

ECE-320 Lab 9: Adding Integral Control and Observers to State Variable Feedback

Note: Be sure all initial estimates in your observers are set to zero before you try and control the ECP systems, and all of your simulated system errors have been removed.

Throughout this lab you will be implementing your full order observers and your full order observers with integral control you did for the prelab on the ECP systems. The best way to do this is as follows:

- *open an existing file (such as **Model210_sv1.mdl**),*
- *save it as a new file, let's say **Model210_observer_sv1.mdl***
- *edit everything out except the yellow ECP block,*
- *open your Simulink simulation file*
- *copy it to your new file, **Model210_observer_sv1.mdl***
- *remove your simulated system and replace it with the yell ECP block*
- *save the new file.*

While it may seem easier to just copy and paste the yellow ECP block, this often leads to really strange errors, so don't do it!

One degree of freedom system with full order observer.

- Set up your one degree of freedom rectilinear system.
- Simulate the system with a state feedback controller and a full order observer. Place the closed loop poles near $\mathbf{p} = [-15 \ -20]$. Keep the state variable feedback poles and the observer poles identical (with pole locations \mathbf{p}).
- Implement your full order observer on the ECP systems (make a Simulink file with the yellow ECP block).
- Run the ECP system with your controller/full order observer.
- Compare the actual states (from the ECP system) and the estimated states (from the observer implemented in the ECP system). You will have to modify **compare1.m** to do this. Be sure to change the legend command and use different line types so the results will be acceptable with black and white printers. Only plot until the system reaches steady state. You will probably have a non-zero steady state error.
- Vary the location of the state feedback and observer poles until you get a good response. *Put this graph in your memo.*

One degree of freedom system with full order observer and integral control.

- Simulate your rectilinear system with a state feedback controller and a full order observer, with a configuration that uses integral control. Try to place the closed loop poles near $\mathbf{ps} = [-10 \ -15 \ -20]$ and observer poles at $\mathbf{po} = [-10 \ -15]$. Do not try for a particularly fast response, it will overwhelm the system! Initially put the observer poles where the state feedback poles are.
- Implement your full order observer with integral control on the ECP system.
- Run the ECP system with your controller/full order observer and integral control system configuration.

d) Compare the actual states (from the ECP system), and the estimated states (from the observer implemented in the ECP system). Only plot until the system reaches steady state. Your system should have near zero steady state error.

e) Vary the location of the state feedback and observer poles until you get a good response. *Put this graph in your memo.*

Two degree of freedom system with full order observer.

a) Set up the two degree of freedom rectilinear system.

b) In your Matlab driver file , be sure the array **get_desired_states** is set as follows:

```
get_desired_states = [1 0 0 0 0 0 0 0 ;  
                     0 1 0 0 0 0 0 0 ;  
                     0 0 1 0 0 0 0 0 ;  
                     0 0 0 1 0 0 0 0 ];
```

c) Simulate the system with a state feedback controller and a full order observer. Assume the position of both carts is available to the observer, and we are trying to control the position of cart 2. Place the closed loop poles near **ps** = [-10, -15, -20, -25] and the observer poles **po** = [-10 -15 -20 -25]. Do not try for a particularly fast response, it will overwhelm the system! c) Construct the corresponding ECP model file for the full order observer

d) Implement your full order observer with integral control on the ECP system.

e) Run the ECP system with your controller/full order observer system configuration.

f) Compare the actual states (from the ECP system), and the estimated states (from the observer implemented in the ECP system). Only plot until the system reaches steady state. You will probably have a non-zero steady state error.

g) Vary the location of the state feedback observer poles until you get a good response. *Put this graph in your memo.*

Two degree of freedom system with full order observer and integral control.

a) Simulate your rectilinear system with a state feedback controller and a full order observer, with a configuration that uses integral control. Try to place the closed loop poles near **ps** = [-10 -15 -20 -25 -30] and observer poles at **po** = [-10 -15 -20 -25]. Do not try for a particularly fast response, it will overwhelm the system! Initially put the observer poles where the state feedback poles are.

b) In your Matlab driver file , be sure the array **get_desired_states** is set as follows:

```
get_desired_states = [1 0 0 0 0 0 0 0 ;  
                     0 1 0 0 0 0 0 0 ;  
                     0 0 1 0 0 0 0 0 ;  
                     0 0 0 1 0 0 0 0 ];
```

c) Implement your full order observer with integral control on the ECP system.

d) Run the ECP system with your controller/full order observer and integral control system configuration.

e) Compare the actual states (from the ECP system), and the estimated states (from the observer implemented in the ECP system). Only plot until the system reaches steady state. Your system should have near zero steady state error.

f) Vary the location of the state feedback and observer poles until you get a good response. *Put this graph in your memo.*