Lab 1: Introduction to the Matlab Robotics System Toolbox and Gazebo Turtlebot simulator

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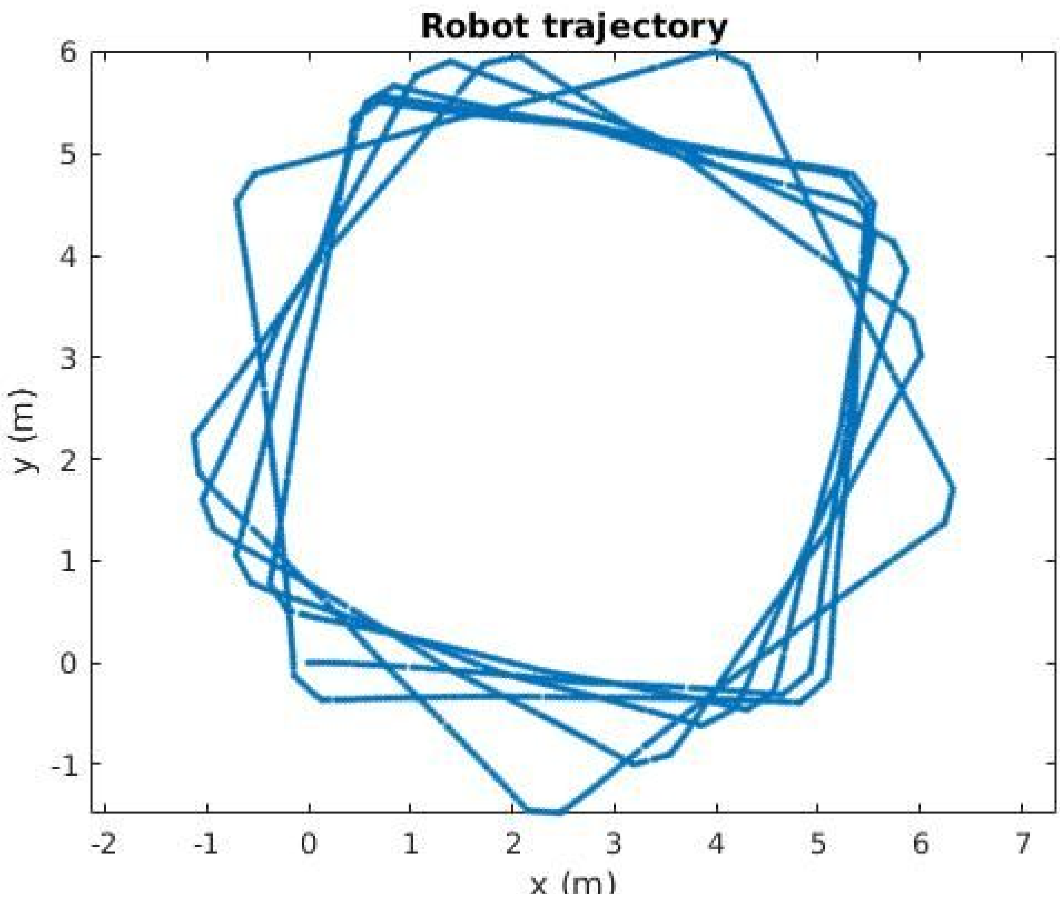
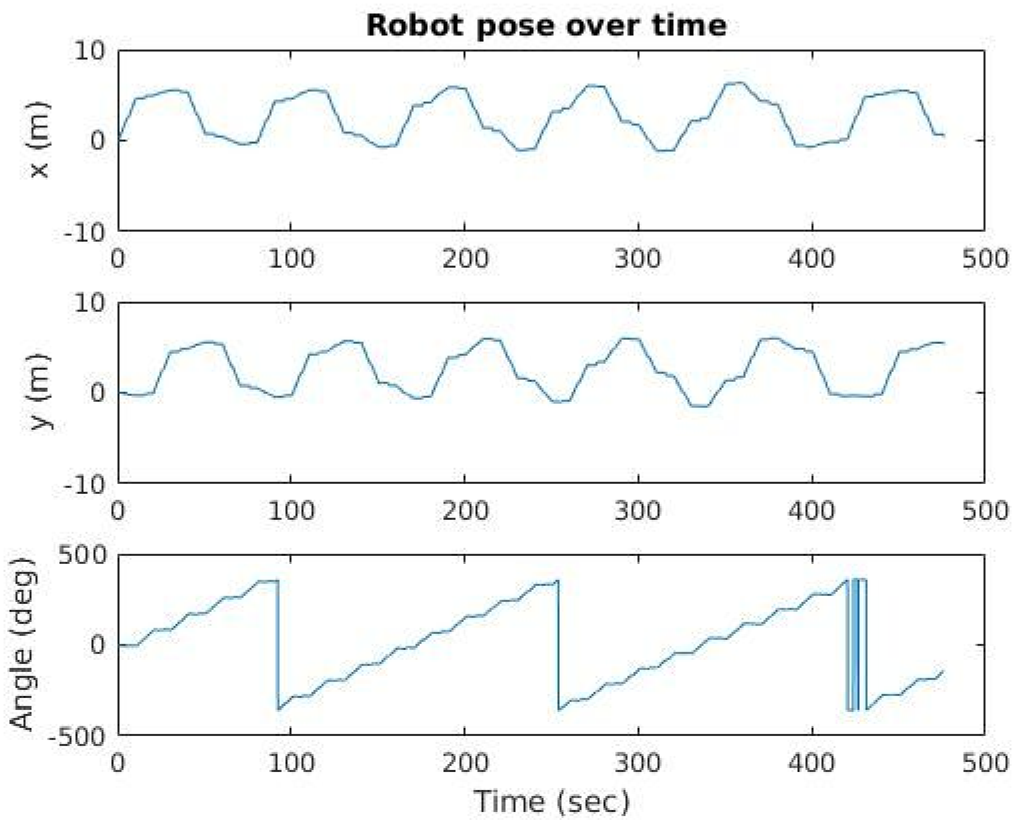
Assignment 1: Moving in a square -- open-loop

The resulting plot





Discussions

- Q1: What do you observe? How well does the robot follow the desired path?
    - For the open-loop control, the actual path for the robot is not as expected. The robot cannot make a precise turn without and feedback control. So every time after it turns, there is some random error generated, which should not appear. Moreover, when the robot is expected to go straight, it often go a little bit left or right on its path, which can be considered as some kind of noise. In all, as shown on the two figure above, the robot does not follow the desired path very well and it turns out some random error both on its line speed and its rotational speed.
- Q2: What are the reasons for my observation?
    - The open-loop control does not have any feedback structure in the system. As a result, the error caused by the mechanism as well as the environment noise (wind, unflat, etc...) will unavoidably affect the running path of the

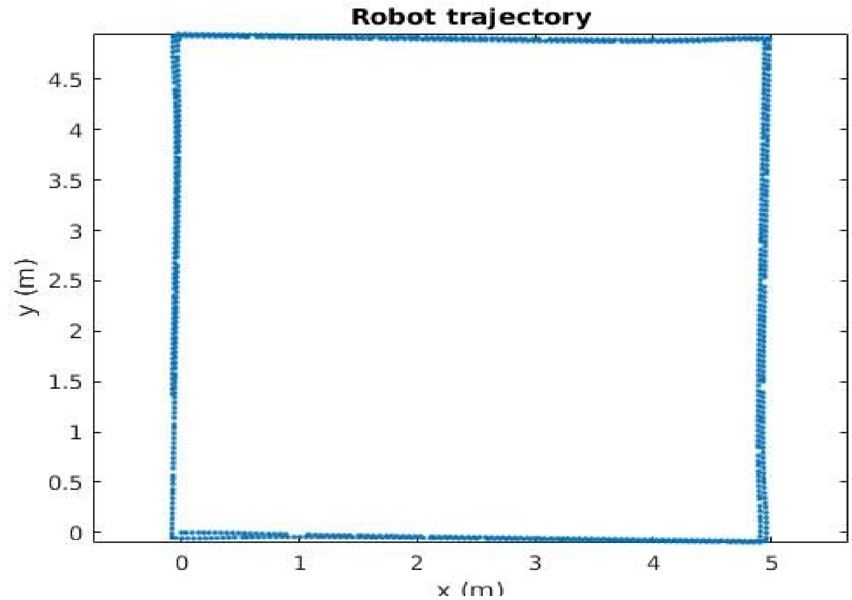
robot, and in the end the robot will not exactly follow its desired path any more.

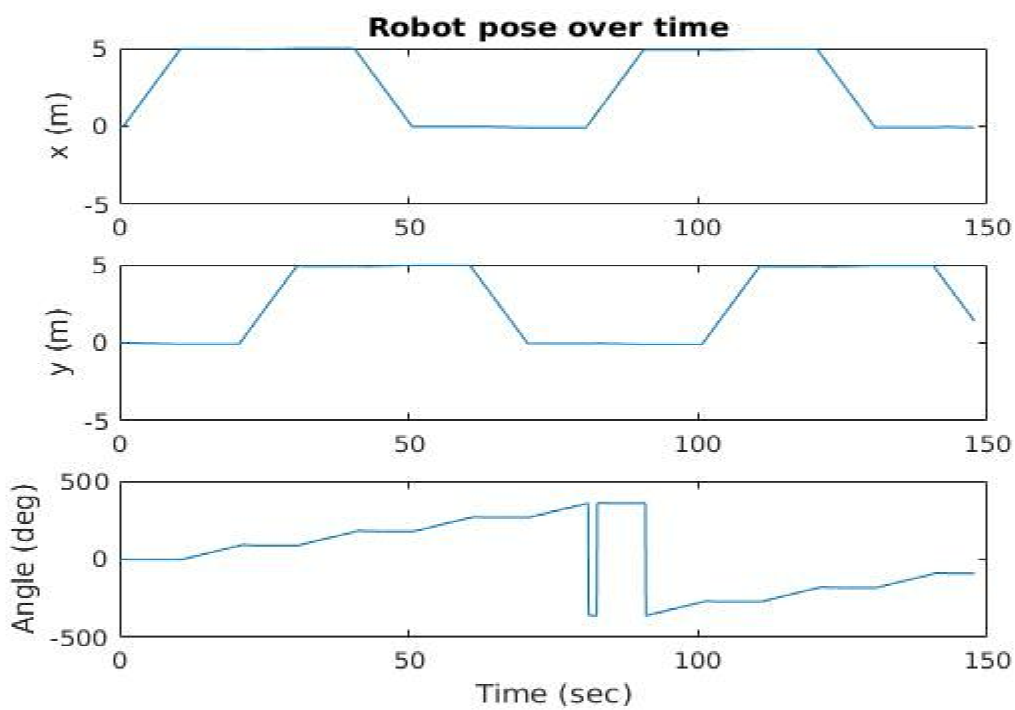
- Solution:
    - To avoid such issue, I need to deploy some feedback control to eliminate the side-effect of both the mechanical and the environmental changes. In other words, a close-loop control is a necessity to address such issue.

Assignment 2: Moving in a square -- closed-loop

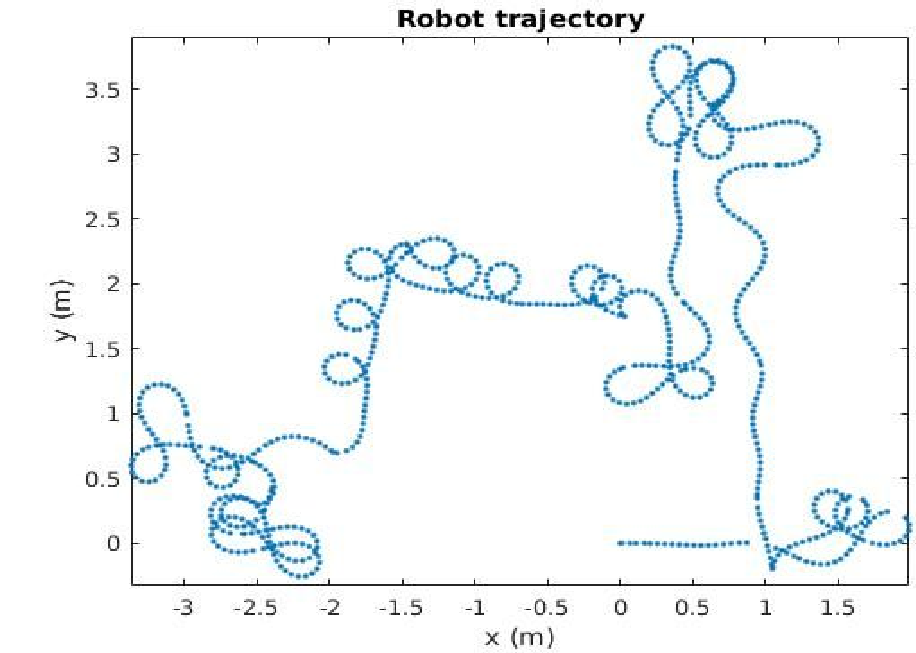
PartA. P Control with Kp = 0.8 (my optimal result)

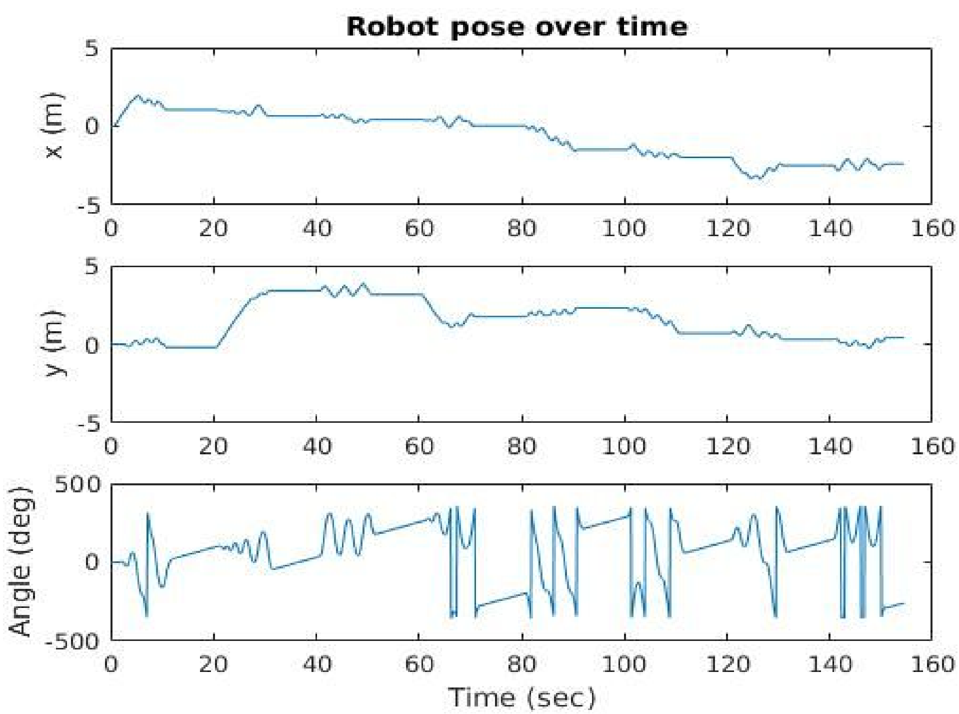
The resulting plot



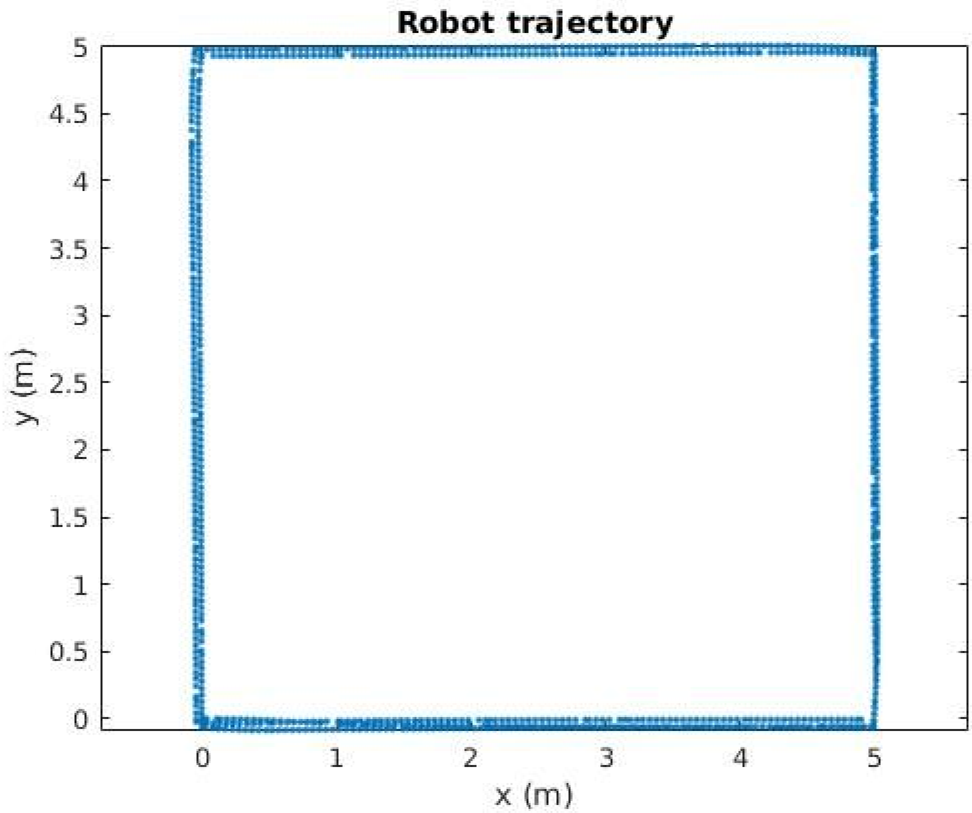


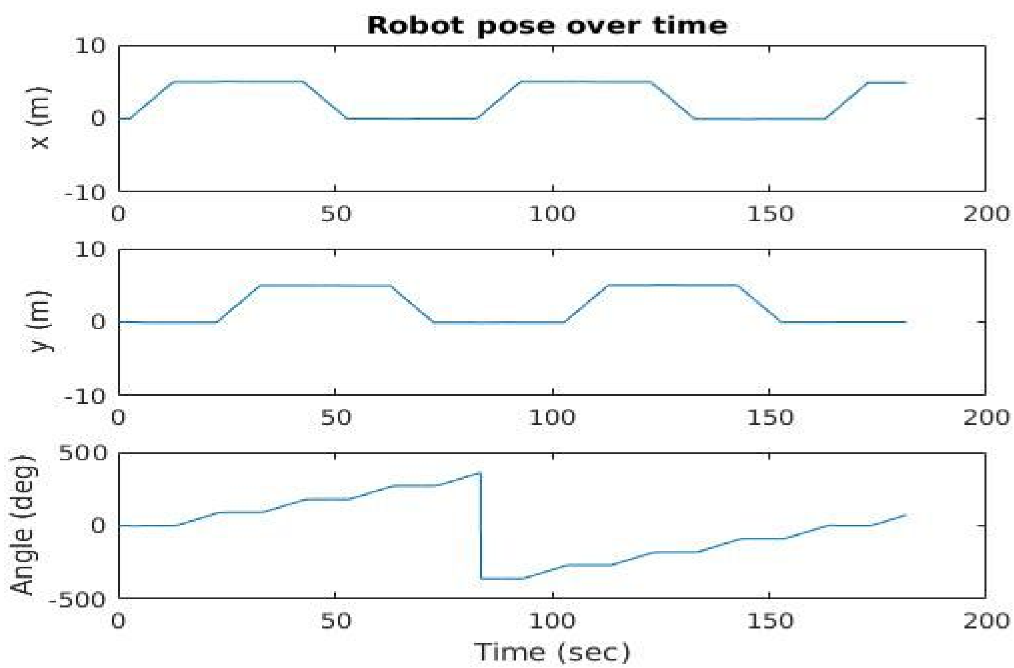
PartB. P Control with Kp = 8 (Kp too big)





PARTC. PID Control (Optimal Parameters)





Discussions

- The P closed-loop control does improve the accuracy of orientation and the difference between the actual orientation and desired one, but there is still minor vibration caused by P control.
- The results of different values of Kp:
    - If Kp is too large, the control result will end up in a vibration
    - If Kp is well selected, the controlled path will fit quite well with our expectation
    - If Kp is too small, the control will not make sense any more.
- To overcome the minor vibration caused by P control, I personally tested PID control for the experiment and found that PID control will perfectly address the vibration issue caused by P control and really did a great job in actuating the orientation of the robot.