

ENPM 662

Project 1

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Objective: CAD Modeling and Simulation using Gazebo

Project Understanding:

- The robot car was designed using SolidWorks, assembled, and then exported to a URDF file.
- Controller information for joint positions and velocities, along with LIDAR and IMU data, was integrated into the file.
- A .yaml file was created to contain the controller details, which were added to the project.
- Utilizing provided launch files, the robot was simulated in Gazebo and Rviz.
- The LIDAR data was incorporated and visualized within the simulation.
- Using a teleoperation script, the car was maneuvered within the competition environment.
- Subsequently, a proportional controller was applied to guide the car from coordinates [0,0] to [10,10].

Problems faced:

- The automatically generated axes and coordinate frames for the joints and wheels in the URDF export were inaccurate, leading to incorrect spawning of the car in Gazebo.

Action taken: All the necessary joints and coordinates frames are defined manually.

- After exporting to gazebo, we noticed that the car is tracing a curve instead of a straight line while using teleop.

Action taken: Noticed that one of the wheel joints is not straight but at an angle to the global origin, hence taking an curved path and it was resolved

- The robot's wheels are not spawning in Rviz environment.

Action taken: Added the velocity controller to missing wheels and respawn.

Contribution:

- Using SolidWorks, the robot car was designed according to the project design specifications.

- Using the SW2URDF Exporter program, the robot's design was exported to URDF format to ensure compatibility with ROS 2.
- Added a LiDAR sensor to the robot's design to enhance its perception.
- Completed a full lap by successfully navigating the robot through a competition scenario using a teleoperation script.
- Controller part was done by both

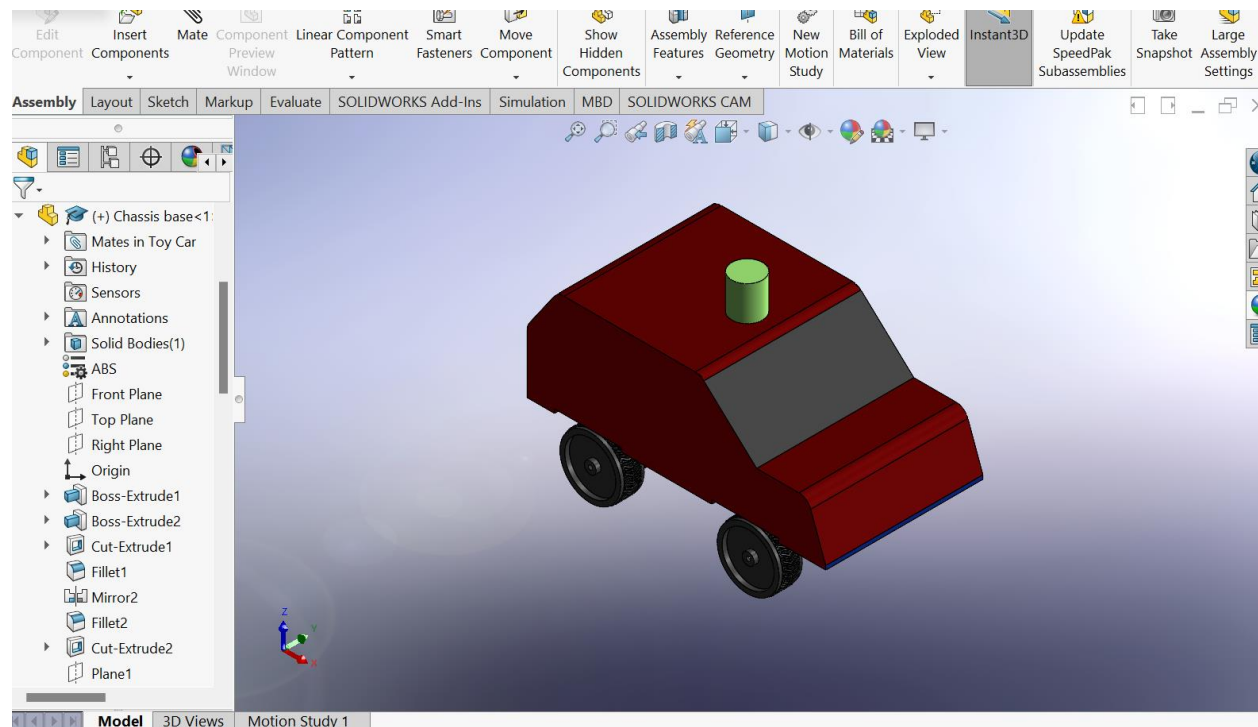
Improvements:

- It would be great if some details about the use of proportional controllers were included.

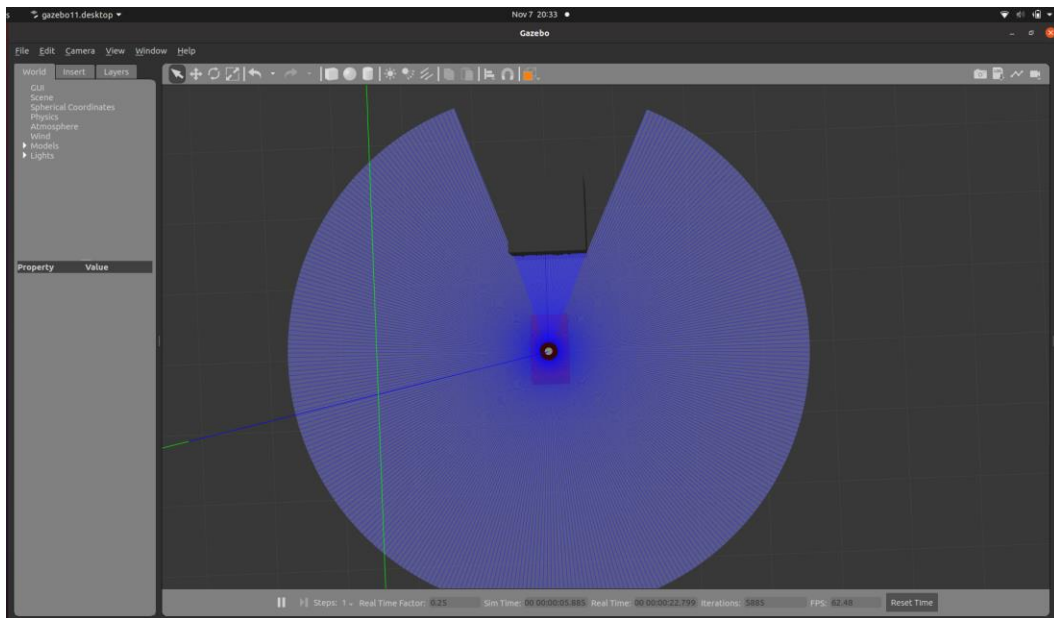
Results:

SolidWorks model:

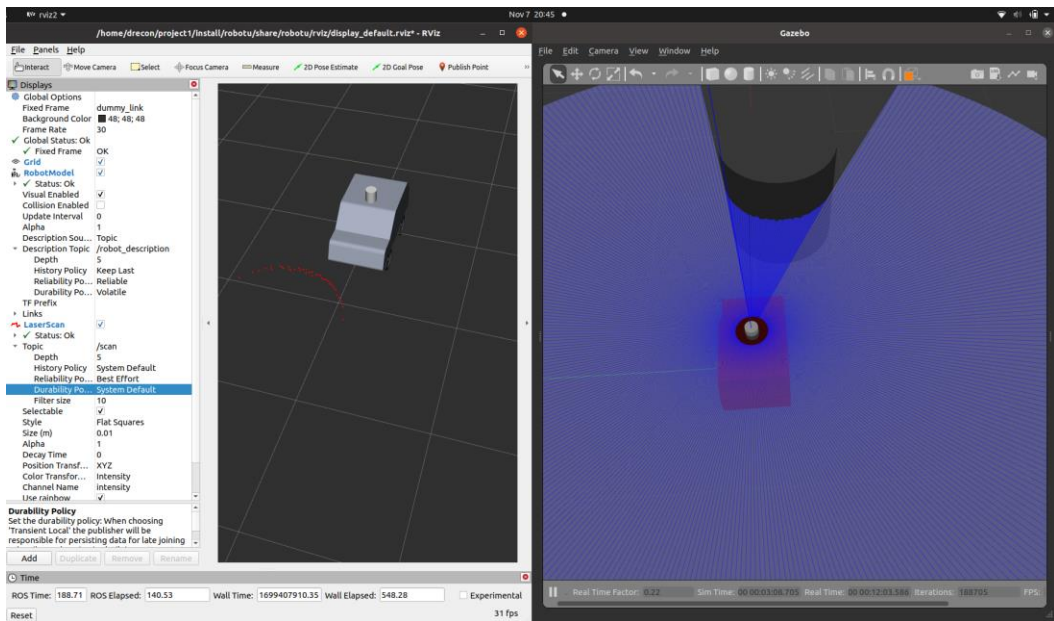
Both the front wheels can be individually steered, and top link is the Lidar



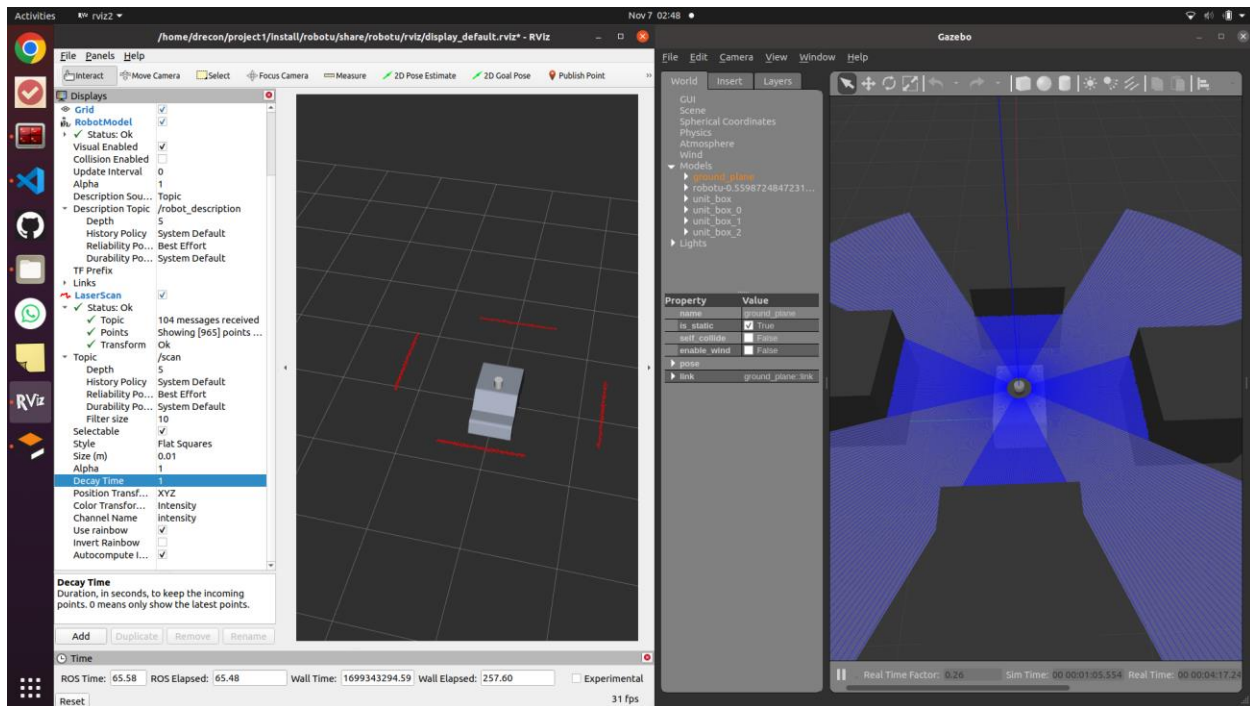
Gazebo Launch:



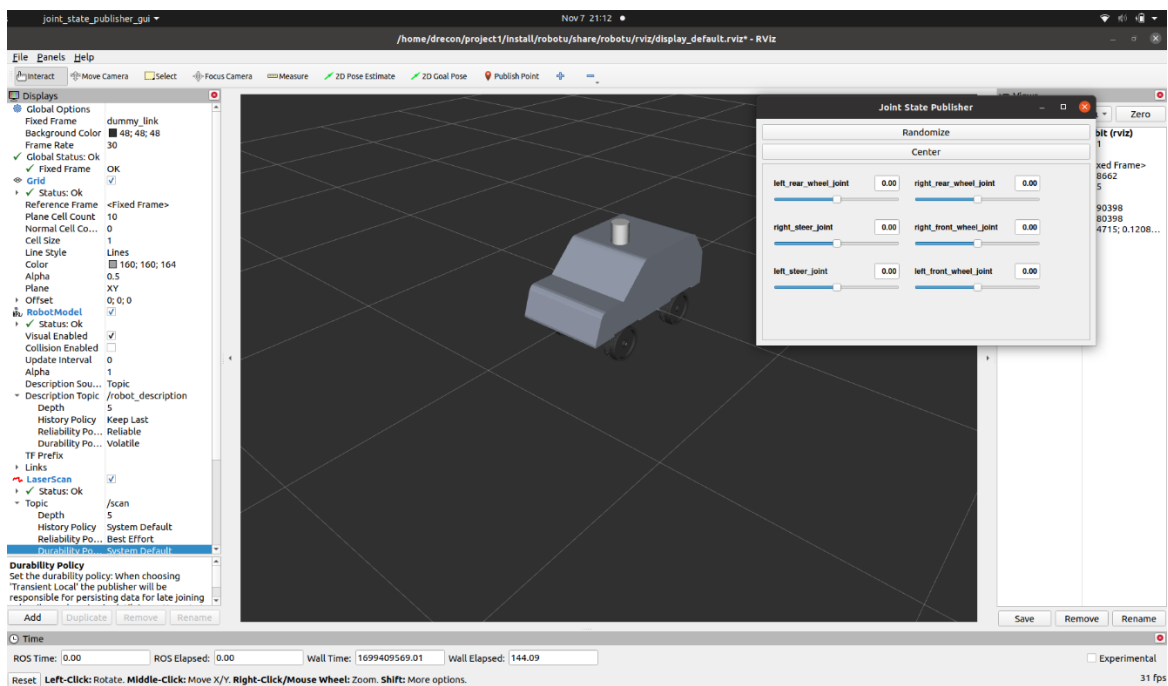
Gazebo and Rviz:



Lidar visualization:



Rviz with joint state publisher:



IMU topic visualization:

The image shows a dual-terminal window. The left terminal displays the output of a ROS2 launch command, showing header information and sensor data for a drecon-inspirom-3593 robot. The right terminal shows the output of a ROS2 topic list command, listing various topics like /clock, /dynamic_joint_states, and /joint_states.

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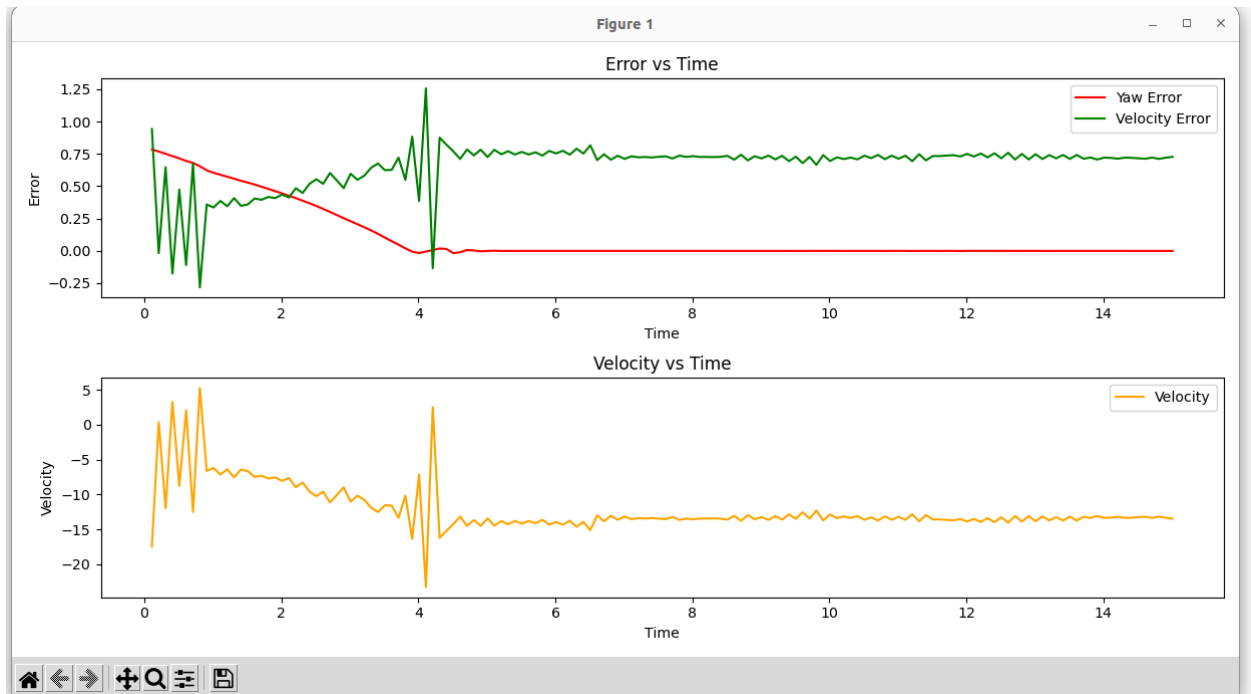
drecon@drecon-inspirom-3593:~/project1 100x3
[INFO] [spawner-8]: process has finished cleanly [pid 125948]
[INFO] [spawner-9]: process has finished cleanly [pid 125950]

drecon@drecon-inspirom-3593:~/project1 100x50
header:
  stamp:
    sec: 14
    nanosec: 233000000
  frame_id: dummy_link
orientation:
  x: -2.8485883261587873e-07
  y: 5.93416599182336e-06
  z: -0.00010577125655922345
  w: 0.9999999943885729
orientation_covariance:
  - 0.0
  - 0.0
  - 0.0
  - 0.0
  - 0.0
  - 0.0
  - 0.0
  - 0.0
  - 0.0
angular_velocity:
  x: -0.00014905896601852844
  y: 0.007678055458348406
  z: -0.00012811317274207126
angular_velocity_covariance:
  - 0.0
  - 0.0
  - 0.0
  - 0.0
  - 0.0
  - 0.0
  - 0.0
  - 0.0
  - 0.0
linear_acceleration:
  x: -0.0001256154875689981
  y: -5.1828857280999755e-05
  z: 9.80000004943961
linear_acceleration_covariance:
  - 0.0
  - 0.0
  - 0.0
  - 0.0
  - 0.0
  - 0.0
  - 0.0
  - 0.0
  - 0.0
...
^Cdrecon@drecon-inspirom-3593:~/project1$

drecon@drecon-inspirom-3593:~/project1 101x10
drecon@drecon-inspirom-3593:~/project1$ ros2 topic list
/clock
/dynamic_joint_states
/turtle_plugin/out
/joint_states
/parameter_events
/performance_metrics
/position_controller/commands
/robot_description
/rosout

```

Error and Control vs Time Graphs:



Teleop operations:

Video link: <https://drive.google.com/file/d/1Y-P311eL-4n64vUKXOKZ4EmCd-KmDKi6/view?usp=sharing>

PD controller:

Video link: <https://drive.google.com/file/d/1xuxxebWyATNuIR7whLErxf4eKjiYw9K-/view?usp=sharing>