LAB 6

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Introduction

The goal of this lab was to combine everything we learned throughout the term and apply it to a relevant to life example. We have been progressively building on this problem for the last six labs. In this lab we took what we learned in class and applied a root locus analysis on the Cruise Control Car example that we worked in previous weeks. Running the root locus looks at how the roots of a system change when you vary a certain parameter. By doing this we can try and reduce the steady state error.

1)

```
clear;
close all;
% ˙ +  = u
% U(s) = m(V(s)s-v(0)) + bV(s)
% U(s) /s+b) -m(v(0))
% openloop: V(s)/U(s) = 1/(ms+ b)
m = 1000;
b = 50;
u = 500;


s = tf('s');
G = 1/(m*s + b) %Open loop
```

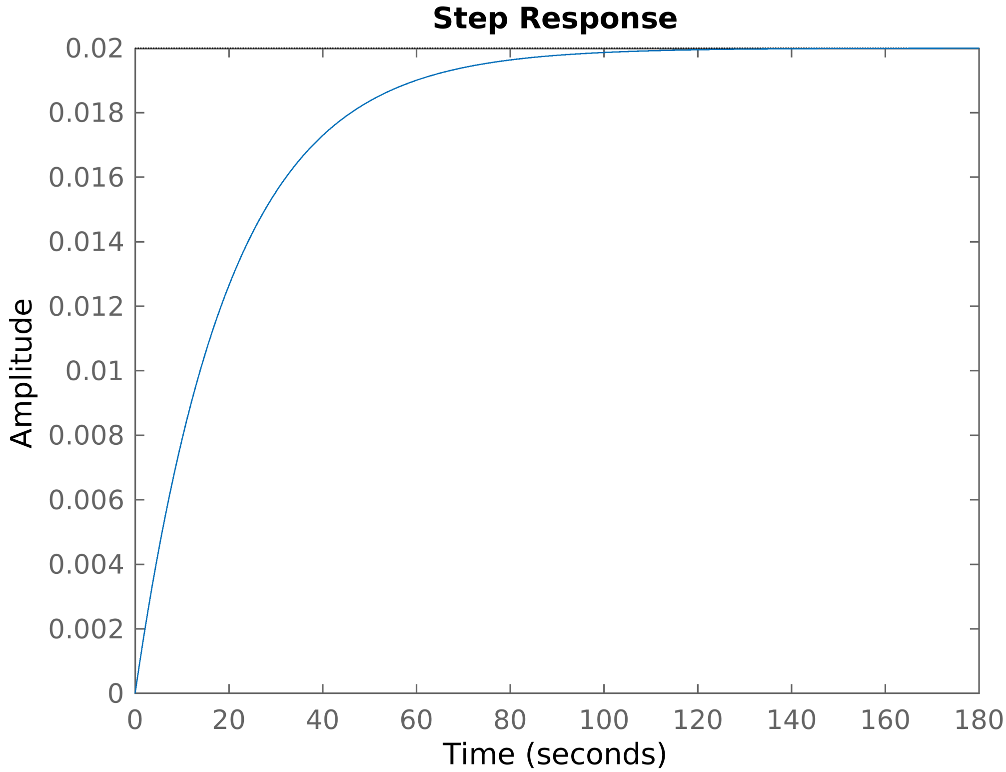
```
G =

       1
  -----------
  1000 s + 50

Continuous-time transfer function.
```

```
step(G)
```

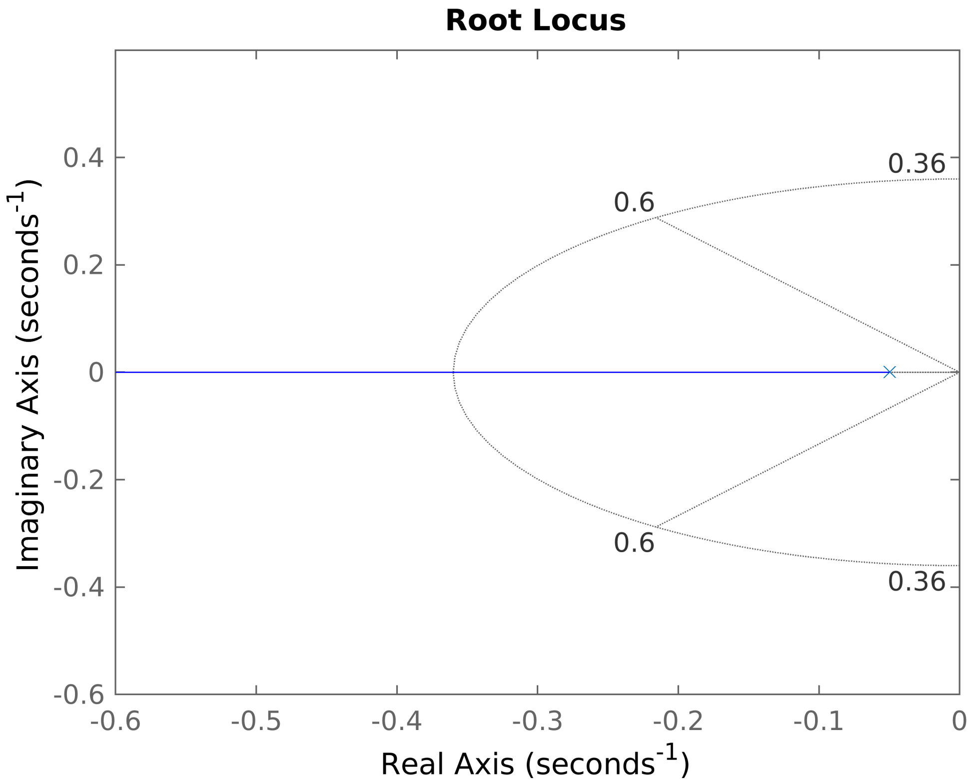
```
Warning: MATLAB has disabled some advanced graphics rendering features by switching to software
 OpenGL. For more information, click here.
```




```
transients=stepinfo(G)
```

```
transients = struct with fields:
        RiseTime: 43.9401
    SettlingTime: 78.2415
     SettlingMin: 0.0181
     SettlingMax: 0.0200
       Overshoot: 0
      Undershoot: 0
            Peak: 0.0200
        PeakTime: 210.9168
```

```
figure;
rlocus(G)
sgrid(0.6, 0.36)
axis([-0.6 0 -0.6 0.6] )
```



2)

```
figure;
rlocus(G);
sgrid(0.6, 0.36);
axis([-0.6 0 -0.6 0.6] );
[Kp,~]=rlocfind(G)
```

```
Select a point in the graphics window
selected_point = -0.3996 + 0.0490i
Kp = 353.0051
```

```
close;

C = pid(Kp)
```

```
C =

  Kp = 353

P-only controller.
```

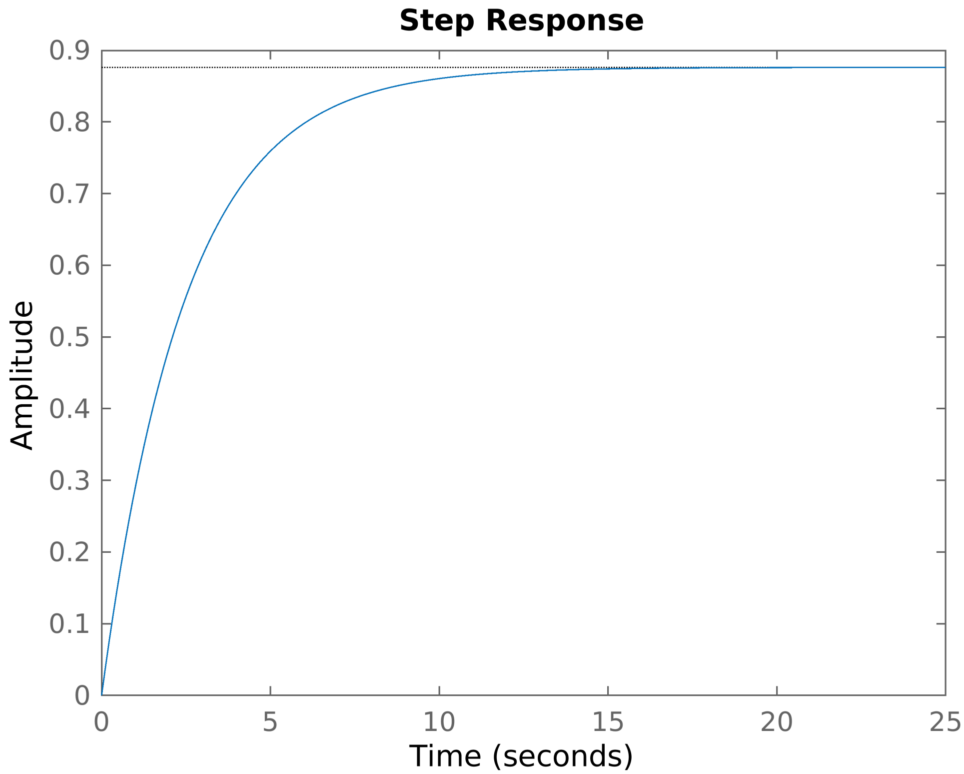
```
TF = feedback(G*C,1)
```

```
TF =

      353
  ------------
  1000 s + 403

Continuous-time transfer function.
```

```
figure;
step(TF)
```




```
transients=stepinfo(TF)
```

```
transients = struct with fields:
        RiseTime: 5.4516
    SettlingTime: 9.7073
     SettlingMin: 0.7923
     SettlingMax: 0.8759
       Overshoot: 0
      Undershoot: 0
            Peak: 0.8759
        PeakTime: 26.1680
```

3)

```
figure;
rlocus(TF);
sgrid(0.6, 0.36);
axis([-0.6 0 -0.6 0.6] );
[Kp,~]=rlocfind(TF)
```

```
Select a point in the graphics window
selected_point = -0.3971 + 0.0565i
Kp = 0.1610
```

```
close;
```

```
z0=0.3;
p0=0.03;
lag = (s+z0)/(s+p0)
```

```
lag =

  s + 0.3
  --------
  s + 0.03

Continuous-time transfer function.
```

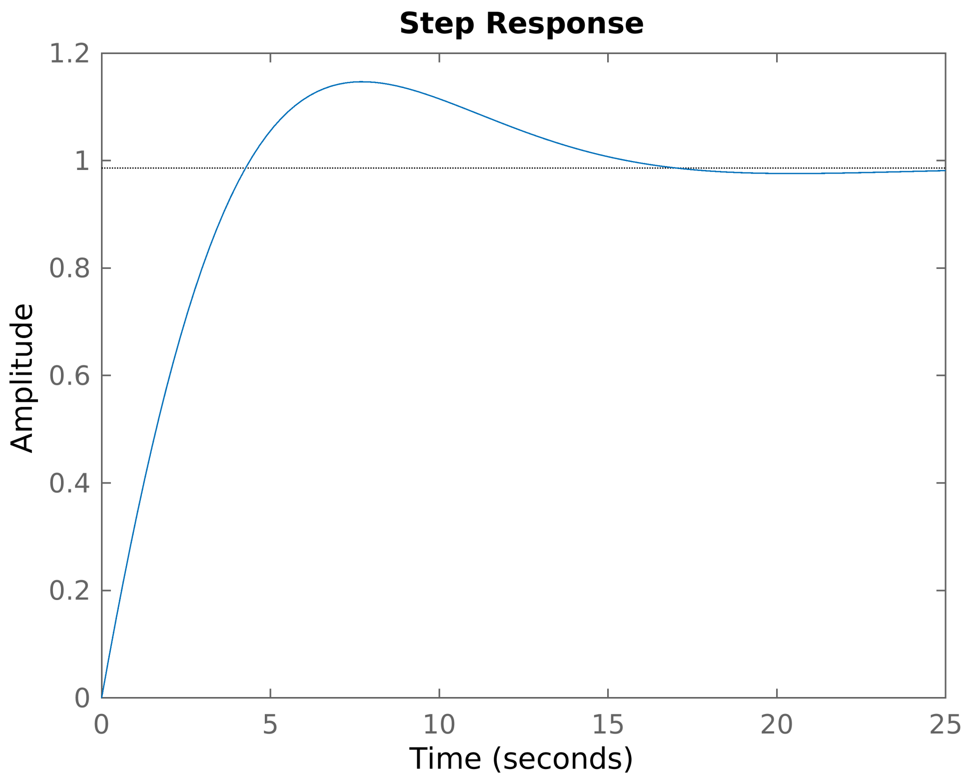
```
TF = feedback(G*C*lag,1)
```

```
TF =

       353 s + 105.9
  ------------------------
  1000 s^2 + 433 s + 107.4

Continuous-time transfer function.
```

```
figure;
step(TF)
```




```
transientsstepinfo(TF)
```

```
transients = struct with fields:
        RiseTime: 3.2225
    SettlingTime: 15.1063
     SettlingMin: 0.9036
```

```
SettlingMax: 1.1467
  Overshoot: 16.2960
 Undershoot: 0
       Peak: 1.1467
   PeakTime: 7.6575
```

The transient info shows that the peak time is smaller, and actually reaches its peak with a brief over shoot.

Conclusion

In this lab we applied what we learned in class and previous labs to take our Cruise Control Car example to another level. For example we found a gain to place the closed-loop poles in the desired region by employing the rlocfind command. After doing so we reduced the steady-state error even further by created a lag controller. Then after designing the controller we were able to look at the transient info .