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Robmap

Ex03

02.11.17

UX

a.) prediction step: the previous state x_{t-1} and the current control u_t are computed using a certain motion/state transition model to ~~the~~^{estimate} the new state \tilde{x}_t

correction step: the estimated state \tilde{x}_t and the current observations z_t are computed using a observation/measurement model to calc a refined/corrected state estimation x_t

b.) $p(x_t | u_t, x_{t-1})$: state transition probability; probability density function of x_t given that control vector u_t and previous state x_{t-1} are the case

$p(z_t | x_t)$: measurement probability: prob. density function of the measurement z_t given that the current state x_t is the case

$bel(x_t)$: believe; probability density function ~~of current state x_t~~ calculated with accumulated $z_{1:t}$ and $u_{1:t}$ (sensor and control data). What's the probability that x_t is the case given current and past sensor and control data?

c.) ~~mean~~ $p(x_t | u_t, x_{t-1}) = p(x_t | u_t, \bar{\mu}_t) = \mathcal{N}(x_t | \bar{\mu}_t, \bar{\Sigma}_t)$

~~mean~~ $p(z_t | x_t) = \mathcal{N}(z_t | \mu_t, \Sigma_t)$

$bel(x_t) = \eta p(z_t | x_t) \int p(x_t | u_t, x_{t-1}) bel(x_{t-1}) dx_{t-1}$

d.) μ_t : mean value of current state estimate $n \times 1$

Σ_t : covariance of current state estimate $n \times n$

G_t^x : jacobian of motion model 3×3

G_t : jacobian of state transition model (motion + map) ~~mean~~ $n \times n$

R_t^x : covariance/uncertainty of motion model ~~mean~~ 3×3

R_t : gaussian noise added to state estimate of prediction step $n \times n$

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g : non-linear state transition function $n \times 1$

h : non-linear measurement function $m \times 1$

H_t : Jacobian of measurement model $m \times m$

Q_t : covariance / uncertainty of measurement model $m \times m$

K_t : Kalman gain; defines to which degree measurement is $m \times 1$ included into state estimation

U12

$$a.) \begin{pmatrix} x_t \\ y_t \\ \theta_t \end{pmatrix} = \begin{pmatrix} x_{t-1} + \delta_{trans} \cos(\theta_{t-1} + \delta_{rot1}) \\ y_{t-1} + \delta_{trans} \sin(\theta_{t-1} + \delta_{rot1}) \\ \theta_{t-1} + \delta_{rot1} + \delta_{rot2} \end{pmatrix}$$

$$G_t^x = \begin{pmatrix} 1 & 0 & -\delta_{trans} \sin(\theta_{t-1} + \delta_{rot1}) \\ 0 & 1 & \delta_{trans} \cos(\theta_{t-1} + \delta_{rot1}) \\ 0 & 0 & 1 \end{pmatrix}$$

$$b.) h(\bar{\mu}_{t,N}) = z_t^i = \begin{pmatrix} r_t^i \\ \phi_t^i \end{pmatrix} = \begin{pmatrix} \sqrt{(\bar{\mu}_{j,x} - \bar{\mu}_{t,x})^2 + (\bar{\mu}_{j,y} - \bar{\mu}_{t,y})^2} \\ \text{atan2}(\bar{\mu}_{j,y} - \bar{\mu}_{t,y}, \bar{\mu}_{j,x} - \bar{\mu}_{t,x}) - \mu_{t,\theta} \end{pmatrix}$$

$$\delta_x = \bar{\mu}_{j,x} - \bar{\mu}_{t,x} \quad \delta_y = \bar{\mu}_{j,y} - \bar{\mu}_{t,y} \quad q = \delta_x^2 + \delta_y^2$$

$$\text{low } H_t^i = \frac{1}{q} \begin{pmatrix} -\sqrt{q} \delta_x & -\sqrt{q} \delta_y & 0 & \sqrt{q} \delta_x & \sqrt{q} \delta_y \\ \delta_y & -\delta_x & q & -\delta_y & \delta_x \end{pmatrix}$$