AUTONOMOUS SYSTEMS
2018/2019

EKF-SLAM (3)
With ITER + visual markers

Grupo 4
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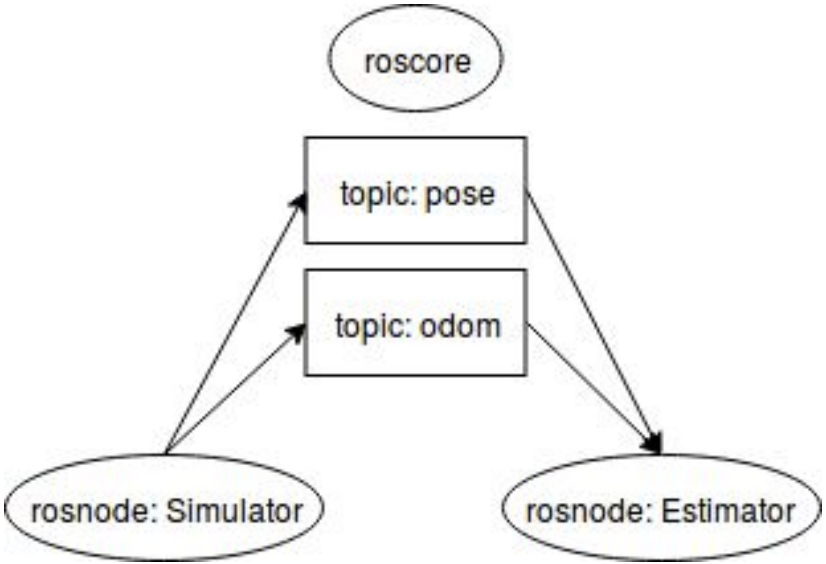
Updates so far

- We have implemented the motion model using the simulator



Models for EKF implementation

$$\mathcal{R} = \begin{bmatrix} x \\ y \\ \theta \end{bmatrix}$$

- The robot moves according to the control signal (u) and the noise (n) - **Prediction**

$$\boxed{\mathcal{R} \leftarrow f(\mathcal{R}, \mathbf{u}, \mathbf{n})}$$ Motion Model

- Observes landmarks previously observed through it’s sensors (S) - **Correction**

$$\mathbf{y}_i = h(\mathcal{R}, \mathcal{S}, \mathcal{L}_i)$$

- Observes new landmarks

$$\mathcal{L}_j = g(\mathcal{R}, \mathcal{S}, \mathbf{y}_j)$$

The map

$$\mathcal{R} = \begin{bmatrix} x \\ y \\ \theta \end{bmatrix}$$

$$\mathbf{x} = \begin{bmatrix} \mathcal{R} \\ \mathcal{M} \end{bmatrix} = \begin{bmatrix} \mathcal{R} \\ \mathcal{L}_1 \\ \vdots \\ \mathcal{L}_n \end{bmatrix}$$

- The goal is to keep this map updated
- Observations of the same landmark, model the position of the landmarks and robot's pose
- New observations expand the map

$$\bar{\mathbf{x}} = \begin{bmatrix} \overline{\mathcal{R}} \\ \overline{\mathcal{M}} \end{bmatrix} = \begin{bmatrix} \overline{\mathcal{R}} \\ \overline{\mathcal{L}}_1 \\ \vdots \\ \overline{\mathcal{L}}_n \end{bmatrix}$$

$$\mathbf{P} = \begin{bmatrix} \mathbf{P}_{\mathcal{R}\mathcal{R}} & \mathbf{P}_{\mathcal{R}\mathcal{M}} \\ \mathbf{P}_{\mathcal{M}\mathcal{R}} & \mathbf{P}_{\mathcal{M}\mathcal{M}} \end{bmatrix} = \begin{bmatrix} \mathbf{P}_{\mathcal{R}\mathcal{R}} & \mathbf{P}_{\mathcal{R}\mathcal{L}_1} & \cdots & \mathbf{P}_{\mathcal{R}\mathcal{L}_n} \\ \mathbf{P}_{\mathcal{L}_1\mathcal{R}} & \mathbf{P}_{\mathcal{L}_1\mathcal{L}_1} & \cdots & \mathbf{P}_{\mathcal{L}_1\mathcal{L}_n} \\ \vdots & \vdots & \ddots & \vdots \\ \mathbf{P}_{\mathcal{L}_n\mathcal{R}} & \mathbf{P}_{\mathcal{L}_n\mathcal{L}_1} & \cdots & \mathbf{P}_{\mathcal{L}_n\mathcal{L}_n} \end{bmatrix}$$

Predictation of location

$$\overline{\mathbf{x}} \leftarrow f(\overline{\mathbf{x}}, \mathbf{u}, 0)$$
$$\mathbf{P} \leftarrow \mathbf{F_x}\mathbf{P}\mathbf{F_x}^\top + \mathbf{F_n}\mathbf{N}\mathbf{F_n}^\top$$

$$\mathbf{F_x} = \begin{bmatrix} \frac{\partial f_{\mathcal{R}}}{\partial \mathcal{R}} & 0 \\ 0 & \mathbf{I} \end{bmatrix} \qquad \mathbf{F_n} = \begin{bmatrix} \frac{\partial f_{\mathcal{R}}}{\partial \mathbf{n}} \\ 0 \end{bmatrix}$$

Questions

- How to define the noise created by the robot?

- How to determine the robots angle based on the wheels? How many degrees of freedom?