fortiss

PID Controller

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PID Controller

What is PID?

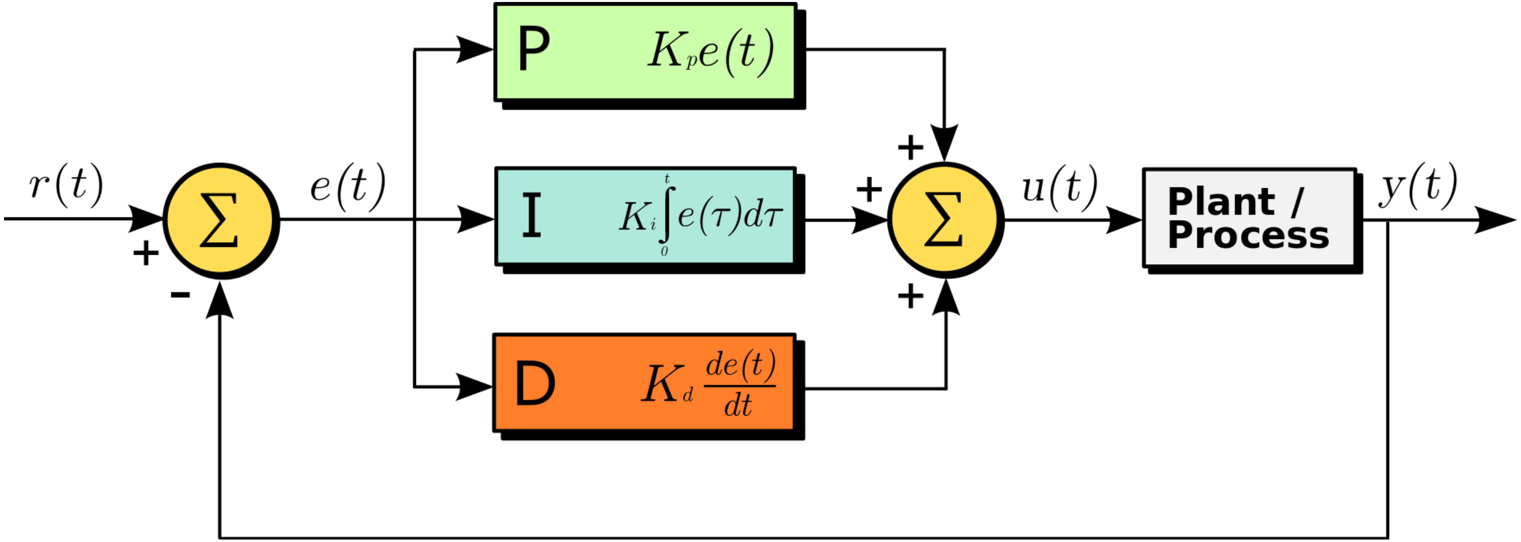
- a control loop feedback algorithm
- widely used in industrial control systems requiring continuously control
- applies a correction based on **P**roportional, **I**ntegral and **D**erivative terms

PID Controller

Why do we use PID?

- applies accurate and responsive correction to a control function
- control any process which has a measurable output,
  e. g. speed, steering angle

How does the PID work?



where error value e(t) = desired setpoint r(t) - measured process variable y(t)

Proportional term

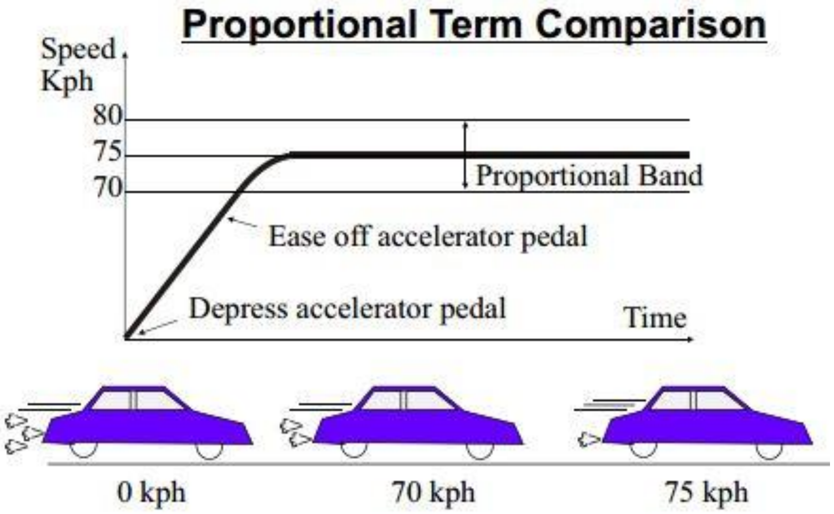
- is proportional to the current error value,

$$P_{\text{out}} = K_{\text{p}} e(t).$$

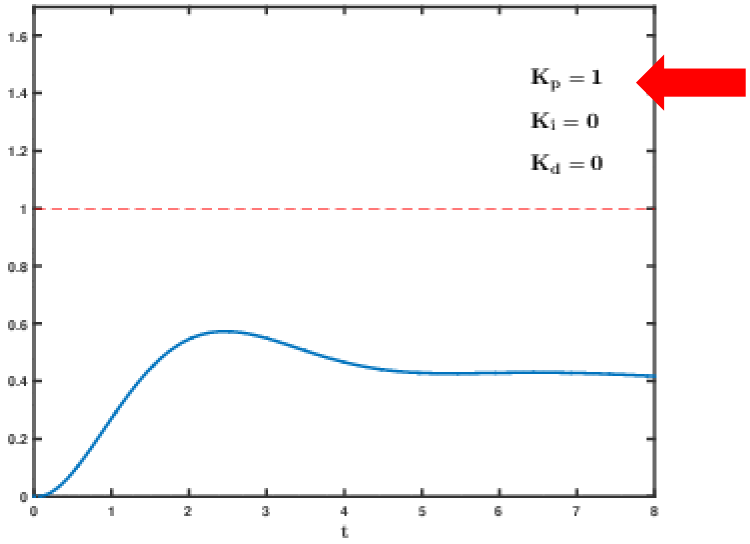
  where K_p is proportional gain constant

- Large Error
  >> output control large
  No Error
  >> no corrective response

- Using proportional control alone
  >> a steady-state error



Proportional term



Response of PV with change of K_p over time

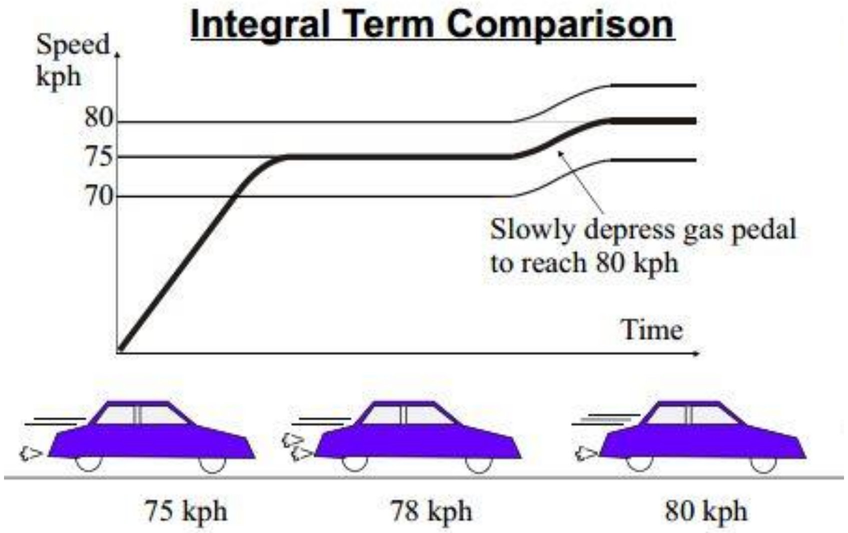
- K_p too small
  >> a small output response to a large input error and a less sensitive controller (-)
- K_p high
  >> a large change in the output for a given change in the error
- K_p too high
  >> the system can become unstable (-)

Integral term

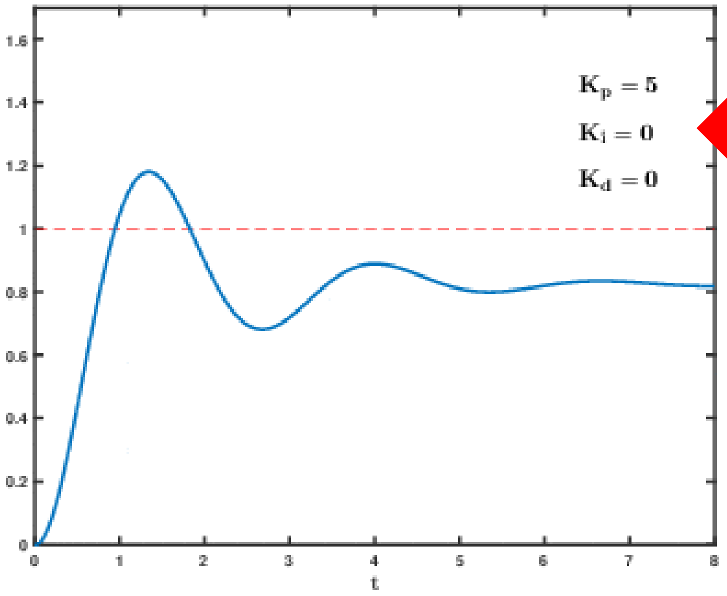
- eliminate the steady-state error
- add a control effect due to the historic cumulative value of the error
- is proportional to both the magnitude of the error and the duration of the error.

$$I_{\mathrm{out}} = K_{\mathrm{i}} \int_0^t e(\tau)\, d\tau.$$

where K_i is integral gain constant



Integral term



Response of PV with change of K_i over time

- eliminates the steady-state error that occurs with a pure P controller (+)
- K_i too high
  >> can cause the current value to overshoot the setpoint value (-)

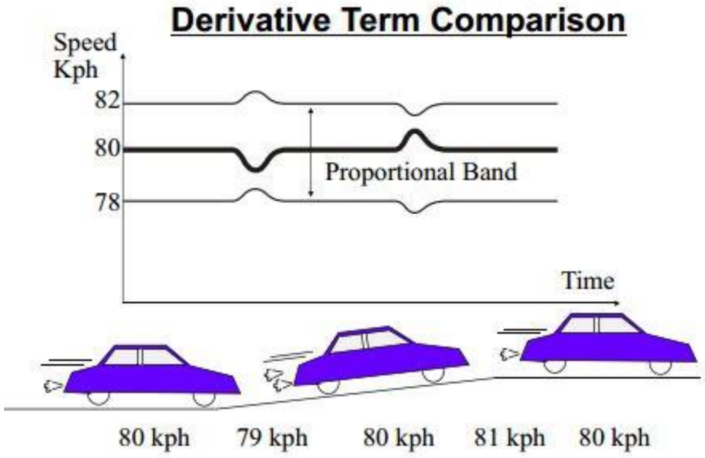
Derivative term

- reduce the effect of a suden-change error considering the rate of error change

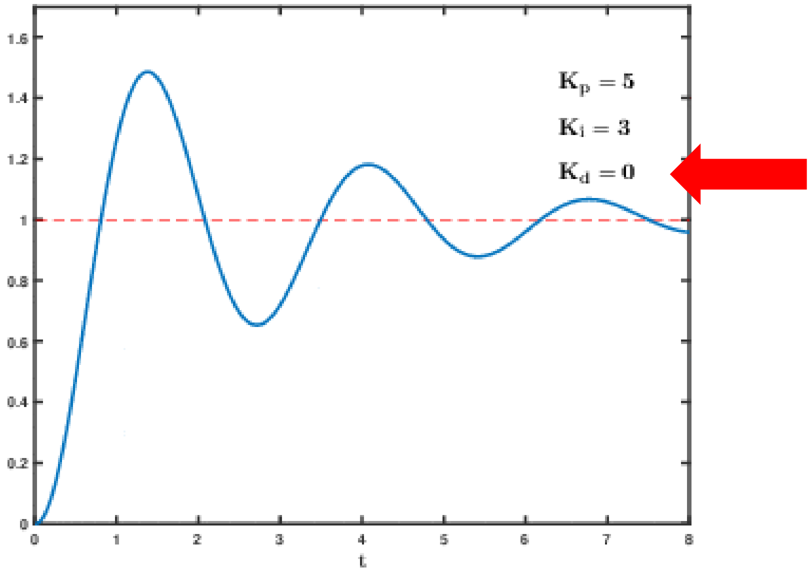
- is proportional to the slope of the error over time

$$D_{\text{out}} = K_{\text{d}} \frac{de(t)}{dt}.$$

where K_d is derivative gain constant



Derivative term



Response of PV with change of K_d over time

- improves settling time and stability of the system
- The more rapid the change, the greater the controlling or dampening effect

Mathematical form of PID

$$u(t) = \mathrm{MV}(t) = K_\mathrm{p} e(t) + K_\mathrm{i} \int_0^t e(\tau)\, d\tau + K_\mathrm{d} \frac{de(t)}{dt},$$

where

K_p is the proportional gain, a tuning parameter,

K_i is the integral gain, a tuning parameter,

K_d is the derivative gain, a tuning parameter,

$e(t) = \mathrm{SP} - \mathrm{PV}(t)$ is the error (SP is the setpoint, and PV(t) is the process variable),

t is the time or instantaneous time (the present),

τ is the variable of integration (takes on values from time 0 to the present t).

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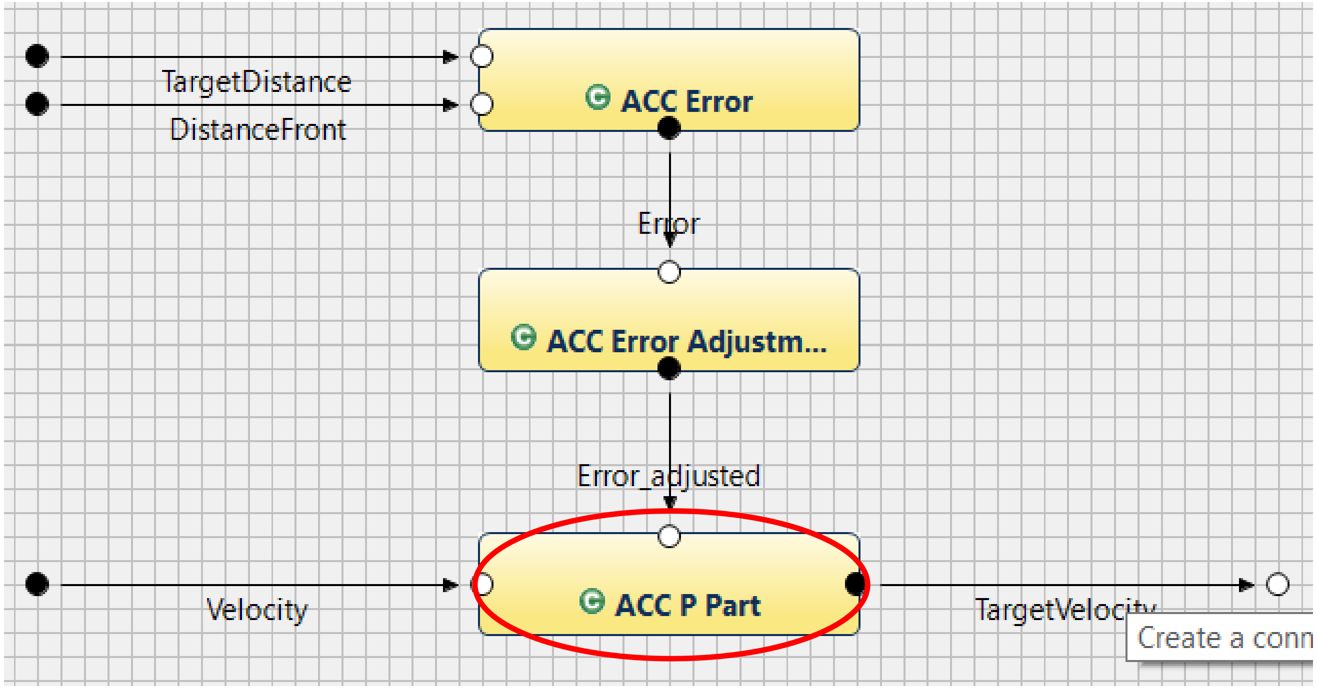
PID in AF3

- can be separatly used,
  e. g. PI, PD, P or I controller

- coefficent already defined in data dictionary

COEFFICIENT_CONTROLLER_D() : double	double	Coefficient for the differential part in the motor value controller
COEFFICIENT_CONTROLLER_F() : double	double	Coefficient for the feed forward part in the motor value controller
COEFFICIENT_CONTROLLER_I() : double	double	Coefficient for the integral part in the motor value controller
COEFFICIENT_CONTROLLER_MAX_ERROR_SUM() : double	double	The maximum error integral in the PID controller
COEFFICIENT_CONTROLLER_P() : double	double	Coefficient for the proportional part in the motor value controller
COEFFICIENT_LK_CONTROLLER_D() : double	double	Coefficient for the differential part in the lane keeping controller
COEFFICIENT_LK_CONTROLLER_I() : double	double	Coefficient for the integral part in the lane keeping controller
COEFFICIENT_LK_CONTROLLER_P() : double	double	Coefficient for the proportional part in the lane keeping controller
COEFFICIENT_LK_FEED_FORWARD() : double	double	Coefficient for the feed forward control

PID in ACC


TargetDistance
DistanceFront
ACC Error
Error
ACC Error Adjustm...
Error_adjusted
ACC P Part
Velocity
TargetVelocity
Create a conn

PID in Lane Keeping