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ENPM662 - INTRODUCTION TO ROBOT MODELING

Project 1

Objective: To build a robot car in Solidworks, Simulate its movement and visualize its environment using ROS1 Noetic.

Goals:

1. To create a 3D model of a car using Solidworks and export it in URDF format.
2. Add a lidar sensor on the robot and visualize the output using Rviz and Gazebo.
3. Add transmissions on the robot to make it move.
4. Make it reach the target position using Teleop.
5. Code a publisher script to make the robot move in a circle/straight line and code individual subscriber scripts that subscribe to the respective topics.

Steps followed:

1. Design part models of the robot in Solidworks
2. Assemble the parts in Solidworks to build the car
3. Export the assembly as a URDF file
4. Create and develop a catkin workspace (Project1) for the file
5. Add lidar files to the workspace
6. Add dummy link and transmission code to the URDF file
7. Integrate the sensor with the URDF file using xacro
8. Update the config files to assign controllers to each joint
9. Create a launch file to start the simulation in competition_arena and load all the controllers
10. Create a Teleop file to make the car move in the simulated environment
11. Create simple scripts for publishing and subscribing to the command topic to make it move in a circle/straight line.
12. Visualize and Simulate the robot car in Gazebo and display the laser scans in Rviz

Challenges Faced:

1. The car was falling from the sky. This was because the alignment of the origins in the Solidworks model and Gazebo URDF model was not done correctly. We changed the origin in Solidworks to match the bottom center of the car to fix the problem.

2. The steering axis was not defined properly for the front wheels and we were unable to steer the robot car. To resolve this issue, we defined the steering axis at the center of the castor revolute joints and then we were able to steer the front wheels independently.
3. The wheels were rotating in the opposite direction while using Teleop. We changed the axis of rotation of each wheel in the URDF file to make it move appropriately with the key bindings of Teleop.
4. We specified the joint type between the shaft and the wheel incorrectly while exporting the URDF file and therefore, we could not rotate the wheels using the shafts. So we had to change the joint types from continuous to fixed to solve the issue.

Contribution:

1. Built 3D models for wheel mechanism. Assembled the parts and exported it to URDF.
2. Coordinated and built a catkin workspace (Project1) with the URDF package in the src folder of the workspace.
3. Coordinated and completed all the tasks for the launch and xacro file to integrate the lidar sensor to the model and launched the model in competition_arena.world in Gazebo.
4. Modified the config file and URDF file to add the controllers.
5. Modified the template_launch file to load the controllers.
6. Worked together to find the solution to the problems discussed above and changed the origin of the model, steering axis alignment, and joint type definitions.
7. Fixed the axis of rotation of the wheels.
8. Coordinated and performed the Teleop with simulation and visualization in Gazebo & RViz.
9. Coded Publisher and Subscriber scripts for moving the car in a circle.

Videos:-

Teleop with Rviz:
https://drive.google.com/file/d/1jPhknL6o5AQxgUZweEbDEyEOKgioJvIW/view?usp=sharing
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https://drive.google.com/file/d/1Wnrpiy5AzGDfJ8WjYb9B5XhBPYpRw0cK/view?usp=sharing