

# Robotics Homework 2016/2017 – Part A.02

Gianluca Bardaro & Matteo Matteucci

## Exercise n°1 – Gazebo model and scripts

Objective of this exercise is to test your abilities in designing robot models using Gazebo and customizing their behavior through scripts. Your reference robot for this homework is an autonomous pallet jack. In the figure, you can see a few pictures of a manual one as a reference.



### Model

No restriction on shape and size of the robot is given, but you need to follow these guidelines:

- The robot must be able to carry a  $1 \text{ m}^3$  (1 m x 1 m x 1 m) block weighting 200 kg. Plan size and strength of the structure accordingly.
- As any pallet jack, it must be possible to rise the forks of at least 50 cm, with the previously mentioned block on top of it.
- The two back wheels are not actuated and cannot rotate except on their own axis.
- The two front wheels are the source of motion and the wheels block can rotate to steer the robot.
- You do not need to model the level used to move the fork.

### Sensors

The robot is equipped with two sensors:

- A camera, pointing in the direction of the movement
- A short range laser scanner used to detect the presence of a load on the pallet jack

### Scripts

Write a script that automatically rises the forks when an object is detected on them. An object is considered fully loaded on the forks if the laser scanner detect a distance lower than a specific threshold.

### Notes

- Usually a pallet jack has to be pulled for the safety of the operator, in this case, since there is no operator, the front part of the robot is the side with the steering system.
- The motion system of a pallet jack is composed by two parallel wheels very close one to each other.

- The fork is composed by two parts: one mobile used to move the load and one fixed to create the frame of the fork.
- Multiple prismatic joints working together can be used to rise the fork.
- Cameras and laser are already available in Gazebo. Modify the laser accordingly to create a short range laser scanner.

You can find advanced example of Gazebo script on the tutorials page of the Gazebo website.

## Exercise n°2 – ROS nodes

Objective of this exercise is to test your abilities in implementing new ROS nodes and making them interact with existing ones. Your task is to implement few nodes and to connect them to an existing simulated robot.

As a simulated robot you will use the ROS Turtlebot. To install all the packages necessary for this simulation use:

```
sudo apt-get install ros-kinetic-turtlebot-simulator
```

To run the simulation use the command:

```
roslaunch turtlebot_gazebo turtlebot_world.launch
```

The nodes you need to implement are the following:

1. `joypad_simulator`: Write a node that receive input from keyboard and publish a `sensor_msgs/Joy` message on the same topic used by the `joy_node` node. At least the two main axes of each joystick and three buttons needs to be simulated.
2. Extend the `joy_cmd` node to use a button press to call the service in the `mux` node to switch between autonomous and manual mode. Both the `joy_cmd` and `mux` node were implemented during the lectures and are **available on the course site**.
3. By using the `/odom` topic provided by the simulator to get the robot position. Write a simple controller to move the robot to a specific destination provided by reading a message from a topic `/goal`. The message of the topic is a `geometry_msgs/Pose`.

If you are curios, and willing to test, you can also do the following ***optional*** point

4. Develop a custom node to compute an improved odometry which publishes on the `/improved_odom` topic and let the previous controller be configured to use either `/odom` or `/improved_odom` via parameter.

The improved odometry node should be configured via its own parameter to use

- a. Simple integration using Euler method (Euler) -> equivalent to standard `/odom`
- b. Runge-Kutta integration (Runge-Kutta)
- c. Exact integration (Exact)

You can find the details of the three methods in these slides

[http://www.dis.uniroma1.it/~oriolo/amr/slides/Localization1\\_Slides.pdf](http://www.dis.uniroma1.it/~oriolo/amr/slides/Localization1_Slides.pdf)