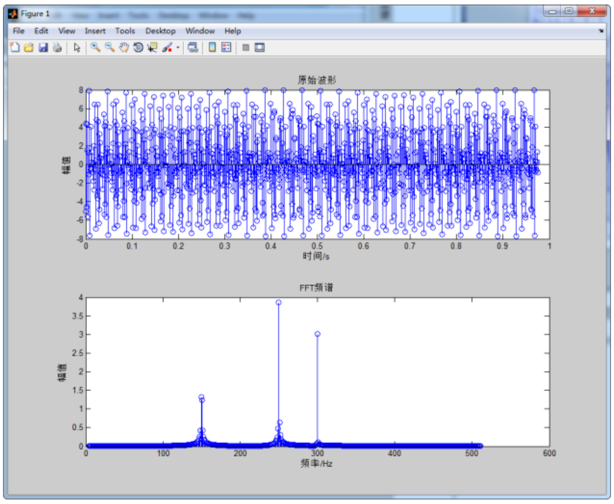

Fig1. The Input signal waveform

Since the defined length Ls=1000, it should be complemented by 0 when seeking FFT.

After adding zeros:

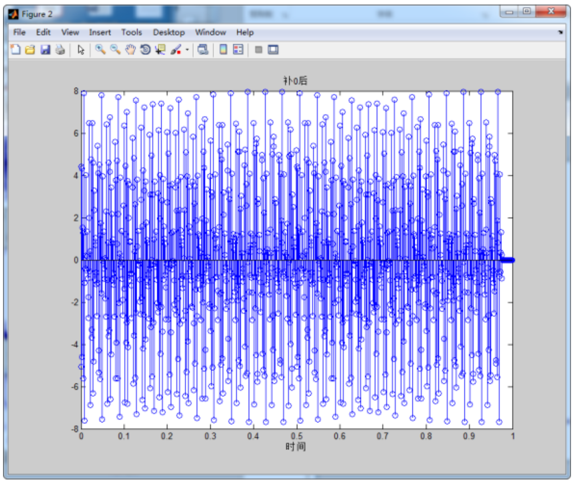

Fig2.Waveform after adding zeros

Perform FFT transformation on the input signal to obtain the amplitude spectrum of the FFT.

Define the function myfft-DX and use it to do the Fourier transform. Then,we can get an image of its amplitude and phase.

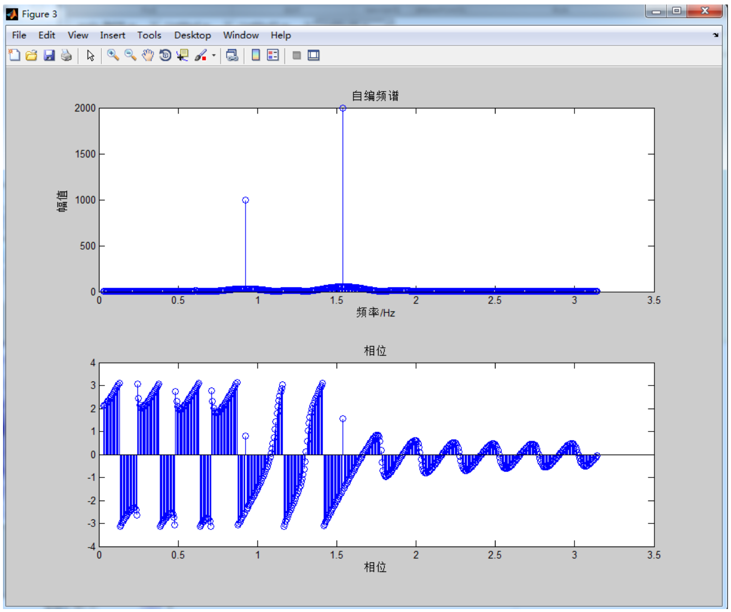

Fig3.The image of FFT amplitude and phase

Next, the amplitude-frequency characteristics of the Fourier transform are analyzed by the fft sub-function.

3.2 Define FIR low pass filter

In FIR low pass, we define the following parameters:

Passband edge frequency: $f_{pass} = 150Hz$; Stop edge frequency: $f_{stop} = 300Hz$;

The Cut-off frequency : $f_c = \frac{1}{2} \times (150 + 300) = 225Hz$; Filter order: $N = 24$;

Window function: Hanning window.

After that we can get the filter response spectrum:

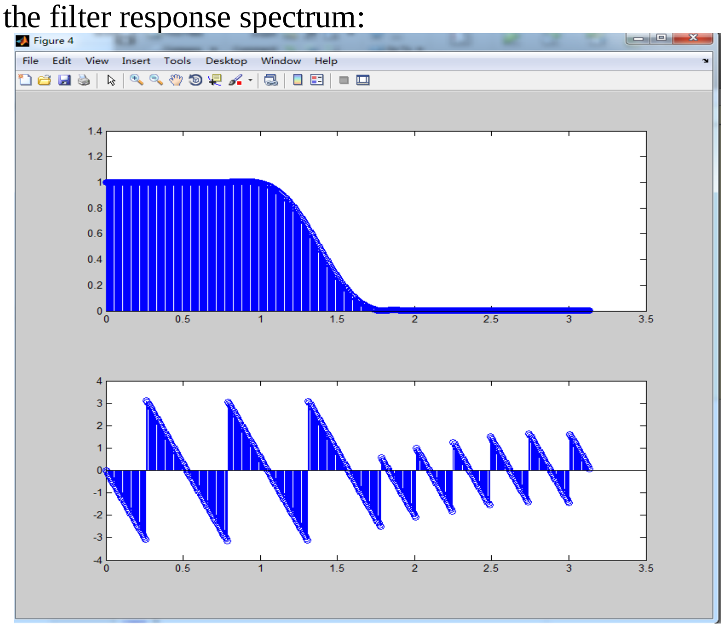

Fig4.The filter response spectrum

3.3 Filter processing input signal

We pass the input signal through the filter to plot the filtered waveform

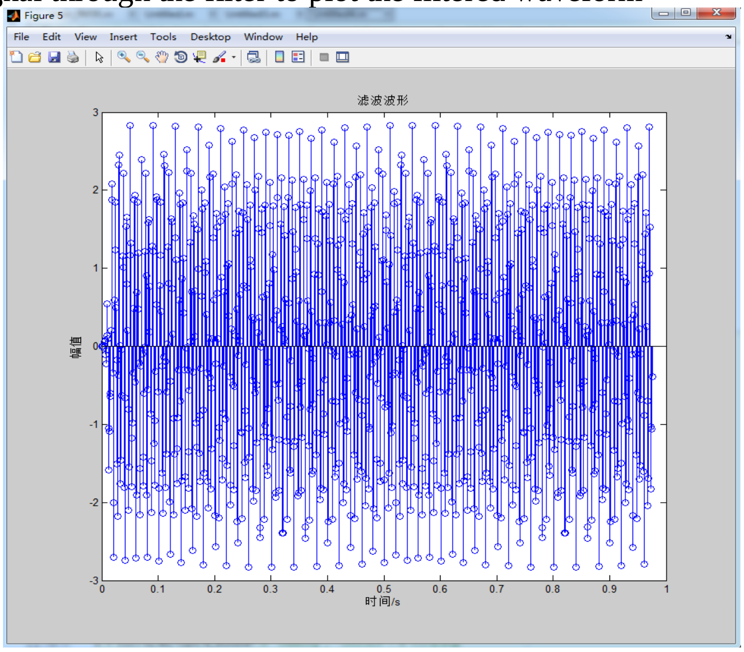

Fig5.The Filtered waveform

3.4 Analyze the spectral characteristics of the output signal.

The characteristics of the passband, stopband and transitionband signals in the output signal are analyzed separately.

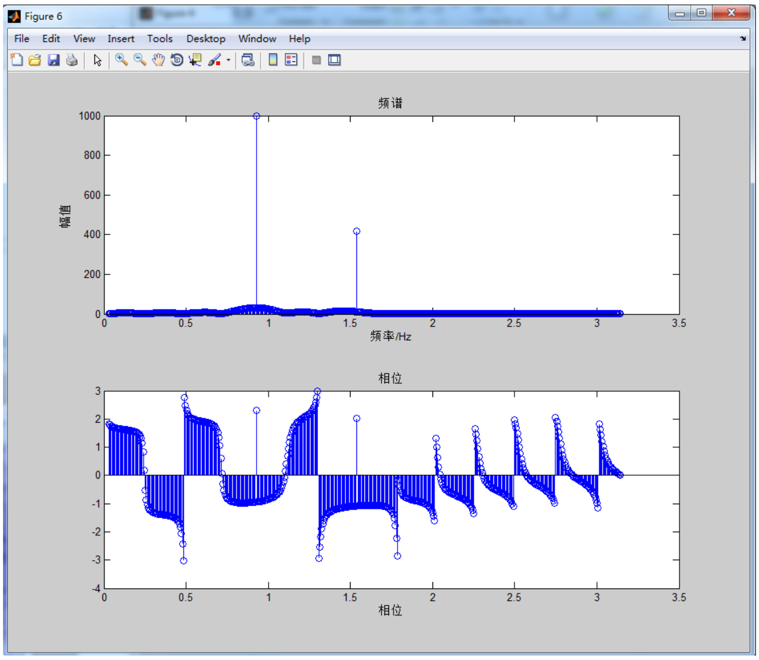

Fig6. The Output signal waveform

The passband edge frequency is 150Hz,and the stop edge frequency is 300Hz. According to the pre-filtering and post-filtering spectrum analysis, the signal with a signal frequency of 150hz is basically unchanged in the passband. Also in the transition zone, we can conclude that the 250Hz signal is suppressed to some extent. For the stop band, the 300Hz signal is filtered by the FIR filter.

4. Conclusion

Through the analysis of this paper, the digital filter can be designed conveniently and quickly using the MATLAB language. The traditional digital filter design method is based on an analog prototype filter to achieve digital discretization. Traditional design methods have some problems, but they are based on MATLAB language. Wave filter design can solve the corresponding problem. It has a rich design function that can find the appropriate function based on the indicators of the digital filter and edit it by calling the toolbox directly. Therefore, the digital filter designed in this paper can meet the actual needs.

References

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