

Extended Kalman Filter (EKF)

⇒ In most realistic problem, motion model and sensor model are not linear.

⇒ Let us consider a non linear motion model and sensor model:

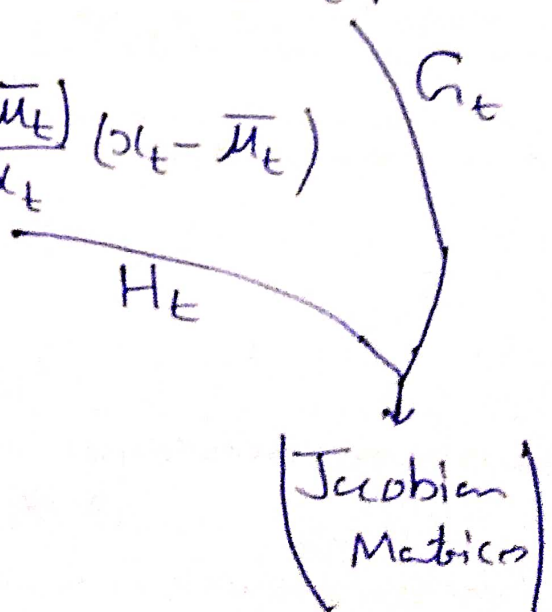
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$$\begin{aligned} x_t &= g(u_t, x_{t-1}) + \epsilon_t \\ z_t &= h(x_t) + \delta_t \end{aligned}$$

★ Linearization of motion & sensor model using First order Taylor Expansion

$$① \quad g(u_t, x_{t-1}) \approx g(u_t, \mu_{t-1}) + \frac{\partial g(u_t, \mu_{t-1})}{\partial x_{t-1}} (x_{t-1} - \mu_{t-1})$$

$$② \quad h(x_t) \approx h(\bar{\mu}_t) + \frac{\partial h(\bar{\mu}_t)}{\partial x_t} (x_t - \bar{\mu}_t)$$



★ Linearized Motion Model

$$P(x_t | u_t, x_{t-1})$$

$$= \det(2\pi R_t)^{-1} \exp \left(-\frac{1}{2} (x_t - g(u_t, \mu_{t-1}) - G_t(x_{t-1} - \mu_{t-1}))^T R_t^{-1} (x_t - g(u_t, \mu_{t-1}) - G_t(x_{t-1} - \mu_{t-1})) \right)$$

★ Linearized Observation Model

$$P(z_t | x_t) = \det(2\pi Q_t)^{-\frac{1}{2}}$$

$$\exp \left(-\frac{1}{2} (z_t - h(\bar{\mu}_t) - H_t(x_t - \bar{\mu}_t))^T Q_t^{-1} (z_t - h(\bar{\mu}_t) - H_t(x_t - \bar{\mu}_t)) \right)$$

★ Extended Kalman Filter Algorithm

① Extended-Kalman-Filter ($\mu_{t-1}, \Sigma_{t-1}, u_t, z_t$):

② $\bar{\mu}_t = g(u_t, \mu_{t-1})$

③ $\bar{\Sigma}_t = G_t \Sigma_{t-1} G_t^T + R_t$

④ $K_t = \bar{\Sigma}_t H_t^T (H_t \bar{\Sigma}_t H_t^T + Q_t)^{-1}$

⑤ $\mu_t = \bar{\mu}_t + K_t (z_t - h(\bar{\mu}_t))$

⑥ $\Sigma_t = (I - K_t H_t) \bar{\Sigma}_t$

⑦ return μ_t, Σ_t