CS 458 Assignment 2: Motion Model & Landmark Detection

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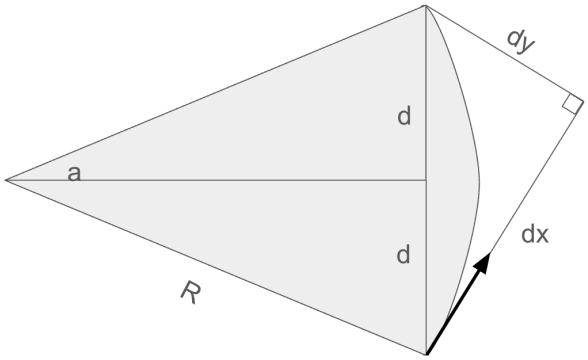
I. Odometry

Given robot pose at the previous time step $l_{t-1} = (x_{t-1}, y_{t-1}, \theta_{t-1})$ and robot state at the current time step $s_t = (v, w)$, find the robot pose at the current time step $l_t = (x_t, y_t, \theta_t)$. To do this, we can assume that the robot is always moving in an arc.



$$
\begin{aligned}
a &= w * \Delta t \\
d &= \begin{cases} v * \Delta t & a = 0 \\ \frac{v*\Delta t}{2} * \sin\left(\frac{a}{2}\right) & a \neq 0 \end{cases} \\
\Delta x &= d \cos\left(\frac{a}{2}\right) \\
\Delta y &= d \sin\left(\frac{a}{2}\right) \\
x_t &= x_{t-1} + \Delta x \cos(\theta_{t-1}) - \Delta y \sin(\theta_{t-1}) \\
y_t &= y_{t-1} + \Delta x \sin(\theta_{t-1}) + \Delta y \cos(\theta_{t-1}) \\
\theta_t &= \theta_{t-1} + a
\end{aligned}
$$

II. Result

According to Fig. 1., initially, the robot position was very close to the ground truth. As time goes, the motion model prediction start getting less and less accurate due to the sensor noise and errors accumulate over time.

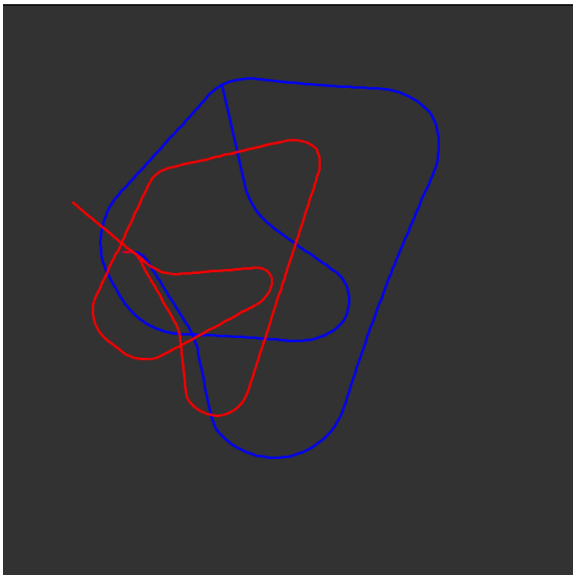
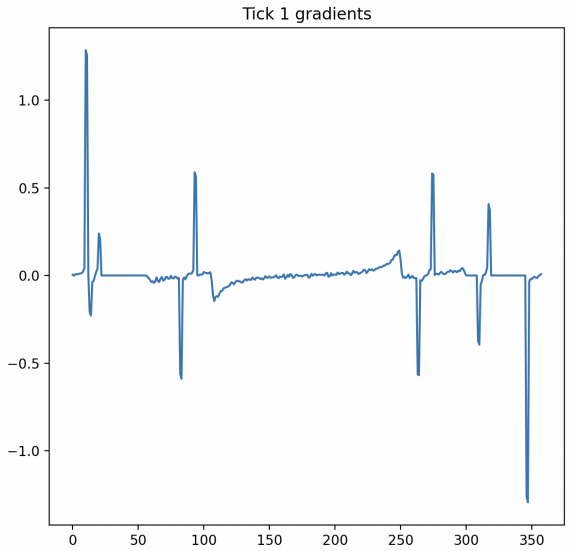
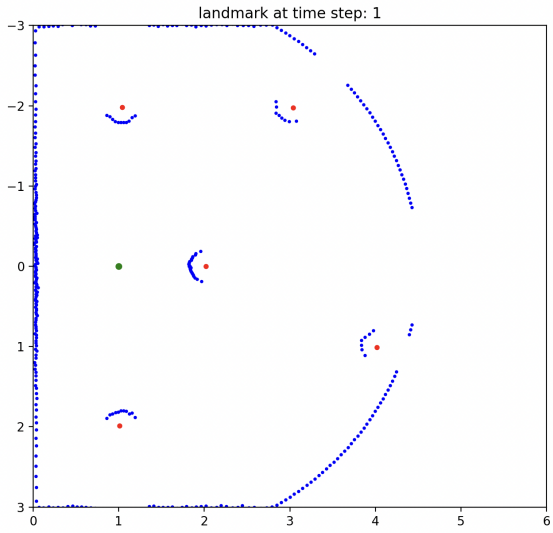


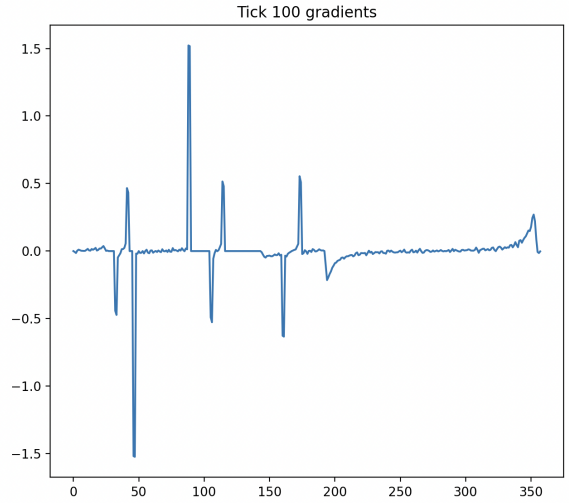
Fig. 1: Blue: Ground Truth, Red: Motion Model Prediction


Tick 1 gradients

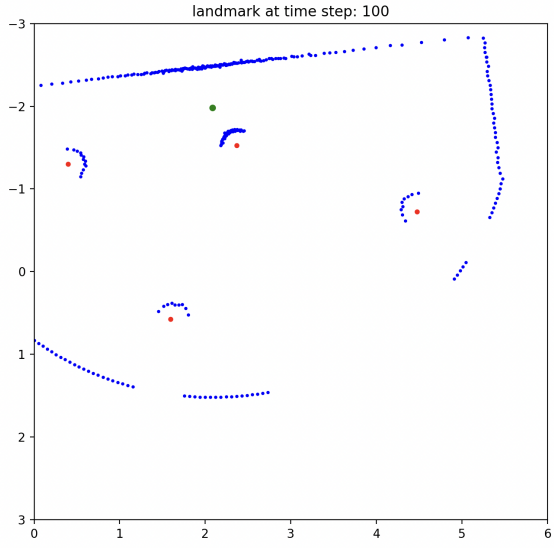
(a) a


landmark at time step: 1

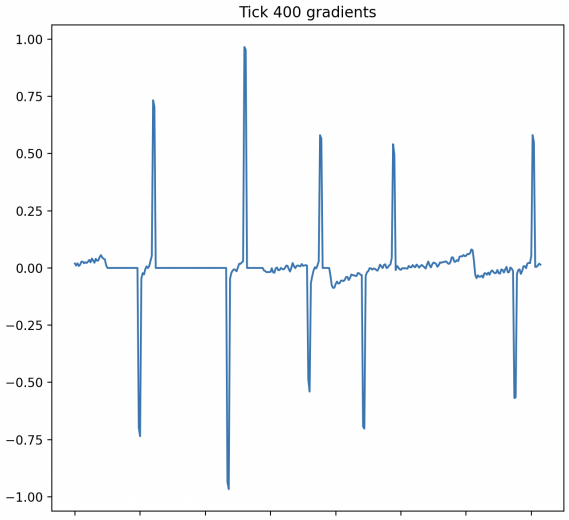
(b) b

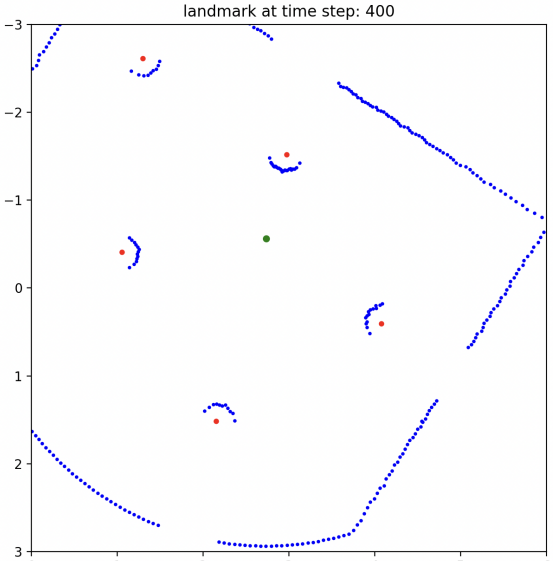

Tick 100 gradients

(c) c


landmark at time step: 100

(d) d


Tick 400 gradients


landmark at time step: 400

IV. Landmark matching