Activity 05 : Continuous time system identification – CONTSID library

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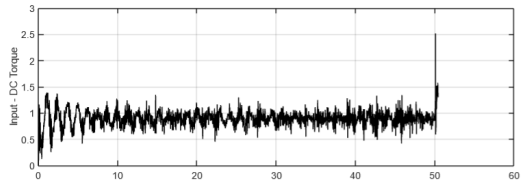
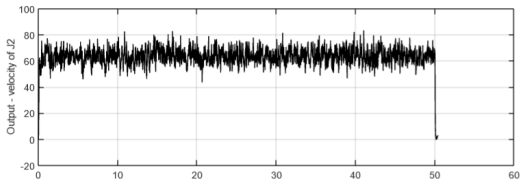
1. Inspect the data pre-processing file

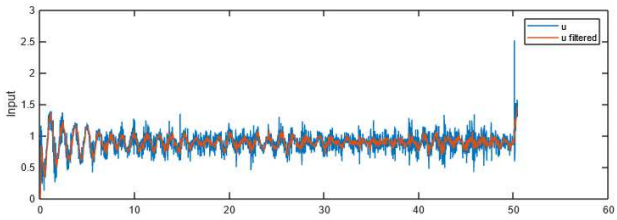
```
% time R2 R3 An2 An3 DC_Torque
rawData = readmatrix('measured_data.csv');

Ts = 0.01;
fs = 1/Ts;
[resData, t] = resample(rawData(:,2:end),rawData(:,1),fs);

figure
subplot(2,1,1)
plot(t,resData(:,5))
ylabel('Input - DC Torque')
subplot(2,1,2)
plot(t,resData(:,2))
ylabel('Output - velocity of J2')
```

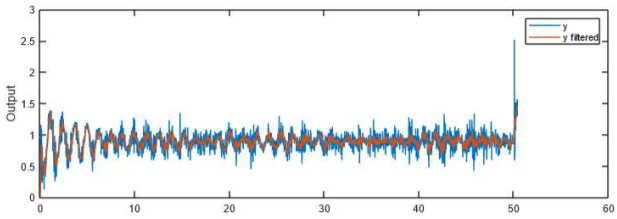




Filtering data

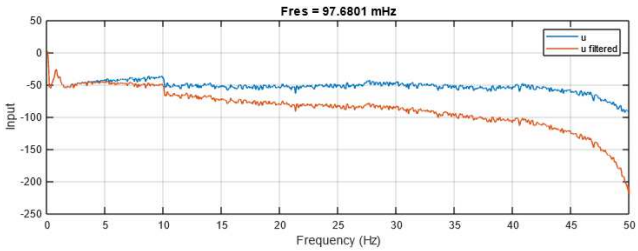
```
z = iddata(resData(:,1),resData(:,5), Ts, 'interSample', 'foh');
[B,A] = butter(2,.1);
zf = idfilt(z,{B,A});

u = z.InputData;
uf = zf.InputData;
yf = zf.OutputData;
y = z.OutputData;

% plotting filtered data
figure
subplot(2,1,1)
plot(t,[u, uf])
ylabel('Input')
legend ('u', 'u filtered')
subplot(2,1,2)
plot(t,[u, uf])
ylabel('Output')
legend ('y', 'y filtered')
```

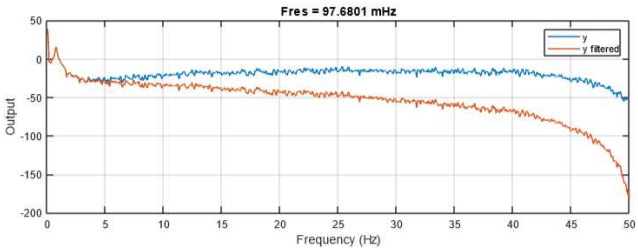




Plotting u and y power spectrum

```
% plotting u and y power spectrum
figure
subplot(2,1,1)
pspectrum(u, fs)
hold on
pspectrum(uf, fs)
ylabel('Input')
legend ('u', 'u filtered')
subplot(2,1,2)
pspectrum(y, fs)
hold on
pspectrum(yf, fs)
ylabel('Output')
legend ('y', 'y filtered')
```





2. Try to model the system using the CONTSID toolbox, using the input as the torque in J3 nd the output as the velocity of J2 (see variable “zf” in the code).

Here we look for model architectures (na, nb) that provides the best identification (R2 score between y and ye (estimated).

```
% Looping over params to proceed system identification
% Measuring quality of fit using R2 Score
best_r2 = -100;
for np = 2:8
  for nz = 0:np-1
    Ghat = tfrivc(zf,np,nz);
    ye = lsim(Ghat, uf, t);
    r2 = mult_corr(yf,ye);
    fprintf('np=%d, nz=%d, R2= %0.4f ', np, nz, r2);
    if r2 > best_r2
      fprintf('(best so far)\n');
      best_r2 = r2;
      best_Ghat = Ghat;
    else
      fprintf('\n');
    end
  end
end

fprintf('>>>>>>>>>>>>>>>>>>> Best R2=%.4f\n',best_r2);
```

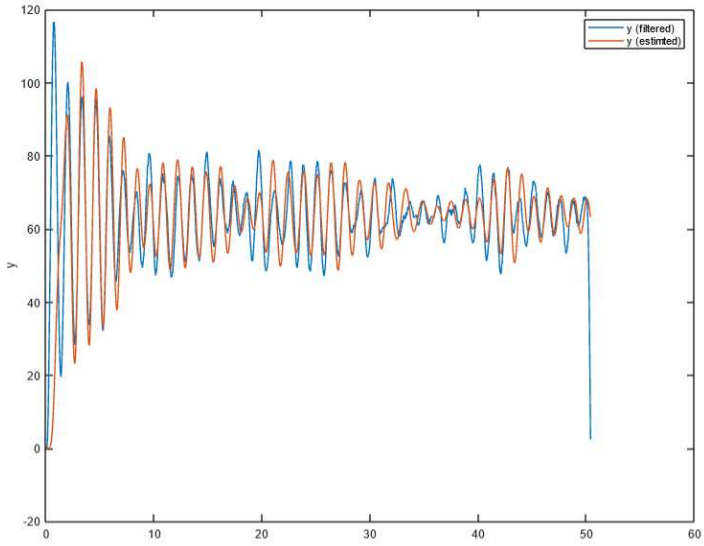
```
np=2, nz=0, R2= -0.0388 (best so far)
np=2, nz=1, R2= -0.1014
np=3, nz=0, R2= -0.1078
np=3, nz=1, R2= -0.0498
np=3, nz=2, R2= -0.0630
np=4, nz=0, R2= -0.1138
np=4, nz=1, R2= -0.0656
np=4, nz=2, R2= 0.0040 (best so far)
np=4, nz=3, R2= -0.2197
np=5, nz=0, R2= 0.0235 (best so far)
np=5, nz=1, R2= -0.0983
np=5, nz=2, R2= -0.1056
np=5, nz=3, R2= 0.0498 (best so far)
np=5, nz=4, R2= 0.0425
np=6, nz=0, R2= -0.0481
np=6, nz=1, R2= -0.0624
np=6, nz=2, R2= -0.3496
...
np=8, nz=0, R2= -1.2139
np=8, nz=1, R2= -0.8971
np=8, nz=2, R2= 0.0864 (best so far)
np=8, nz=3, R2= -0.1982
np=8, nz=4, R2= -0.0606
np=8, nz=5, R2= -0.9849
np=8, nz=6, R2= -0.2685
np=8, nz=7, R2= -0.3253

>>>>>>>>>>>>>>>>>>> Best R2=0.0864
```

Best model fits are highlighted in the previous table. The best combination for this system identification is achieved with na=8 and nb=2, but the scores are very poor.

3. Report your results accordingly

Plotting model simulated vs measured response

```
% simulating system (best Ghat)
ye = lsim(best_Ghat, uf, t);
ze = iddata(ye, uf, Ts);

% measured vs estimated
figure
plot(t,[yf, ye]);
ylabel('y');
legend('yf', 'ye')
```



4. Propose adjustments in the data acquisition activity, according to the analysis of your numerical experiments

When we plot the power spectrum of y, yf and ye we see that the latter has lost higher frequency information. Based on this, we suppose that the identification process would have reached better results if the input excitation signal were composed of higher frequency information.

```
figure
pspectrum(y, fs)
hold on
pspectrum(yf, fs)
hold on
pspectrum(ye, fs)
ylabel('Output')
legend ('y', 'y filtered', 'y estimated')
```