CT.2306 : Signal & Systems II

Report

Processing motion signals from a PTZ camera

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isep
École d'ingénieurs du numérique

Made with LaTeX

Contents

1 Data visualization

1) When we load *data-proj.mat*, we can see that there are two vectors in the file :

```
Name        Size

omega       1x20001
t           1x20001
```

2) Plot of the angular speed *omega* as a function of time.

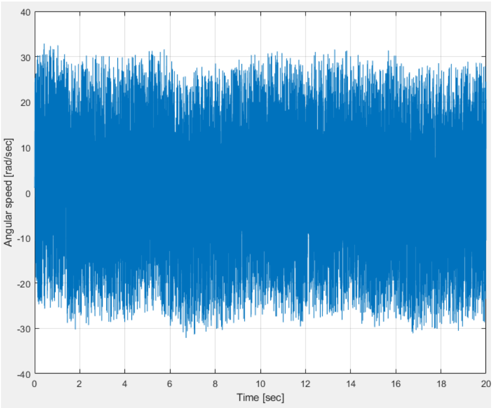

Figure 1: Angular speed as a function of time

To obtain this graph :

```
figure(1)
plot(t, omega)
grid on
hold on
xlabel('Time [sec]')
ylabel('Angular speed [rad/sec]'
    )
```

It is not possible to use the signal as it is now, mostly because there is too much information (too noisy) or the window is too large. This signal is continuous (analog). Electronic control devices requires digital signals.

2 Analog filtering

3) The sampling period T_{e_1} can be calculated with :

```
Te1=t(2)-t(1)

>>Te1 =

1.0000e-03
```

4) Plot of the amplitude spectrum of $omega(t)$, with the use of the workshop 5 :

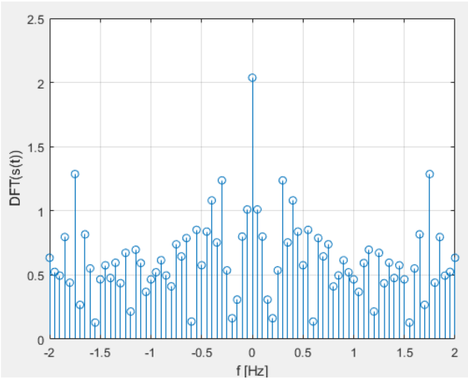

Figure 2: DFT plot of $omega(t)$

To obtain this graph :

```
% Plot of the DFT of omega(t)
Te2= 0.05;
Fe2=1/Te2;
Tf=t(end);
N=Tf/Te2 ;

f1=-Fe2*(N/2-1)/N:Fe2/N:0;
f2=Fe2/N:Fe2/N:(N/2)*Fe2/N;
f = [f2,f1];
S= zeros(N,1);
for m=1:N
  for k=1:N
    S(m)=S(m)+omega(k)*exp(-1i
       *2*pi*m*k/N);

  end
end

figure(2)
stem(f,abs(S)/N)
grid on
hold on
xlim([-2 2])
xlabel('f [Hz]')
ylabel('DFT(\omega (t))')
```

5) The frequencies contained inside the signal are ranging from -2 Hz to 2 Hz with a step of 0.05.

$F_{max} = 2Hz$

6) The cutoff frequency is $f_c = 2Hz$.
On Matlab :

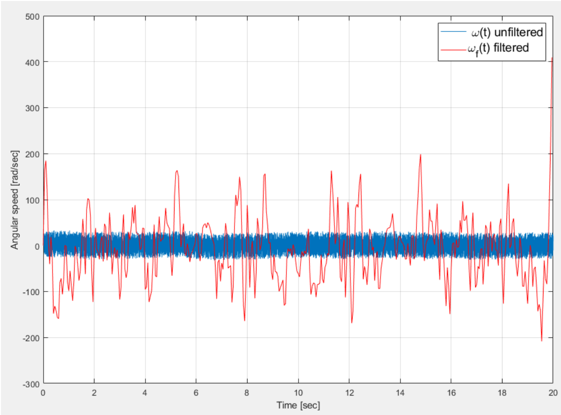

Figure 3: $omega(t)$ filtered and unfiltered ($omega_f(t)$)

To obtain this graph :

```
% filter design
t1=0:Te2:t(end)-Te2;
fc1=2;
H1=tf(1,[1/(2*pi*fc1)  1]);
Sf=lsim(H1,S,t1);

% plot of filtered signal
figure(1);
plot(t1,Sf,'r')
grid on
legend(' \omega(t) unfiltered','
   \omega_{f}(t) filtered','
   Fontsize',14)
```

On Simulink :

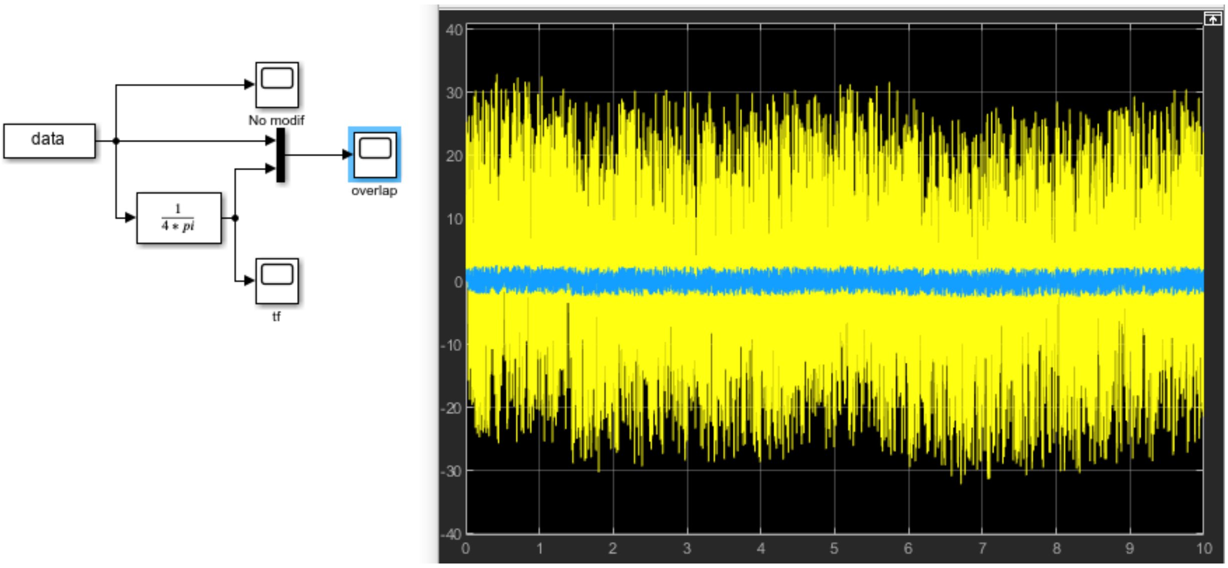

Figure 4: Simulink

We need to add a part in the Matlab code as well :

```
t_temp = t';
omega = omega';
data = [t_temp,omega];
```

7) Plot of the amplitude spectrum of $omega_f(t)$, with the use of the workshop 5 :

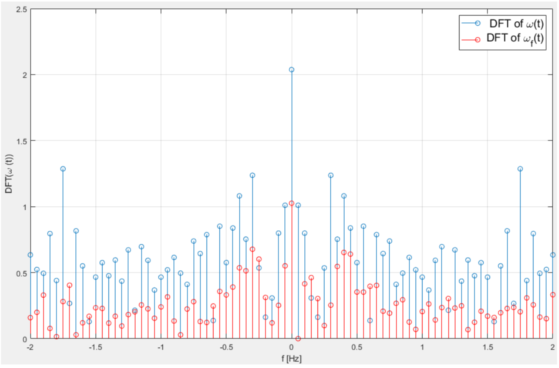

Figure 5: DFT plot of $omega(t)$ and $omega_f(t)$

To obtain this graph :

```
figure(2)
stem(f,abs(Sf)/N, 'r')
grid on
xlim([-2 2])
legend(' DFT of \omega(t)','DFT
    of \omega_{f}(t)','Fontsize'
    ,14)
```

3 Sampling

8) To create a vector $omega_e(t)$ which contains the values of the vector $omega_f(t)$ with a period between the values of $T_{e2} = 0.05$ sec.

```
temp1 = 1:round(Te2/Te1):length(wf);
we=wf(temp1);
```

9) To get the size of $omega_e(t)$, we use :

```
size(we)
```

```
>> size(we)

ans =

     8     1
```

Figure 6: Size of $omega_e$

10) The new vector t_e which corresponds to the vector $omega_e(t)$ can be created using :

```
Te = (0:length(we)-1) * Te2;
```

Where we is $omega_e(t)$.

And we get those values for t_e :

```
Te =

         0    0.0500    0.1000    0.1500    0.2000    0.2500
    0.3000    0.3500
```

11) Plot of $omega_f(t)$ and $omega_e(t)$:

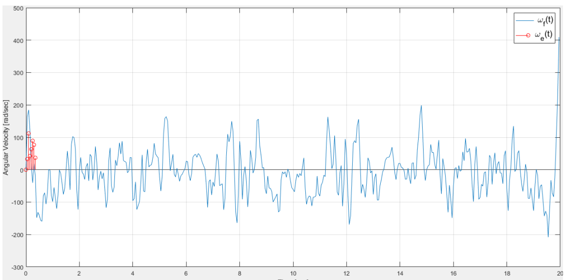

Figure 7: Plot of $omega_f(t)$ and $omega_e(t)$

```
figure(3)
plot(t1,wf)
xlabel('Time [sec]')
ylabel('Angular Velocity [rad/
   sec]')
grid on
hold on
stem(Te,abs(we), 'r')
legend(' \omega_{f}(t)','\omega_
   {e}(t)','Fontsize',14)
```

To plot the graph between 10 and 12, we add xlim([10 12]) to the Matlab code.

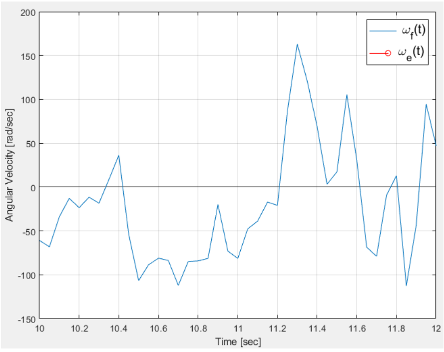

Figure 8: Plot of $omega_f(t)$ and $omega_e(t)$, focused between 10 and 12

```
figure(3)
plot(t1,wf)
xlim([10 12])
xlabel('Time [sec]')
ylabel('Angular Velocity [rad/
   sec]')
grid on
hold on
stem(Te,abs(we), 'r')
legend(' \omega_{f}(t)','\omega_
   {e}(t)','Fontsize',14)
```

We can see that $omega_e(t)$ is not visible because it is only display between 0 and 0.35 sec.

12) Plot of $omega(t)$, $omega_f(t)$ and $omega_e(t)$:

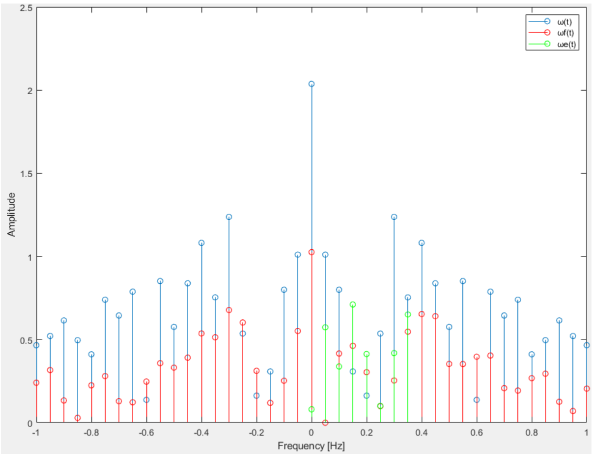

Figure 9: Plot of $omega_f(t)$ and $omega_e(t)$

```
we_dft = fft(we);

figure(4)
stem(f,abs(w)/N)
hold on
stem(f,abs(wf)/N, 'r')
stem(Te,abs(we_dft)/N, 'g')
xlabel('Frequency [Hz]')
ylabel('Amplitude')
legend('\omega(t)', '\omega_{f}(
   t)', '\omega_{e}(t)')
xlim([-1 1])
```

4 Angular position and acceleration

13) To calculate the angular acceleration$omegadot(t)$ and the position $theta(t)$:

```
wd=zeros(8,1);
j=0;

TeM=Te';

wd(1)=(we(1))/TeM(1);
for i=2:7
    wd(i)=(we(i)-we(i-1))/(2*TeM(i));
end
wd(8)=(we(8)-we(7))/TeM(8);

%theta=Te*sigma(we(i))

theta=zeros(8,1);
sum=0;

for i=1:8
    sum=sum+we(i);
    theta(i)=TeM(i)*sum;
end
```

14) We can now plot the two graphs for $theta(t)$ and $omegadot(t)$:

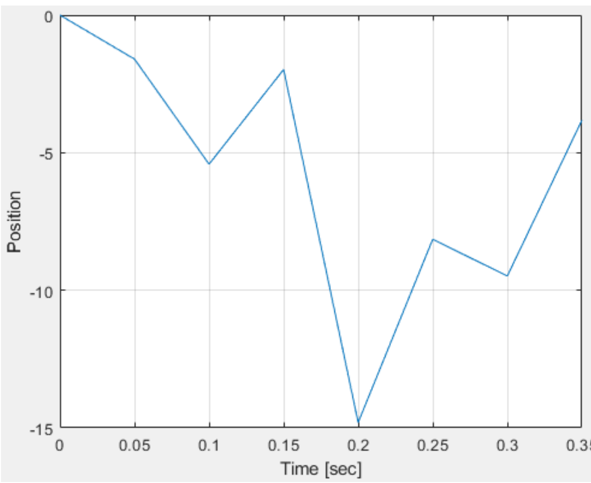

Figure 10: Plot of $theta(t)$

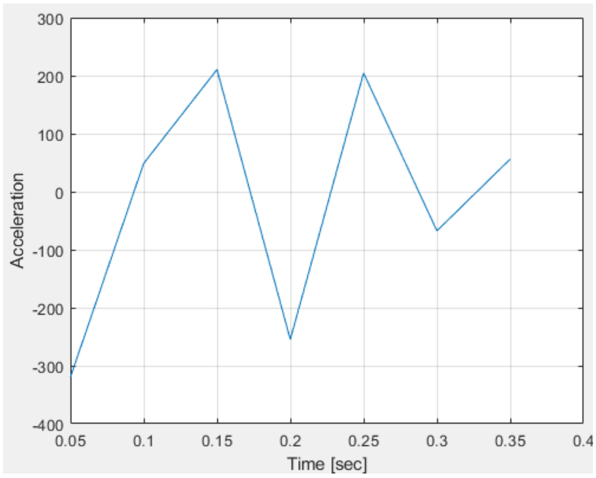

Figure 11: Plot of $omegadot(t)$

15) A

5 Digital filtering

16) A

17) A

18) A