ENPM662 – INTRODUCTION TO ROBOT MODELLING

Project 1: CAD Modeling & Simulation using Gazebo

Project Objective -

1. To build a robot car CAD model in SolidWorks.
2. Export CAD as URDF. Add LiDAR sensor by integrating LiDAR URDF with robot car URDF using Xacro.
3. Perform teleop node control
4. Launch the publisher – subscriber node through packages in ROS

Robot Car Specifications

Chassis Length – 38in

Chassis Width – 20 in

Wheelbase – 20 in

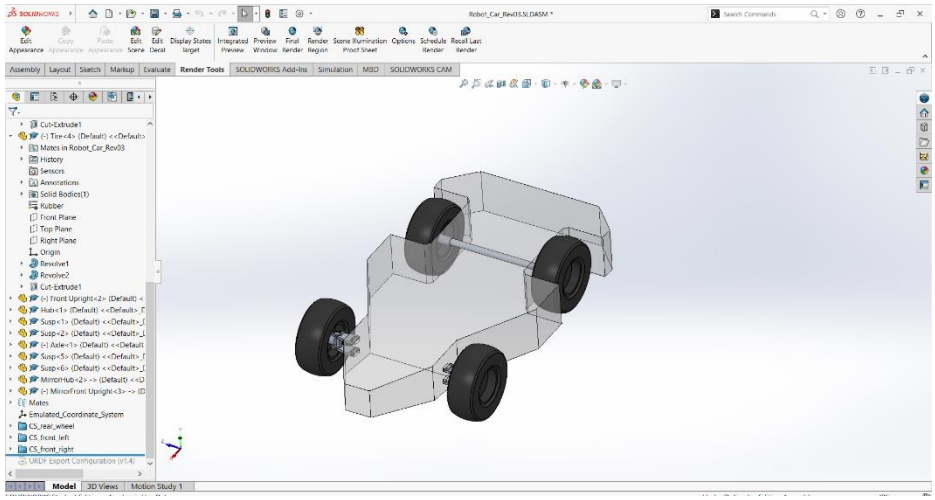
Front Track Width – 17 in

Rear Track Width – 15 in

Front Wheel Caster – 8 deg

Wheel Diameter – 8 in

Wheel Width – 3 in



Robot Car CAD Modelling

1. The Initial design of robot car was decided based on project robot specification requirements and modelled in Solidworks CAD Package.
2. The vehicle geometry layout was plotted using a 3D-Sketch in Chassis part file. Rear Track Width was kept at 15 in help enable short turning radius.
3. The chassis was connected to wheels through a wheel assembly – wheel hub and wheel upright. Caster of 8° was incorporated in chassis for wheels to have a camber gain during steering which aids robot car turning capability.
4. The rear wheels were connected through a rotation-locked solid axle.
5. Post modelling, the parts were assembled in the robot assembly file. Reference Geometry – Axis and Coordinate Frames were created at every joint.
6. Maintaining lower power to weight ratio (inertia) is necessary for effective use of motor actuators. Hence the chassis material of ABS was selected. For wheel components, commercial Aluminum alloy was chosen and tire were modelled as rubber.
7. After vehicle modelling, the robot car was exported using solidworks urdf exported tool through selection of appropriate joints.
    - Joint Definitions –
        i. Steering Joint – Front Left and Front Right – Revolute Joint
        ii. Wheels – Front and Rear Wheels – Continuous Joint

Project Responsibility:

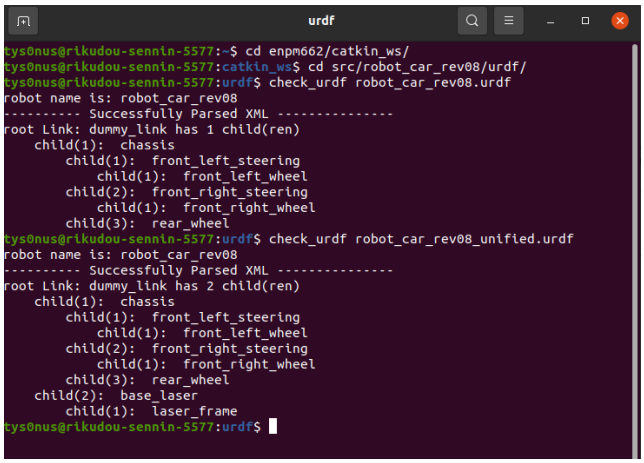
1. CAD Files Geometry
2. Wheel Assembly Components
3. ROS Xacro - URDF file integration
4. ROS teleop scripts
5. ROS Publisher Subscriber Packages and scripts
6. ROS Launch file creation

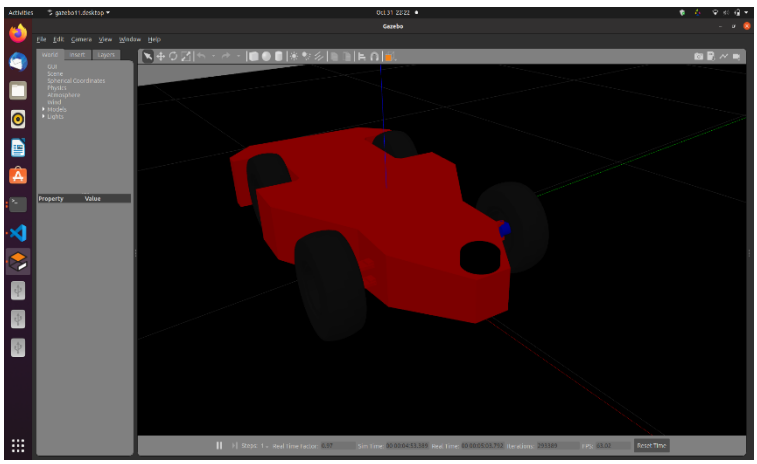
7. ROS Simulation in Gazebo and Rviz

Challenges Faced:

1. A geometry driven Robot Car assembly cad was necessary to establish kinematic mechanism
2. Controllers for the steering mechanism did not show up in Rviz
3. So, we rebuilt the model with new design to accommodate the steering controls
4. Placing the LiDAR sensor at appropriate location on the robot
5. Joint state publisher was not available for revolute joint for steering the robot
6. Tuning the PIDs for all 3 controllers and editing the robot URDF files

Reference Images





check_urdf – a. robot urdf b. unified lidar & robot car urdf

Gazebo Arena Robot Car Visualization

1. **Video 1 - Gazebo scene controlling Robot Car using teleop node**
   a. Simulation: Video : Spawned in Playground world file
   b. Simulation: Video: Lidar Attached on Top
   c. Simulation: Rviz Visualisation
   d. Simulation: Video : Teleop + traversal from center to one end.

   Link – https://drive.google.com/file/d/1exGQE69sUVnIPqdVEfN2HyqEFimZgEAD/view?usp=share_link

2. **Video 2 - Gazebo scene controlling Turtlebot3 using Publisher**
   a. Video of robot driven by the commands from the publisher

   Link – https://drive.google.com/file/d/1GPtPinrDI5i7DjVGwFRS_OJyxce2KyqR/view?usp=share_link

3. **Catkin Package:**
   Link: https://drive.google.com/file/d/1mCQk0uM8-LPkyEzIc8y7s2c5ukViy7h_/view?usp=share_link

4. **CAD Assembly**
   Link : https://drive.google.com/file/d/1dOK4Wzf2ys22idxUEYaEeOQ4bj9nMznn/view?usp=share_link

5. **Additional Links**
   Link : https://drive.google.com/drive/folders/1mpWawUaWJKWYZi7Cb6GmkoPdg8TA9Mr9?usp=sharing

Results:

The robot car model built in SolidWorks was spawned in the gazebo arena world and Rviz and navigated the robot using teleop to top right of arena. In Publisher Package, the robot was moved in a circular path using publisher nodes. Subscriber nodes was called to visualize the subscribed topic list.