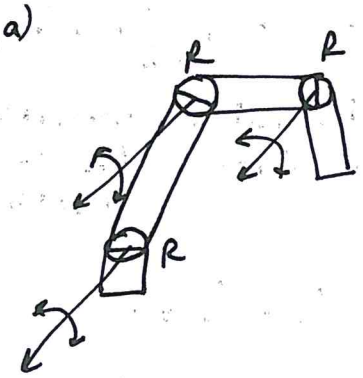
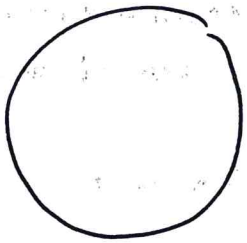
BLM4830 Robot Teknolojisine Giriş

1. Vize Cevaplar

13/4/2018

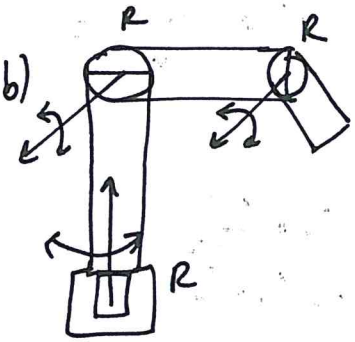
(1) a)

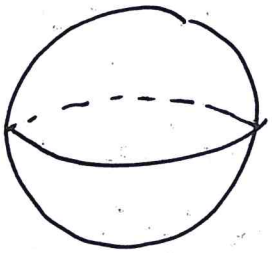




Düzlemsel Dairesel Çalışma alanı

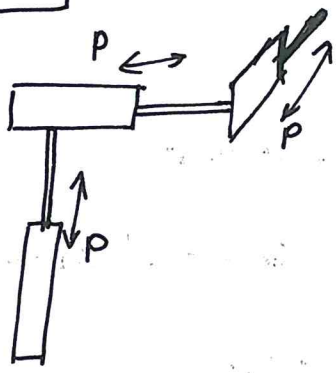
b)

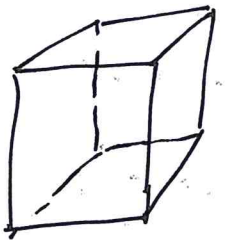




Küresel Çalışma alanı

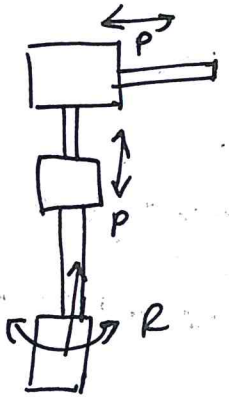
c)

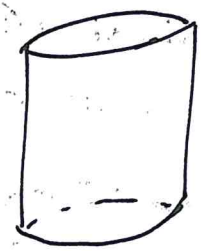




Kartezyen Çalışma alanı

d)





Silindirik Çalışma alanı

(2) a)
$$\begin{bmatrix} 1 & 0 & 0 & I_{ccx} \\ 0 & 1 & 0 & I_{ccy} \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \cos\theta & -\sin\theta & 0 & 0 \\ \sin\theta & \cos\theta & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \cos\alpha & -\sin\alpha & 0 & 0 \\ \sin\alpha & \cos\alpha & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & -R \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} c \\ 0 \\ 0 \\ 1 \end{bmatrix}$$

icc'den global orijine taşıma — ilk oryantasyondan kaynaklı düzeltme — w hızı ile t süre boyunca dönme — eksen tekrar icc'ye taşındı

b)
$$\left.\begin{aligned} V_L &= \left(R - \frac{b}{2}\right)w \\ V_R &= \left(R + \frac{b}{2}\right)w \end{aligned}\right\} \quad \left.\begin{aligned} V_L &= Rw - \frac{bw}{2} \\ V_R &= Rw + \frac{bw}{2} \end{aligned}\right\} \quad \begin{aligned} V_R - V_L &= bw \\ w &= \frac{V_R - V_L}{b} \end{aligned}$$

$$\alpha = t.w = t.\frac{(V_R - V_L)}{b}$$

c)
$$\left.\begin{aligned} V_L &= Rw - \frac{bw}{2} \\ V_R &= Rw + \frac{bw}{2} \end{aligned}\right\} \quad \left.\begin{aligned} V_L + V_R &= 2Rw \\ w &= \frac{V_R - V_L}{b} \end{aligned}\right\} \quad R = \frac{(V_L + V_R).b}{2(V_R - V_L)}$$

d) $V_L = V_R \} \; R \to \infty \;,\; \alpha \to 0$ — düz hareket

e) $V_L = -V_R \} \; R \to 0 \;,\; \alpha = \frac{2V_R}{b}$ — olduğu yerde dönme

(3)

$P(\text{siyah} \mid \text{koyu}) = 0.6$
$P(\text{beyaz} \mid \text{koyu}) = 0.4$
$P(\text{siyah} \mid \text{açık}) = 0.2$
$P(\text{beyaz} \mid \text{açık}) = 0.8$

sensör modeli

$P(x_i \mid x_{i-u}, u) = 0.6$
$P(x_i \mid x_{i-u+1}, u) = 0.2$
$P(x_i \mid x_{i-u-1}, u) = 0.2$

hareket modeli

a) $bel(x_i) = P(x_1) = P(x_2) = P(x_3) = P(x_4) = P(x_5) = \frac{1}{5} = 0.2$

b) $bel(x_i) = P(x_i \mid \text{beyaz}) = \frac{P(\text{beyaz} \mid x_i).P(x_i)}{P(\text{beyaz})} = \alpha.P(\text{beyaz} \mid x_i).P(x_i)$

$P(x_1 \mid \text{beyaz}) = 0.8 \times 0.2 \times \alpha = 0.16\alpha \longrightarrow 0.25$
$P(x_2 \mid \text{beyaz}) = 0.4 \times 0.2 \times \alpha = 0.08\alpha \longrightarrow 0.125$
$P(x_3 \mid \text{beyaz}) = 0.4 \times 0.2 \times \alpha = 0.08\alpha \longrightarrow 0.125$
$P(x_4 \mid \text{beyaz}) = 0.8 \times 0.2 \times \alpha = 0.16\alpha \longrightarrow 0.25$
$P(x_5 \mid \text{beyaz}) = 0.8 \times 0.2 \times \alpha = 0.16\alpha \longrightarrow 0.25$

$0.64\alpha = 1$ olmalı

$\alpha = 1/0.64$

c) $bel(x_i) = P(x_i|u) = \sum_j P(x_i|x_j,u) \cdot p(x_j)$ $\quad u=1$

$P(x_i|x_j,u)$

x_i \ x_j	x_1	x_2	x_3	x_4	x_5
x_1	0.2	0	0	0.2	0.6
x_2	0.6	0.2	0	0	0.2
x_3	0.2	0.6	0.2	0	0
x_4	0	0.2	0.6	0.2	0
x_5	0	0	0.2	0.6	0.2

$P(x_j)$: bir önceki sıktaki olasılıklar

$[0.25 \quad 0.125 \quad 0.125 \quad 0.25 \quad 0.25]$

$P(x_1|u=1) = 0.2 \times 0.25 + 0.2 \times 0.25 + 0.6 \times 0.25 = 0.25$

$P(x_2|u=1) = 0.6 \times 0.25 + 0.2 \times 0.125 + 0.2 \times 0.25 = 0.225$

$P(x_3|u=1) = 0.2 \times 0.25 + 0.6 \times 0.125 + 0.2 \times 0.125 = 0.15$

$P(x_4|u=1) = 0.2 \times 0.125 + 0.6 \times 0.125 + 0.2 \times 0.25 = 0.15$

$P(x_5|u=1) = 0.2 \times 0.125 + 0.6 \times 0.25 + 0.2 \times 0.25 = 0.225$

d) $bel(x_i) = P(x_i|beyaz) = \alpha P(beyaz|x_i) \cdot p(x_i)$

$P(x_1|beyaz) = 0.8 \times 0.25 \times \alpha = 0.2\alpha \longrightarrow 0.31$

$P(x_2|beyaz) = 0.4 \times 0.225 \times \alpha = 0.09\alpha \longrightarrow 0.14$

$P(x_3|beyaz) = 0.4 \times 0.15 \times \alpha = 0.06\alpha \longrightarrow 0.09$

$P(x_4|beyaz) = 0.8 \times 0.15 \times \alpha = 0.12\alpha \longrightarrow 0.18$

$P(x_5|beyaz) = 0.8 \times 0.225 \times \alpha = 0.18\alpha \longrightarrow 0.28$

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$0.65\alpha = 1$ olmalı

$\alpha = 1/0.65$

e) $bel(x_i) = P(x_i|u) = \sum_j p(x_i|x_j,u) \cdot p(x_j)$ $\quad u=2$

$p(x_i|x_j,u)$

x_i \ x_j	x_1	x_2	x_3	x_4	x_5
x_1	0	0	0.2	0.6	0.2
x_2	0.2	0	0	0.2	0.6
x_3	0.6	0.2	0	0	0.2
x_4	0.2	0.6	0.2	0	0
x_5	0	0.2	0.6	0.2	0

$P(x_j)$: bir önceki sıktaki olasılıklar

$[0.31 \quad 0.14 \quad 0.09 \quad 0.18 \quad 0.28]$

$P(x_1|u=2) = 0.2 \times 0.09 + 0.6 \times 0.18 + 0.2 \times 0.28 = 0.182$

$P(x_2|u=2) = 0.2 \times 0.31 + 0.2 \times 0.18 + 0.2 \times 0.28 = 0.266$

$P(x_3|u=2) = 0.6 \times 0.31 + 0.2 \times 0.14 + 0.2 \times 0.28 = 0.270$

$P(x_4|u=2) = 0.2 \times 0.31 + 0.6 \times 0.14 + 0.2 \times 0.09 = 0.164$

$P(x_5|u=2) = 0.2 \times 0.14 + 0.6 \times 0.09 + 0.2 \times 0.18 = 0.118$

f) $bel(x_i) = P(x_i|\text{beyaz}) = \alpha . P(\text{beyaz}|x_i) . P(x_i)$

$P(x_1|\text{beyaz}) = 0.8 \times 0.182 \times \alpha = 0.15\alpha \longrightarrow 0.249$

$P(x_2|\text{beyaz}) = 0.4 \times 0.266 \times \alpha = 0.11\alpha \longrightarrow 0.182$

$P(x_3|\text{beyaz}) = 0.4 \times 0.270 \times \alpha = 0.11\alpha \longrightarrow 0.184$

$P(x_4|\text{beyaz}) = 0.8 \times 0.164 \times \alpha = 0.13\alpha \longrightarrow 0.224$

$P(x_5|\text{beyaz}) = 0.8 \times 0.118 \times \alpha = 0.09\alpha \longrightarrow 0.161$

$+$

0.59α

$\alpha = 1/0.59$

(4) a) $\theta^+ = \theta + \frac{S}{R}$

b) $\theta_1 = \theta_0 + \frac{S}{R} = 0 + \frac{4}{3} = 1.33$ radyan

$\sigma_1^2 = \sigma_0^2 + \frac{\sigma_S^2}{R^2} = 4 + \frac{5}{9} = 4.55$

c) $\theta_2 = \frac{\sigma_{sensor}^2 . \theta_1 + \sigma_1^2 . \theta_{sensor}}{\sigma_{sensor}^2 + \sigma_1^2} = \frac{1.33 \times 3 + 2 \times 4.55}{3 + 4.55} = 1,73$ radyan

$\sigma_2^2 = \frac{\sigma_1^2 . \sigma_{sensor}^2}{\sigma_1^2 + \sigma_{sensor}^2} = \frac{4.55 \times 3}{4.55 + 3} = 1.81$

(5) Proprioceptive: Ortam ile robot arasındaki etkileşimi ölçer.
Enkoder, GPS

Exteroceptive: Ortama ilişkin doğrudan ölçümler
Kontaktswitch, range sensor

Interoceptive: Robotun iç işleyişi ile ilgili sensörler
Failure detection, battery level check

Active: Ölçüm için gerekli sinyali üreten sensör
Radar, sonar

Passive: Ortamda hazır bulunan sinyalleri kullanır
Kamera, Compass

Absolute: Sensörün sıfır referansı her yerde aynı
Absolute encoder

Relative: Sensörün sıfır referansı anlamlı değil
Incremental encoder