Autonomous Mobile Robots

Exercise 5: EKF Simultaneous Localization And Mapping (SLAM)

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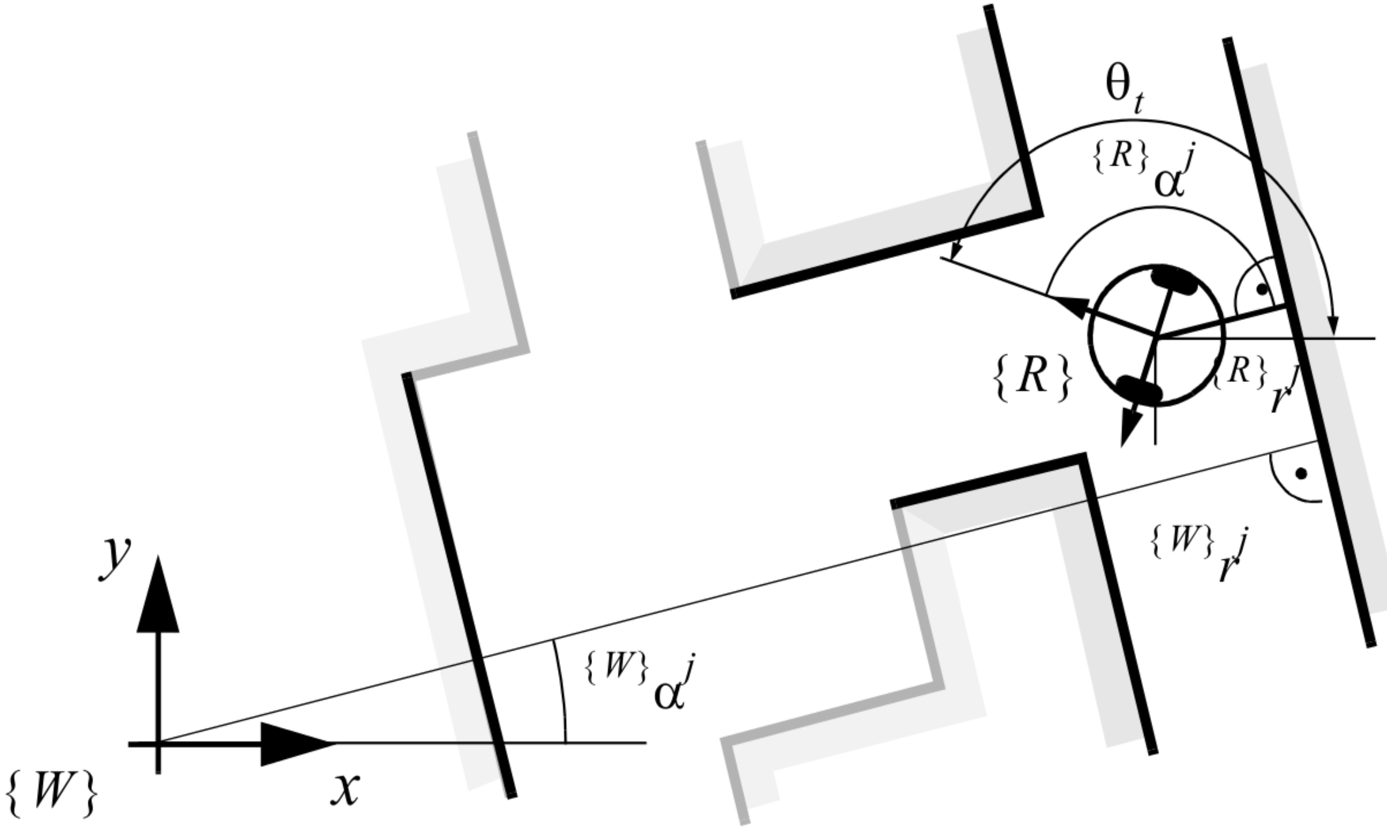
EKF SLAM



$$\hat{x}_t = \begin{bmatrix} \hat{x}_t \\ \hat{y}_t \\ \hat{\theta}_t \end{bmatrix}$$

EKF SLAM

Prediction

State Propagation

$$\hat{\mathbf{x}} = f(\mathbf{x}_{t-1}, \mathbf{u}_t)$$

Covariance Propagation

$$\mathbf{P}_t = \mathbf{F}_{\mathbf{x}} \mathbf{P}_{t-1} \mathbf{F}_{\mathbf{x}}^\top + \mathbf{F}_{\mathbf{u}} \mathbf{Q}_t \mathbf{F}_{\mathbf{u}}^\top$$

Update

Measurement

$$\hat{z}^j = \begin{bmatrix} \hat{\alpha}^j \\ \hat{r}_j \end{bmatrix} = h^j(\hat{x}, m^j)$$

Update

$$\mathbf{P}_t = (\mathbf{I} - \mathbf{K}\mathbf{H})\mathbf{P}_{t-1}$$

$$\mathbf{x}_t = \hat{\mathbf{x}}_{t-1} + \mathbf{K}\mathbf{v}$$

EKF SLAM

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Prediction

1

State Propagation

$$\hat{\mathbf{x}} = f(\mathbf{x}_{t-1}, \mathbf{u}_t)$$

Covariance Propagation

$$\mathbf{P}_t = \mathbf{F}_\mathbf{x} \mathbf{P}_{t-1} \mathbf{F}_\mathbf{x}^\top + \mathbf{F}_\mathbf{u} \mathbf{Q}_t \mathbf{F}_\mathbf{u}^\top$$

Update

Measurement

$$\hat{z}^j = \begin{bmatrix} \hat{\alpha}^j \\ \hat{r}_j \end{bmatrix} = h^j(\hat{x}, m^j)$$

Update

$$\mathbf{P}_t = (\mathbf{I} - \mathbf{K}\mathbf{H})\mathbf{P}_{t-1}$$

$$\mathbf{x}_t = \hat{\mathbf{x}}_{t-1} + \mathbf{K}\mathbf{v}$$

EKF SLAM

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Prediction

State Propagation

$$\hat{\mathbf{x}} = f(\mathbf{x}_{t-1}, \mathbf{u}_t)$$

Covariance Propagation

$$\mathbf{P}_t = \mathbf{F}_\mathbf{x}\mathbf{P}_{t-1}\mathbf{F}_\mathbf{x}^\top + \mathbf{F}_\mathbf{u}\mathbf{Q}_t\mathbf{F}_\mathbf{u}^\top$$

Update

Measurement

$$\hat{z}^j = \begin{bmatrix} \hat{\alpha}^j \\ \hat{r}_j \end{bmatrix} = h^j(\hat{x}, m^j)$$

2

Update

$$\mathbf{P}_t = (\mathbf{I} - \mathbf{K}\mathbf{H})\mathbf{P}_{t-1}$$

$$\mathbf{x}_t = \hat{\mathbf{x}}_{t-1} + \mathbf{K}\mathbf{v}$$

EKF SLAM

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3

Prediction

State Propagation

$$\hat{\mathbf{x}} = f(\mathbf{x}_{t-1}, \mathbf{u}_t)$$

Covariance Propagation

$$\mathbf{P}_t = \mathbf{F}_{\mathbf{x}} \mathbf{P}_{t-1} \mathbf{F}_{\mathbf{x}}^\top + \mathbf{F}_{\mathbf{u}} \mathbf{Q}_t \mathbf{F}_{\mathbf{u}}^\top$$

Update

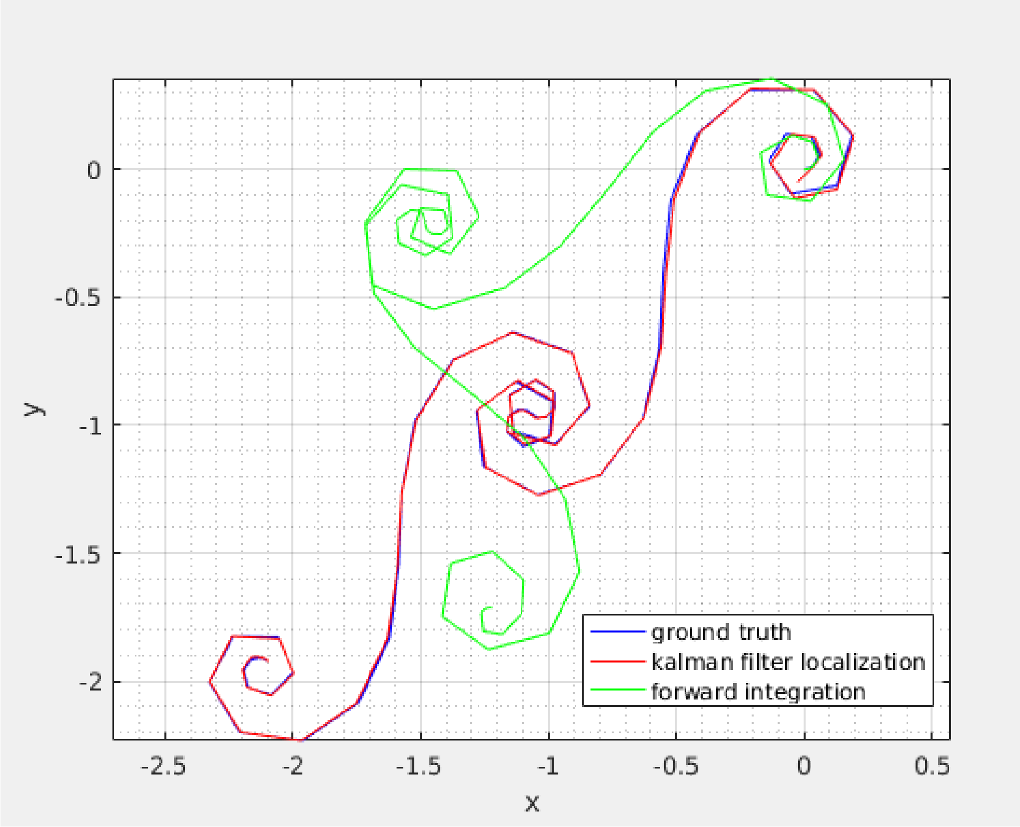
Measurement

$$\hat{z}^j = \begin{bmatrix} \hat{\alpha}^j \\ \hat{r}_j \end{bmatrix} = h^j(\hat{x}, m^j)$$

Update

$$\mathbf{P}_t = (\mathbf{I} - \mathbf{K}\mathbf{H})\mathbf{P}_{t-1}$$
$$\mathbf{x}_t = \hat{\mathbf{x}}_{t-1} + \mathbf{K}\mathbf{v}$$

Expected EKF SLAM solution



V-Rep Simulation