Kalman filter

Motion model:

$$\begin{cases} x_t = x_{t-1} + V_t \cos(\theta_{t-1})dt \\ y_t = y_{t-1} + V_t \sin(\theta_{t-1})dt \\ \theta_t = \theta_{t-1} + \omega_t dt \\ V_t^x = V_t \cos(\theta_{t-1} + \omega_t dt) \\ V_t^y = V_t \sin(\theta_{t-1} + \omega_t dt) \\ \omega_t^\theta = \omega_t \end{cases}$$

$$G = \begin{bmatrix} 1 & 0 & -V_t \sin(\theta_{t-1})dt & 0 & 0 & 0 \\ 0 & 1 & V_t \cos(\theta_{t-1})dt & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & -V_t \sin(\theta_{t-1}) & 0 & 0 & 0 \\ 0 & 0 & V_t \cos(\theta_{t-1}) & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \end{bmatrix}$$

$$\begin{cases} x_t = x_{t-1} + \frac{V_t}{\omega_t}\left(\sin(\theta_{t-1} + \omega_t dt) - \sin(\theta_{t-1})\right) \\ y_t = y_{t-1} + \frac{V_t}{\omega_t}\left(-\cos(\theta_{t-1} + \omega_t dt) + \cos(\theta_{t-1})\right) \\ \theta_t = \theta_{t-1} + \omega_t dt \\ V_t^x = V_t \cos(\theta_{t-1} + \omega_t dt) \\ V_t^y = V_t \sin(\theta_{t-1} + \omega_t dt) \\ \omega_t^\theta = \omega_t \end{cases}$$

$$G = \begin{bmatrix} 1 & 0 & \frac{V_t}{\omega_t}\left(\cos(\theta_{t-1} + \omega_t dt) - \cos(\theta_{t-1})\right) & 0 & 0 & 0 \\ 0 & 1 & \frac{V_t}{\omega_t}\left(\sin(\theta_{t-1} + \omega_t dt) - \sin(\theta_{t-1})\right) & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & -V_t \sin(\theta_{t-1}) & 0 & 0 & 0 \\ 0 & 0 & V_t \cos(\theta_{t-1}) & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \end{bmatrix}$$

Sensor model:

$$h = \begin{bmatrix} \theta_t \\ \frac{V_t^x}{\cos(\theta_t)} \\ \omega_t^\theta \end{bmatrix}$$

$$H = \begin{bmatrix} 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & \frac{V_t^x \sin(\theta_t)}{\cos(\theta_t)^2} & \frac{1}{\cos(\theta_t)} & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix}$$