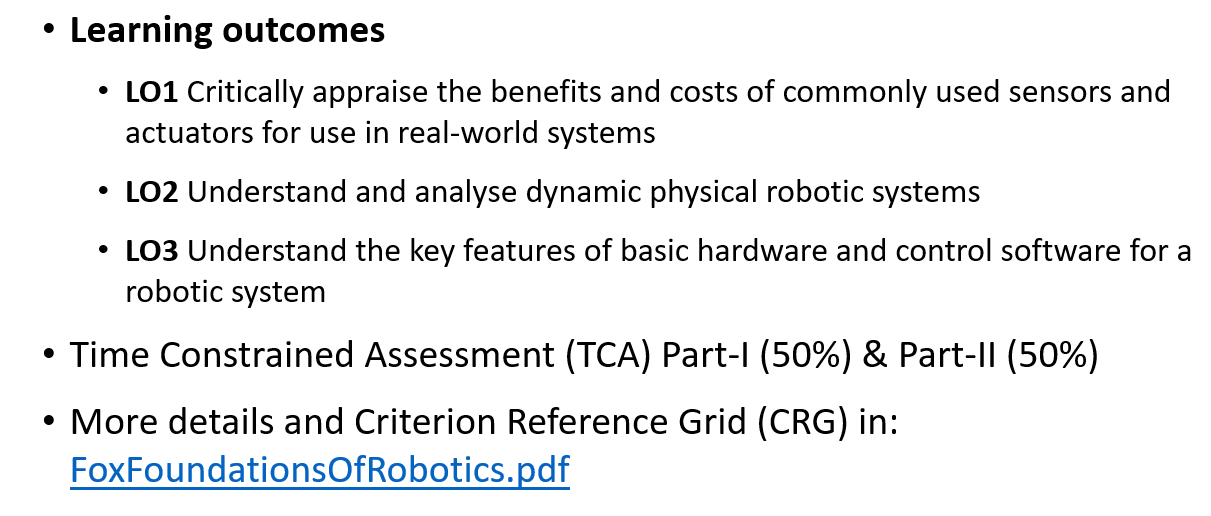
Foundations of Robotics

Introduction to Mobile Robotics and Odometry



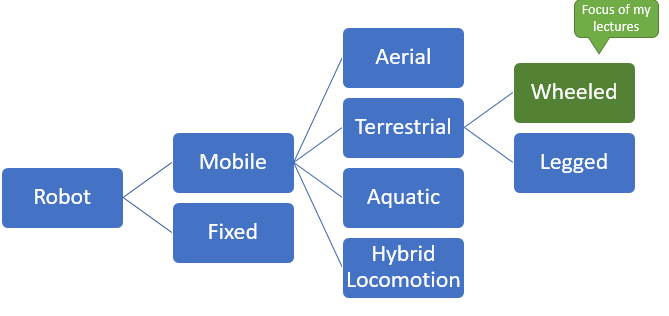
What is a robot?

A machine that can intelligently perform a complicated series of tasks by itself

How can we differentiate between an automaton and a robot?

* Capability to perform complex series of actions intelligently
* Sensors help robot to perceive the environment state and perform these complex actions intelligently
* Most automata don’t have sensors and cannot adapt their actions to new situations

Classification – based on environment



Overview – What will be covered in Gautham’s lectures

Robot motion and odometry

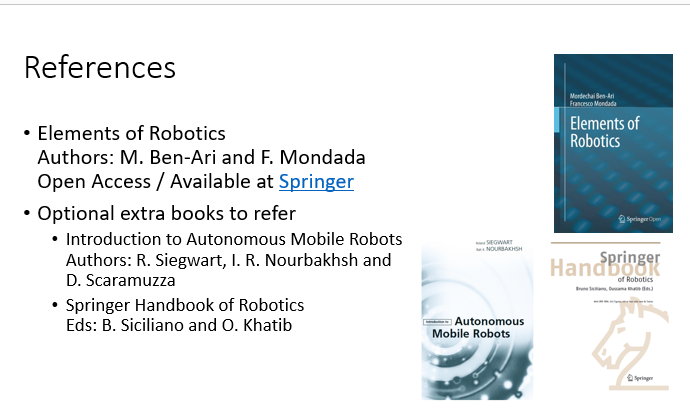
Control Systems

Local navigation – obstacle avoidance

Introduction to localisation

Environment mapping

Multi-robot systems

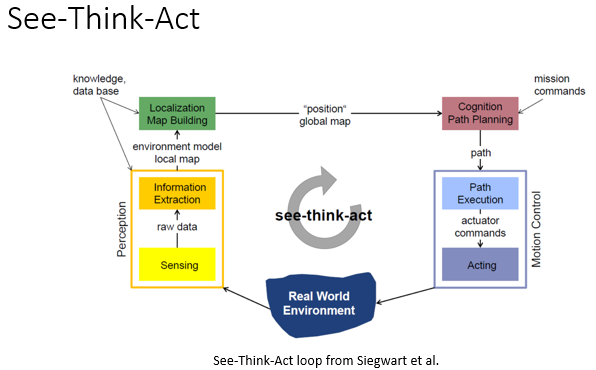


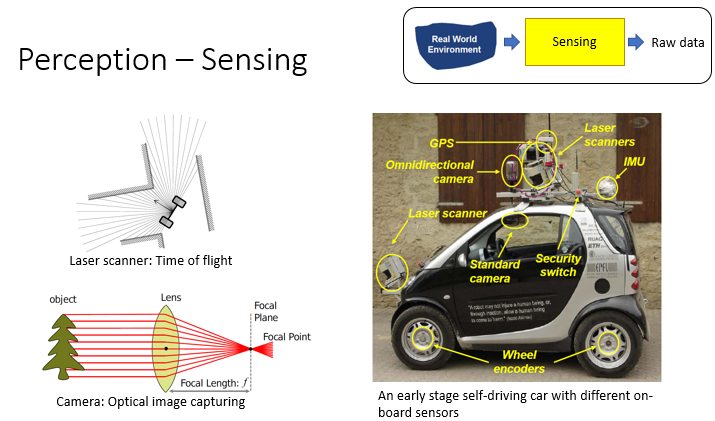
Challenge with Mobile Robots

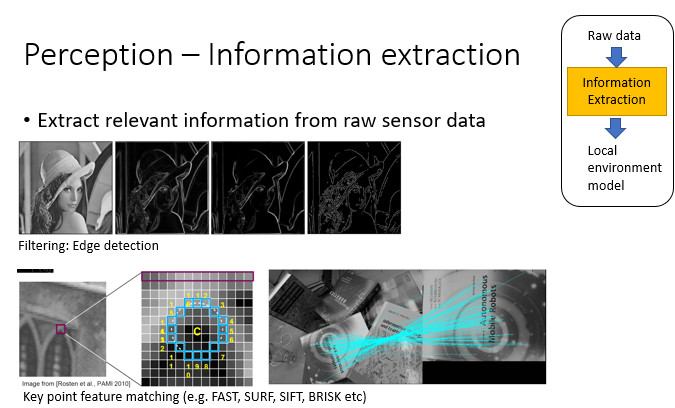
Localisation

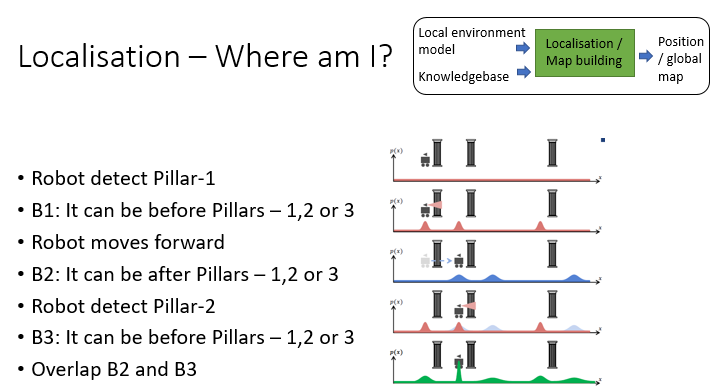
Knowing where to go

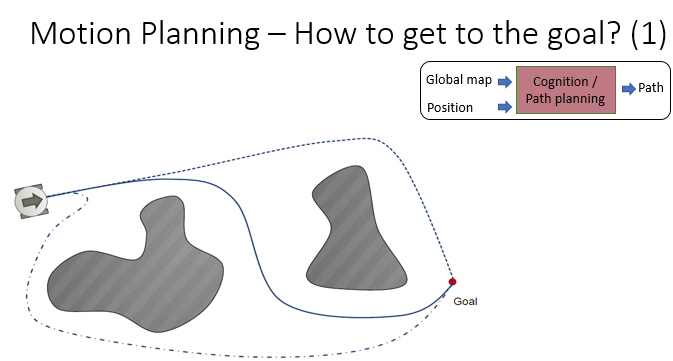
Deciding how to get there

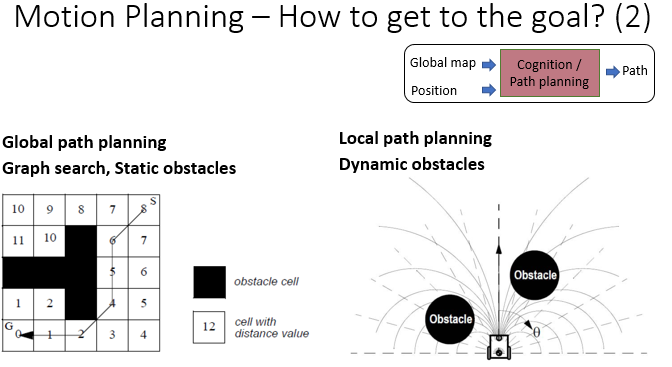


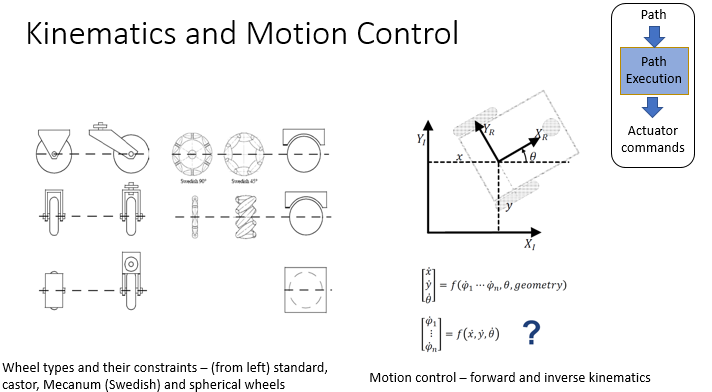


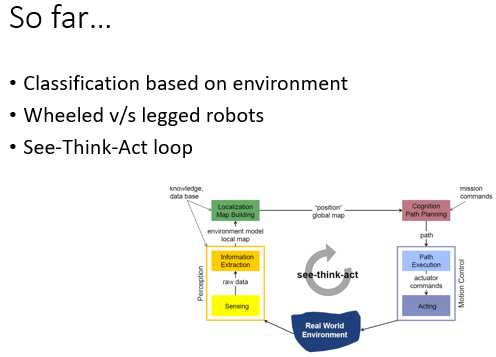












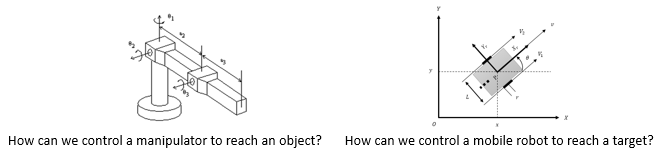
Lecture 1.2 Robot Motion and Odometry

Mobile Robot Kinematics

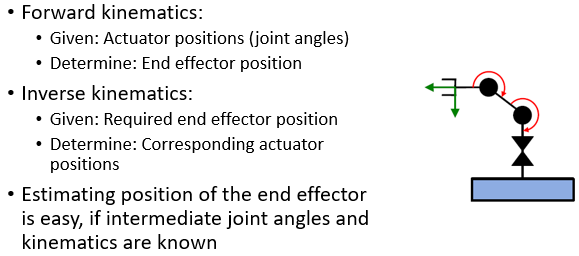
Describes motion of points, bodies or system of bodies without looking into the forces that caused it.

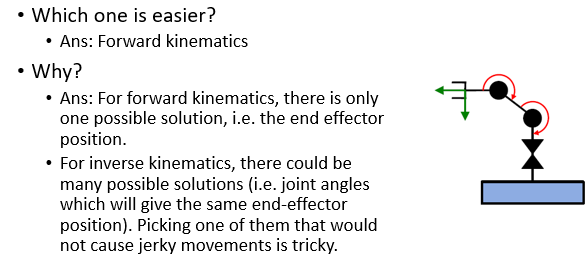
We need to understand the mechanical behaviour of the robot.

* To design appropriate mobile robots for tasks
* To understand how to create control software for a particular mobile robot instance.

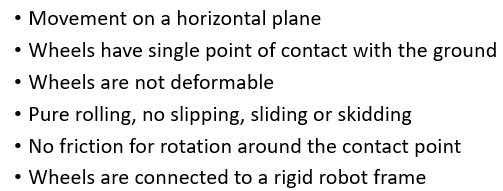


Manipulator Arm Kinematics

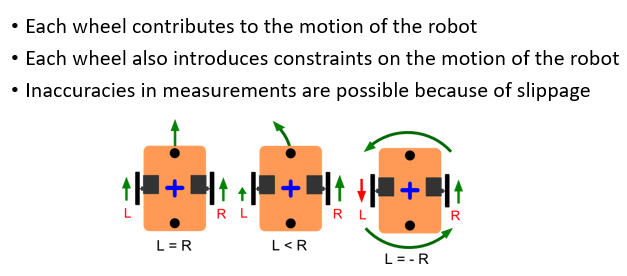




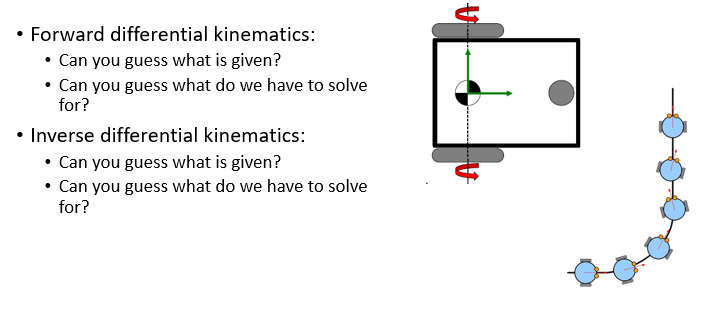
Mobile Robots: Common Assumptions

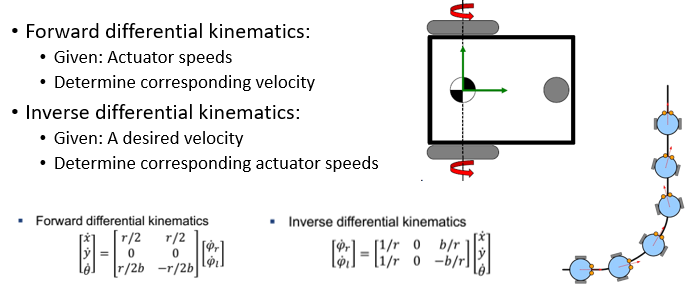


Mobile Robot – Wheels and Motion

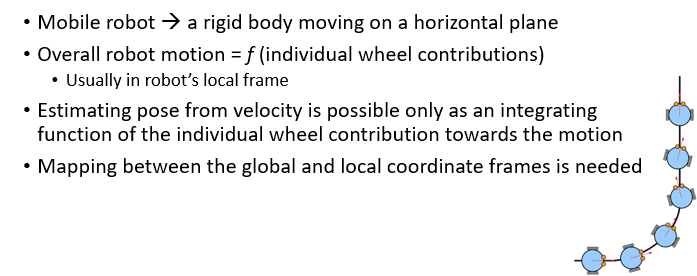


Wheeled Robot Kinematics

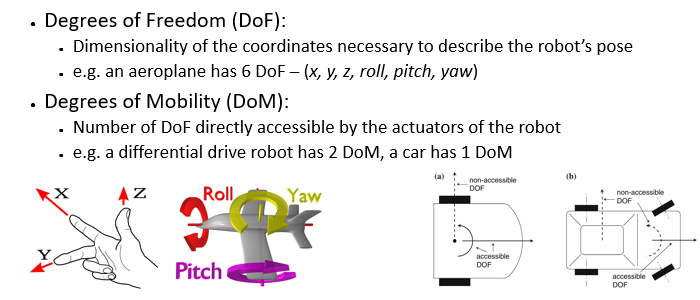




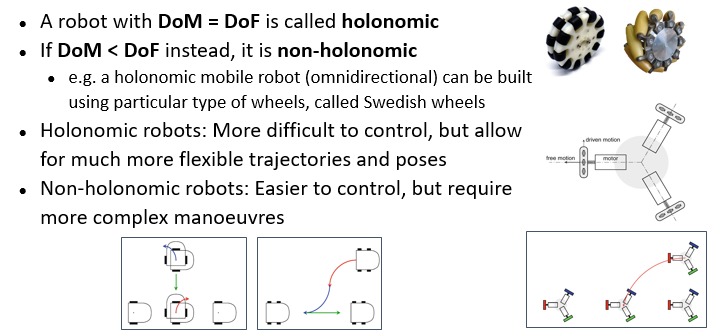
Representing Robot Position



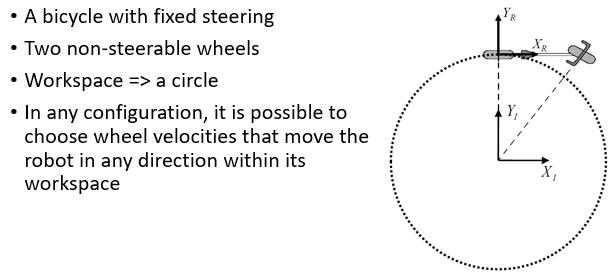
Degrees of Freedom and Degrees of Mobility



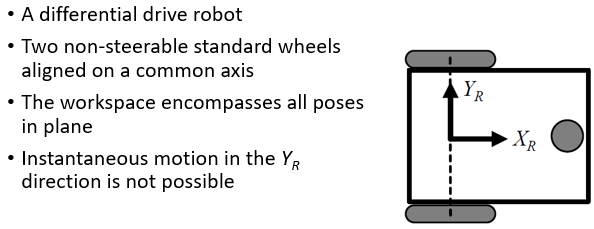
Holonomic and Non-holomic Motion



Holonomic System: Example

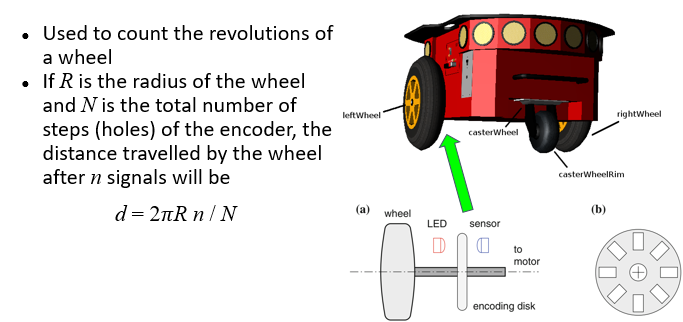


Non-holonomic System: Example

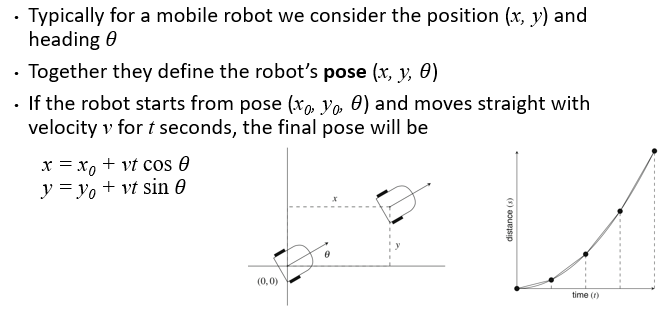


Odometry

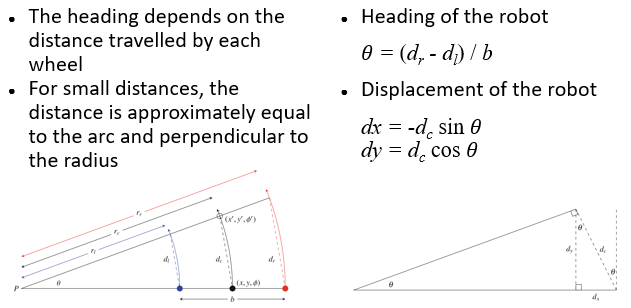
Encoder



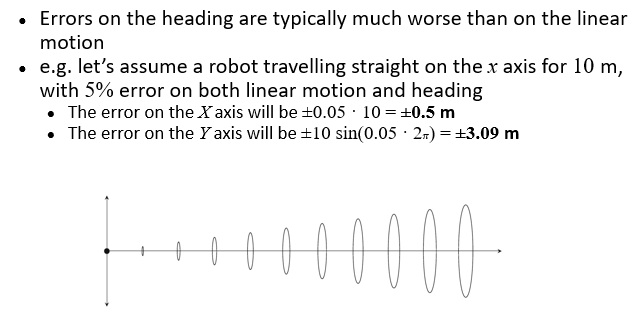
Linear Odometry



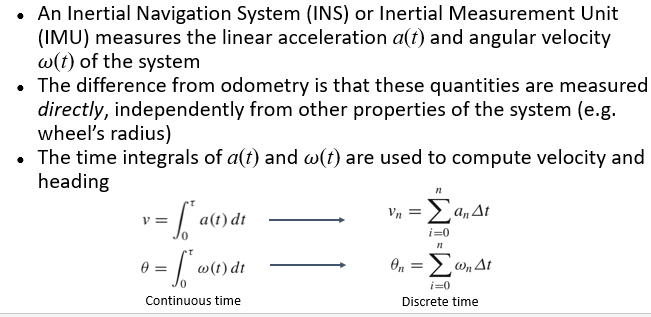
Turning Motion



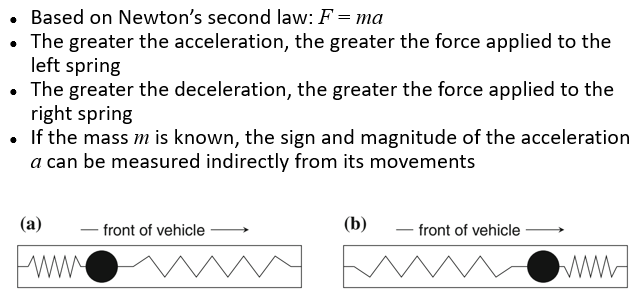
Errors



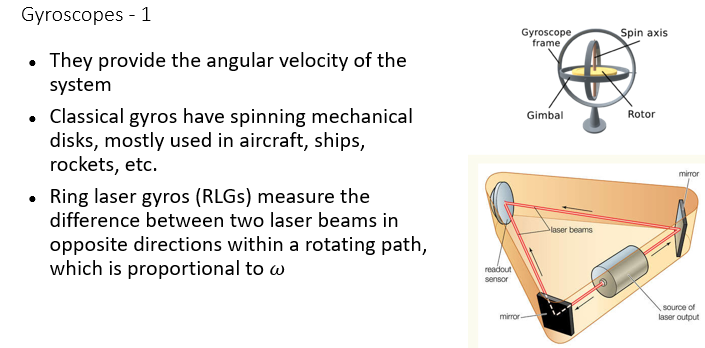
Inertial Navigation System

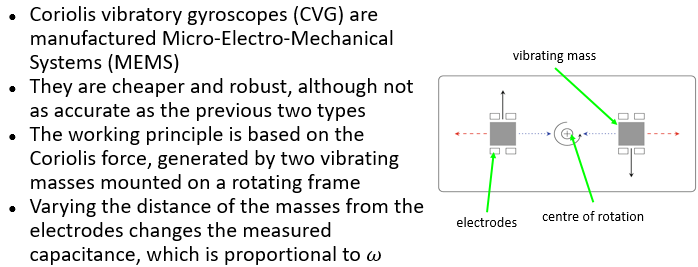


Accelerometers

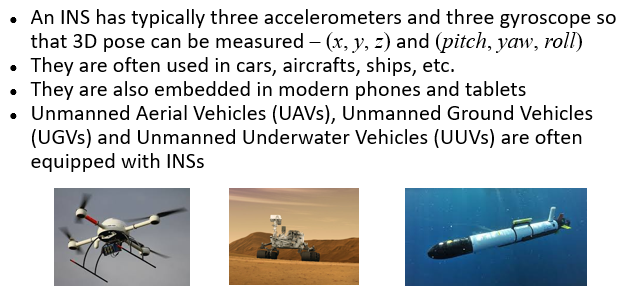


Gyroscopes - 1

Gyroscopes – 2



Applications



To revise

* Read Chapter 5 of Ben-Ari & Mondada “Elements of Robotics”
* Try the activities suggested in the text
* For further details, see the book’s references or get in touch

Exercises

An example implementation of Differential drive robot: <https://github.com/gpdas/pygame-robot>

1. Write a program to move a differential drive robot in a straight line for 2 m, turns 180° and then move again in a straight line for 2 m. How far is it from the starting position?
2. A mobile robot is equipped with an INS providing the current linear acceleration *a* and angular velocity 𝜔 every 𝛥t = 0.1 s. The initial pose of the robot is (*x* = 0, *y* = 0, 𝜃 = 0). Compute the final pose of the robot knowing that the INS gives *a* = 0, 𝜔 = 𝜋/4 rad/s for the first 20 time steps, then *a* = 0.5 m/s2, *a* = 0, and *a* = -0.5 m/s2 for the next 10, 20 and 10 steps, respectively (𝜔 = 0).
3. Write a program for a differential drive robot that does the parking manoeuvre shown in the previous example (rotate > move > rotate). Write another program for an alternative (curvilinear) manoeuvre where the robot simultaneously rotates *and* moves.