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1. Building a Solidworks Model and URDF Export

With the given dimensions a four wheeled robot was created. Front two wheels are independently steerable and the all 4 wheels can independently rotate which was done by mating the axis of the links/parts which were designed and imported as individual part files.
A urdf model was generated and transferred to a ROS working directory named catkin_ws/src and the package was built using catkin commands.

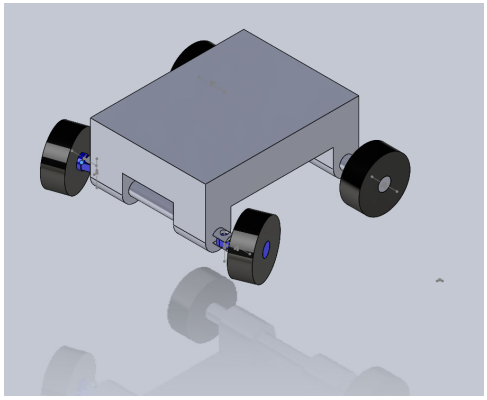

Figure 1

2. Add controllers and Laser lidar to the bot.

Now we modified the urdf file to add a dummy link as the root link in order to launch it in Gazebo. After launching the model I encountered a lot of problems like the axes of actuation we defined in solidworks were not the z axis and hence the model was not imported properly. So I defined the local coordinate systems and kept the wheel and steering rotation along the z axis and it came out fine. The model was not stable since there was no transmission and controller.
After this I defined a velocity based interface for the four wheels and an effort based interface to the steering joint. Then I defined the six different controllers in the config file for six different joints in order to control each of the joints individually as shown in Figure 2.

```
    pid : {p: 100.0 , i: 0.0 , d: 0.0}
  # Controller 2
  rear_wheelL_velocity_controller:
    type: velocity_controllers/JointVelocityController
    joint: WBL
    pid : {p: 100.0 , i: 0.0 , d: 0.0}
  # Controller 3
  front_wheelL_effort_controller:
    type: effort_controllers/JointEffortController
    joint: WFL
    pid : {p: 100.0 , i: 0.0 , d: 0.0}
  # Controller 4
  front_wheelR_effort_controller:
    type: effort_controllers/JointEffortController
    joint: WFR
    pid : {p: 100.0 , i: 0.0 , d: 0.0}
  # Controller 5
  front_steerL_position_controller:
    type: position_controllers/JointPositionController
    joint: SL_Joint
    pid : {p: 100.0 , i: 0.0 , d: 0.0}
  # Controller 6
  front_steerR_position_controller:
    type: position_controllers/JointPositionController
    joint: SR_Joint
    pid : {p: 100.0 , i: 0.0 , d: 0.0}
  # Controller 7
```

Figure 2

Then I used the xacro file to integrate Lidar into the bot which I attached to the root link (dummy) of the robot. Now using the launch template file I integrated everything I did till now and replaced the gazebo empty world with a new world to run the visualization.

3. **Run teleop.**

To run the robot into the new world I used teleoperation using the keyboard which was defined using a python script which was edited as per our need and stored in the src folder of our package. The script used four publishers to control the front two wheels individually for steering and rear wheels individually for moving the bot forward and backward. Then we recorded our video by moving the robot from one place to another in the new world. Though there were some glitches mainly because of the PID tuning, overall it worked fine.

4. **Publisher and Subscriber**

Now we were asked to code a publisher and subscriber to move the robot. We did it to move the robot in a straight line. The publisher published the command to the velocity topics of our controller and the subscriber subscribed to the same topic. We recorded the whole video showing all the operations.

5. **Contribution**

Since we both were having problems with the urdf model so we debugged the problems and did everything together to run the launch template. After that, I took the task of editing teleop script and moving the bot, recording it while the subscriber and publisher script were coded by Alvina.

Problem faced:

1. Axis Alignment in solidworks to Rviz: Figuring out the correct alignment of the axis of each part was a difficult task. When the robot was opened in the gazebo, it would explode due to the above problem.
2. Deciding on the type of Joint controllers and errors due to unrecognised joint controllers.
3. Alignment of the lidar on the robot platform.

Link for videos:

Teleop Video:
https://drive.google.com/file/d/1hUINYBY93EUs-b1xef68_0FLOQulGVsP/view?usp=sharing

Publisher Video:
https://drive.google.com/file/d/1aQQLD68xdz2g-WqbV2rmSDJxpPm3CGWL/view?usp=sharing