Omni-rataste juhtimine ja PID kontroller

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Valgemetsa

Loengukava

- Mis on *omni*-ratas?
  - Lihtne liikumisteooria
- Natuke matemaatikat
- Tagasiside
- PID kontroller

- 45 min

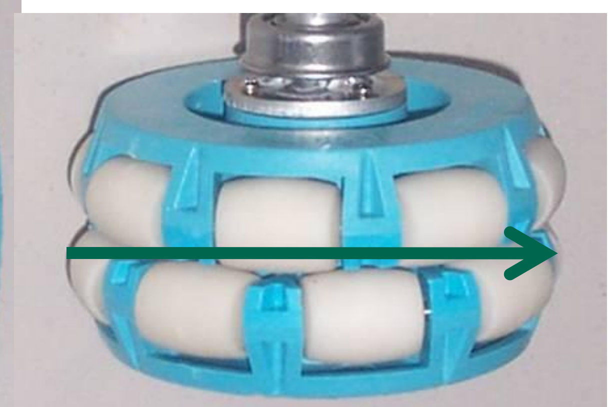
Mis on *omni*-ratas?

- Mitmesuunaline ratas
- ing k *omni wheel*
  poly wheel

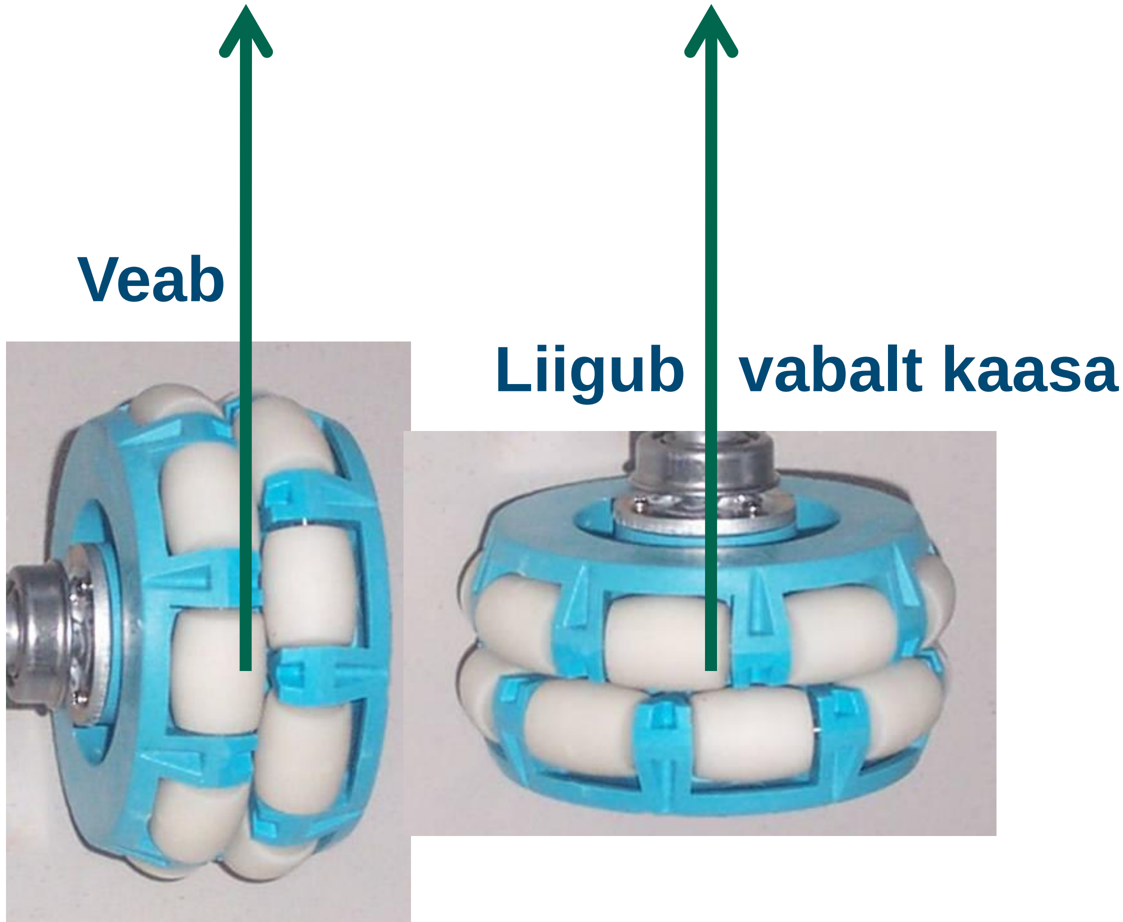
Omni-ratta omadused (1)

Liigub vabalt kaasa

Veab

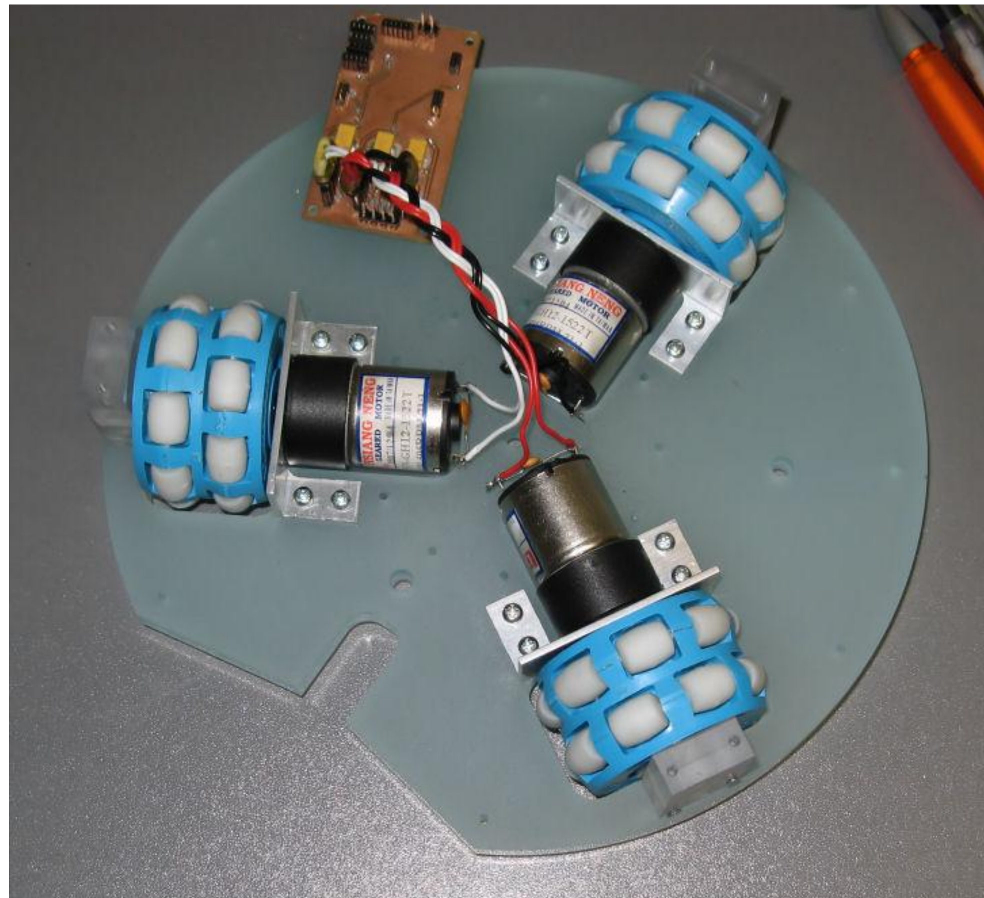


Omni-ratta omadused (2)

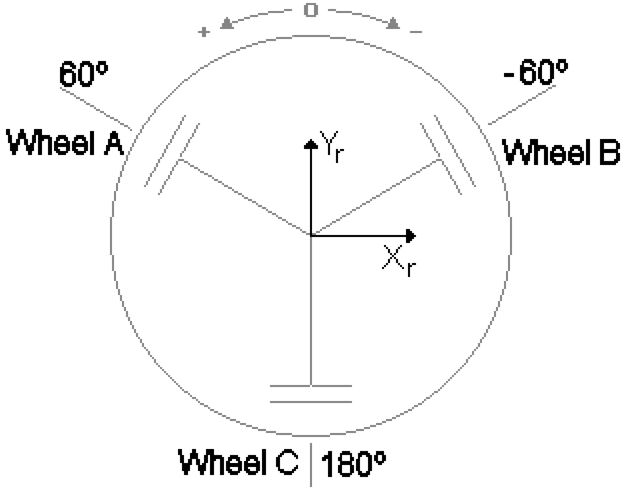


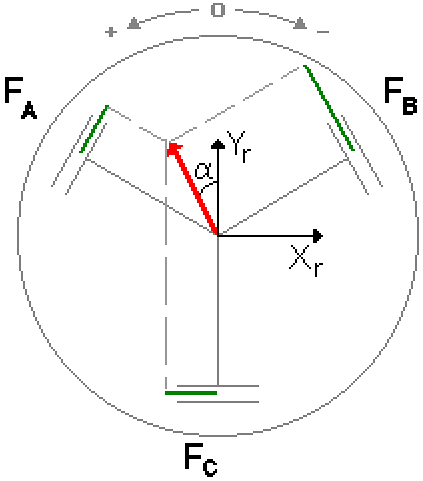
Omni-rataste paigutamine

- 3 ratast

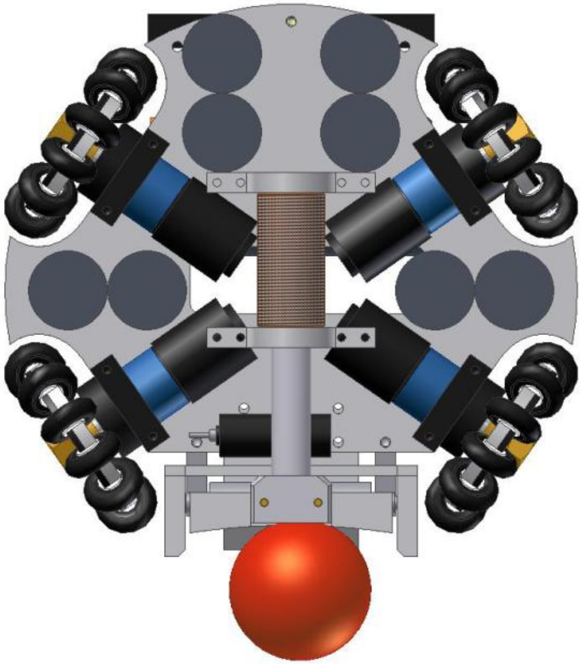


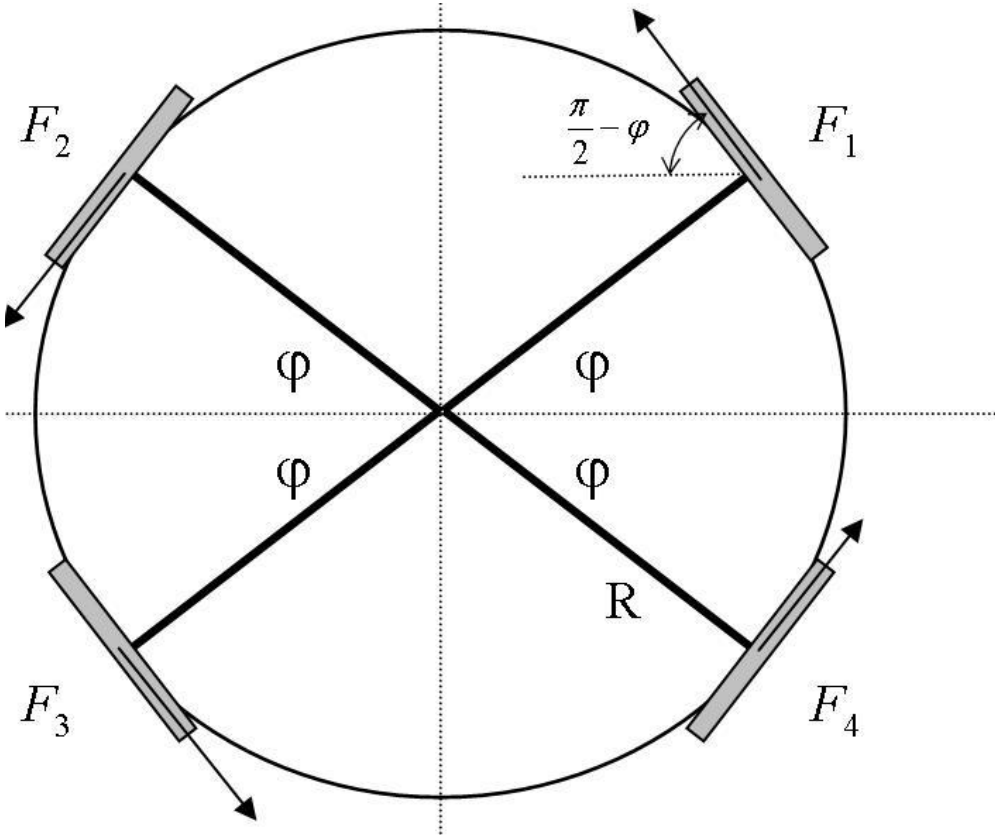
3-rattaline liikumisloogika





Nelja *omni*-rattaline süsteem





Matemaatika: tähistused

v_x – roboti liikumiskiiruse x-komponent

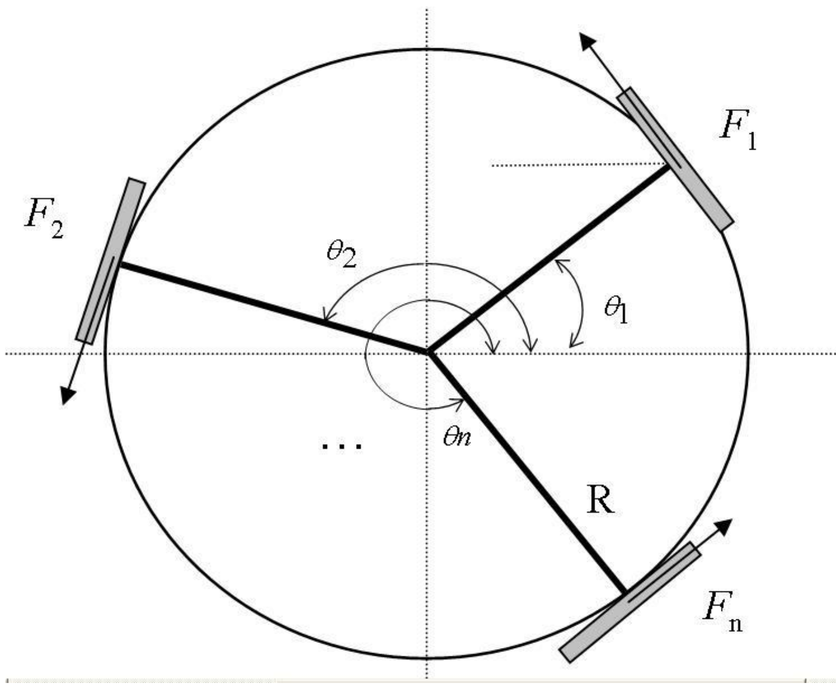
v_y – roboti liikumiskiiruse y-komponent

ω – roboti pöörlemise nurkkiirus

R – ratta kaugus roboti keskpunktist

θ_i – nurk i-nda ratta võlli ja x-telje vahel

v_i – i-nda ratta joonkiirus



Matamaatika: põhiküsimus

Millise kiirusega peaks iga ratas veerema, et robot tervikuna liiguks meile vajalikus suunas?

Matemaatika: seos (1)

$$\begin{pmatrix} v_1 \\ v_2 \\ v_3 \\ v_4 \end{pmatrix} = \begin{pmatrix} -\sin\theta_1 & \cos\theta_1 & 1 \\ -\sin\theta_2 & \cos\theta_2 & 1 \\ -\sin\theta_3 & \cos\theta_3 & 1 \\ -\sin\theta_4 & \cos\theta_4 & 1 \end{pmatrix} \begin{pmatrix} v_x \\ v_y \\ R\omega \end{pmatrix}$$

$i = 4$ (neli ratast)

Matemaatika: seos (2)

$i = 3$ (kolm ratast)

$$v_1 = -v_x \sin\theta_1 + v_y \cos\theta_1 + R\omega$$

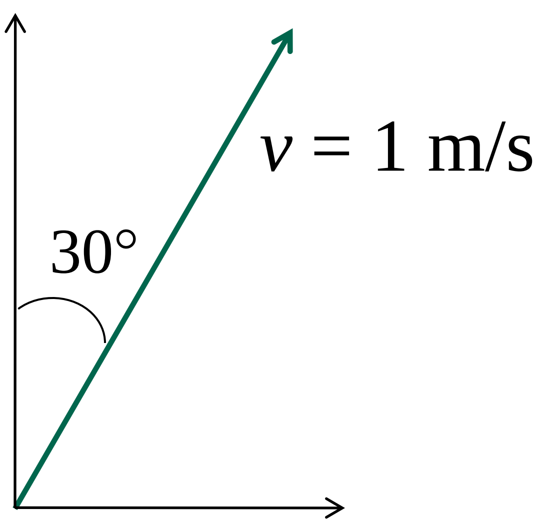
$$v_2 = -v_x \sin\theta_2 + v_y \cos\theta_2 + R\omega$$

$$v_3 = -v_x \sin\theta_3 + v_y \cos\theta_3 + R\omega$$

$$v_4 = -v_x \sin\theta_4 + v_y \cos\theta_4 + R\omega$$

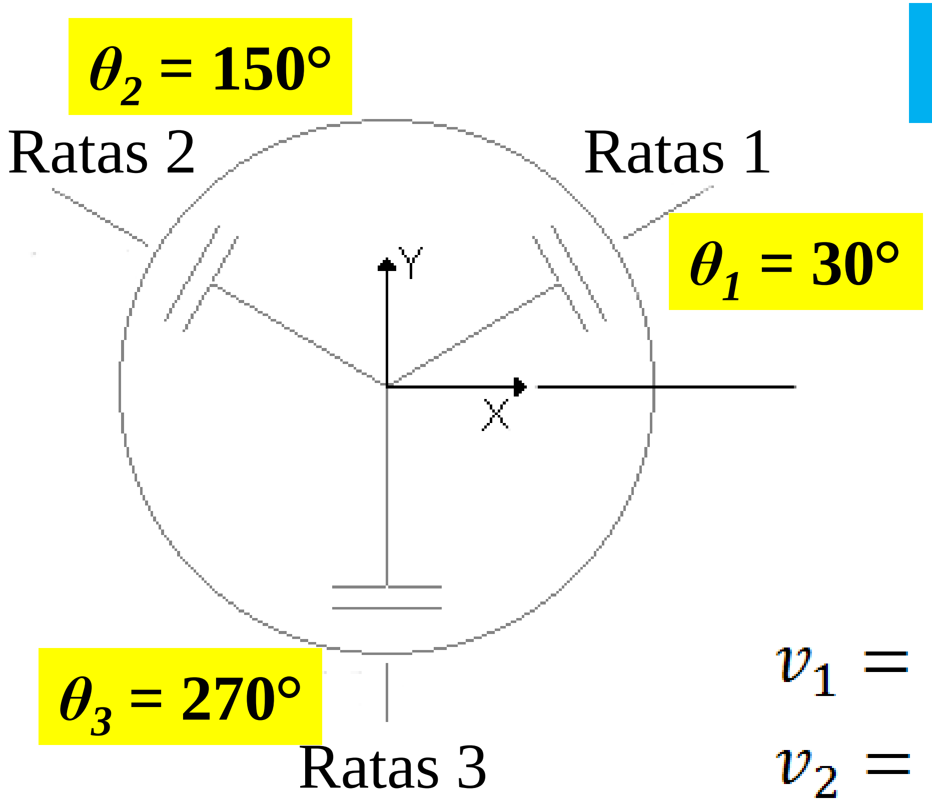
Matemaatika: näiteülesanne

- Olgu meil kolme *omni*-rattaga robot, mille rataste võllide vahelised nurgad on võrdsed.
- Millised peaks olema rataste kiirused, et liikuda sirgjoones 30-kraadise nurga all paremale kiirusega 1 m/s?



TARTU ÜLIKOOL

Matemaatika: lahendus (1)

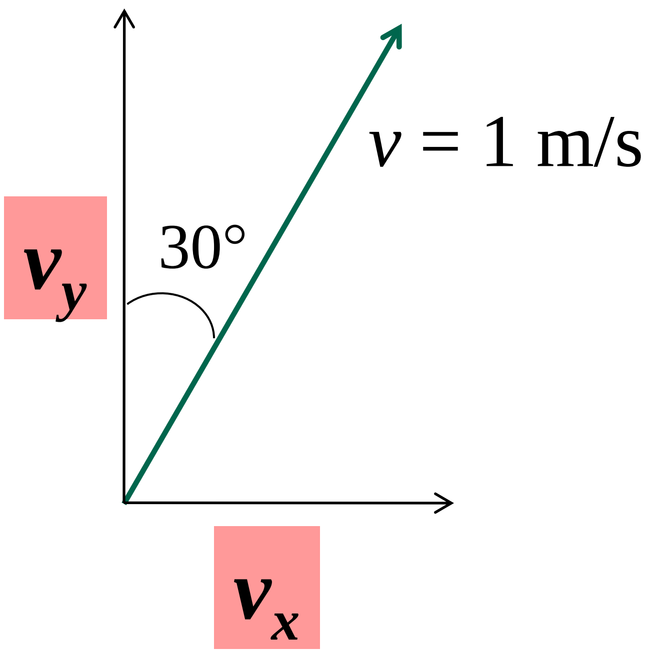


- Vaja leida v_1, v_2 ja v_3

Kuna $\omega = 0$, siis $R\omega = 0$

$$v_1 = -v_x \sin\theta_1 + v_y \cos\theta_1 + R\omega$$
$$v_2 = -v_x \sin\theta_2 + v_y \cos\theta_2 + R\omega$$
$$v_3 = -v_x \sin\theta_3 + v_y \cos\theta_3 + R\omega$$

Matemaatika: lahendus (2)



$$\boldsymbol{v}_x = \sin 30°$$
$$\boldsymbol{v}_y = \cos 30°$$

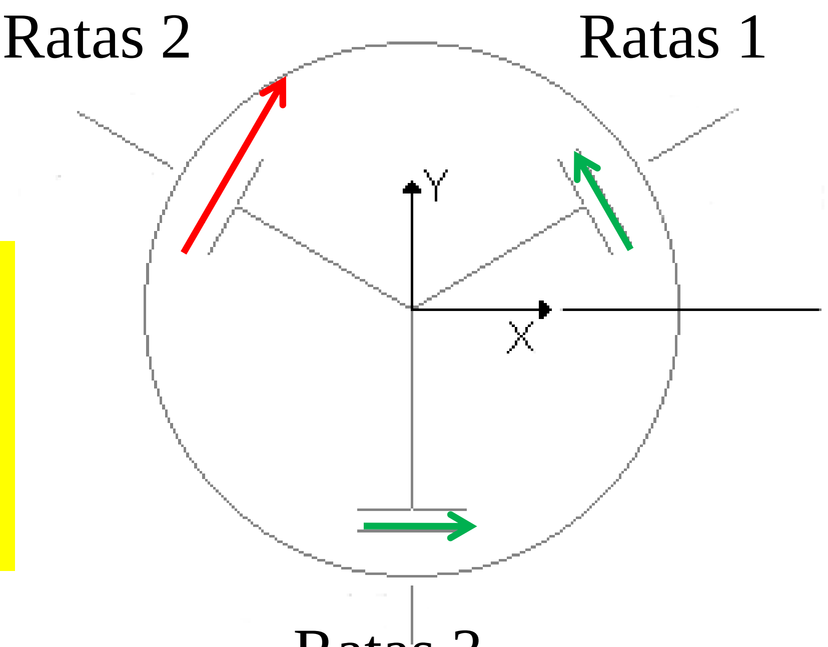
$$v_1 = -v_x \sin\theta_1 + v_y \cos\theta_1 + R\omega$$
$$v_2 = -v_x \sin\theta_2 + v_y \cos\theta_2 + R\omega$$
$$v_3 = -v_x \sin\theta_3 + v_y \cos\theta_3 + R\omega$$

Matemaatika: lahendus (3)

$$v_1 = -v_x \sin 30° + v_y \cos 30°$$
$$v_2 = -v_x \sin 150° + v_y \cos 150°$$
$$v_3 = -v_x \sin 270° + v_y \cos 270°$$

$$v_1 = -0{,}5\, v_x + 0{,}866\, v_y$$
$$v_2 = -0{,}5\, v_x - 0{,}866\, v_y$$
$$v_3 = v_x + 0\, v_y$$

$v_1 = 0{,}5$
$v_2 = -0{,}866$
$v_3 = 0{,}5$

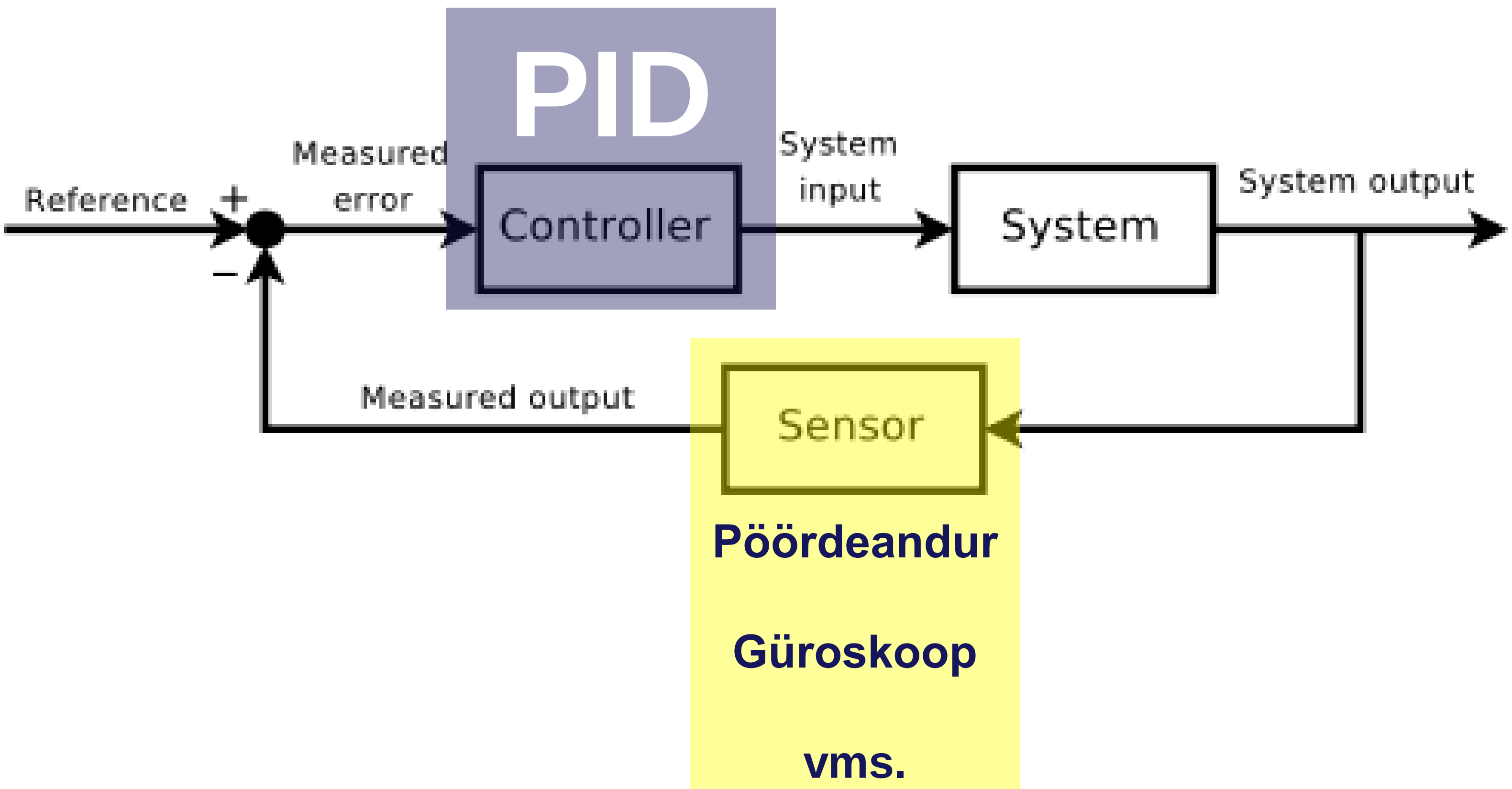


Teooria vs. praktika

- Ratta kiiruse v_i määramiseks pinge
  – Mootorid, rattad, ülekanded ei ole identsed
  – Polaarsus mõjutab draiverkivide väljundeid

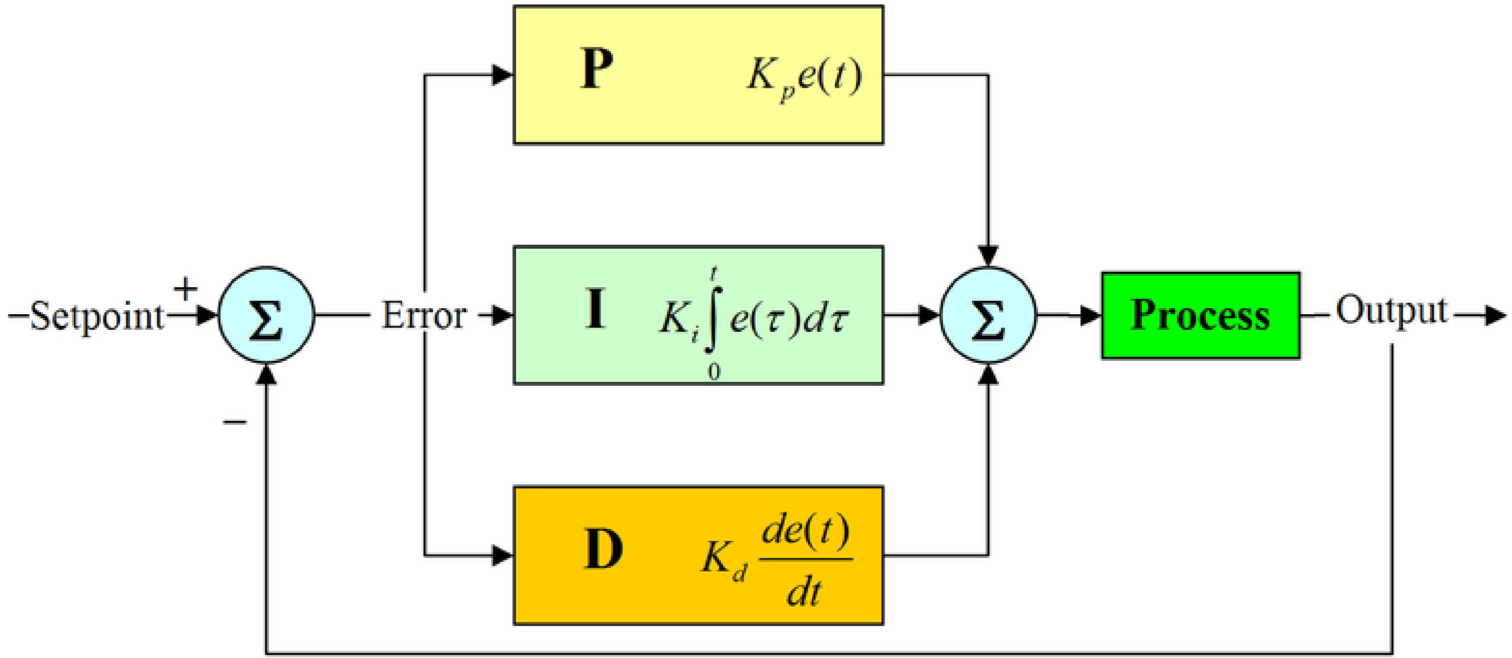
- Vaja kasutada tagasiside
  – Pöördeandurid ratastele
  – Güroskoop robotile

Tagasisidega juhtimine



PID kontroller

Proportsinaalne-**I**ntegreeriv-**D**iferentseeriv (**PID**) kontroller



PIDi näide pseudokoodis

```
previous_error = 0
integral = 0
start:
   error = desired_velocity - actual_velocity
   integral = integral + (error*dt)
   derivative = (error - previous_error)/dt
   output = (Kp*error) + (Ki*integral) + (Kd*derivative)
   previous_error = error
   wait(dt)
   goto start
```

Kus kasutada PIDi?

- Igal pool, kus vaja!

- Mootorite (rataste) kiiruste seadmisel
- Nurkkiiruse seadmisel
- Sõidutrajektoori määramisel

Loengu lõpp!

Küsimused?

$$\frac{d\,\text{Optimus}}{dx} =$$

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