UPDATE

LASER OR RADAR ?

LASER

Set up LASER MATRICES

Note: The Laser gives us linear measurements so we can use standard KF

$$H_{(2\times4)} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \end{bmatrix}$$

$$y_{(2\times1)} = z_{(2\times1)} - H_{(2\times4)} \cdot x'_{(4\times1)}$$

$$R_{(2\times2)} = \begin{bmatrix} 0.0225 & 0 \\ 0 & 0.0225 \end{bmatrix}$$

measurement covariance matrix (given by manufacturer)

Note: $R = \begin{bmatrix} \sigma_{px}^2 & 0 \\ 0 & \sigma_{py}^2 \end{bmatrix}$ for Laser

$$S_{(2\times2)} = H_{(2\times4)} P_{(4\times4)} H^T_{(4\times2)} + R_{(2\times2)}$$

$$K_{(4\times2)} = P_{(4\times4)} \cdot H^T_{(4\times2)} \cdot S^{-1}_{(2\times2)}$$

$$x'_{(4\times1)} = x_{(4\times1)} + (K_{(4\times2)} \cdot y_{(2\times1)})$$

$$P'_{(4\times4)} = (I_{(4\times4)} - K_{(4\times2)} H_{(2\times4)}) \cdot P_{(4\times4)}$$

$$S_{(3\times3)} = H_{(3\times4)} P_{(4\times4)} H^T_{(4\times3)} + R_{(3\times3)}$$

$$K_{(4\times3)} = P_{(4\times4)} H^T_{(4\times3)} \cdot S^{-1}_{(3\times3)}$$

$$x'_{(4\times1)} = x'_{(4\times1)} + (K_{(4\times3)} \cdot y_{(3\times1)})$$

$$P'_{(4\times4)} = (I_{(4\times4)} - K_{(4\times3)} H_{(3\times4)}) \cdot P_{(4\times4)}$$

RADAR

Set up Radar Matrices

Note: The radar has not a linear output Therefore we need to use a linear aproximation and that implies using EKF meaning that H changes in every situation:

$$h(x') = \begin{pmatrix} \sqrt{px'^2 + py'^2} \\ \arctan(py/px) \\ \frac{px'vx' + py'vy'}{\sqrt{px'^2 + py'^2}} \end{pmatrix}$$

$$y_{(3\times1)} = z_{(3\times1)} - h(x')_{(3\times1)}$$

$$H_{j\,(3\times4)} = \begin{bmatrix} \frac{px}{\sqrt{px^2+py^2}} & \frac{py}{\sqrt{px^2+py^2}} & 0 & 0 \\ -\frac{py}{px^2+py^2} & \frac{px}{px^2+py^2} & 0 & 0 \\ \frac{py(vxpy - vypx)}{(px^2+py^2)^{3/2}} & \frac{px(vypx - vxpy)}{(px^2+py^2)^{3/2}} & \frac{px}{\sqrt{px^2+py^2}} & \frac{py}{\sqrt{px^2+py^2}} \end{bmatrix}$$

$$R_{(3\times3)} = \begin{bmatrix} 0.09 & 0 & 0 \\ 0 & 0.0009 & 0 \\ 0 & 0 & 0.09 \end{bmatrix}$$

given by manufacturer

Note: $R = \begin{bmatrix} \sigma_\rho^2 & 0 & 0 \\ 0 & \sigma_\phi^2 & 0 \\ 0 & 0 & \sigma_{\dot\rho}^2 \end{bmatrix}$ for Radar