Laboratory activity 2 - "To do" list

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1 Activity goals

The activity consists on the simulated and experimental tuning of a Kalman Filter (KF), applied to the DC servomotor, by using a whiteness test on the innovation signal. Once the KF is tuned, the estimated state feedback is used for both state feedback control and disturbance feedforward compensation.

2 KF tuning

The KF tuning is at first performed on the 2x2 system, without considering the input disturbance model.
Do the following tasks:

1. Open the Simulink model $KF\_to\_play\_with\_real.slx$
2. Run the script $KF\_script.m$, with the initial value of the input noise variance
3. Once the script pauses, run the Simulink to generate the innovation samples
4. Go back to the Matlab command window and press a key. This will start the generation of the Bartlett test.
5. Re–run the script KF_script, with a different value of the input noise variance and verify the changes on the Bartlett test. Report the graphs with different variances and justify the results.

Once the proper process noise variance is found, its value is used also in the 3x3 model of the system.

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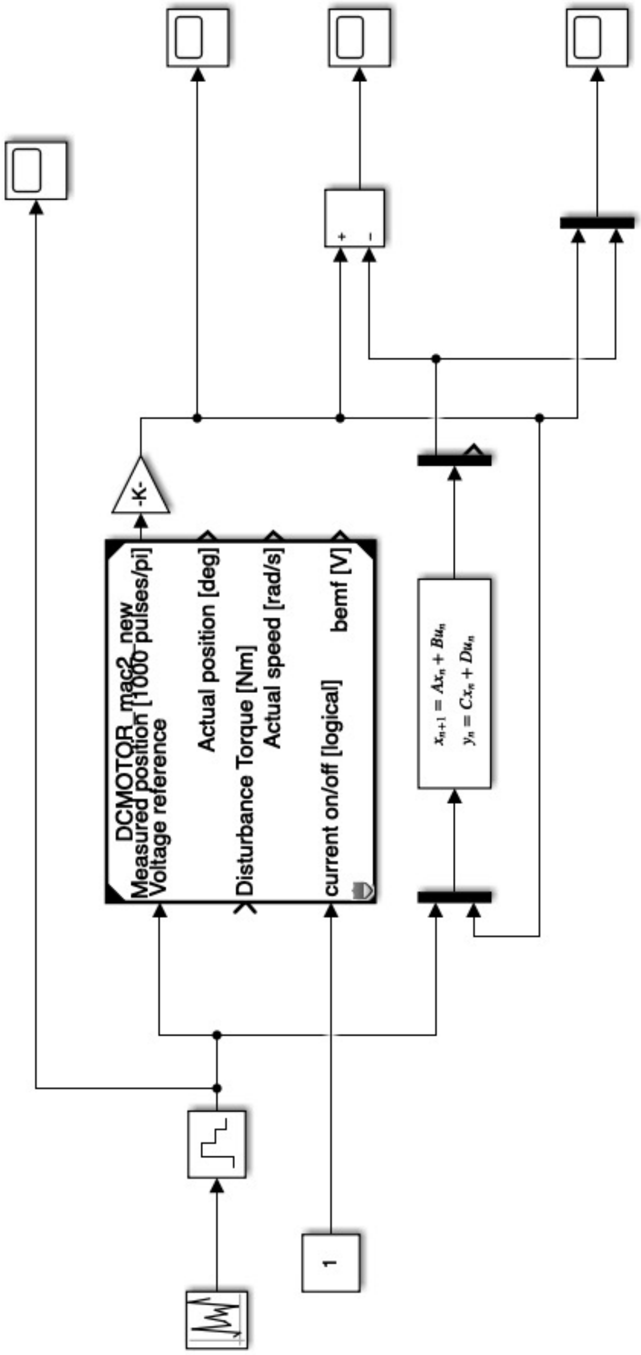

Figure 1: KF simulator

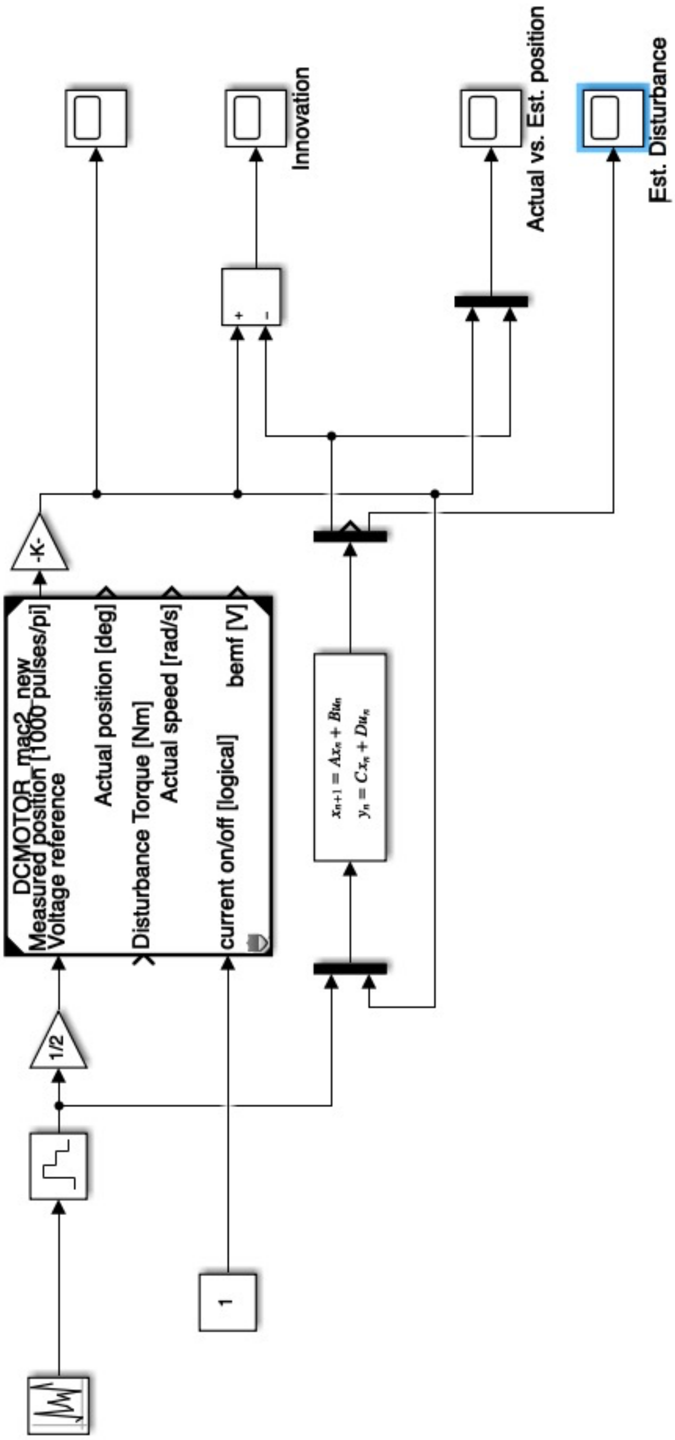

Figure 2: KF simulator with random–walk disturbance model

Do the following tasks on the 3x3 system:

1. Open the Simulink model $KF3\_to\_play\_with\_real.slx$
2. Run the script $KF3\_script.m$, with the value of the input noise variance set at the value previously found and an initial guess for the variance of the random walk input
3. Once the script pauses, run the Simulink to generate the innovation samples
4. Go back to the Matlab command window and press a key. This will start the generation of the Bartlett test.
5. Re–run the script $KF3\_script$, with a different value of the random walk noise variance and verify the changes on the Bartlett test. Report the graphs with different variances and justify the results.

A general instruction is to modify the provided scripts, in order to set the viscous friction in the estimator at zero, while the simulated process is designed on the nominal friction provided. This because we want the estimator to estimate the viscous friction torque as a disturbance. Another (optional) test is to apply command through a low-pass filter and execute the whiteness test.

3 State feedback control

With the tuned 3x3 estimator, we proceed to the design of a state feedback controller. Remember that only the reachable subsystem is involved in this design. In the script $LQG\_script.m$, a pole placement is used. Students are asked to design the feedback by using LQR and test the results on the Simulink model $LQG\_to\_ply\_with.slx$. Note that feedforward disturbance compensation can be turned off . Verify the results with and without disturbance compensation. Report and compare actual and estimated variables.

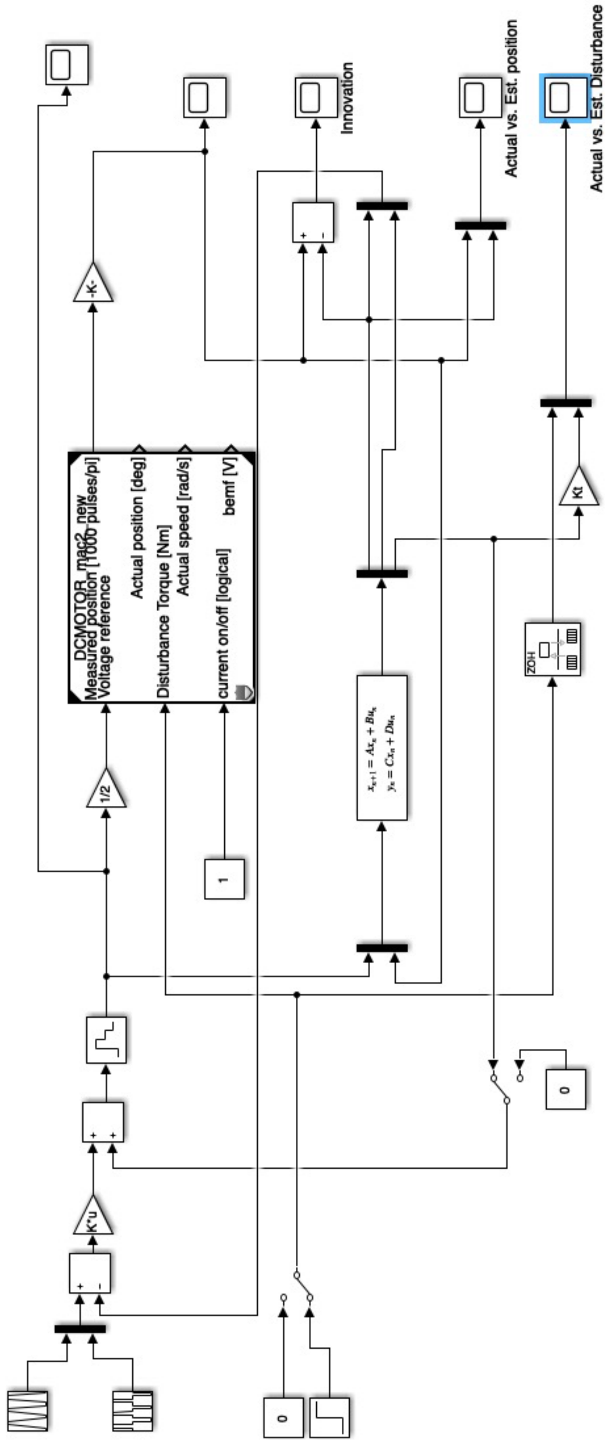

Figure 3: State feedback control with estimated disturbance compensation