

デジタル信号処理の基礎

#6

November 10, 2025

Assignment # 5

Exercise 3.4 (threeTonesFft) If we produce a harmony A with the following script, we obtain frequency domain signal where the level of the three tones are different. If we generate three A tones such that $A_{220} = 220\text{ Hz}$, $A_{440} = 440\text{ Hz}$ and $A_{880} = 880\text{ Hz}$, these three tones produce exactly the same level frequency components. Explain why the three levels are different only in the case of harmony A.

```
%% fft of harmony A.m
%
% generate a 440Hz tone
Fs = 8000; % sampling rate
A = 440; %tone frequency
period = 0.02; %signal length in second
t = (0:1/Fs:period-1/Fs);
f = (1/period:1/period:Fs);
sep = power(2, 1/12);
Cs = A*power(sep, 4)
E = Cs*power(sep, 3)
% we reduce the amplitude by 0.2 to avoid distortion.
y = 0.2*sin(2*pi*(A)*t) + 0.2*sin(2*pi*Cs*t) + 0.2*sin(2*pi*E*t);
sound(y, Fs);
fy = fft(y);
plot(f, abs(fy)/length(t));
xlabel('frequency (Hz)')
ylabel('gain')
```

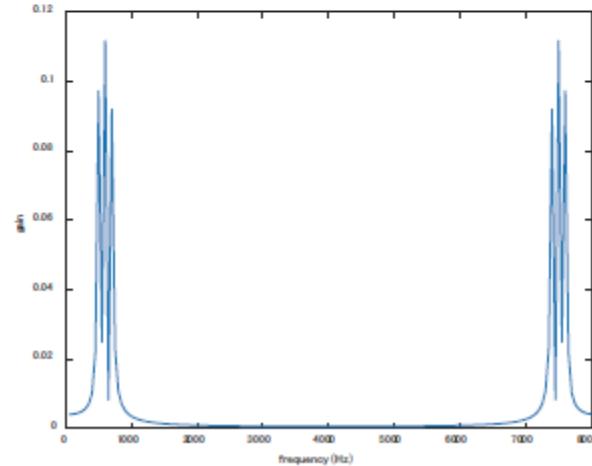


Figure 3.15: Frequency domain signal of harmony A for 0.02 second

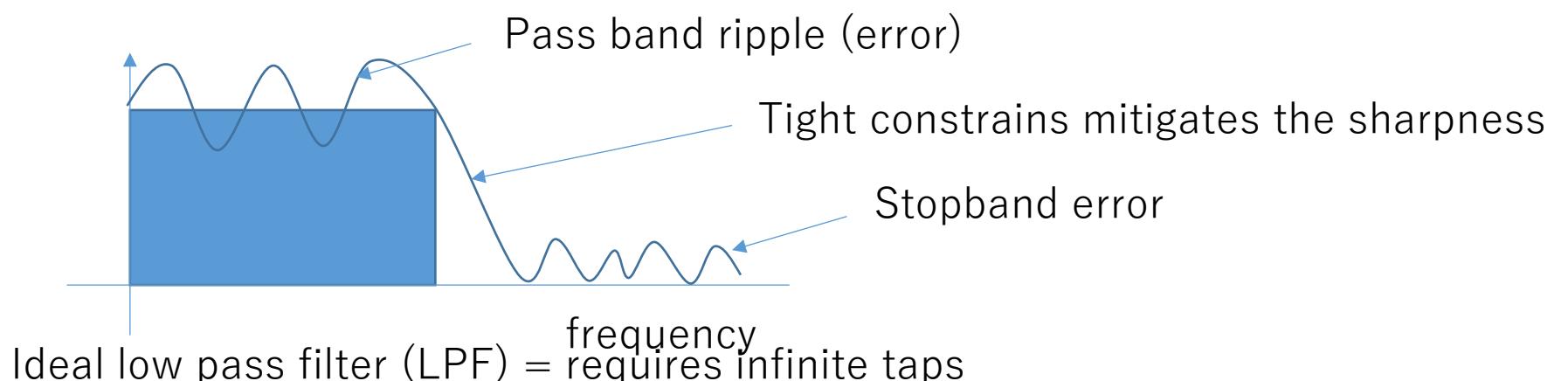
Testcoef.m

```
b = firceqrip(30,0.4,[0.05 0.03]);
```

Tap number $30+1 = 31$:

passband : 0.4 of Nyquist Frequency

Passband error (ripple) and stopband error : [0.05 0.03]



Highpass filter can be produced by adding 'high'

```
b = firceqrip(30,0.4,[0.05 0.03], 'high');
```

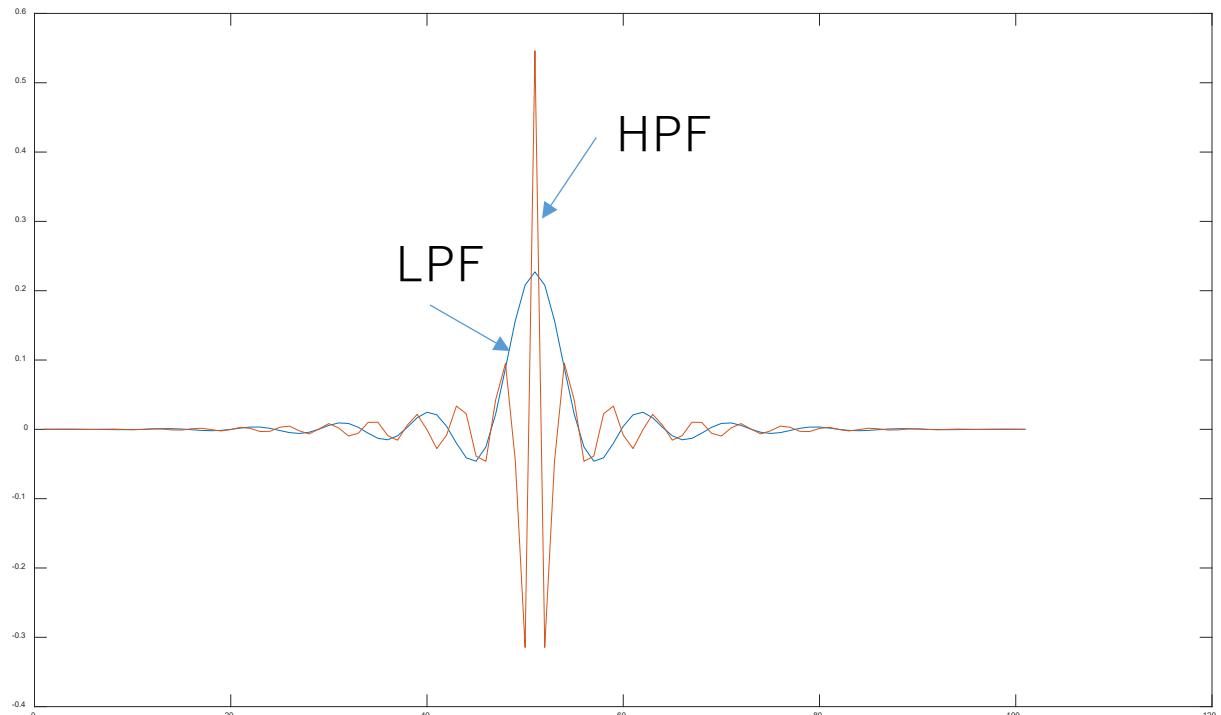
Exercise 1 (musicdsp)

- FIR LPF and apply to mp3 file
- Passband 5000 Hz
- Tap number 101

Exercise 2 (musicdsp_high)

- High Pass Filter
- Stopband 10,000 Hz
- Tap number 101

Coefficients of
HPF and LPF



```
frameLength = 1024;
mfile = uigetfile('*mp3');
N = 100; % FIR filter order
Fp = 10e3; % 10 kHz passband-edge frequency
Rp = 0.00057565; % Corresponds to 0.01 dB peak-to-peak ripple
Rst = 1e-5; % Corresponds to 80 dB stopband attenuation
```

```
eqnum = firceqrip(N,2*Fp/Fs,[Rp Rst],'high'); % eqnum = vec of coeffs
highpassFIR = dsp.FIRFilter('Numerator', eqnum);
fileReader = dsp.AudioFileReader(...  
mfile,...  
'SamplesPerFrame',frameLength, 'OutputDataType', 'int16');
deviceWriter = audioDeviceWriter(...  
'SampleRate',fileReader.SampleRate);
```

```
while ~isDone(fileReader)
    signal = fileReader();
    yy = highpassFIR(signal);
    deviceWriter(yy);
end
```

```
release(fileReader);
release(deviceWriter);
```

#6 assignment バンドパスフィルタ(BPF)

通過域が4kHz～10kHzのバンドパスフィルタを作成し、
Example 4.2のmusicdspに組み込みmファイルを提出せよ。