HL Klemove

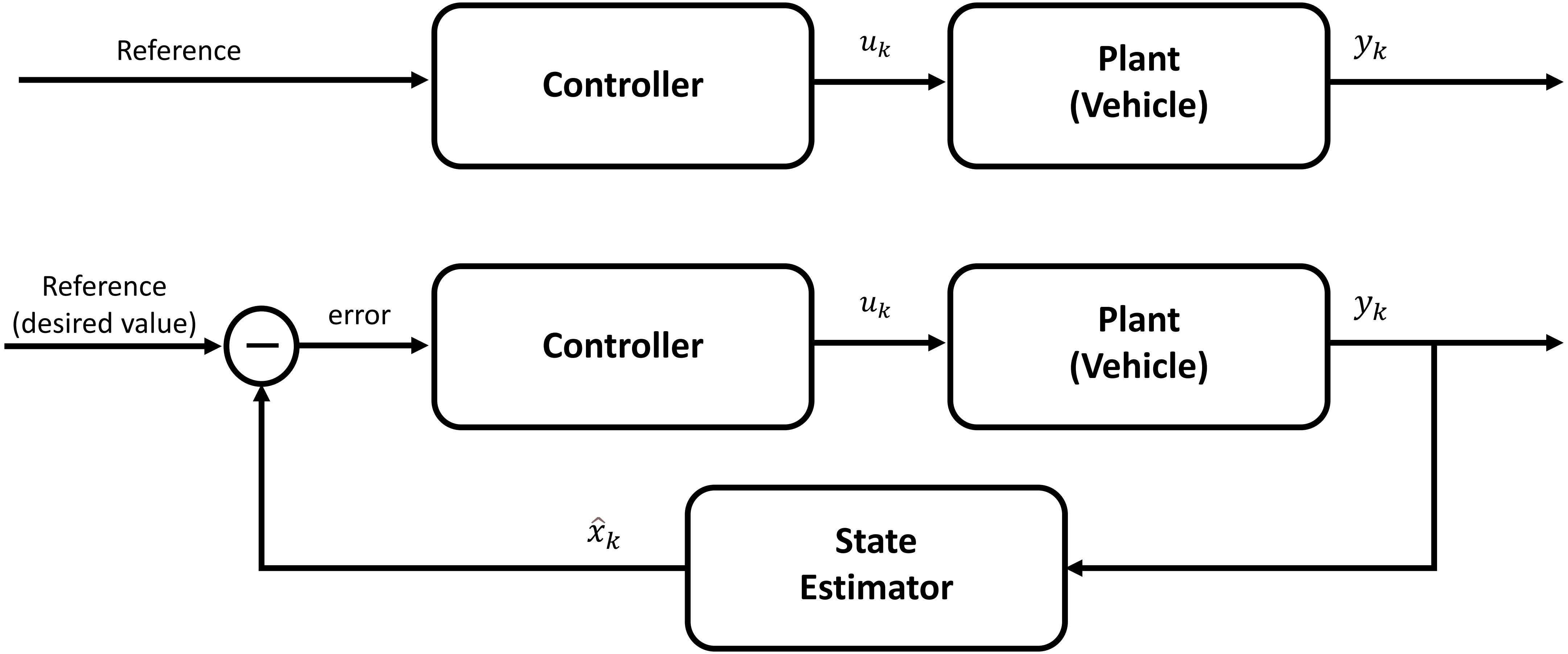
PID Control

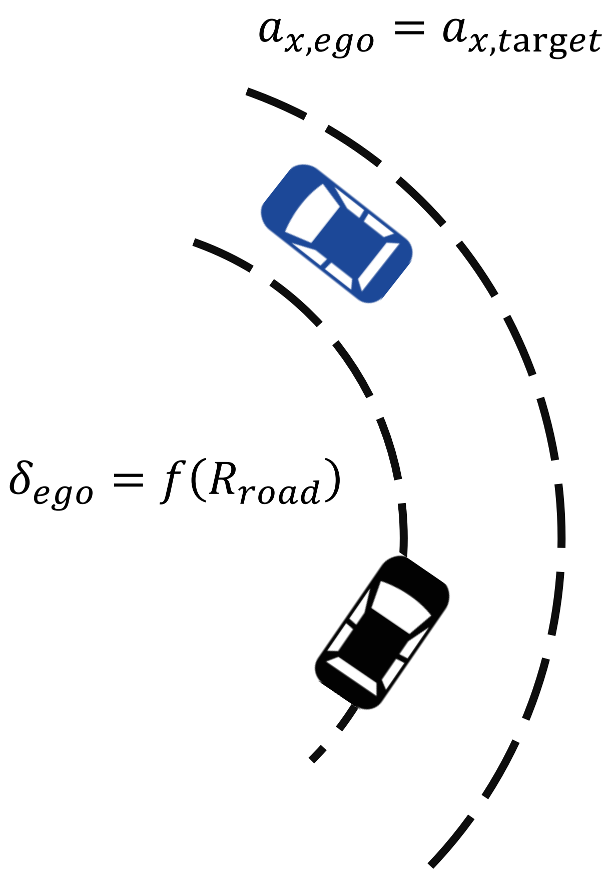
Lecturer : Seungmok Song

Contents

Introduction

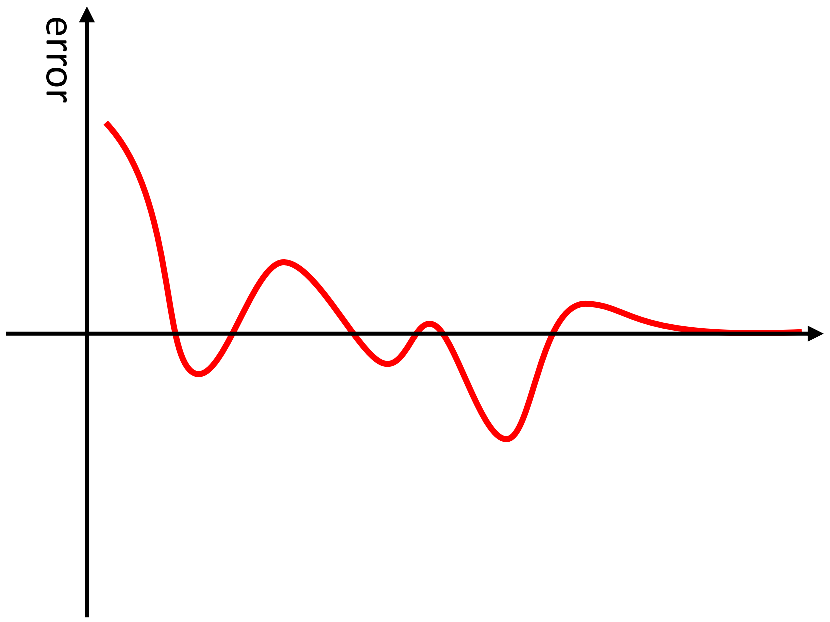
- Feedback vs. Feedforward controller

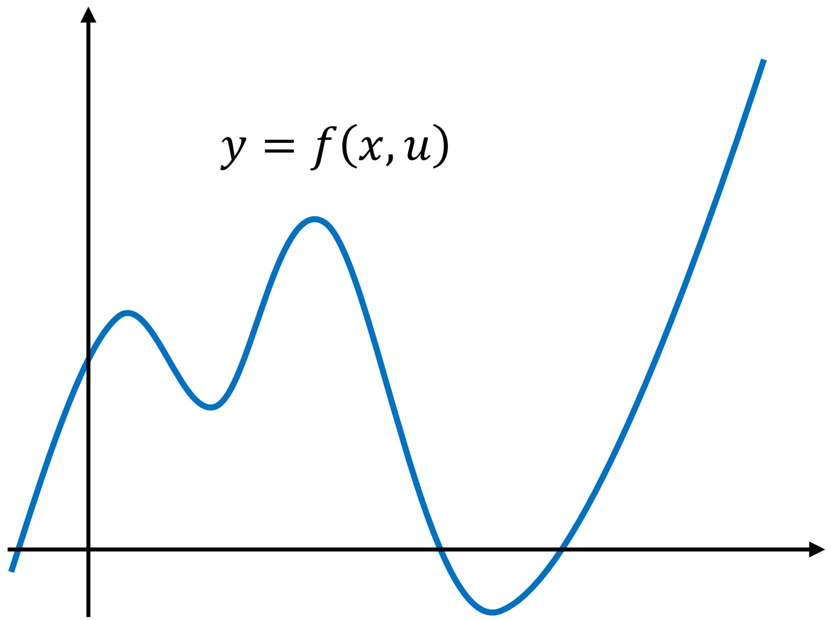


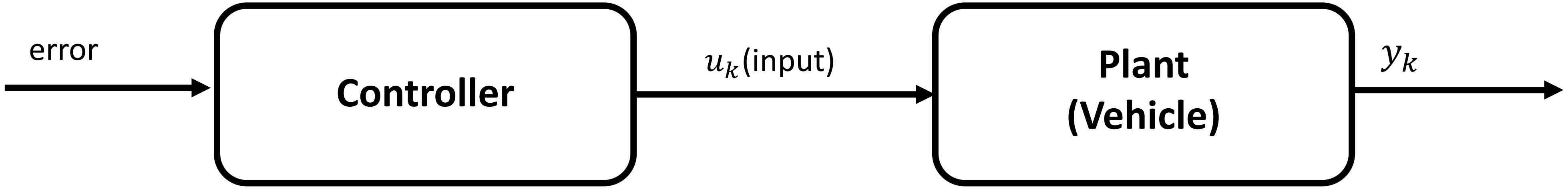


Introduction

- PID Controller
  - We don’t have to care about the system model

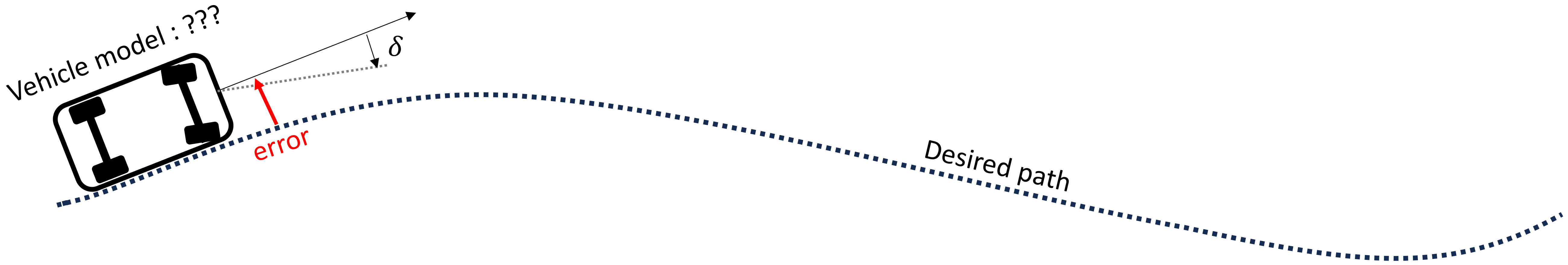






Introduction

- Path tracking example

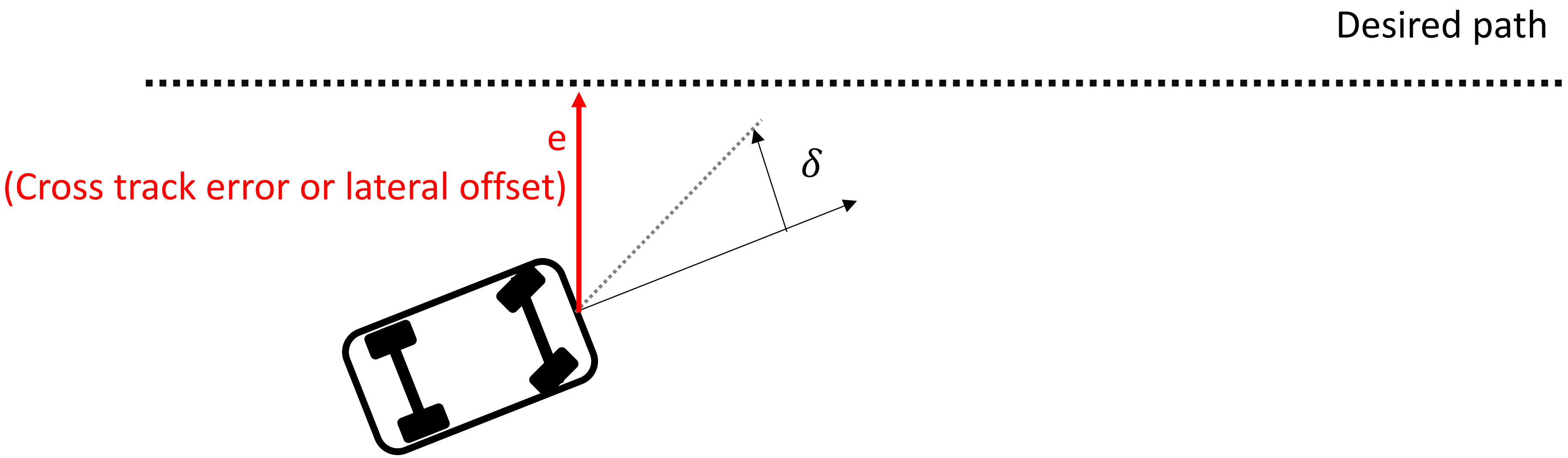


P Controller

- Error 에 비례한 control input 생성

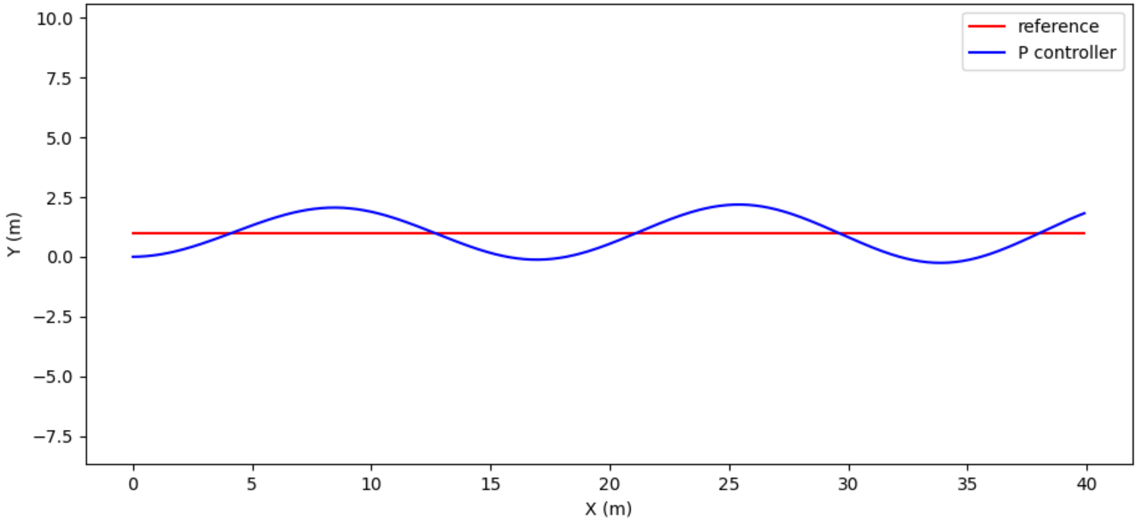
$$input(\delta) \propto error(e)$$

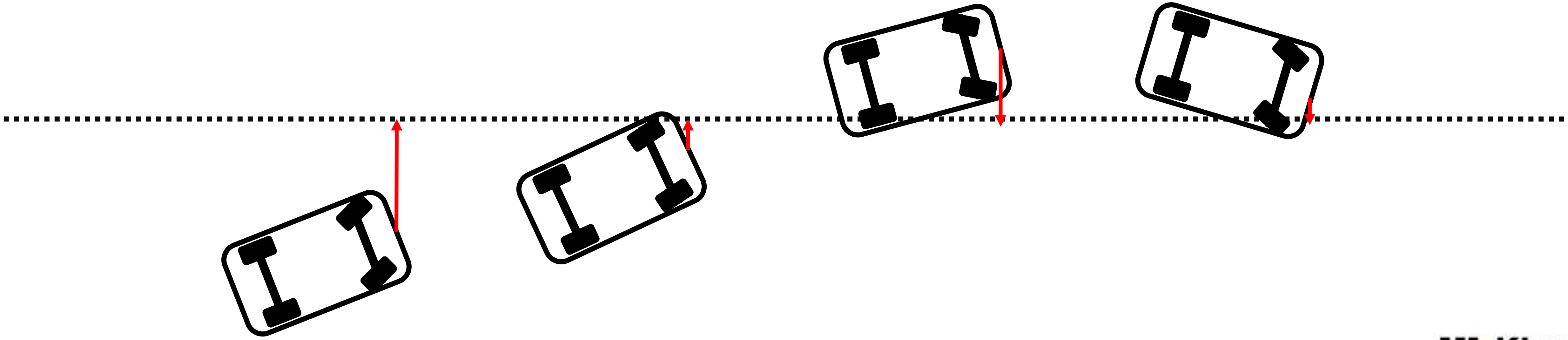
$$\delta_p = K_p e$$



P Controller

- Result
  - Overshoot

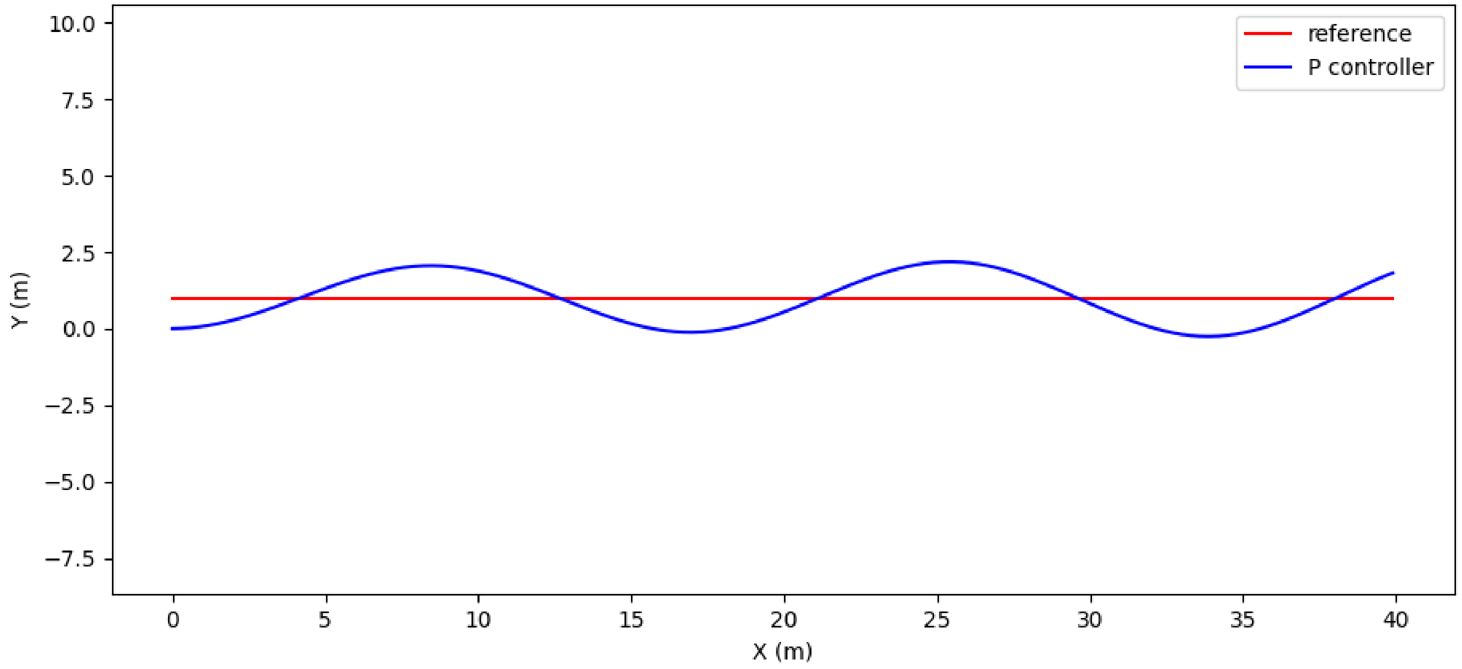




PD Controller

- Derivative term
  - Reducing overshoot

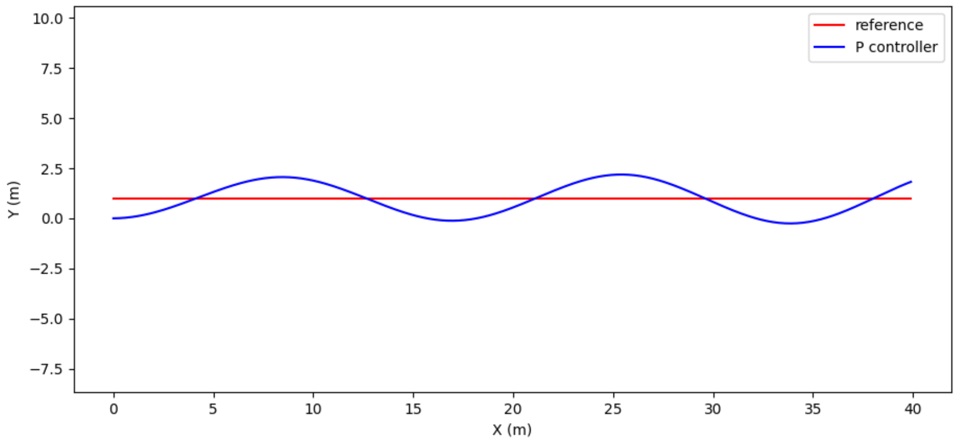
$$\delta_{pd} = K_p e + K_d \frac{d}{dt}(e)$$

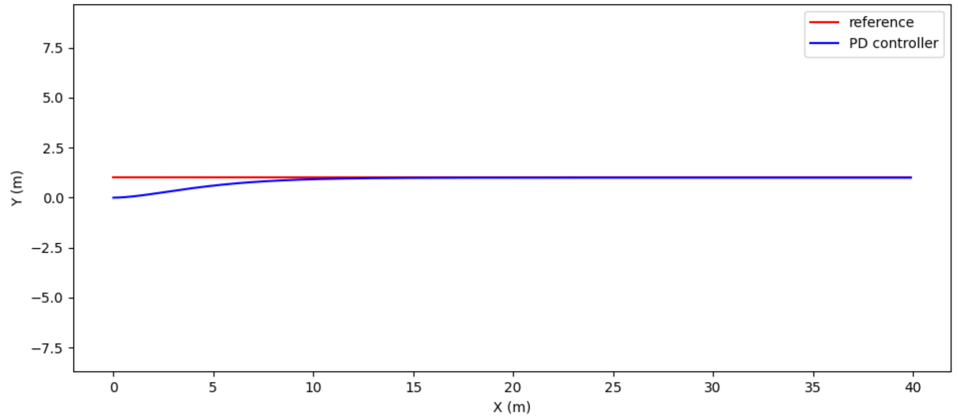


HL Klemove

PD Controller

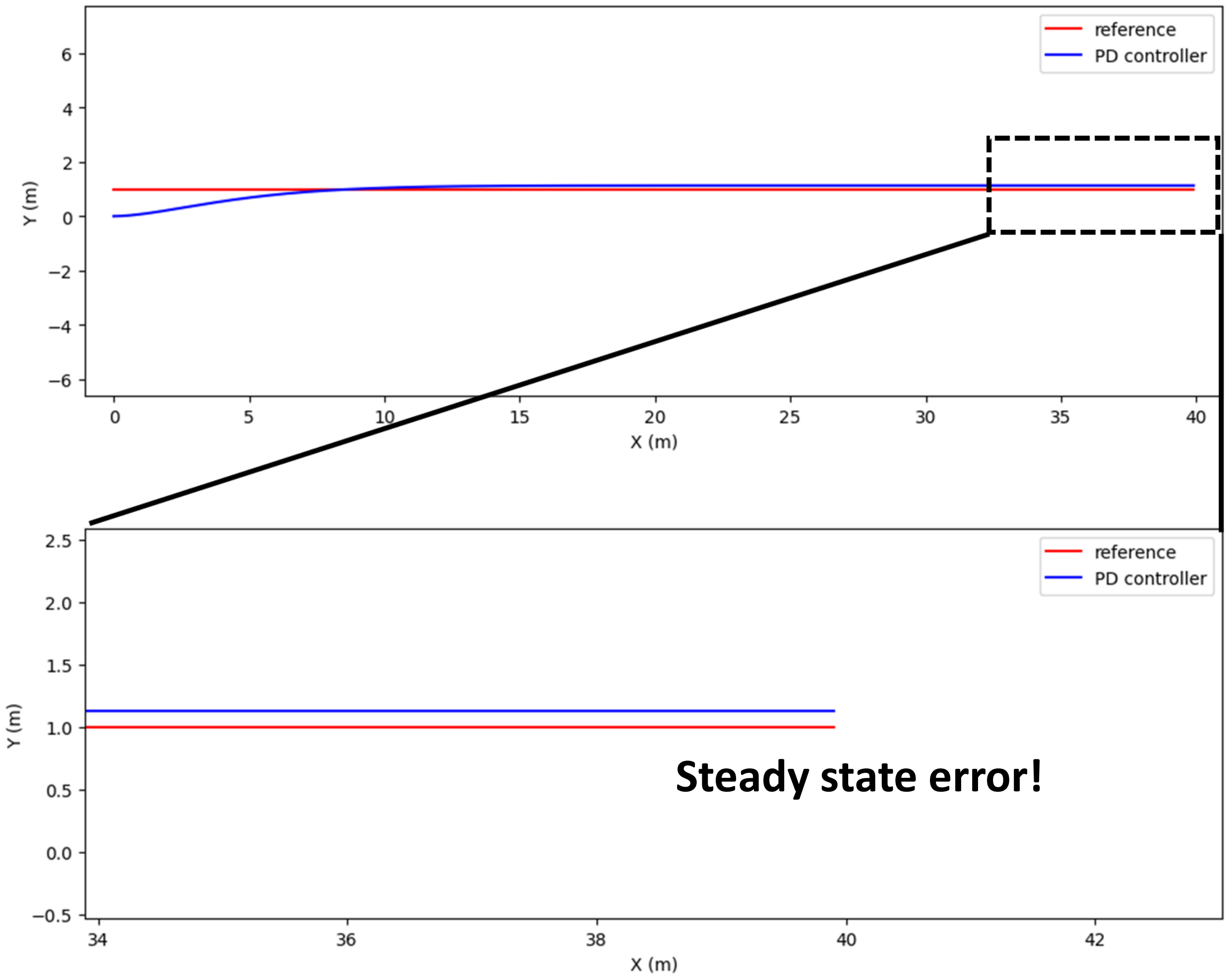
- Result

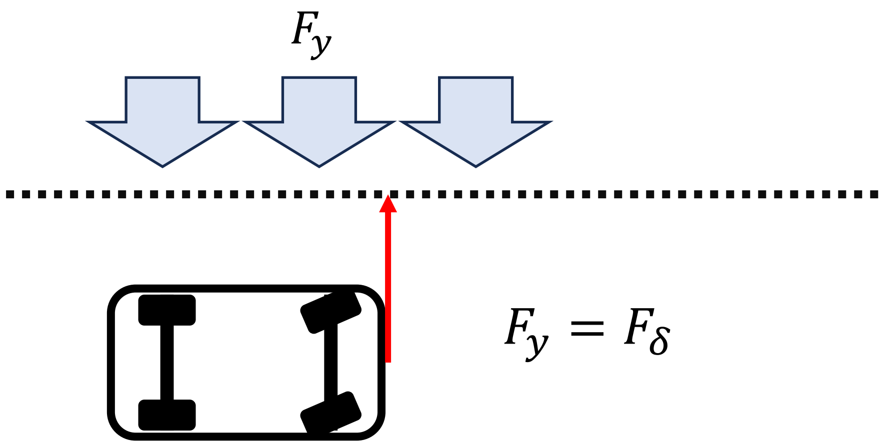




PD Controller

- Result
  - Bias





$$F_y = F_\delta$$

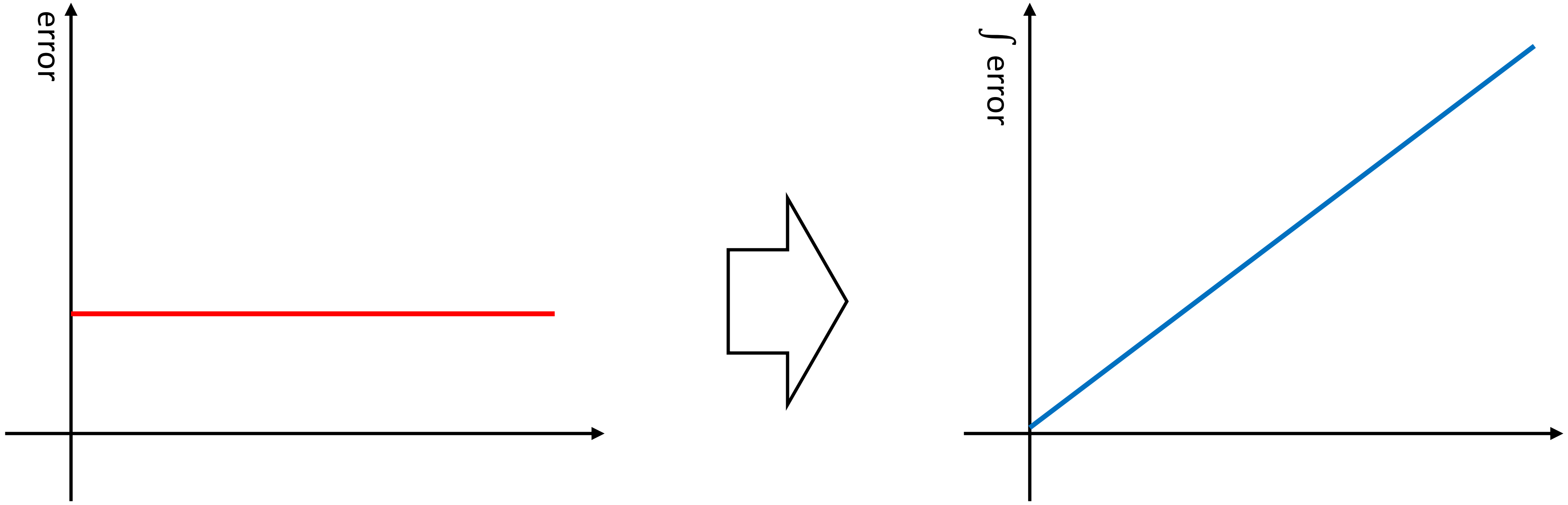
$$\delta_{pd} = K_p e + K_d \underbrace{\frac{d}{dt}(e)}_{= 0}$$

PID Controller

- Integral term
  - Reducing steady state error

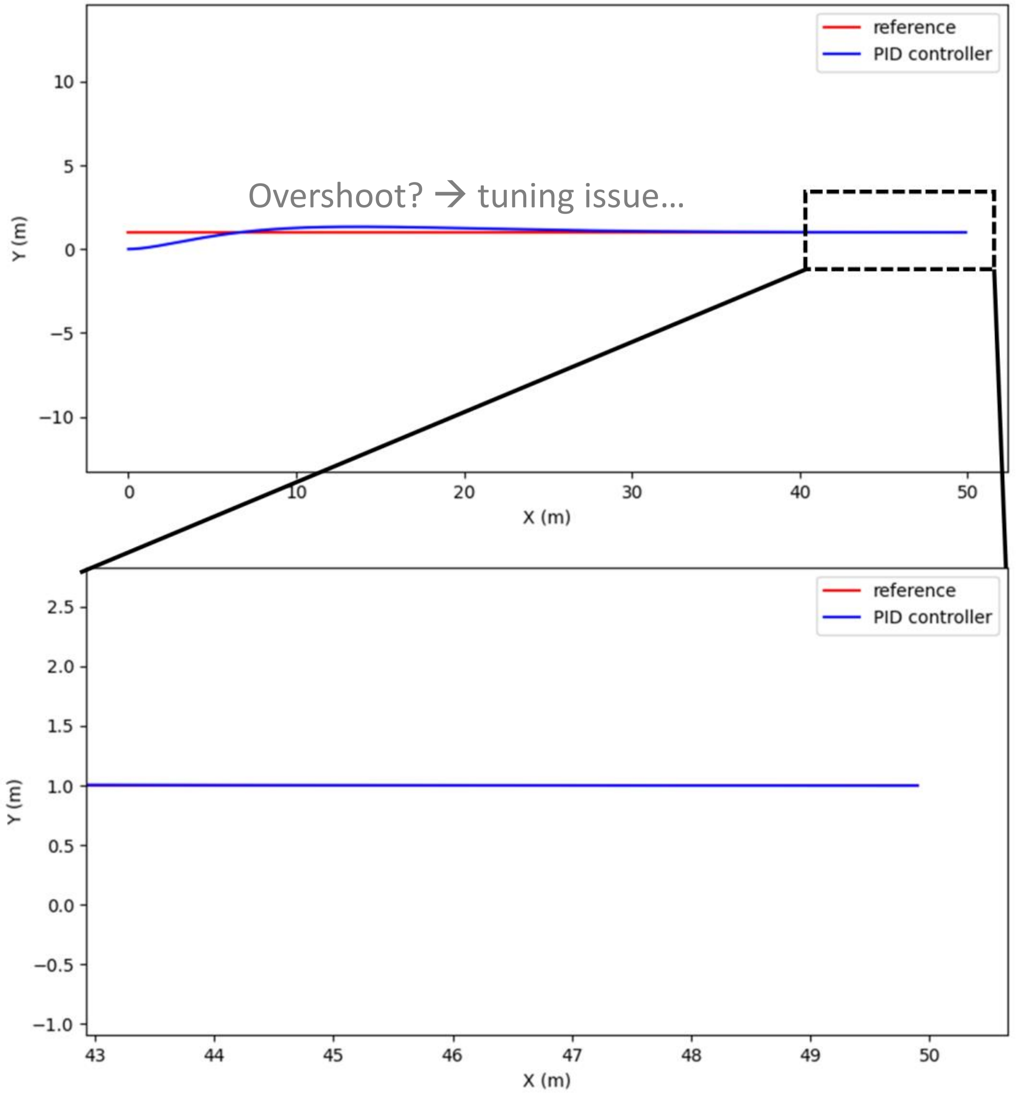
$$\delta_{pd} = K_p e + K_d \frac{d}{dt}(e) + K_i \underline{\int (e) dt}$$

Error 가 존재하는 시간이 길어질 수록 커짐!



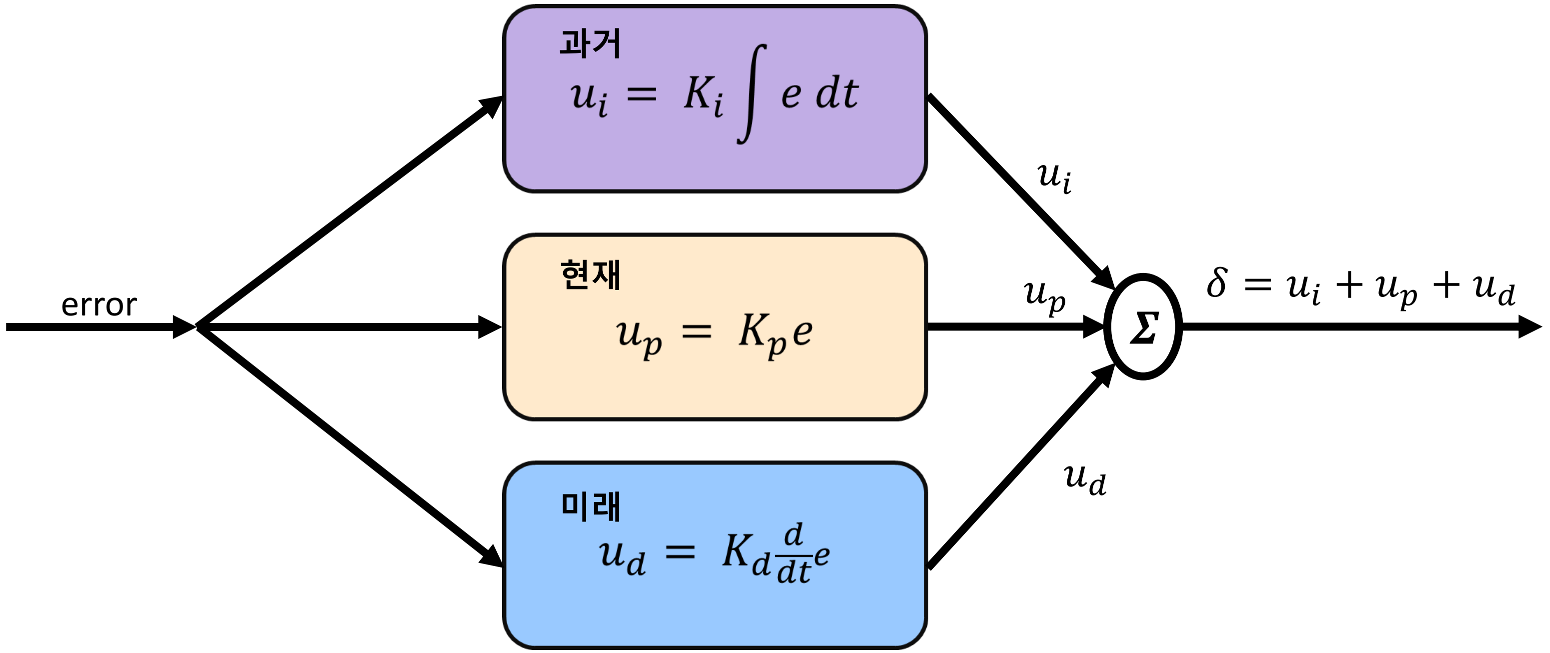
PID Controller

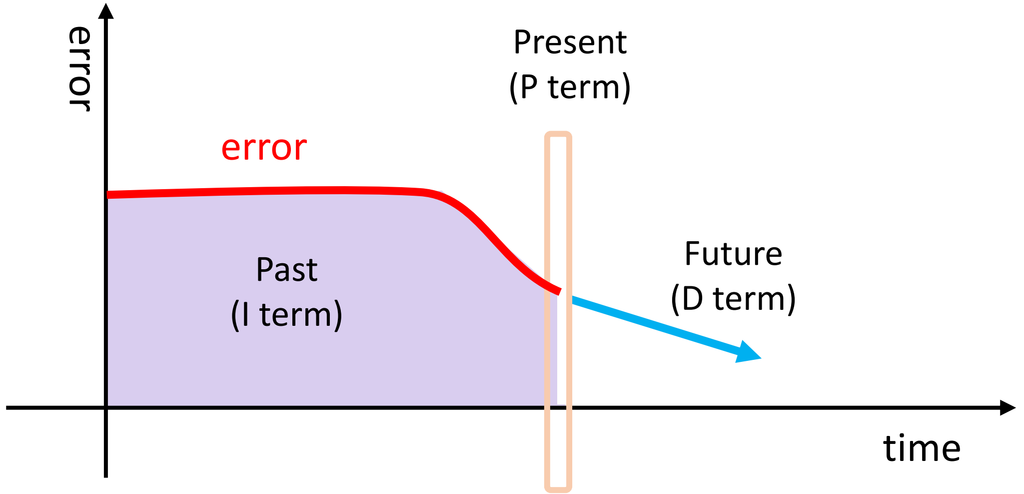
- Result



PID Controller

- Meanings of each controller

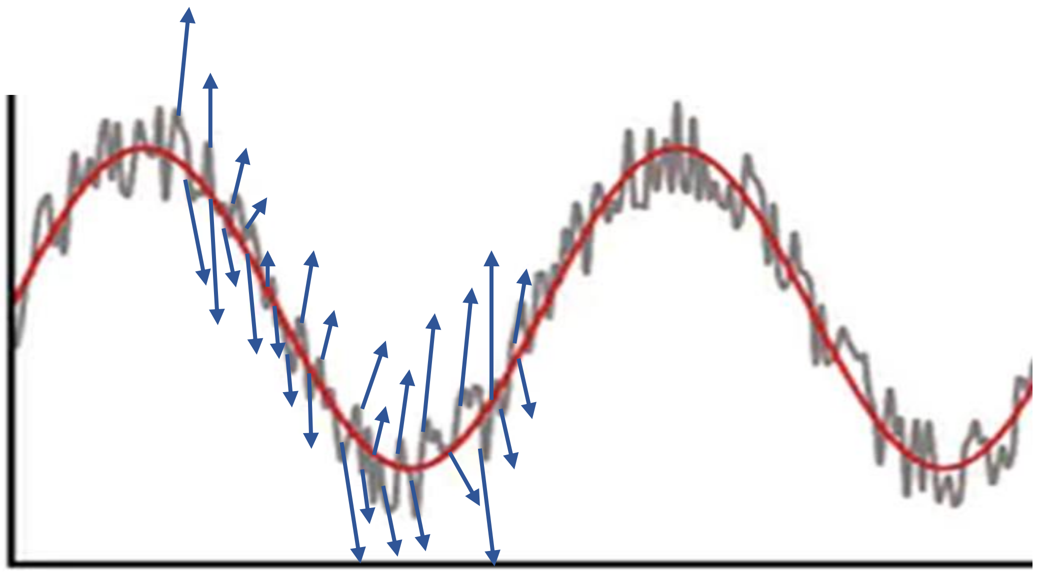


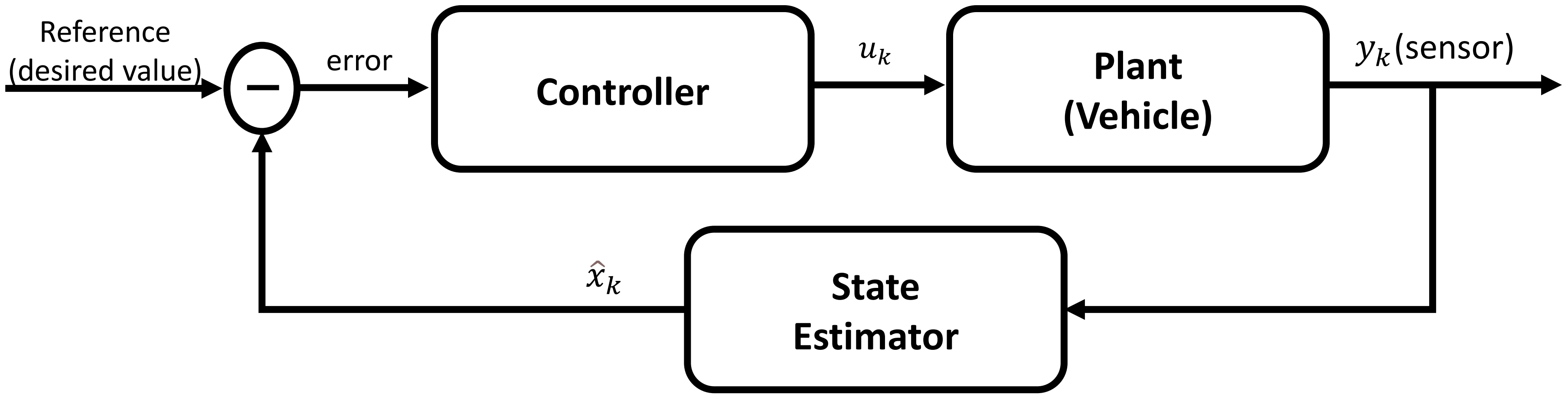


https://www.youtube.com/watch?v=1nJ79wX5EDM&ab_channel=%EB%A9%8D%EC%87%BC%EC%B8%A0

Beyond PID controller

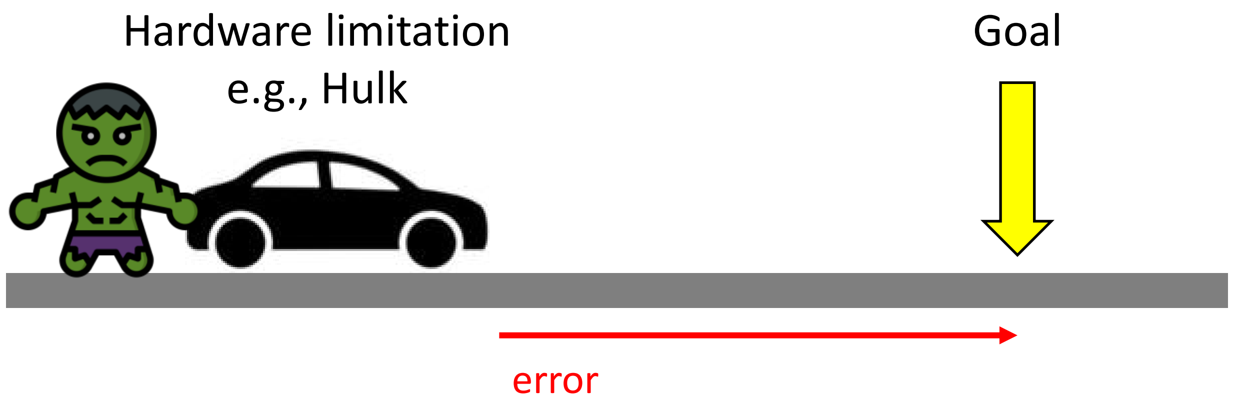
- State estimator
  - Proper filter required!

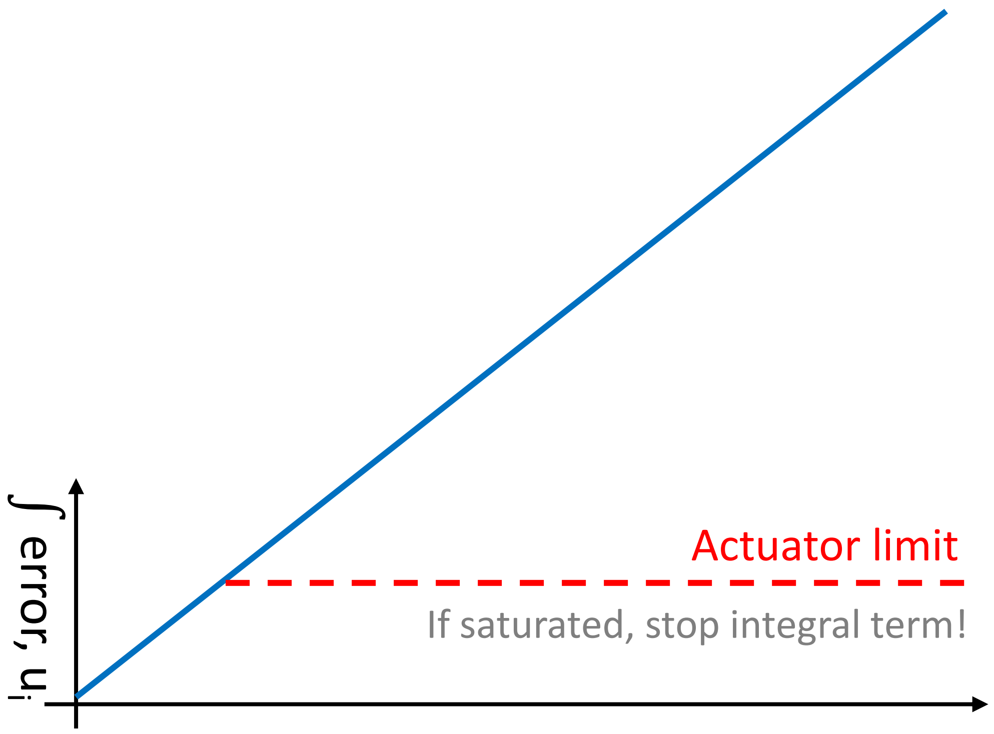




Beyond PID controller

- Integrator anti-windup
  - Error 적분이 해소될 수 없을 때 적분 term 은 점점 커짐

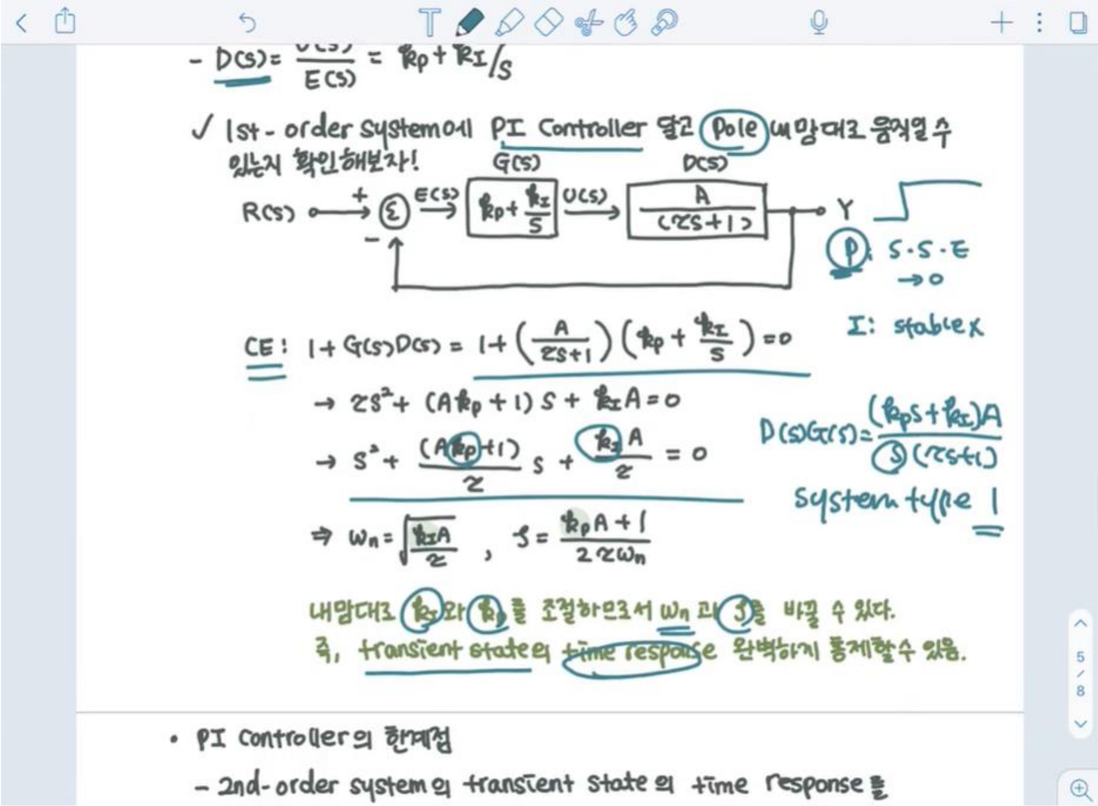




$$\delta_{pd} = K_p e + K_d \frac{d}{dt}(e) + K_i \int (e) dt$$

Beyond PID controller

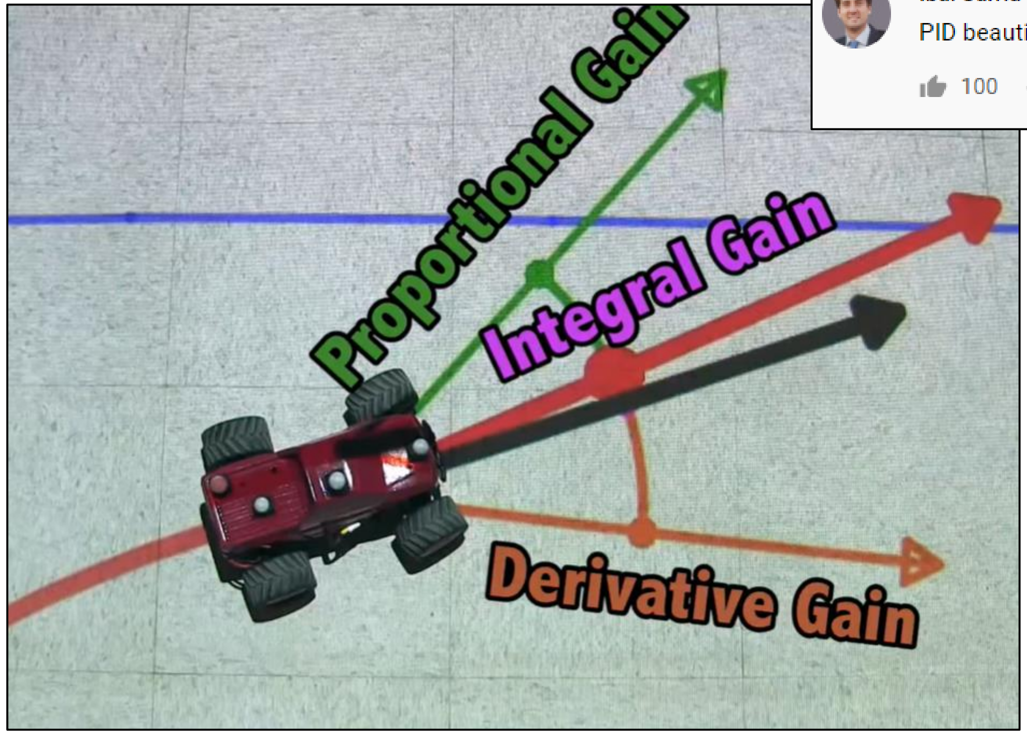
- Control engineering
  - 제어공학에서는 Plant와 PID controller가 수식으로 주어지면 input에 대한 system의 response를 계산하는 방법도 배웁니다
  - Laplace transform을 아는 것이 필수
  - 한국어 lecture “제어공학 뽀개기 (99%의 확률로 내가 부서짐)”이 유튜브에 공개되어 있으니 제어공학이 궁금하신 분들은 한번 들어 보시는 것도 좋겠습니다.
  - https://youtu.be/pVjKo_OVhU4 (강추)



Beyond PID controller

- Controlling Self Driving Cars (Video)
  - Aerospace Controls Lab (MIT)

    https://youtu.be/4Y7zG48uHRo



Thank You