Adaptive PID Controller

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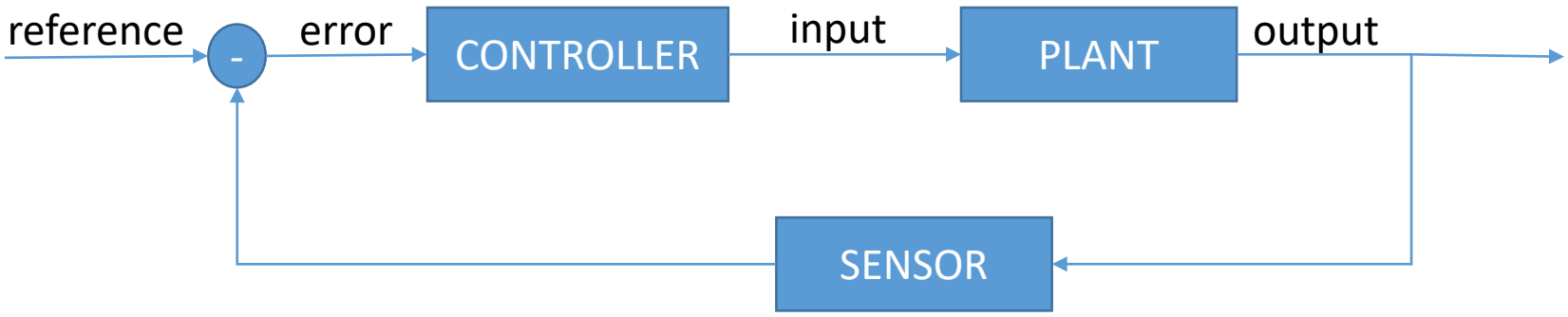
- Control system
- PID controller
- Adaptive PID

Control System

- Open-loop system

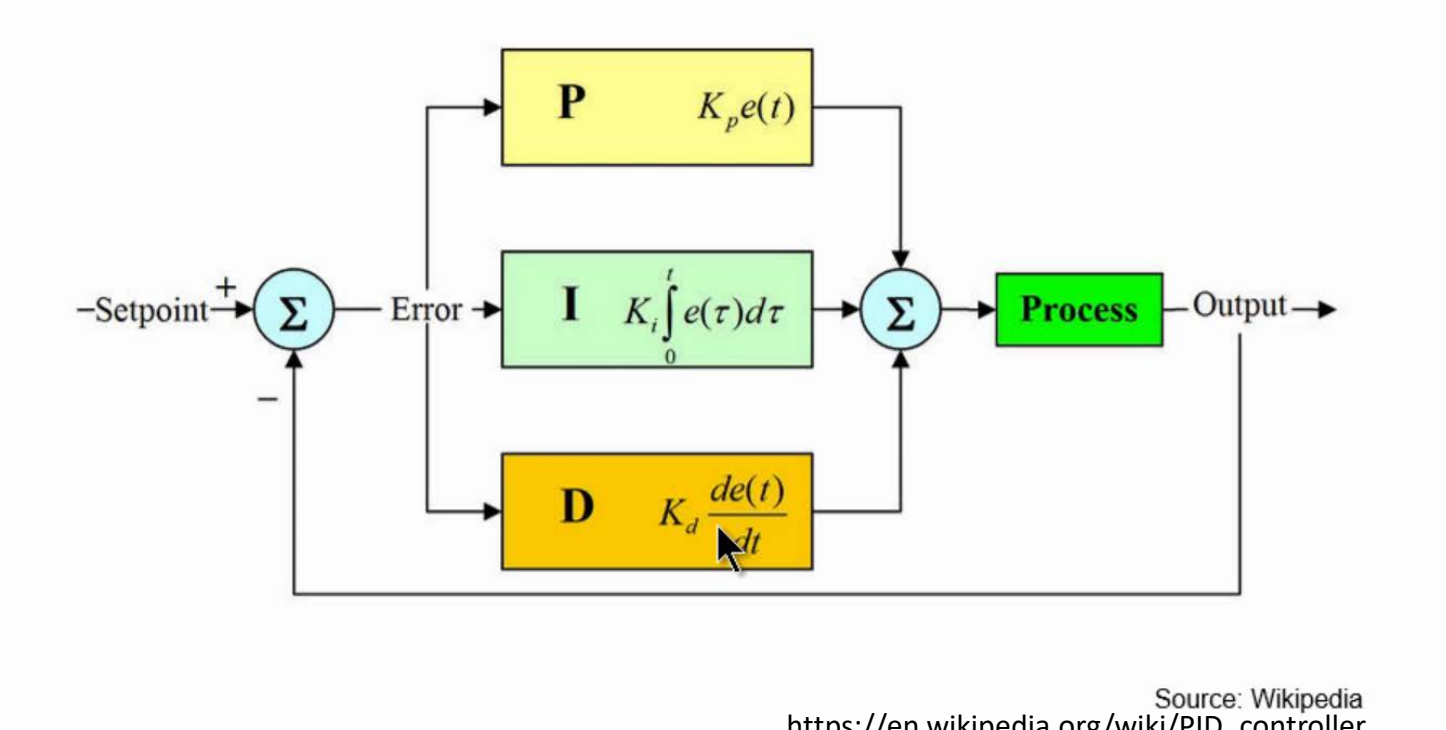
Control System

- Closed-loop system/feedback control system



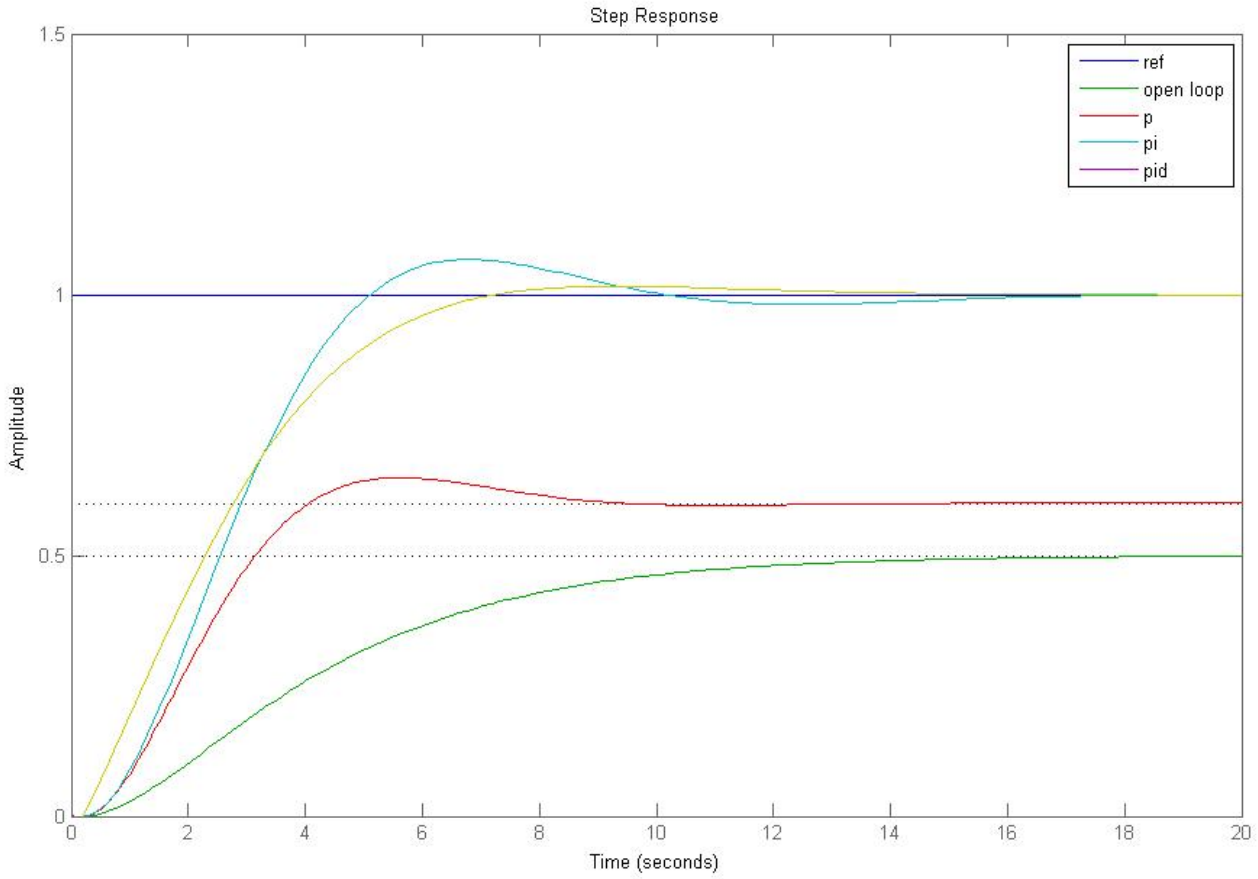
PID - Introduction

- Proportional-integral-derivative



Source: Wikipedia
https://en.wikipedia.org/wiki/PID_controller

PID – P,PI,PID

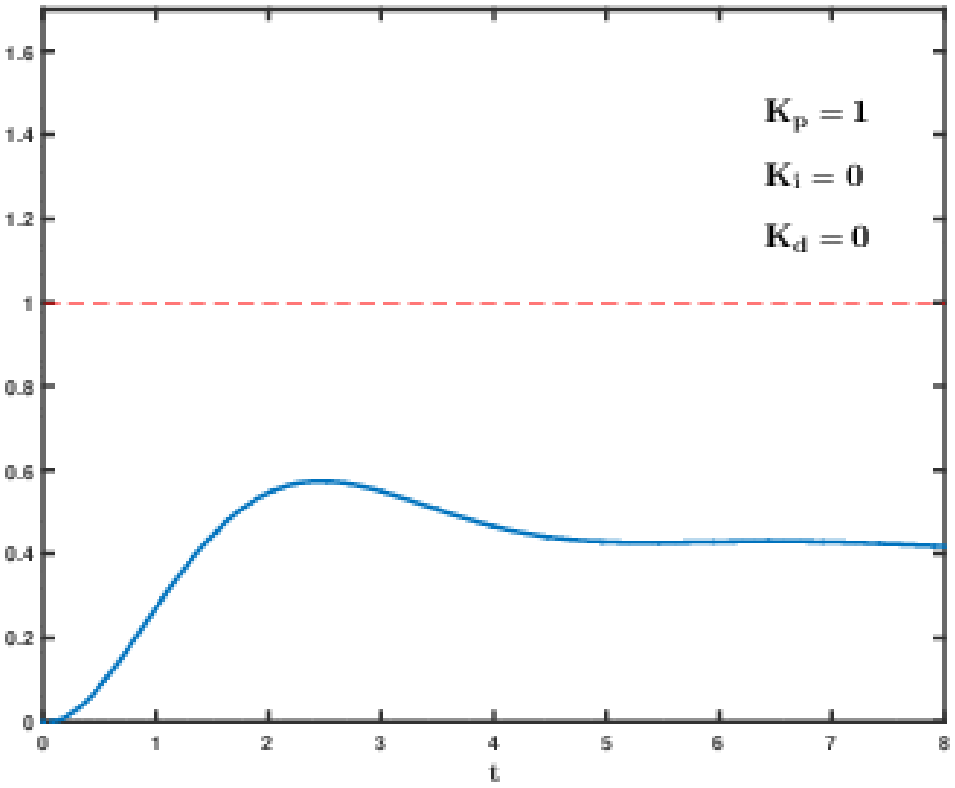

Step Response
ref
open loop
p
pi
pid
Amplitude
Time (seconds)
0
0.5
1
1.5
0
2
4
6
8
10
12
14
16
18
20

PID – Basic Tuning

Four major characteristics of the closed loop step response

	Rise Time	Overshoot	Settling time	Steady state error	oscillation
Kp	Decrease	Increase	NT	Decrease	increase
KI	Decrease	Increase	Increase	Eliminate	increase
KD	NT	Decrease	Decrease	NT	de/increase

PID – Basic Tuning



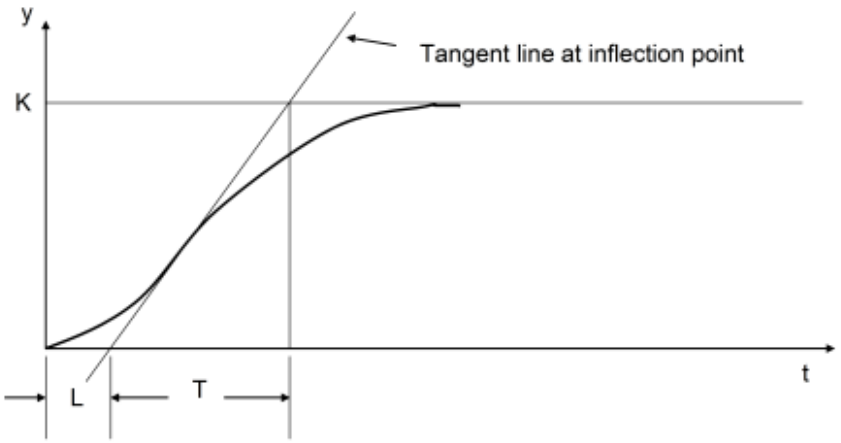
Source: wikipedia
https://en.wikipedia.org/wiki/PID_controller

PID - Tuning Methods

- ZN (Ziegler Nicholes) reaction curve method
- ZN step response method
- ZN Frequency response method
- ZN self-oscillation method
- Matlab/simulink

PID – Ziegler Nicholes reaction curve method

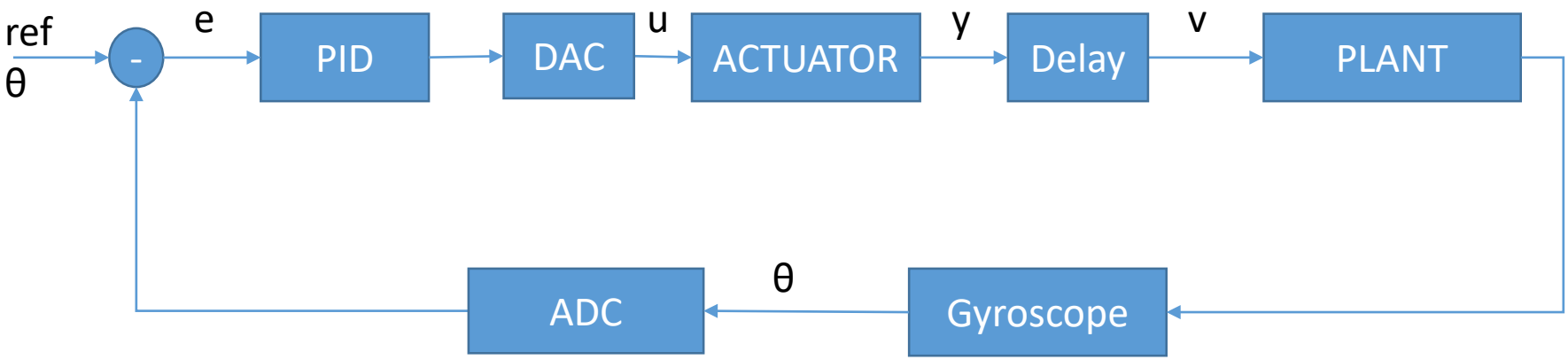
Controller	Kp	Ki	Kd
P	T/L		
PI	0.9(T/L)	0.27 T/L^2	
PID	1.2(T/L)	0.6 T/L^2	0.6T



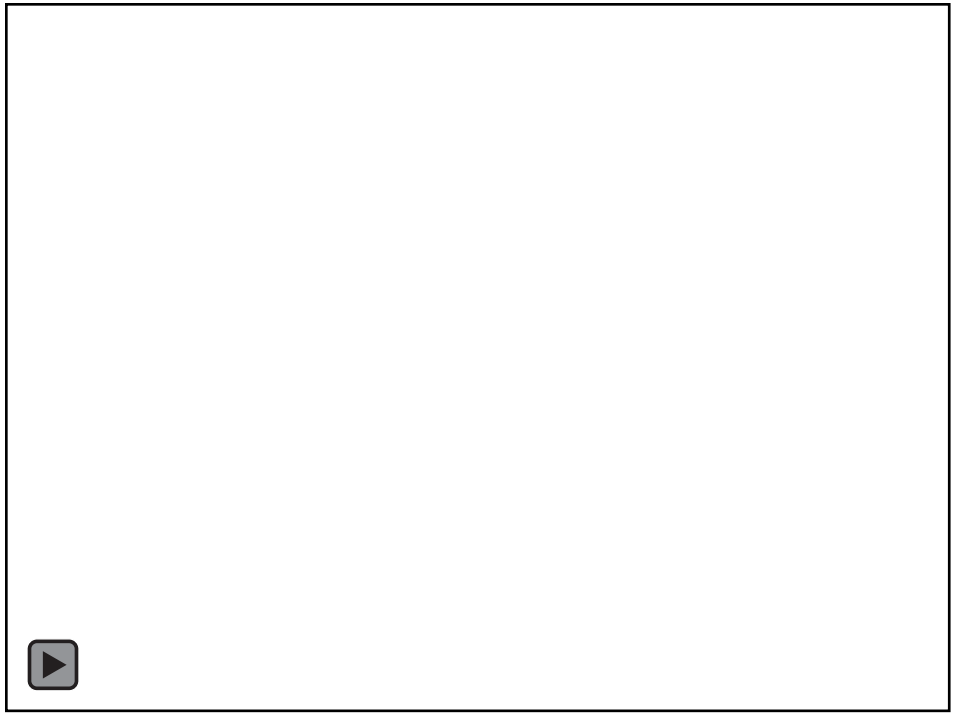
Source: Verver Training Ltd,
Three term controller tuning

PID – use case in real world

- Drone wings with PID



PID - Implementation



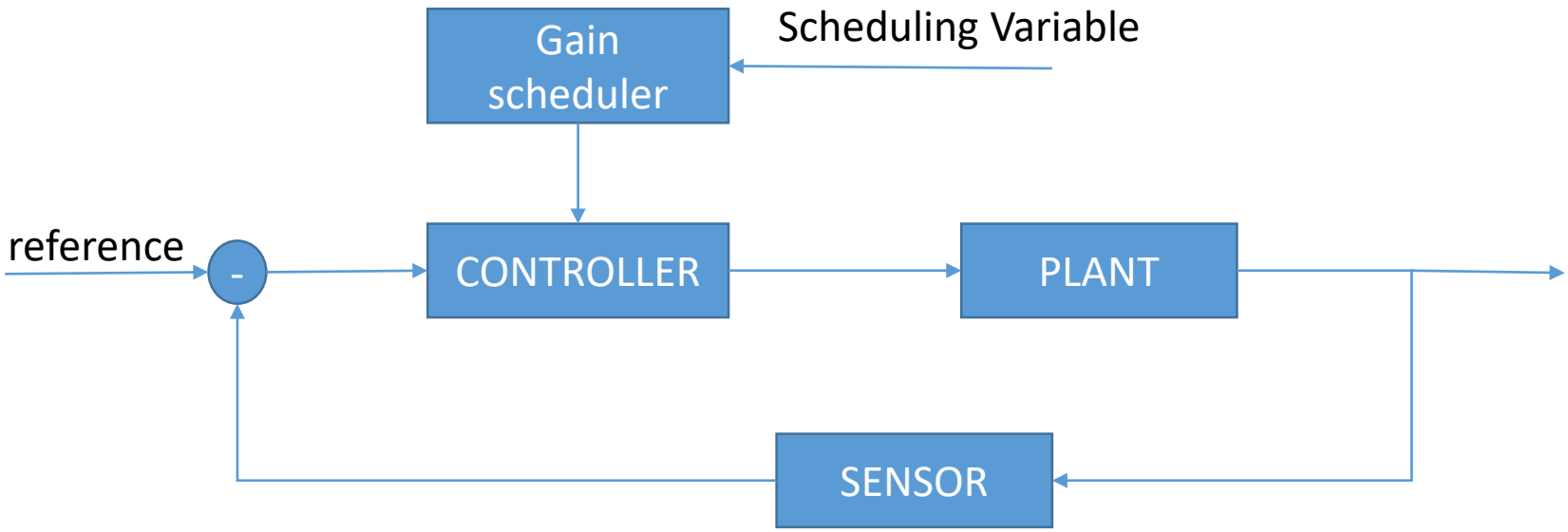
Source: https://www.youtube.com/watch?v=7qw7vnTGNsA&list=PLl0qyij_5jgF_75V49owrHSDCCAvwAVhw&index=2

Adaptive PID – Movtivation

- To fit into different circumstance
- To make the automation working
- Personal interest (IAS)

Adaptive PID – Self tuning

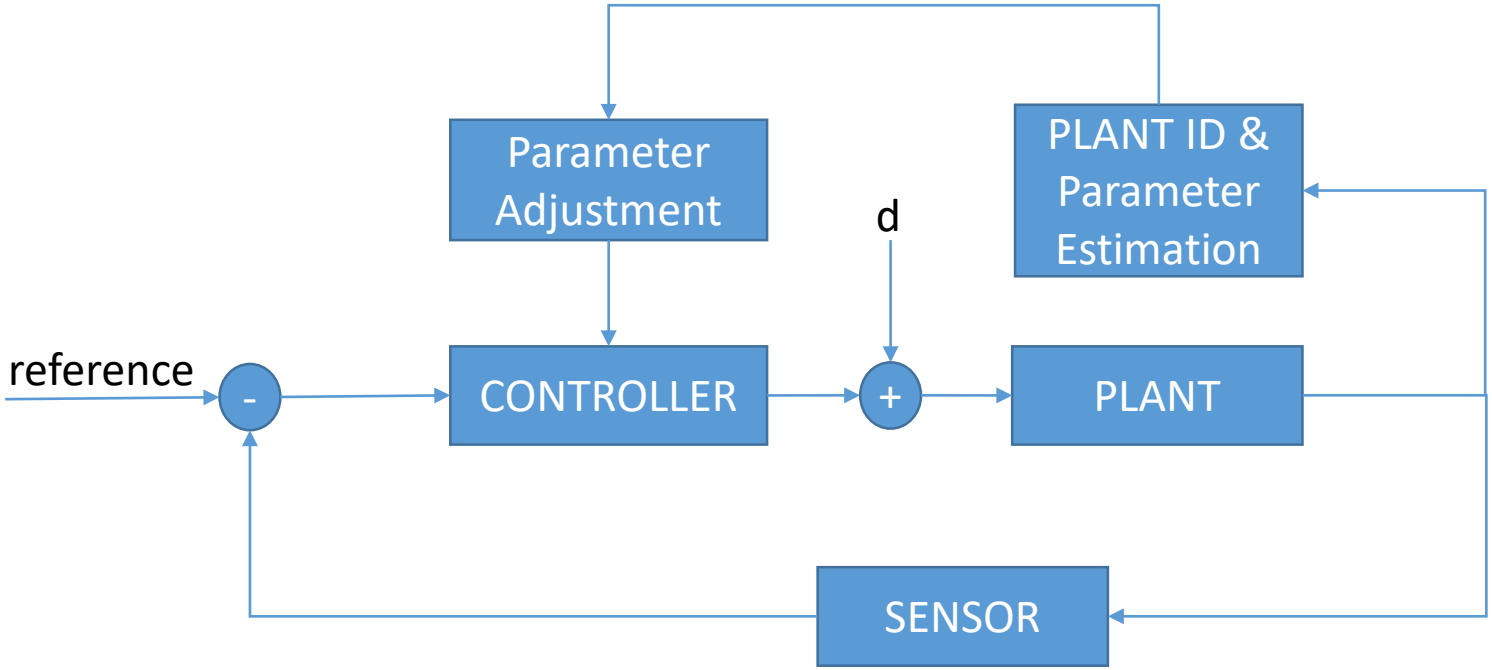
- Gain-scheduling controller structure



source: P.A. Tapp A, A Comparion of three self-tuning control algorithms

Adaptive PID – Self tuning

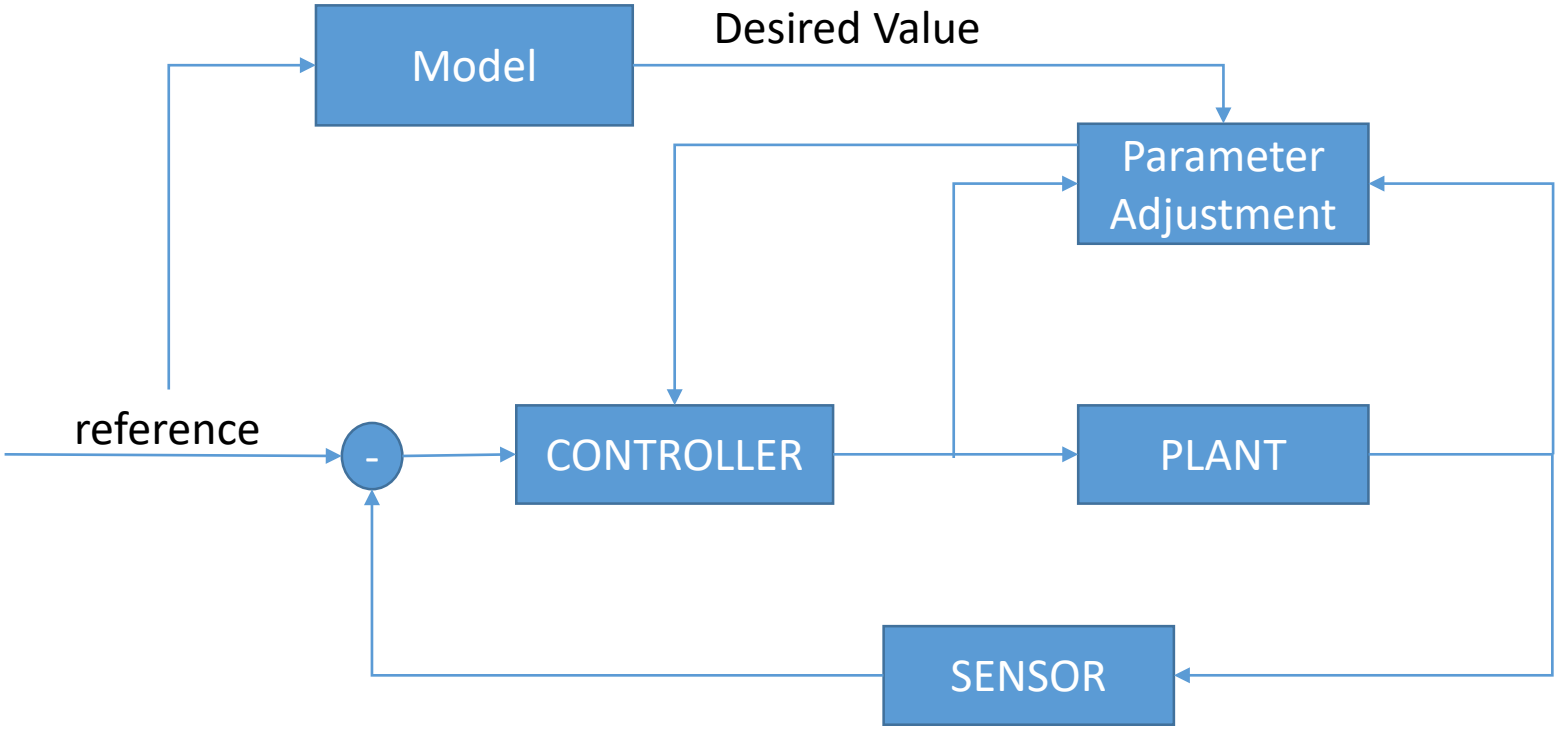
- Self-tuning controller structure



source: P.A. Tapp A, A Comparion of three self-tuning control algorithms

Adaptive PID – Self tuning

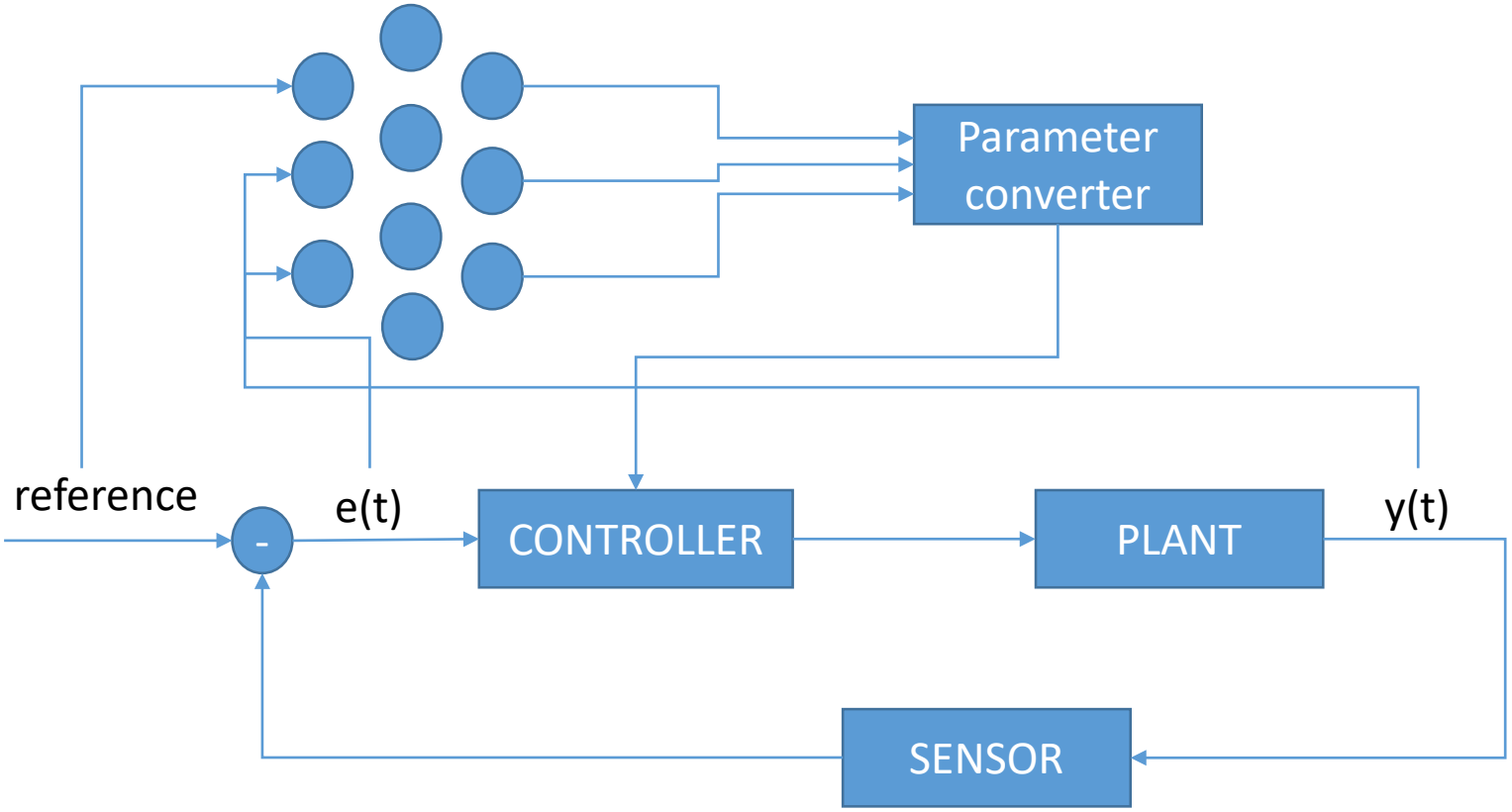
- Model-reference adaptive controller structure



source: P.A. Tapp A, A Comparion of three self-tuning control algorithms

Adaptive PID – auto tuning

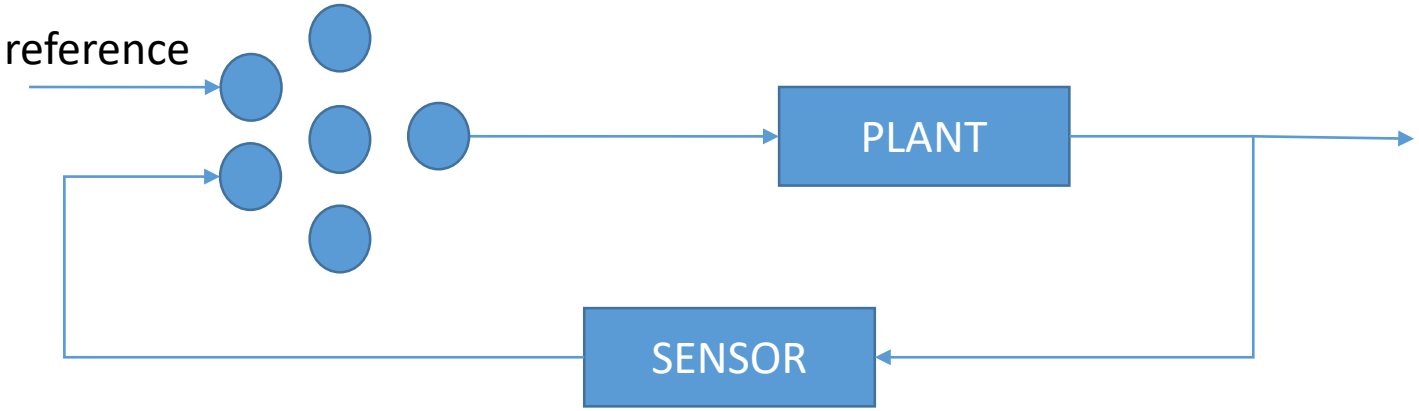
- PID auto-tuning scheme using neural networks



source: Frankcklin Rivas-echeverria. Nerual Network-based Auto-Tuning for PID Controllers

Adaptive PID – PIDNN

- Suitable for non-linear system
- Computation critical



source: F. Shahraki, M.a. Fanaei. Adaptive System Control with PID Neural networks

Conclusion

Conventional PID Control	Adaptive PID Control
Analytical approach	Learning based approach
Good for linear systems	Suitable for non-linear systems
Sensitve to the change of plant system	Doesn‘t need to know the detail of the plant system
Fast calculation just in time	Slow in learning phase

References

- [1]F. Shahraki, M.A. Fanaer Neural Network-based Auto-Tuning for PID Controllers
- [2] F. Shahraki, M.A. Adaptive System Control with PID Neural Networks
- [3] Astrom, K. J. and Haggland, T. 1988, Automatic Tunning of PID Controlles
- [4] Karl Johan Åström (2002) Control System Design (Chapter 6)
- [5] H.L. Shu, Y. Pi (2005), Decoupled Temperature Control System Based on PID Neural Network