Robotics and Intelligent Systems Lab II
Report 5

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Task 1.24. *Proceed as follows:*

1. *To start discretizing the controller first make a copy of your work up to now and rename the file. Now open the new Simulink model file.*

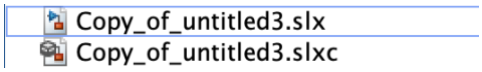


Fig (1)

2. *Create a variable Tsample= 0.01 (in seconds) in the Matlab workspace.*

```
>> Tsample=0.01

Tsample =

    0.0100
```

Fig (2)

3. *Now copy the motor and controller block so that you have two motors and controllers being simulated simultaneosly. We will make one of the controllers discrete. Mux their inputs/output signals before feeding them to the scopes. This way, you can compare the performance of the discrete and continuous controllers easily.*

Fig (3)

4. *Now change the PID controller subsystem of one of the two controllers to that shown in Fig. 1.16. You will need the block Discrete/Discrete-Filter from the SLB. Double-click the block and specify the discrete transfer-function. Enter the numerator and denominator of G(z) from (1.44) in the expected format. In the field "Sample Time" enter Tsample.*

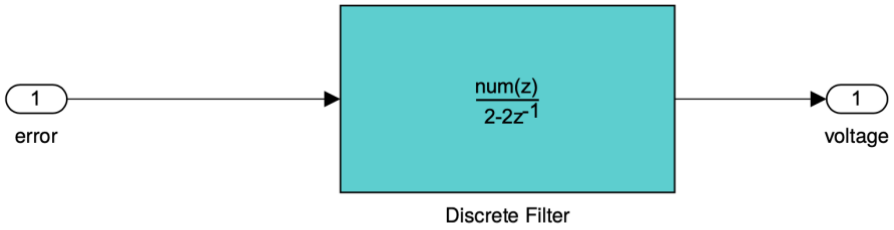


Figure 1.16: Change the PID controller subsystem to make it discrete. Take the sample-time from the workspace variable `Tsample` initialized to 0.1 seconds.

```
>> Gz= c2d(Gs, Tsample, 'tustin')

Gz =

  0.00915 z - 0.00765
  -------------------
         z - 1

Sample time: 0.01 seconds
Discrete-time transfer function.
```

Fig (4)

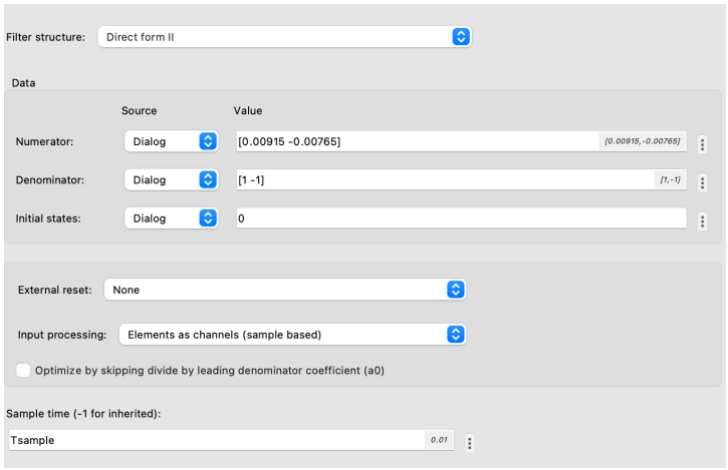


Fig (5)

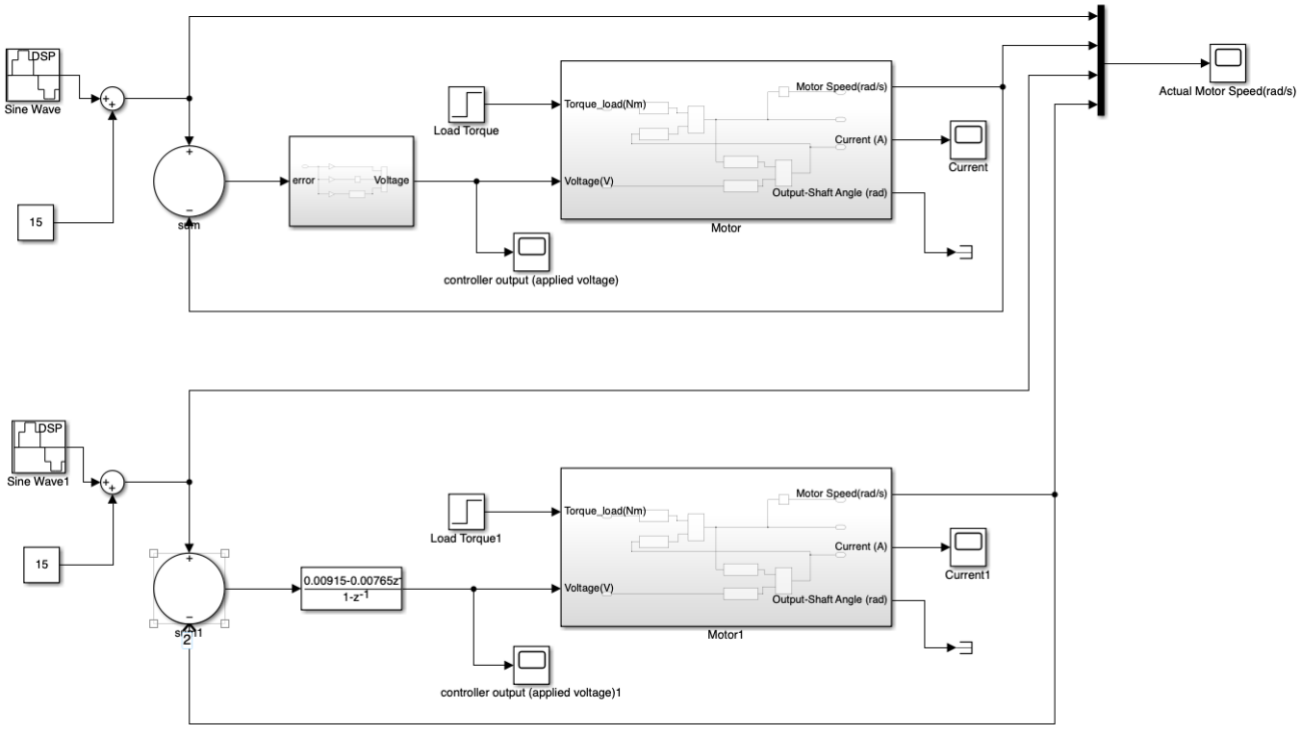


Fig (6)

5. *Now do the simulation for a step reference-speed input and look at the response. Zoom in the voltage (controller's output) scope – you will be able to see how the controller changes the voltage only at discrete intervals (refer to Fig. 1.17). What happens when you increase Tsample to* 0.5*s or higher? Also look at the current scope.*

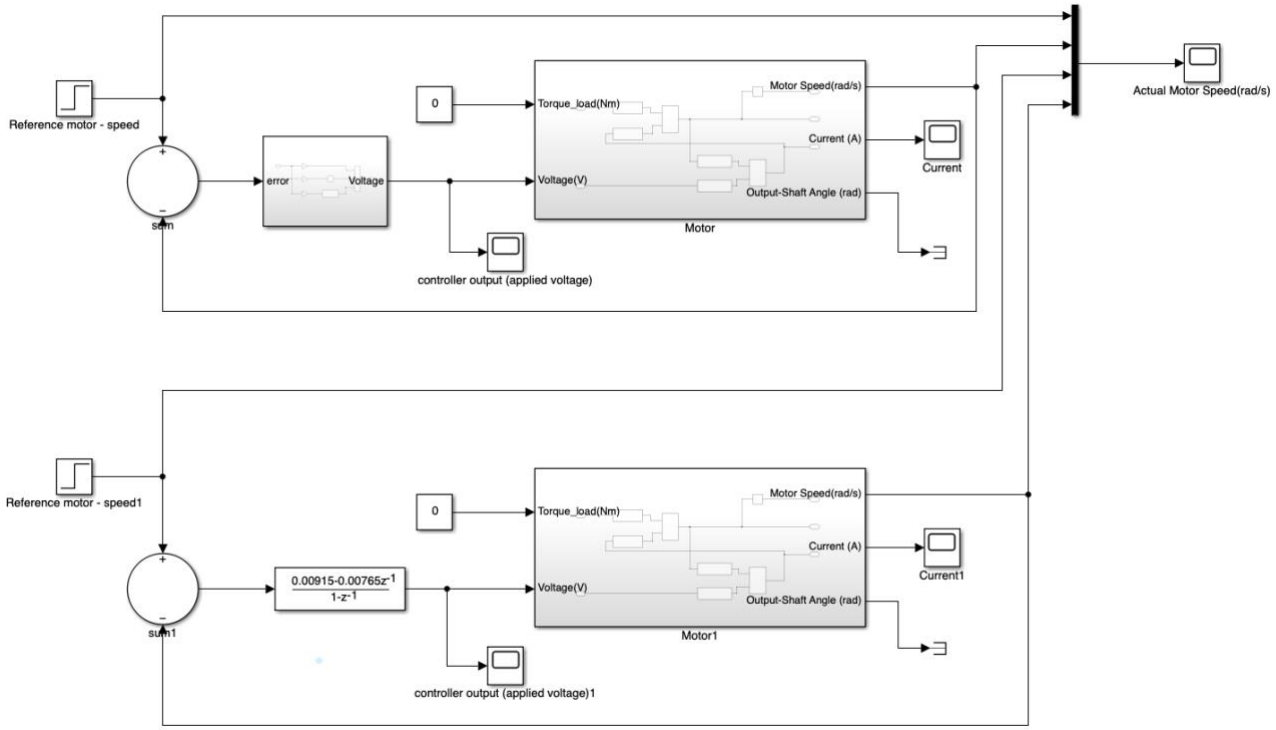


Fig (7)

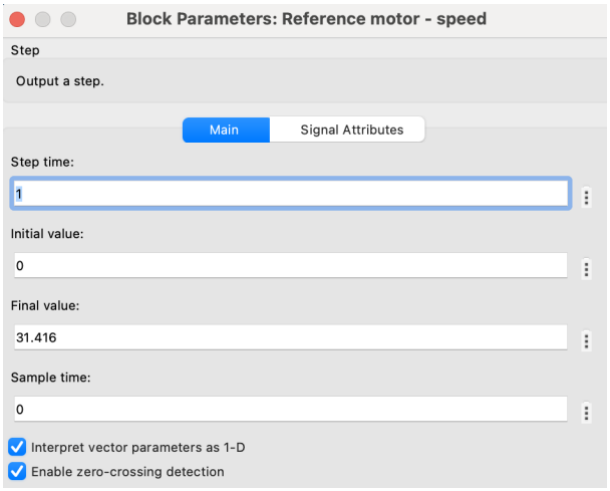
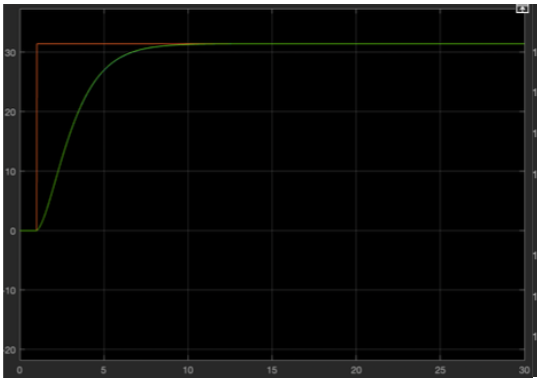
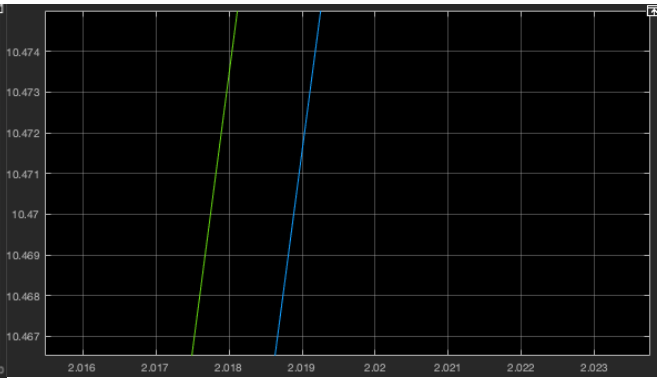


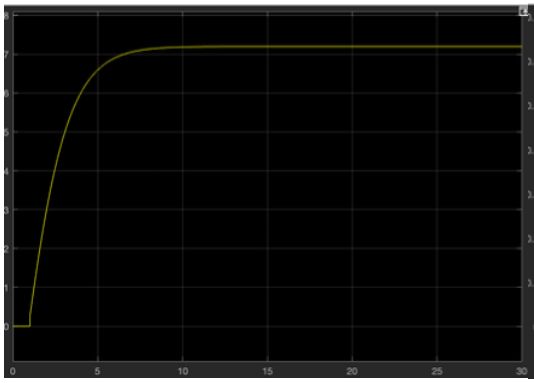
Fig (8)



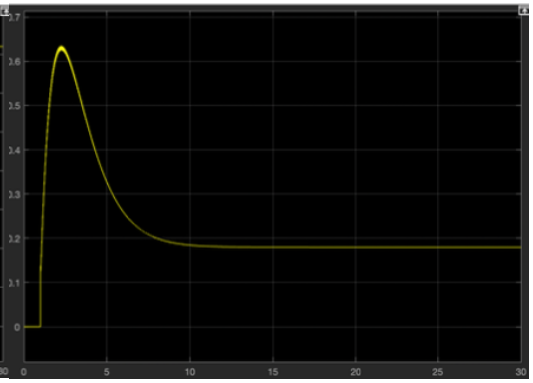
Actual Motor Speed Fig (9)



Actual Motor Speed Fig (10)

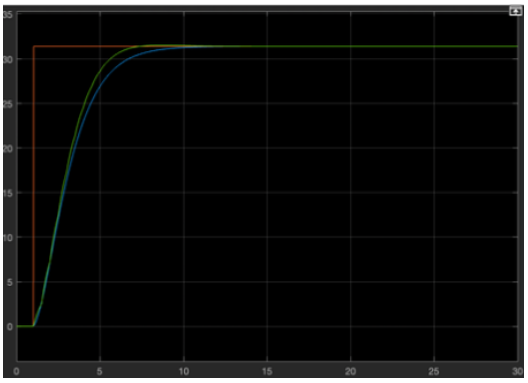


Controller output (applied voltage)1 Fig (11)

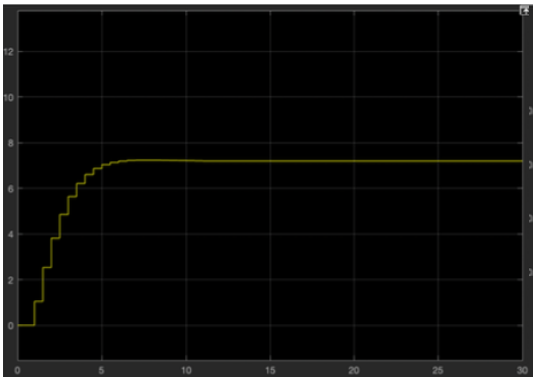


Current 1 Fig (12)

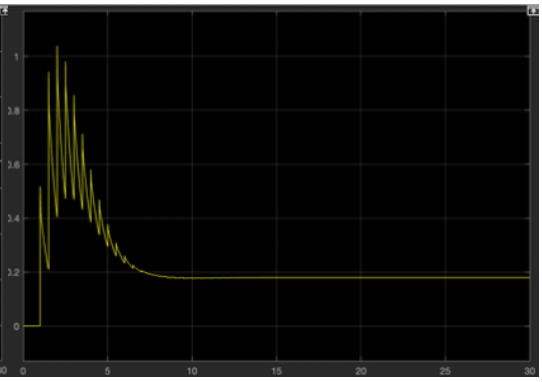
Tsample = 0.01s



Actual Motor Speed Fig (13)

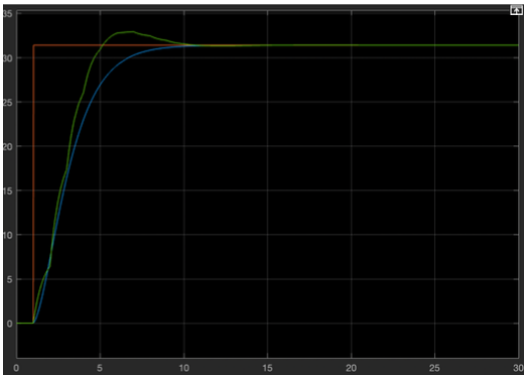


Controller output (applied voltage)1 Fig (14)

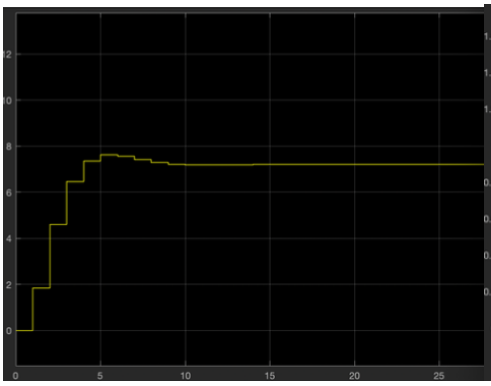


Current 1 Fig (15)

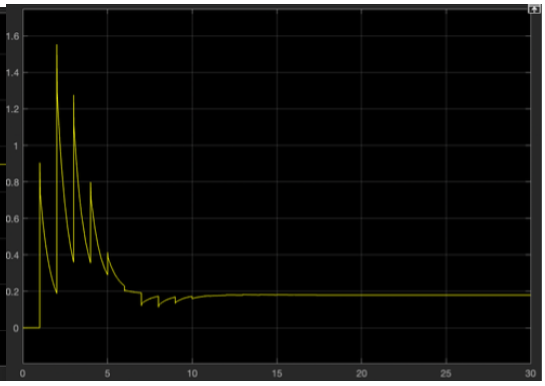
Tsample = 0.5s



Actual Motor Speed Fig (16)



Controller output (applied voltage)1 Fig (17)



Current 1 Fig (18)

Tsample = 1s

When dealing with different values of "Tsample", it becomes necessary to modify the discrete transfer-function accordingly. The discrete transfer-function represents the input-output relationship of a discrete-time system, and its values are dependent on the sampling interval "Tsample". Therefore, to ensure accurate and optimal system performance, it is important to adjust the values of the transfer-function as needed when the sampling interval changes. This ensures that the system remains stable and efficient under varying conditions, ultimately leading to reliable and consistent results.

The scopes displayed above demonstrate that as the value of Tsample increases, there is a noticeable gap in the speed of the motors. This effect is due to the fact that the voltage of the controller is only updated at discrete intervals, which are determined by the value of Tsample. Specifically, the controller voltage updates occur at intervals of 0.01, 0.5, or 1.0, resulting in a varying level of smoothness in the curves. At smaller intervals, such as 0.01, the curve is smoother since the updates occur more frequently. Additionally, the current exhibits several spikes, indicating that it oscillates during operation.