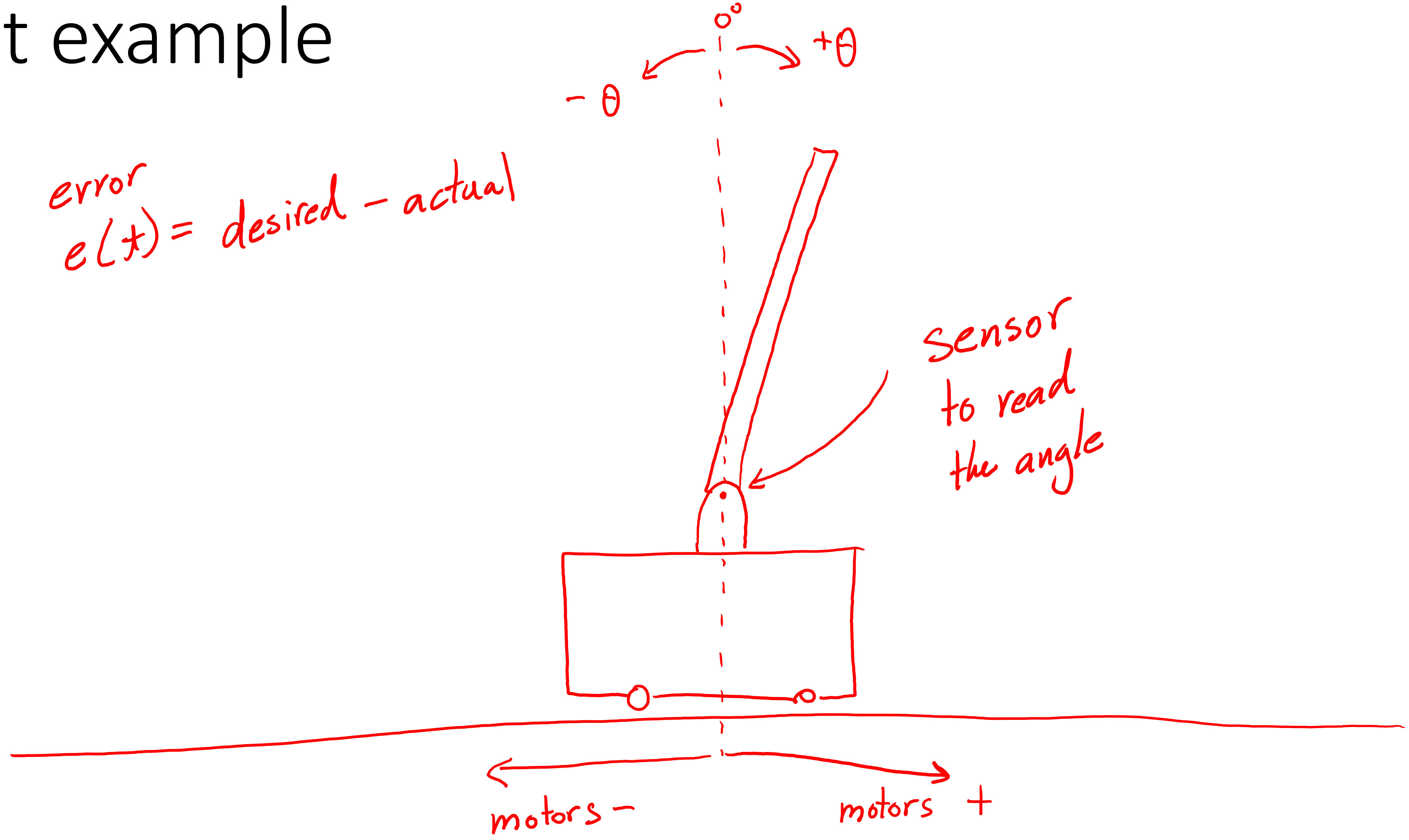
bracket
- Upload picture by
end of class today

PID Control

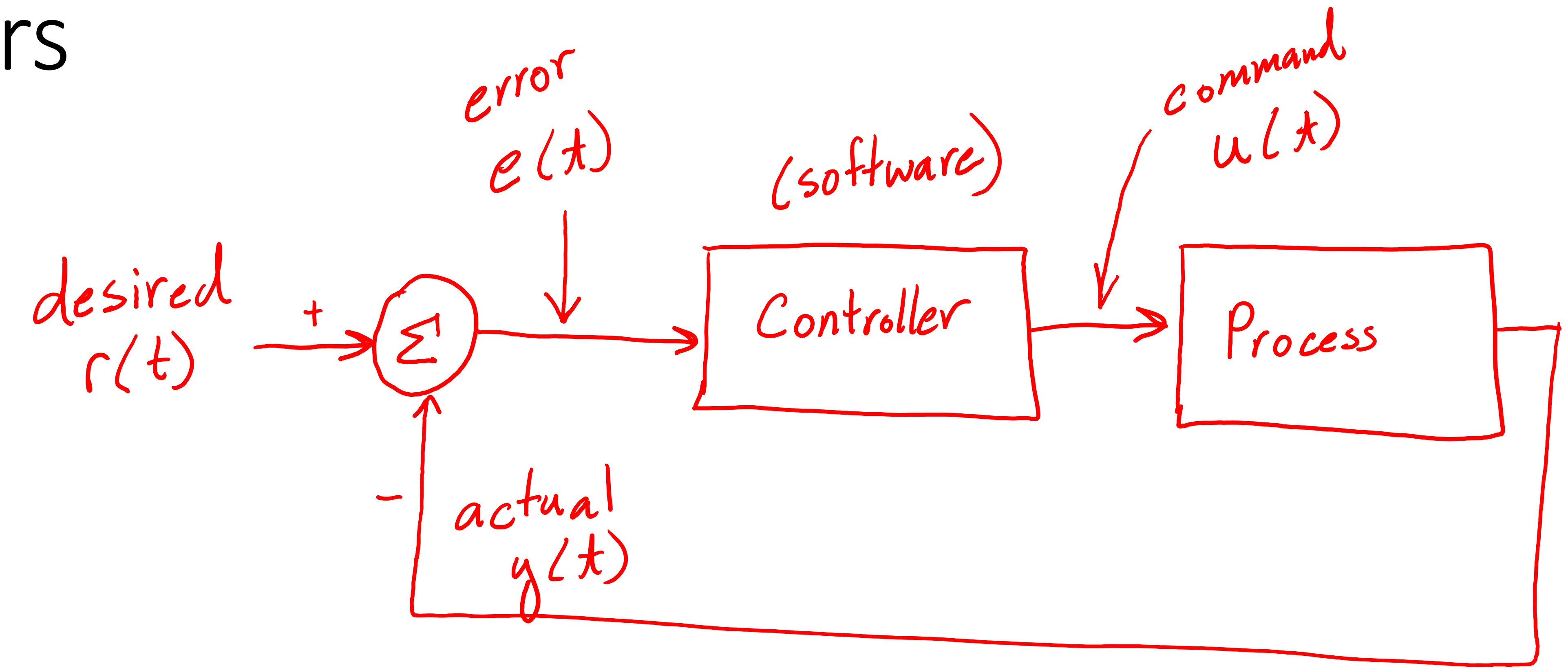
Robot example

error

$e(t) = \text{desired} - \text{actual}$



Controllers



Examples:

- drive system on a golf cart
- cruise control
- heater or A/C

Controller overview

- Open loop = the output has no influence on the input to the controller

- Closed loop = the output is used in reducing the error

Simple controller

On-off (bang-bang controller)

If (θ > threshold) then motors set to +100%

If (θ < -threshold) then motors set to -100%

Drawbacks:

- operation is not smooth
- may get oscillation

P-term

(Proportional)

P.I.D.

$$u(t) = K_p \cdot e(t)$$

Proportional constant

- if the error is big, then the correction is big

Problems with using only K_p

- if K_p is too small : motors are not set too a fast enough speed

- if K_p is too big : the system acts like an on-off controller (overshoot)

D-term

(Derivative)

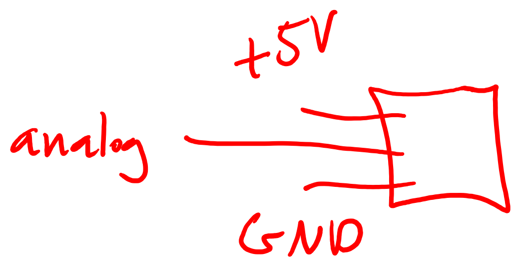
the rate of change of the error

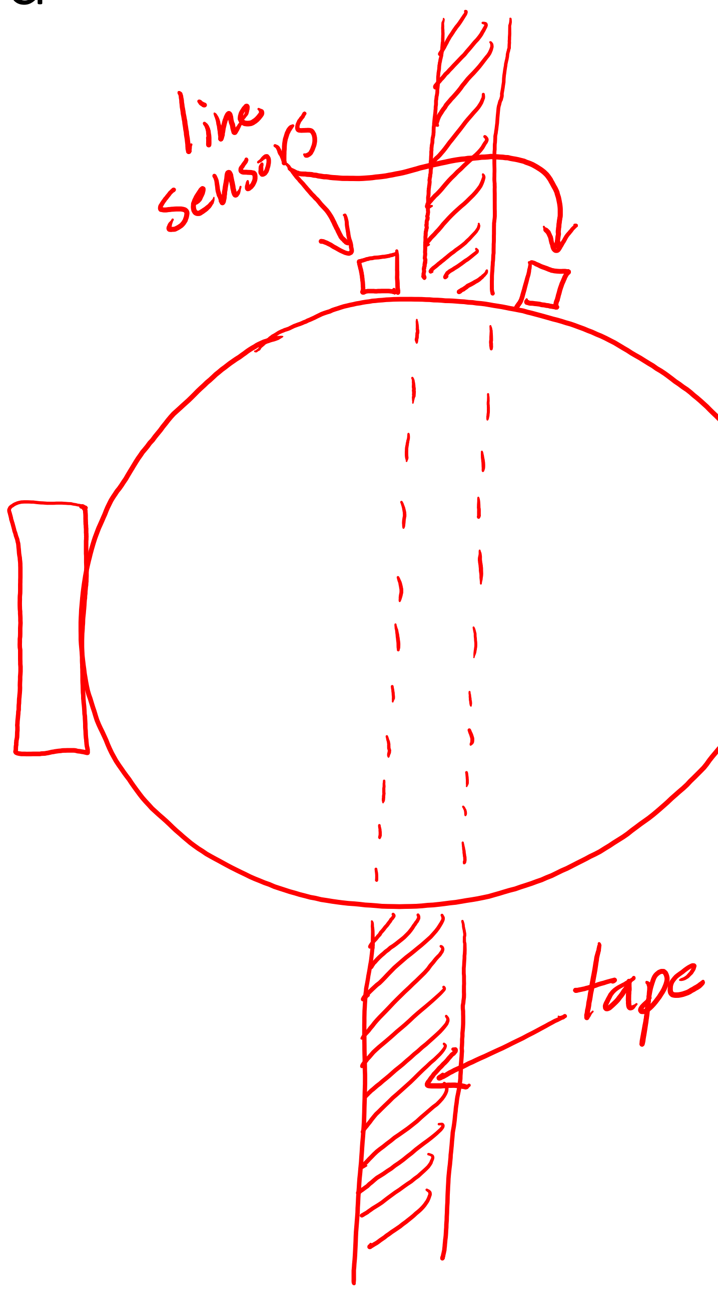
PD

$$u(t) = K_p \cdot e(t) + \underbrace{K_d \cdot \frac{de(t)}{dt}}_{\text{counteracts the proportional term}}$$

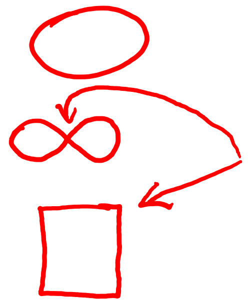
negative

~~Computing K_d in a program~~





- Implement a Proportional Controller
- come up with an expression for $e(t)$



it is okay to have a hard-coded routine for turns and intersections

I-term

(Integral)

PID

$$u(t) = K_p \cdot e(t) + \underbrace{K_i \int e(t)\,dt}_{\text{giving the system a nudge to eliminate steady state error}} + K_d \cdot \frac{de(t)}{dt}$$

Problem with K_i

- Do not apply the integral term unless the error is below a threshold

PID controller form

Tuning PID controllers