ENPM662: Introduction to Robot Modelling

Project-01

Report

Author: Adarsh Malapaka (118119625)

Team Member: Sai Sandeep Adapa (118411460)

Robot CAD

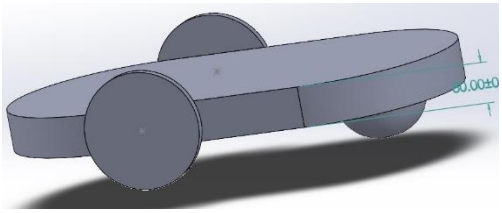

Figure 1: Simple Car (initial CAD)

Process & Problems Faced:

1. In the beginning to simplify the learning process of CAD design + integration with ROS, we first modelled a simple differential drive car (Fig 1.) based on this online tutorial having only one joint in the rear wheels and a dummy fixed front caster wheel.
2. After finishing the CAD modelling, before using the URDF exporter tool, every link on the car was assigned a co-ordinate frame system using the 'Reference Geometry' feature on SolidWorks, making it easy to define the individual link coordinate frames and joint axes in the URDF exporter tool.
3. After designing the simple car CAD model, a refined car CAD model (Fig 2.) with independently steerable front wheels was designed using Dominos' autonomous delivery robot (Fig 3.) as an inspiration.
4. A 'C' shaped mount was used to model the steering mechanism of the front wheels such that the wheel's and the mount's axes of rotation are collinear giving the ability to turn the wheel full 360 degrees with a smaller wheel hole on the chassis as opposed to an 'L' shaped mount.

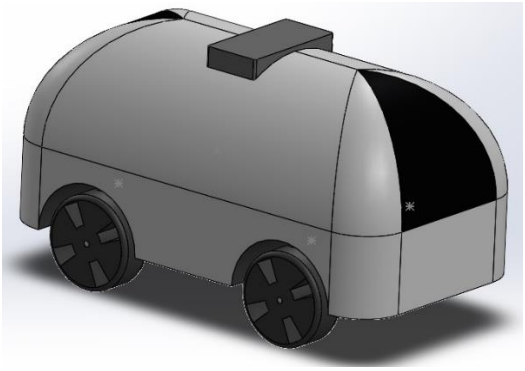

Figure 2: Delivery car (final CAD)

Figure 3: Dominos autonomous delivery car

5. While inserting the first part into the SolidWorks Assembly, it was ensured that the origin of the part coincided with the origin of the world. If not, this would lead to an offset between the Gazebo origin and base_link origin after spawning.
6. Spawning the robot in Gazebo made half of the body to appear below the ground surface and the rest above. To solve this issue, the coordinate frame at the base frame of the assembly in SolidWorks had to be placed at the floor of the robot (on the ground along the plane where the wheels touch the ground).
7. Following the dimension specifications as mentioned in the instruction's pdf, the car's chassis + upper body weighed >100 kg while each wheel system weighed < 2kg. Since this could pose an issue of the wheels not being able to sustain the weight, cut extrudes were placed in the car to make it as hollow as possible bringing the mass of the upper body down to about 70kg.
    a. Click here, here, here, here and here for the robot dimensions pictures.

Robot ROS package build

Process & Problems Faced:

1. For the delivery car's generated URDF file, the SimpleTransmission interface transmission interfaces were added to this file for each joint which needed to be actuated. There are a total of 4 joints to be controlled out of which the 2 rear wheels are defined as Velocity Joint hardware Interfaces and the front two steerable wheels are Effort Joint Interfaces with mechanical reduction of 1.

2. The config file was updated with 4 controllers of which 2 were velocity_controllers/JointVelocityController and the other 2 were effort_controllers/JointPositionController. Setting the PID values and later launching the robot gave an error of 'No p value specified for pid_gains" error came which could be resolved using this source.
3. The given xacro file was modified to add the LIDAR sensor onto the top of the robot on the mount. The visualized laser scan data would also include the edges of the mount which is undesirable. To rectify this, the 'z' value of the 'xyz' tag in the URDF file was tweaked until the laser points were not seen.
4. Also, while roslaunching the files, after the laser sensor was spawned, a 'segmentation core dumped' error appeared. This was rectified by making the 'always_on' parameter false in the xacro file.
5. While using the Teleop file to move the robot, the robot would move opposite to the input command. This was rectified by negating the joint axis 'z' value in the URDF file.

Simulation Videos

1. Teleop Simulation Video: click here

2. Publisher-Subscriber Demo Video: click here

Contribution

In this project, my contribution has been on the following: First, CAD modelling the simple differential drive robot (used for getting familiar with SolidWorks) and exporting using the URDF exporter tool. After the final delivery car CAD was modelled, I modified the necessary controller, launch, teleop and xacro files to be able to move the steering car and to add the LIDAR on top of this car. The coding of the publisher and subscriber nodes was shared equally.