Prediction and Current Estimator

1)

i) **Ackerman Formula:**

By hand,

We know,

K=[0 1]' * inv([gamma phi*gamma]) * function(phi)

phi = [1 0.1;
0 1]

gamma = [0.005;
0.1]

H = [1 0]

J= [0]

function(Z)=Z^2 -1.5Z +0.75

We calculate,

inv([gamma phi*gamma]) =[-100 15;
100 -5]

function(phi) = [0.25 0.05;
0 0.25]

So, Gain is,

Gain=K=[0 1]' * inv([gamma phi*gamma]) * func(phi) = **[25 3.75]**

Using matlab,

Gain=K= [25.0249 3.7488]

```
K2 =

   25.0249    3.7488
```

Both the K are close to each others.

2) **I) Predictor Estimator (Lp)**

Using matlab, Lp was found to be,

```
Lp_T =

    1.3500    6.0003
```

Lp Transpose

```
ans =

  0.3250 + 0.3800i
  0.3250 - 0.3800i
```

Eigen Values

The eigen values was also checked and it was found to be **desired**.

Similarly, for **Current Estimator (Cp)**

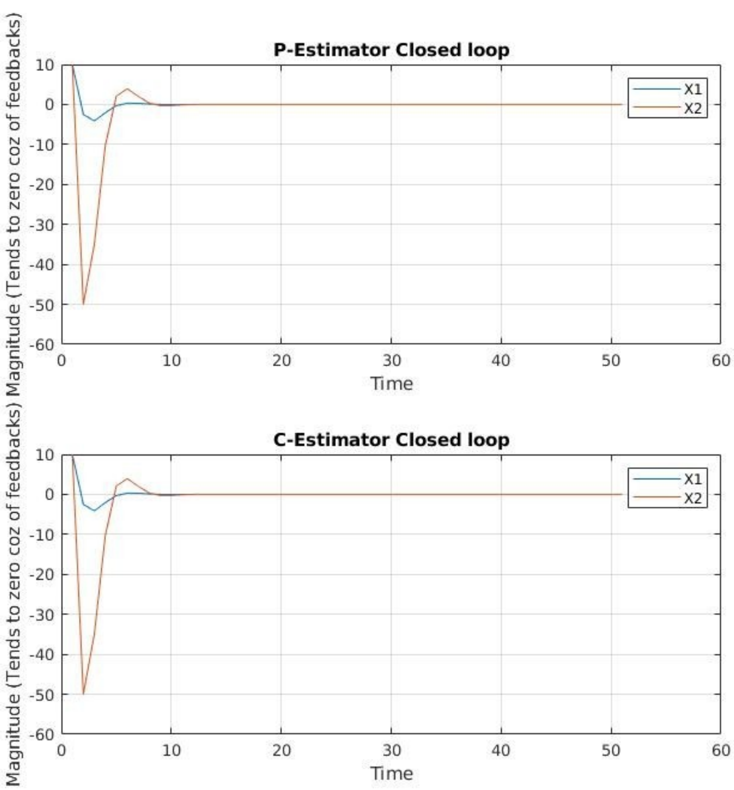
```
Lc_T =

    0.7500    6.0003
```

Lc Transpose

```
ans =

  0.3250 + 0.3800i
  0.3250 - 0.3800i
```

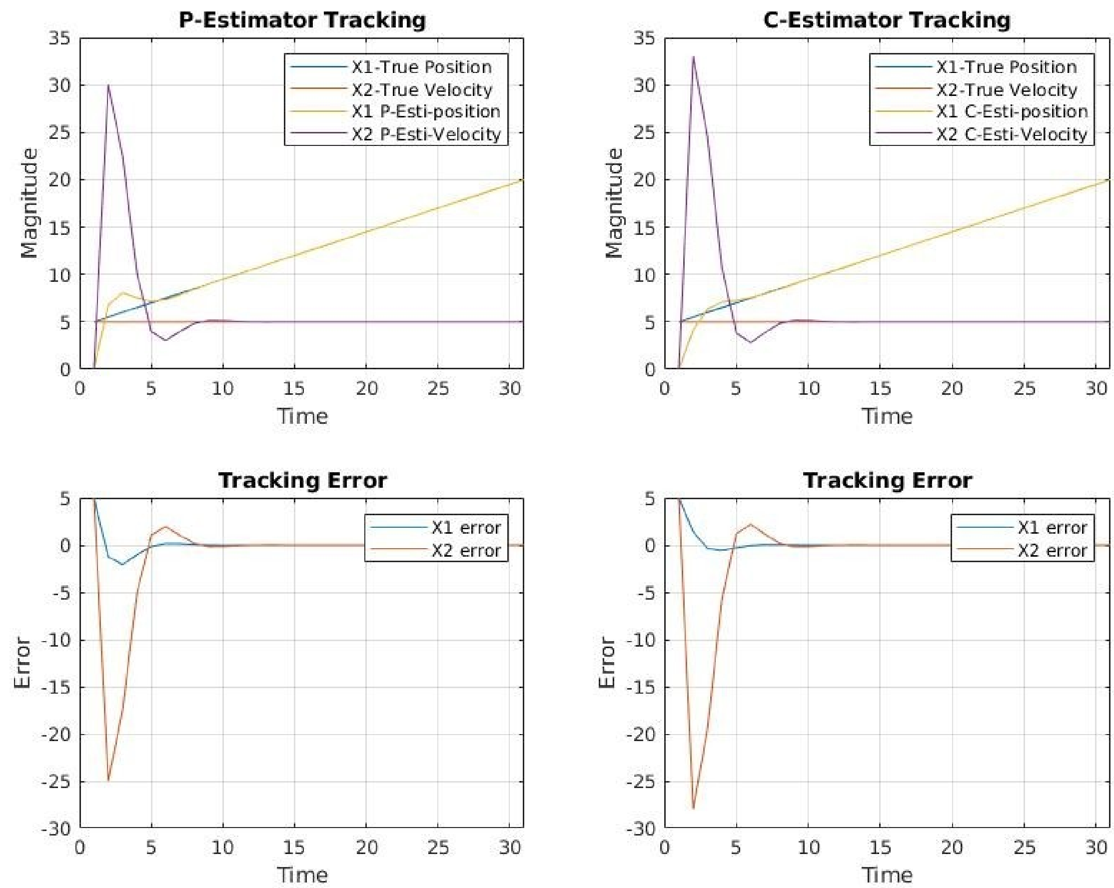
Eigen Values

Since, **both have desired poles**, it is logical that, **we are getting same eigen values for both Lp and Lc.**

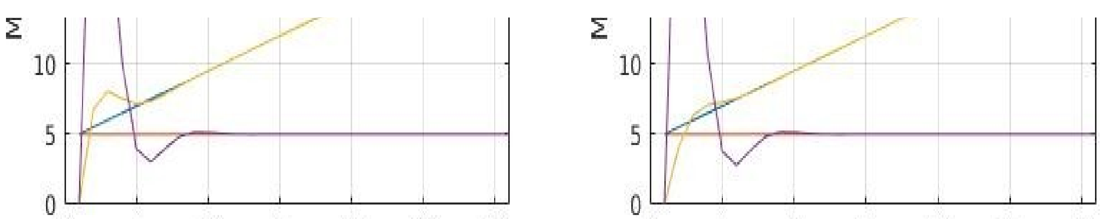


It can be from the graph that the **closed loop for Both prediction and current estimators tend to zero.**

Similarly. For **Current Estimator.**



In the above fig, I **compared the tracking of estimators**, by setting the **same initial conditions** to both. We can see that, **both** the estimator **tracks the states properly after some time.** But if we notice well enough, we can see that **current estimator is better than prediction estimator.** (Look at the state **X1 (yellow line) (cropped image is shown below),** we can infer that **Current estimator tracks it faster than prediction estimator.** In view of error, we can see C estimator shows more error, which is understandable as it track the states faster than prediction estimator.



Prediction Estimator vs Current Estimator

Cropped image

3) **Regulator**:

The root are found to be,

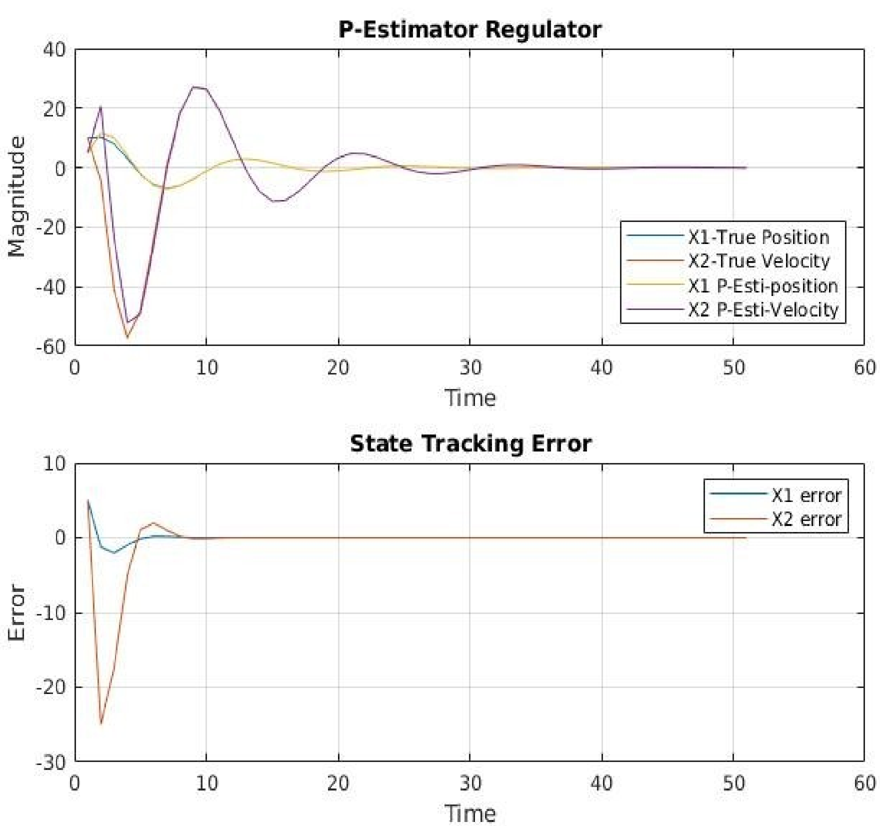
```
Peig =

   0.3250 + 0.3800i
   0.3250 - 0.3800i
   0.7500 + 0.4330i
   0.7500 - 0.4330i


Ceig =

   0.3250 + 0.3800i
   0.3250 - 0.3800i
   0.7500 + 0.4330i
   0.7500 - 0.4330i
```

We can infer that we got **all the four desired root (Two from full state feedback, and other two from state estimator)**

Thus, our system matrix can be consider to be correct and we can proceed to next steps.

Where
Peig is the poles of **Regulator with Prediction Estimator**
Ceig is the poles of **Regulator with Current Estimator**

The regulatory performance of each regulator are shown below



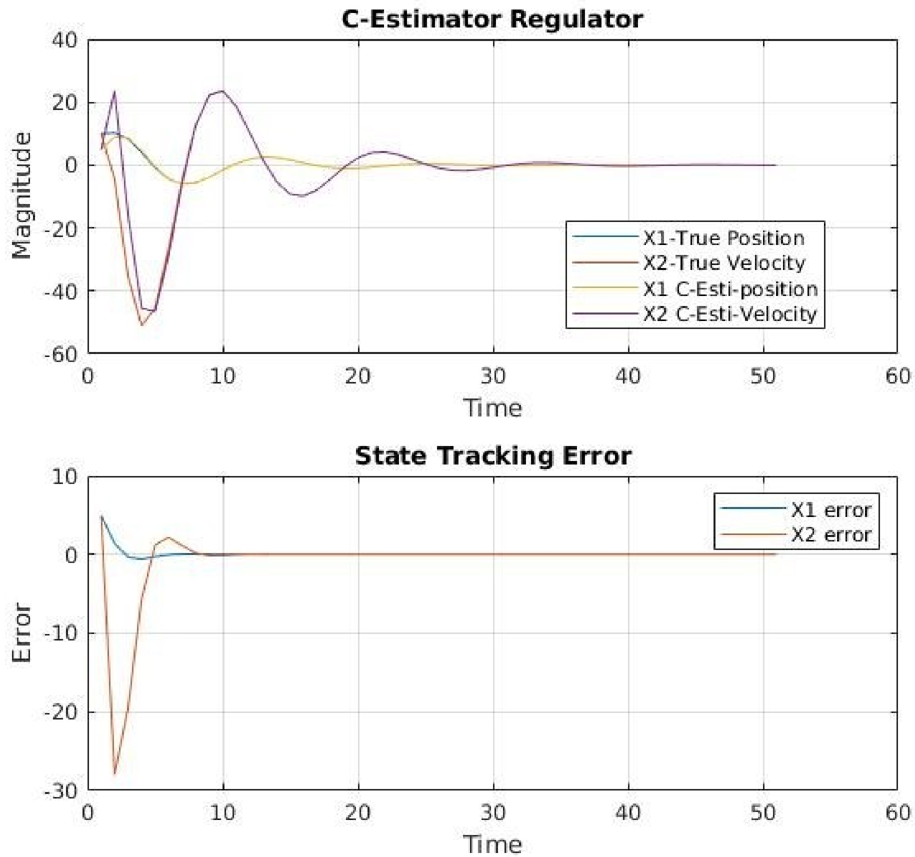
Regulator with Prediction Estimator
The initial condition of **state** and **estimator** were set with **different** values. So that, we can **check the working of estimator and feedback** at the same time

Initial condition are
X1 True = 10
X2 True = 10
X1 Estimate = 5
X2 Estimate = 5

Thus, it can **inferred from graph that both estimation and regulation had happened.**

We can also see the tracking error (which tends to zero) and the states (which also tends to zero)

Regulator with Current Estimator



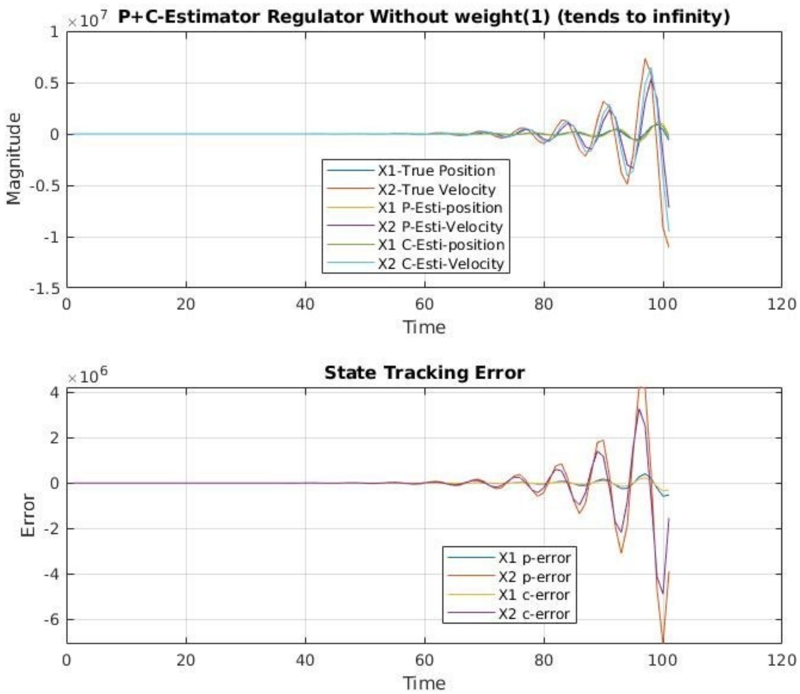
Similarly, using Current estimator.

Initial condition are
X1 True = 10
X2 True = 10
X1 Estimate = 5
X2 Estimate = 5

Thus, it can **inferred from graph that both estimation and regulation had happened.**

We can also see the tracking error (which tends to zero) and the states (which also tends to zero)

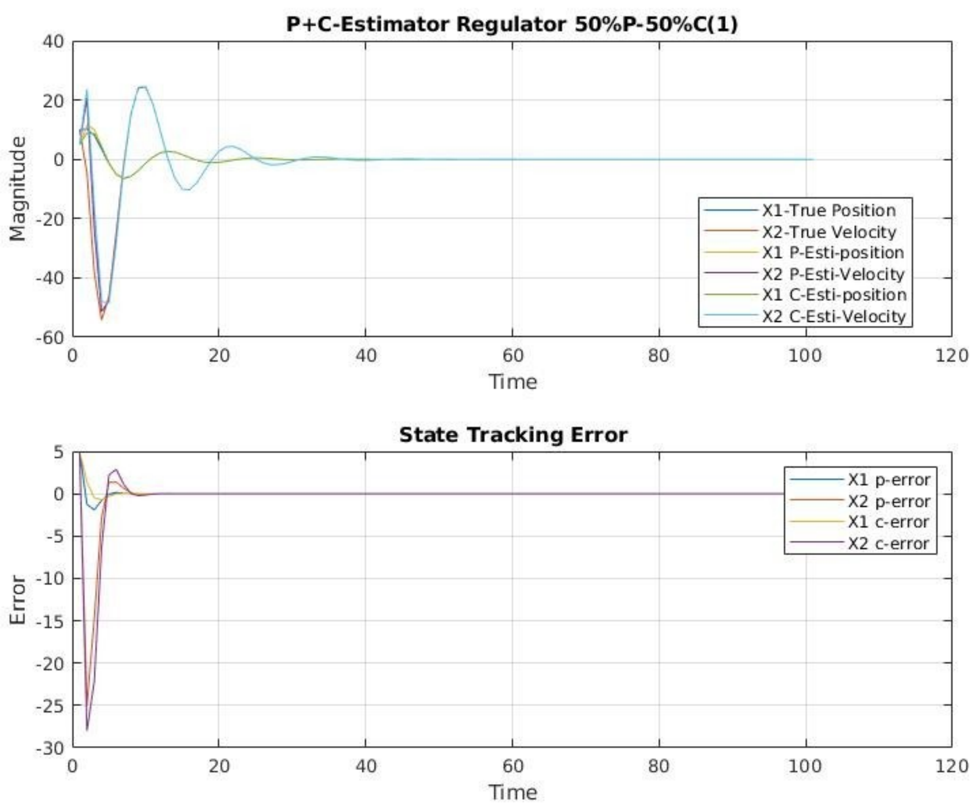
Regulator with Both Prediction and Current Estimator



We can see that, if we **use two estimate simultaneously** and use them to predict our states. we are **simply adding up two estimates,** which **eventually** makes the system to reach **infinity (as we add two times the actual estimates for each estimates)**

We can **overcome** this issue by using weights. Like **50% from prediction estimate and remaining 50% from Current estimate**. By this, we **can achieve the same results** as we achieved by using single estimator.

The results are as follows,



Thus, **by using weight, we can overcome the issue.** We **can also use any such ratio** to achieve similar result (30%-70% or 40%-60%). But most of the time, the **portion from current estimator is chosen high because it is more faster and accurate than prediction estimator.**