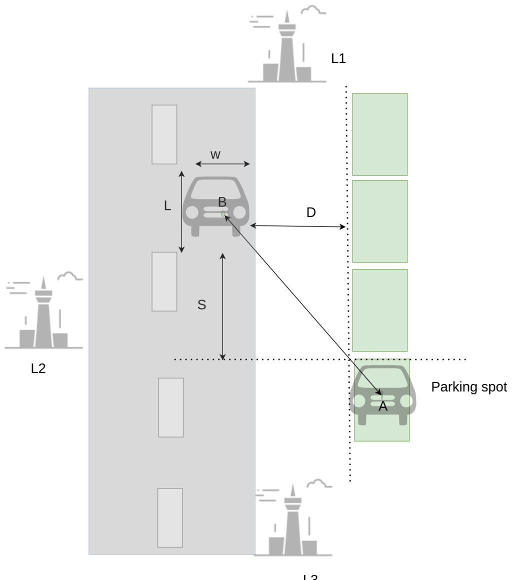
Control of Mobile Robots // Homework 04

Task: Particle filter using EKF for local linearization



Problem Description

- Landmark locations: L1 (5, 30), L2 (5, -30), and L3 (-5, 0), which can be seen by the sensor attached to car. Sensor readings are obtained in the following way

$$\underbrace{\begin{bmatrix} r_t^i \\ \theta_t^i \end{bmatrix}}_{z_t^i} = \underbrace{\begin{pmatrix} \sqrt{(m_{j,x} - x)^2 + (m_{j,y} - y)^2} \\ atan2(m_{j,y} - y, m_{j,x} - x) - \theta \end{pmatrix}}_{h(x_{t,j,m})} + N(0, R), \tag{1}$$

where $m_{j,x}, m_{j,y}$ denotes the coordinate of the jth landmark that detected at time t. The optimal robot current location estimation, the vehicle heading angle, and each sensor white noise reading are given by $\mathbf{x}_{t,x}^- = x, \mathbf{x}_{t,y}^- = y$, θ, and $R = \begin{bmatrix} \sigma_r^2 & 0 \\ 0 & \sigma_r^2 \end{bmatrix}$, respectively.

Particle filter using EKF for local linearization

Problem Description

In this homework, a particular implementation of a Particle filter where the Importance Density is derived from local linearization made independently for each particle with the use of an Extended Kalman filter is considered.

- Generate N number of random samples for the initial robot state estimation using Gaussian distribution around the start location
- Apply EKF prediction and correction steps for each particle
- Define reasonable logic for generating weights w for each particle
- It is not necessary to resample particles in every iteration. Use the following condition to decide when to resample particles $\frac{1}{\Sigma w^2} < \delta$, where δ is some threshold value

Particle filter using EKF for local linearization

Problem Description

- When $\frac{1}{\Sigma w^2} < \delta$ condition is satisfied, applying to resample followed by importance sampling
- Estimate the robot's state using the selected particles
- Repeat the listed steps, except the first step
- Location A has to be obtained using the given information, where lateral and longitudinal displacement, denoted by D and S, respectively.
- You can make assumptions about this robot vehicle parameters, including width W and length L

- When formulating the control strategy, you may use Dubins path planning (or you can drive the trajectory analytically)
- Derive an expression for the motion model that is based on the kinematic model you decided to use
- Derive an expression for the sensor model that is based on the problem description
- Plot the estimated robot position over the time
- Your submission should include **the report** and the **source code**