DSP2 Week 10 experiment Report

2019023436 Kim, Hyunsoo

Exercise 1

a. (Source Code)

```
t = 0:0.01:1;
x = sin(4*pi*t);
noise = randn(1, length(t));
x1 = x + 0.15*noise;
h = [1/4 1/2 1/4];
```

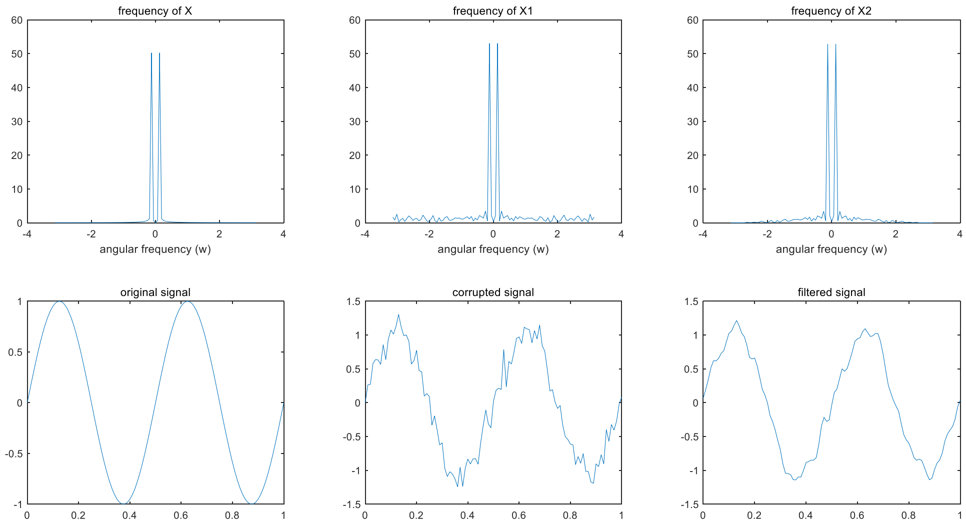
I generated signal x, x1 and a low-pass filter h.

b. (Source Code)

```
angular_freq = -pi:2*pi*0.01:pi;

X = fft(x);
X = fftshift(X);
magX = abs(X);

X1 = fft(x1);
X1 = fftshift(X1);
magX1 = abs(X1);

X2 = fft(x2);
X2 = fftshift(X2);
magX2 = abs(X2);
```

```
subplot(2,3,1);
plot(angular_freq, magX);
title('frequency of X')
xlabel('angular frequency (w)')
subplot(2,3,2);
plot(angular_freq, magX1)
title('frequency of X1')
xlabel('angular frequency (w)')
subplot(2,3,3);
plot(angular_freq, magX2)
title('frequency of X2')
xlabel('angular frequency (w)')

subplot(2,3,4);
plot(t, x);
title('original signal')
subplot(2,3,5);
plot(t, x1);
title('corrupted signal')
subplot(2,3,6);
plot(t, x2);
title('filtered signal')
```

(Result)



c. (Source Code)

```
Err1 = mean((x-x1).^2)
Err2 = mean((x-x2).^2)
difference = (Err1 - Err2)
```

(Result)

```
Err1 = 0.0214
Err2 = 0.0089
difference = 0.0125
```

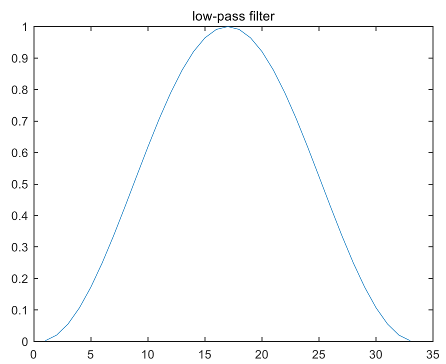
d. x is the original signal. x1 is a new signal with some noise and x2 is a filtered signal with low-pass filter. Upper three graphs are frequency of x, x1 and x2. The frequency of x1 has lots of noise on the overall frequency whereas the frequency of x2 is more concentrated on the low frequency region. Lower three graphs are the graphs of x, x1 and x2. The graph of x1 looks very distorted whereas the graph of x2 looks more similar to the original graph x1.

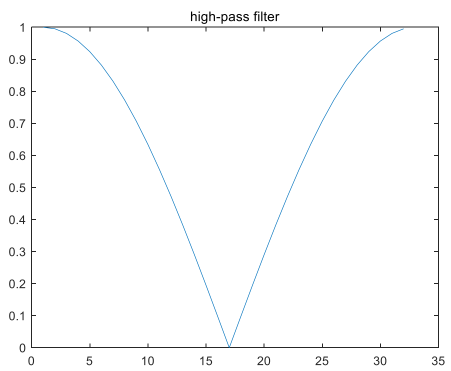
Exercise 2

a. (Source Code)

```
[y, Fs] = audioread("dsp2_experiment10.wav")

lpf = [1/4 1/2 1/4];
pad = zeros(1, 30);
lpf = [lpf, pad];
LPF = fft(lpf);
LPF = fftshift(LPF);
magLPF = abs(LPF);
plot(magLPF)
title('low-pass filter')

hpf = [1/2 -1/2]
hpf = [hpf, pad];
HPF= fft(hpf);
HPF = fftshift(HPF);
magHPF= abs(HPF);
plot(magHPF)
title('high-pass filter')

y_lpf = conv(y, lpf);
y_hpf = conv(y, hpf);
```

(Result)





b. (Source Code)

```
sound(y, Fs)
%sound(y_lpf, Fs)
%sound(y_hpf, Fs)
```

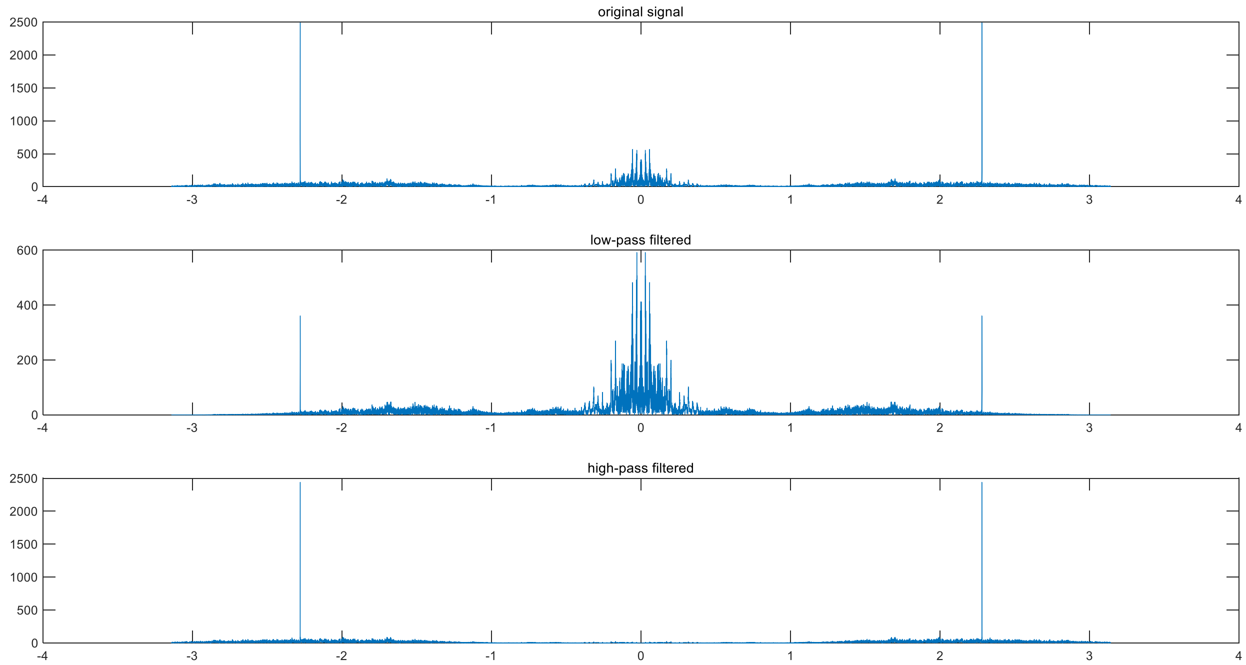
(Result)

The original signal is a mixture of low-pitched voice and high-pitched noise. The low-pass filtered signal sounds less high-pitched noise. However, the high-pass filtered signal sounds very small voice.

c. (Source Code)

```
Y = fft(y);
Y = fftshift(Y);
Y_lpf = fft(y_lpf);
Y_lpf = fftshift(Y_lpf);
Y_hpf = fft(y_hpf);
Y_hpf = fftshift(Y_hpf);

angular_freq = -pi:2*pi/(length(y)-1):pi;
subplot(3,1,1);
plot(angular_freq, abs(Y));
title('original signal')

angular_freq = -pi:2*pi/(length(y_lpf)-1):pi;
subplot(3,1,2);
plot(angular_freq, abs(Y_lpf));
title('low-pass filtered')

angular_freq = -pi:2*pi/(length(y_hpf)-1):pi;
subplot(3,1,3);
plot(angular_freq, abs(Y_hpf));
title('high-pass filtered')
```

(Result)



Low-pass filtered frequency graph shows that the magnitude of the high frequency has decreased, and the magnitude of the low frequency is almost the same as the original signal. High-pass filtered frequency graph shows that the magnitude of the low frequency has decreased, and the magnitude of the high frequency is almost the same as the original signal.