Control system theory

Introduction to PID controllers

Robotics Club IITK

Need for control system

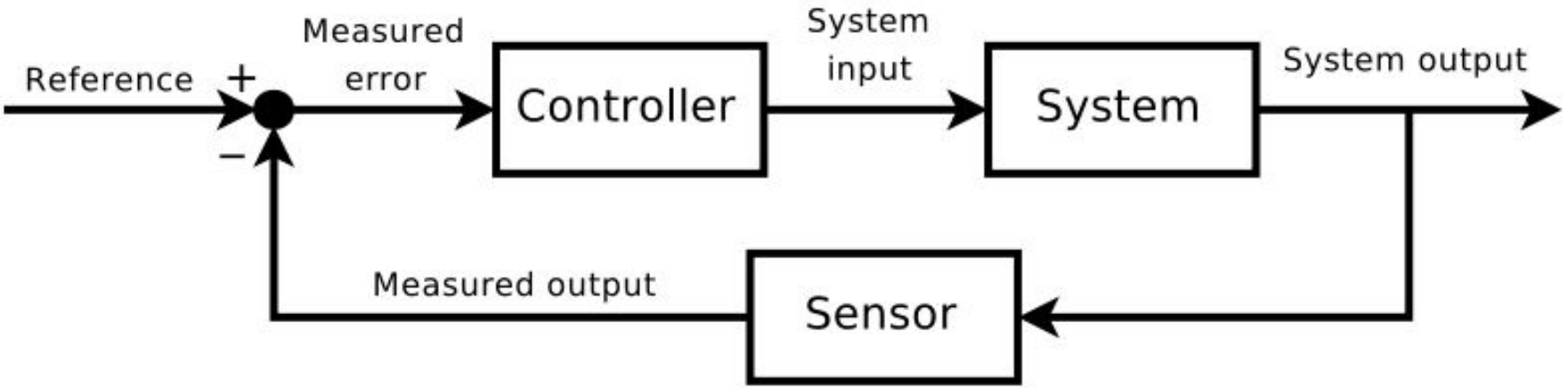
https://www.youtube.com/watch?v=TOl0ZPexRhI#t=33s

https://www.youtube.com/watch?v=Z0v-G0oo_FQ&index=4&list=PL2uH4qIrAkdoFWEr8cQ96JnnH4ms-DCvB

https://www.youtube.com/watch?v=HfiHOpv6HtI&list=PL2uH4qIrAkdoFWEr8cQ96JnnH4ms-DCvB&index=7

Controllers

Controllers deal with controlling a dynamic system. The objective of the control is to get a desired output from the system, given some constraints, ensuring stability.

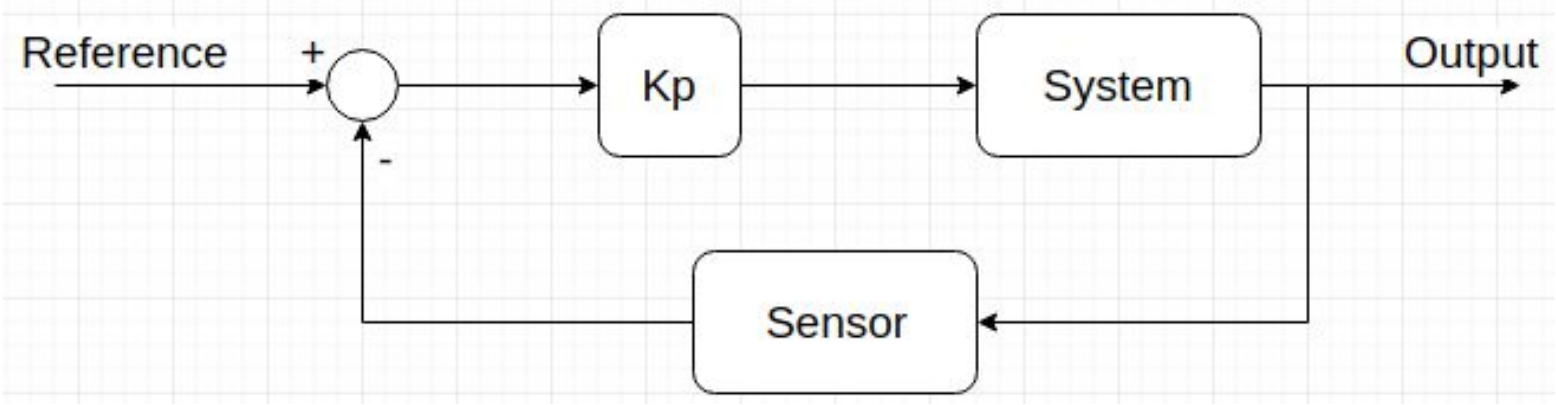


Different controllers

- P controller
- PI controller
- PD controller
- PID controller

Proportional(P) controller

In the Proportional only mode, the controller simply multiplies the error by the Proportional Gain (Kp) to get the controller output.



Advantages and drawbacks of P Control

Advantages

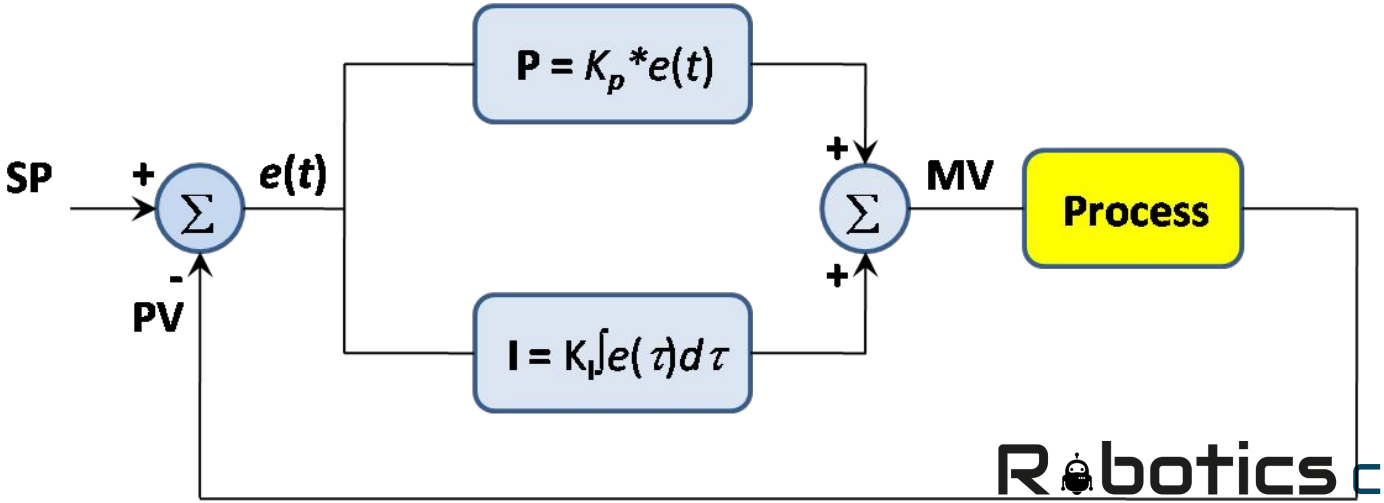
- Easy to implement
- Less computation resources required

Drawbacks

- Oscillations in the output might be present
- Steady state error is not zero
- Maximum overshoot is high

Proportional integral(PI) controller

In the PI only mode, the controller multiplies the error by the Proportional Gain (Kp) and adds integral of error to proportional term. Integral term makes sure that the steady state error is zero.



Advantages and drawbacks of PI controller

Advantages

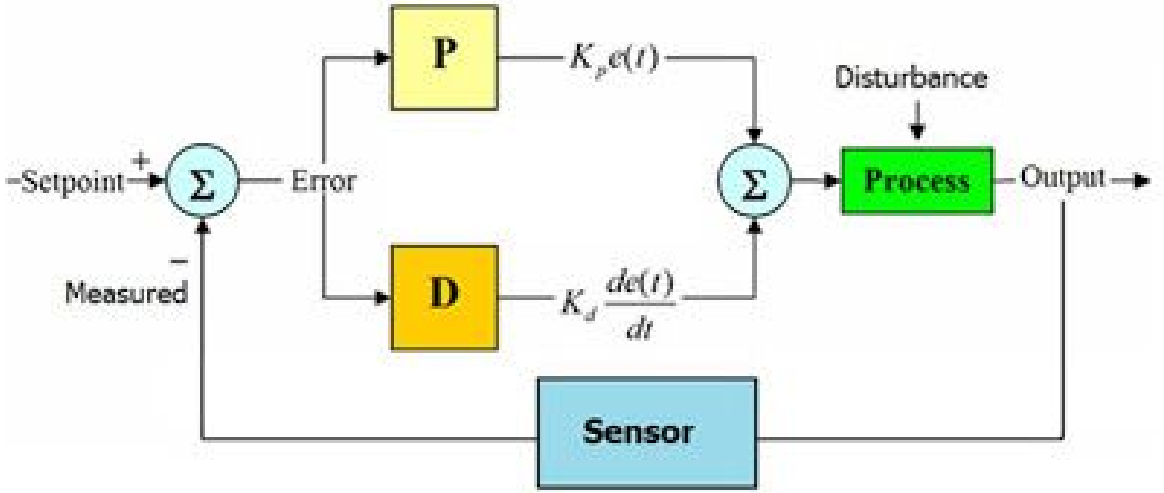
- Steady state error is zero

Drawbacks:

- Requires timer to keep track of time
- Tuning is difficult

PD controller

In the PI only mode, the controller multiplies the error by the Proportional Gain (Kp) and adds integral of error to proportional term.



Advantages and drawbacks

Advantages

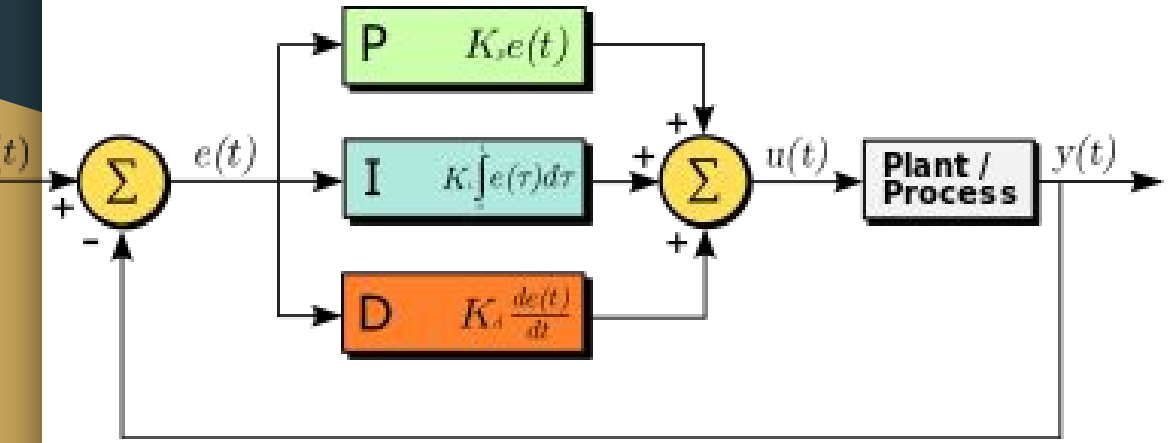
- Minimises the maximum overshoot
- Fast response

Drawbacks

- Steady state error is not guaranteed to be zero
- Amplifies noise signals

Proportional Integral Derivative(PID) controller

PID controller packs the benefits of all of the above controller.



Advantages and drawbacks

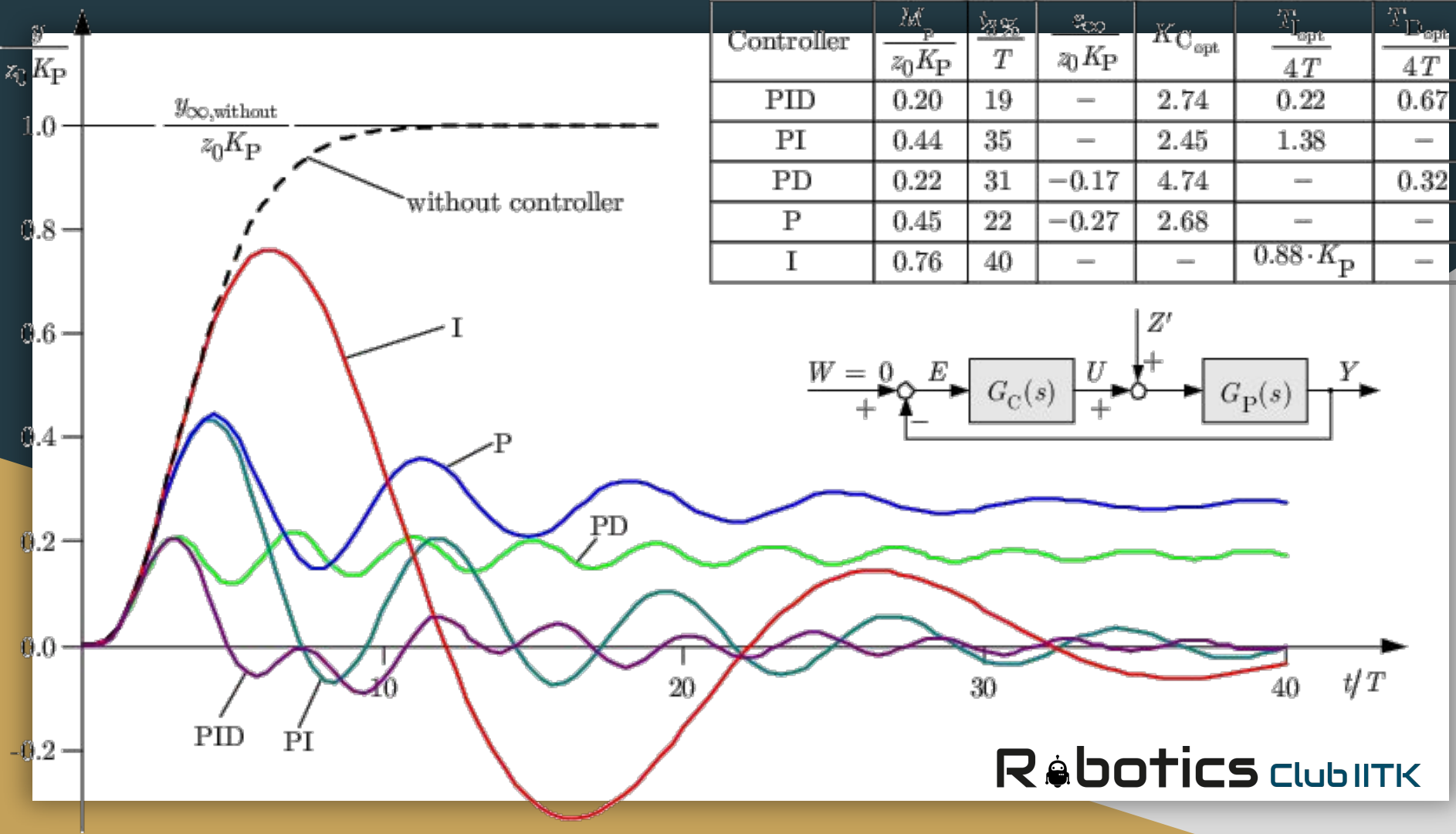
Advantages:

- No steady state error
- Low maximum overshoot

Drawbacks:

- Difficult to implement
- Gain tuning is a difficult task

Controller	$\frac{M_P}{z_0 K_P}$	$\frac{t_{95}}{T}$	$\frac{e_\infty}{z_0 K_P}$	$K_{C_{opt}}$	$\frac{T_{I_{opt}}}{4T}$	$\frac{T_{D_{opt}}}{4T}$
PID	0.20	19	–	2.74	0.22	0.67
PI	0.44	35	–	2.45	1.38	–
PD	0.22	31	−0.17	4.74	–	0.32
P	0.45	22	−0.27	2.68	–	–
I	0.76	40	–	–	$0.88 \cdot K_P$	–



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Demonstration

https://www.youtube.com/watch?v=fusr9eTceEo

https://sites.google.com/site/fpgaandco/pid

References

- Robotics club, IITK lecture on PID(2016-17)
- http://www.ee.ic.ac.uk/pcheung/teaching/DE2_EE/Lecture%2017%20-%20PID%20controller%20(notes%20x1).pdf
- https://www.youtube.com/watch?v=UR0hOmjaHp0
- https://www.youtube.com/watch?v=XfAt6hNV8XM

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