Project Kratos
Electronics QSTP

Week 3 : Differential Drive Mechanism

Turtlebot Installation

1) Install Turtlebot and through apt-get using the following command :

```
sudo apt-get update

sudo apt-get install ros-melodic-turtlebot3-*
```

2) Set the Turtlebot3 model to `burger` by setting the following environment variable in your .bashrc file:

```
gedit ~/.bashrc        (Opens your .bashrc file)
export TURTLEBOT3_MODEL=burger  (Add this line to your .bashrc file at the end)
```

3) Install dependencies for Gazebo + ROS interface :

```
sudo apt-get install ros-melodic-gazebo-*
```

Check if everything is working fine by launching the Turtlebot in an empty world using:

```
roslaunch turtlebot3_gazebo turtlebot3_empty_world.launch
```

Try playing around with the Turtlebot by teleoperating it with keyboard:

```
roslaunch turtlebot3_teleop turtlebot3_teleop_key.launch
```

Resources

DIFFERENTIAL DRIVE:

1. Go through the module 1 and 2 of the course “Control of Mobile Robots”, and familiarize yourself with control theory, the different types of sensors and the concept of differential drive. Control of Mobile Robots .
2. The paper given below explains the concept of forward and inverse kinematics of a differential drive robot. Go through the paper and use the concepts in the questions given below.
   http://www.cs.columbia.edu/~allen/F15/NOTES/icckinematics.pdf.
3. Trajectory tracking and control of differential drive robot for predefined regular geometrical path .Differential drive kinematics.

TURTLEBOT :

1. Go through their official manual to know more about Turtlebot.
2. Watch this video for more insight.
3. You can also read from the book Morgan Quigley about controlling a differential drive robot in ROS simulations.

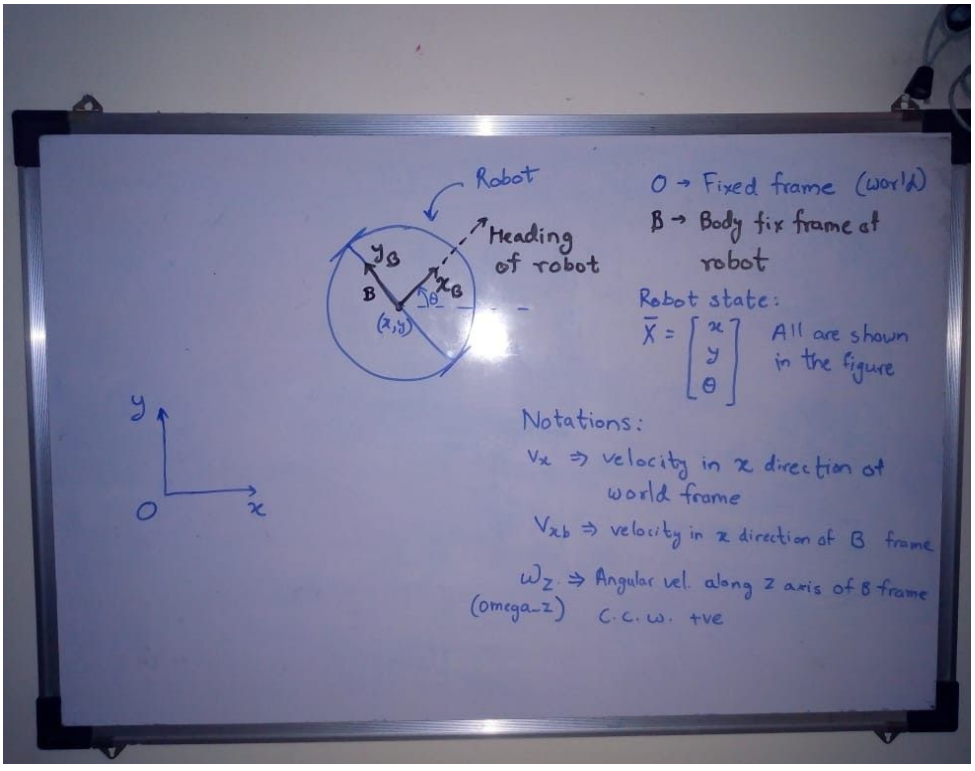
Assignment Questions

(Show the complete working for Q1, Q2, Q3)

1. You are given a circular robot which uses the differential drive mechanism to move. Dimensions of the robot are as follows:
   Wheel to wheel distance: 15 cm
   Wheel radius: 3 cm
   Calculate the wheel speeds for executing the following velocities:
   a. Vxb = 5 cm/s, omega_z = 0.1 rad/s
   b. Vxb = -1.5 cm/s, omega_z = 0.2 rad/s

2. Calculate wheel speeds as a function of time for the robot to follow the following trajectories:
   a. Circle of radius 50 cm. 1 revolution should be completed within 70 s.

   Use the image attached for the above question:



3. A differential-drive robot is equipped with a wheel encoder with 10 "ticks" per revolution, wheel radius of 0.1m, and the two wheels are 0.2m apart. The robot starts at the origin (position and orientation is 0) and, during a short time interval of 0.5s a total of 5 ticks were recorded for the right wheel and 3 ticks for the left. Where is the robot approximately located after 0.5s ?

   (Solve Q4, Q5, Q6 by launching Turtlebot in an empty world environment.)

4. Take an input radius from the user and make the Turtlebot move in a circle of that radius.

   (Note : For Q5 and Q6 you are not allowed to use the time library. You are supposed to get the odometry by subscribing to the `/odom` *topic and thus control the bot by passing appropriate commands to the topic* `/cmd_vel`*)*

5. Write a node which makes the Turtlebot move 5 units forward and stop.

6. Take an input angle from the user and write a node to make the Turtlebot turn through that angle in its place.

Submission details :

Directly upload the solutions to Q1, Q2, Q3 and python scripts for Q4, Q5, Q6 to the classroom. Make sure your code is commented where necessary and readable.

Note 1: Submit the assignments before the due date. Any delay has to be notified with reasons. Punctuality is an essential part of the Kratos Team.

Note 2: Most of you would be doing these things for the first time, so you are bound to get struck at some point and may get overwhelmed by the course content. We don't expect you to solve everything in the first try. You have a week. We highly encourage you to ask any doubt, however small or dumb you think it is. That is the only way by which you grow. Your job here is to learn and our job is to help you.

Note 3: Any feedback regarding the course structure or the assignments, is very valuable. We are also students, just like you and we have a lot of scope for improvement.