



Experiment1

PID Gain 값

- $K_i=0.5$
- $K_p=15$
- $K_d=0.5$

가속 시간

- $T_{a_1} = 0.05s$

```
import pandas as pdimport matplotlib.pyplot as plt
```

```
data1 = pd.read_csv("Experiment1.csv")
```

data1

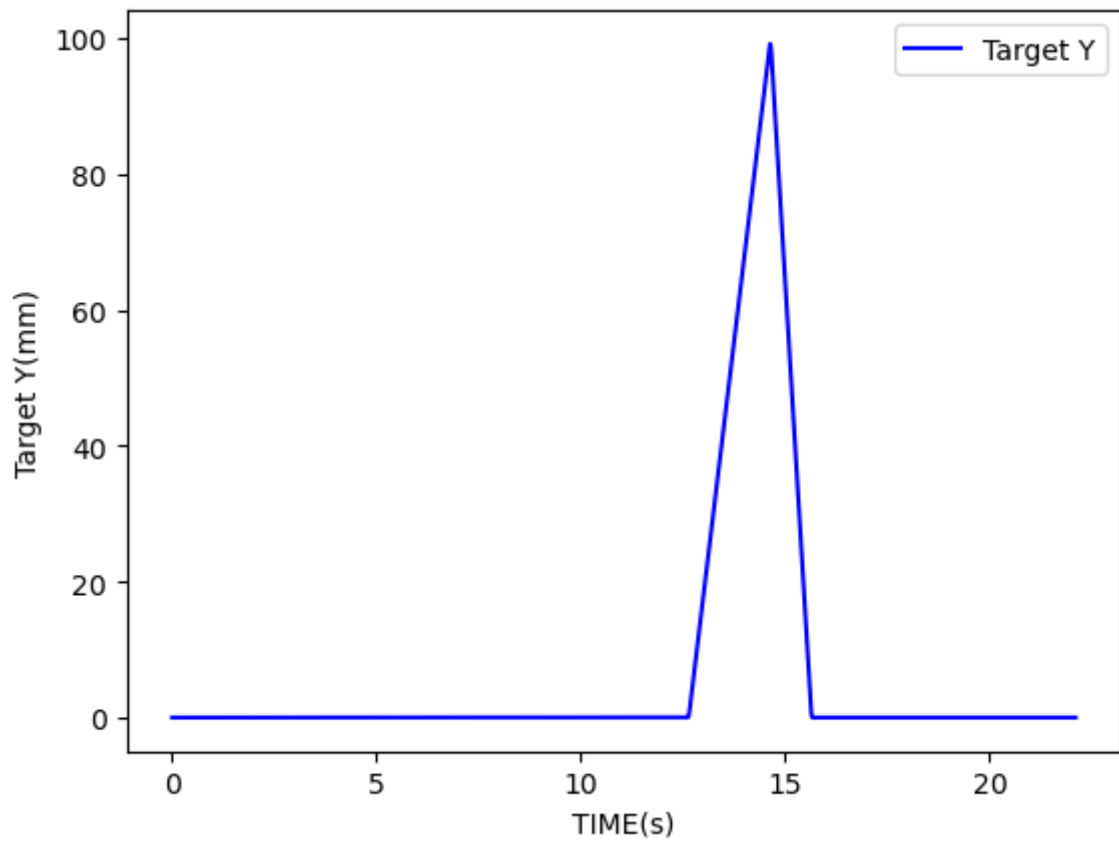
	TIME	Target Y	Actual Y	Following Error
0	0.000000	0.000000e+00	0.0000	0.0000
1	0.000100	0.000000e+00	0.0000	0.0000
2	0.000200	0.000000e+00	0.0000	0.0000
3	0.000300	0.000000e+00	0.0000	0.0000
4	0.000400	0.000000e+00	0.0000	0.0000
...
221056	22.106051	-3.030000e-11	-0.0491	0.0491
221057	22.106152	-3.030000e-11	-0.0491	0.0491
221058	22.106251	-3.030000e-11	-0.0491	0.0491

221059	22.106351	-3.030000e-11	-0.0491	0.0491
221060	22.106451	-3.030000e-11	-0.0491	0.0491

221061 rows × 4 columns

```
x = data1["TIME"]
y1 = data1["Target Y"]

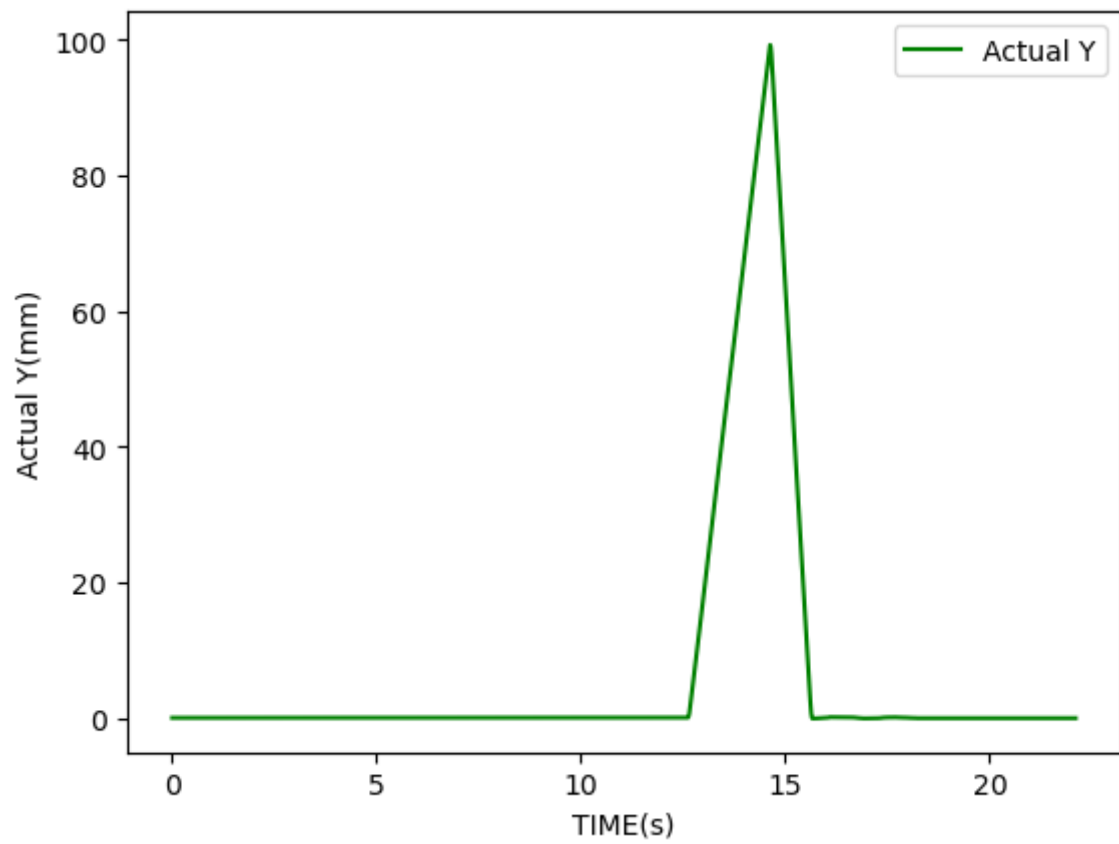
plt.plot(x, y1, 'b', label = "Target Y")
plt.xlabel("TIME(s)")
plt.ylabel("Target Y(mm)")
plt.legend(loc="best")
plt.show()
```



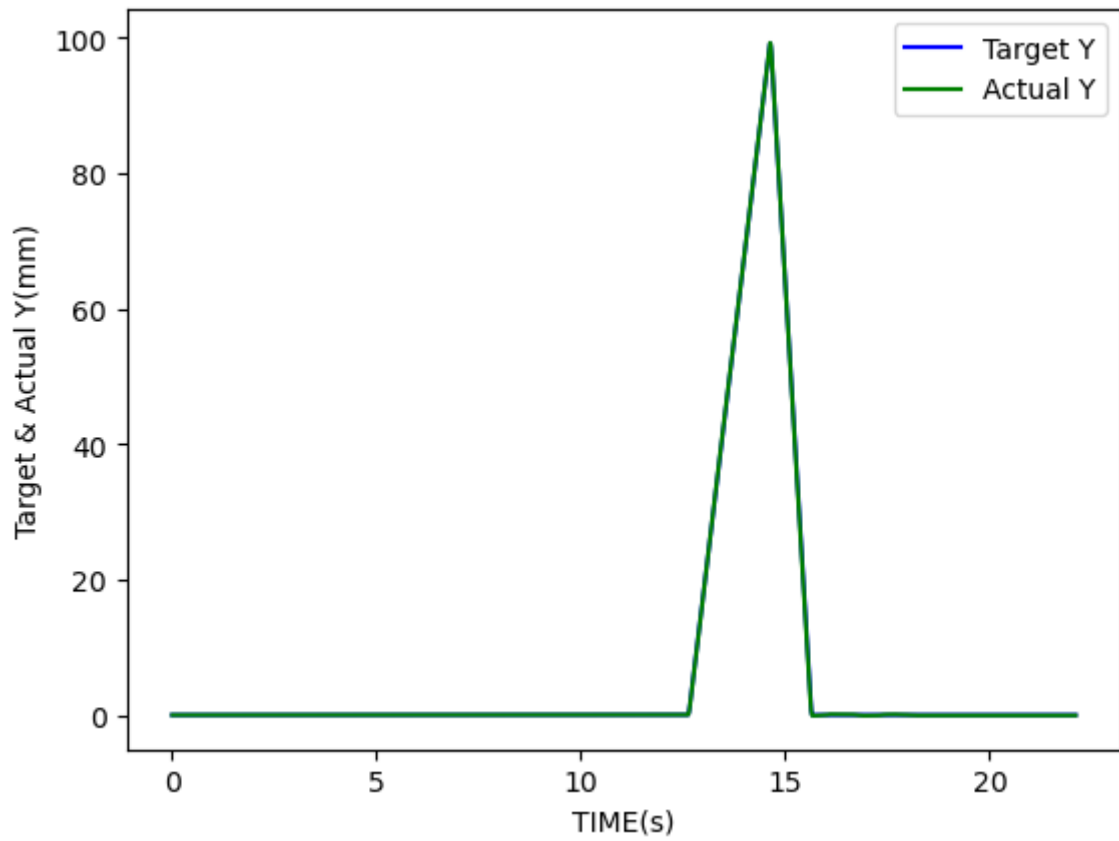
```
y2 = data1["Actual Y"]
plt.plot(x, y2, 'g', label = "Actual Y")

plt.xlabel("TIME(s)")
plt.ylabel("Actual Y(mm)")
```

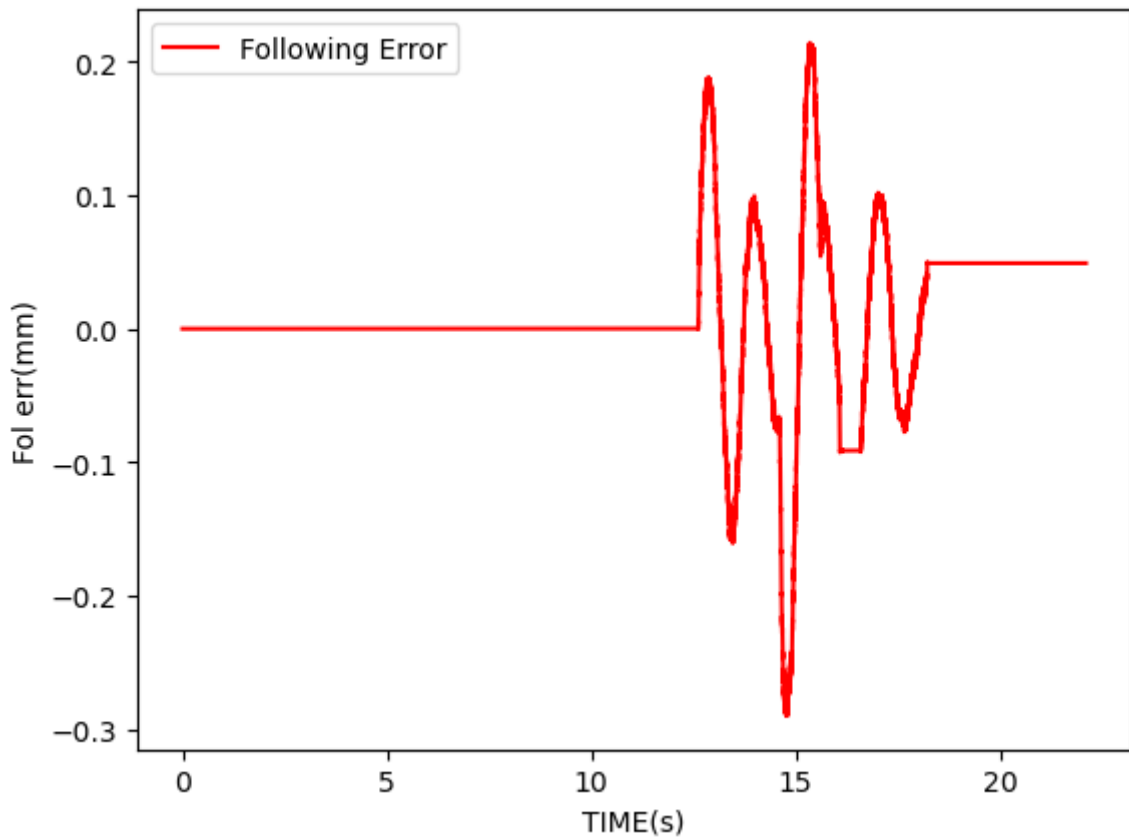
```
plt.legend(loc="best")  
plt.show()
```



```
plt.plot(x, y1, 'b', label = "Target Y")  
plt.plot(x, y2, 'g', label = "Actual Y")  
plt.xlabel("TIME(s)")  
plt.ylabel("Target & Actual Y(mm)")  
plt.legend(loc="best")  
plt.show()png
```



```
y3 = data1["Following Error"]  
plt.plot(x, y3, 'r', label = "Following Error")  
plt.xlabel("TIME(s)")  
plt.ylabel("Fol err(mm)")  
plt.legend(loc="best")  
plt.show()
```



분석

```
print("목표 변위의 최대값: ", max(y1), "mm")
print("실제 변위의 최대값: ", max(y2), "mm")
```

목표 변위의 최대값: 99.16667 mm

실제 변위의 최대값: 99.2808 mm

목표 변위가 0이고 시간이 15초 보다 작을 때

```
data1[(data1["Target Y"]==0) & (data1["TIME"]<15)]
```

	TIME	Target Y	Actual Y	Following Error
0	0.000000	0.0	0.0	0.0

1	0.000100	0.0	0.0	0.0
2	0.000200	0.0	0.0	0.0
3	0.000300	0.0	0.0	0.0
4	0.000400	0.0	0.0	0.0
...
126140	12.614226	0.0	0.0	0.0
126141	12.614326	0.0	0.0	0.0
126142	12.614426	0.0	0.0	0.0
126143	12.614526	0.0	0.0	0.0
126144	12.614626	0.0	0.0	0.0

126145 rows × 4 columns

=> 12.61426초 이후에 이송 시작

목표 변위가 대략 0이고 시간이 15초 보다 클 때

```
data1[(data1["Target Y"]>=0) & (data1["TIME"]>15)]
```

	TIME	Target Y	Actual Y	Following Error
149998	15.000085	63.95500	64.0894	-0.13440
149999	15.000185	63.94500	64.0795	-0.13450
150000	15.000286	63.93500	64.0695	-0.13450
150001	15.000386	63.92500	64.0594	-0.13440
150002	15.000486	63.91500	64.0492	-0.13420
...
156638	15.664099	0.00030	-0.0910	0.09130
156639	15.664199	0.00020	-0.0907	0.09090
156640	15.664299	0.00012	-0.0904	0.09052
156641	15.664399	0.00006	-0.0902	0.09026
156642	15.664499	0.00002	-0.0900	0.09002

6645 rows × 4 columns

=> 약 15.6645s 에 목표변위가 0이라고 할 수 있다.

15.6645초 이후에, 그러니까 모터가 원위치에 도착한 후에도 모터가 진동한다.

그래서 추종오차가 지속적으로 변화하다가 수렴한다.

수렴한 추종 오차 값(Steady state error)는 대략 0.05mm이다.