ENGR 4421: Robotics II

ROS Tutorial: Gazebo Simulation

03/09/2023

Outline

- Physical Properties
- Gazebo Plugins for ROS
- Gazebo Elements
- Create a World

Gazebo ROS Helpful Resources

- Using a URDF in Gazebo Tutorial page: https://classic.gazebosim.org/tutorials?tut=ros_urdf
- Gazebo ROS plugin: https://github.com/ros-simulation/gazebo_ros_pkgs/wiki
- Example Repository: https://github.com/linzhangUCA/homeplater

Build A Gazebo Simulation Package from Scratch

- Create a package:
  ```
  cd ~/<workspace_name>/src
  ros2 pkg create --build-type ament_python <simulation_package_name>
  ```
- Create data directories:
  ```
  cd <simulation_package_name>
  mkdir launch/ worlds/
  ```
- Edit package.xml:
  ```
  code package.xml  # make sure vscode is available
  ```
- Edit setup.py:
  ```
  code setup.py
  ```
- Edit launch file:
  ```
  code launch/<launch_filename>.launch.py
  ```
- Edit URDF file in <urdf_package_name>:
  ```
  code ~/<workspace_name>/src/<urdf_package_name>/urdf/<urdf_filename>.urdf
  ```

package.xml

```
<?xml version="1.0"?>
<?xml-model href="http://download.ros.org/schema/package_format3.xsd" schematypens="http://www.w3.org/2001/XMLSchema"?>
<package format="3">
  <name>package_name</name>
  <version>0.0.0</version>
  <description>TODO</description>
  <maintainer email="todo@todo">TODO</maintainer>
  <license>TODO</license>

  <exec_depend>gazebo_ros</exec_depend>
  <exec_depend>gazebo_ros_packages</exec_depend>
  <exec_depend>joint_state_publisher</exec_depend>
  <exec_depend>robot_state_publisher</exec_depend>
  <exec_depend>rviz2</exec_depend>
  <exec_depend>xacro</exec_depend>

  <test_depend>ament_copyright</test_depend>
  <test_depend>ament_flake8</test_depend>
  <test_depend>ament_pep257</test_depend>
  <test_depend>python3-pytest</test_depend>

  <export>
    <build_type>ament_python</build_type>
  </export>
</package>
```

CHANGE package_name (line 4) TO ACTUAL PACKAGE NAME

setup.py

```
import os
from glob import glob
from setuptools import setup

package_name = '<package_name>'  # CHANGE <package_name> TO ACTUAL PACKAGE NAME

setup(
    name=package_name,
    version='0.0.0',
    packages=[package_name],
    data_files=[
        ('share/ament_index/resource_index/packages',
            ['resource/' + package_name]),
        ('share/' + package_name, ['package.xml']),
        (os.path.join('share', package_name, 'launch'), glob(os.path.join('launch', '*'))),
        (os.path.join('share', package_name, 'worlds'), glob(os.path.join(worlds, '*'))),
    ],
    install_requires=['setuptools'],
    zip_safe=True,
    maintainer='TODO',
    maintainer_email='todo@todo',
    description='TODO',
    license='TODO',
    tests_require=['pytest'],
    entry_points={
        'console_scripts': [
        ],
    },
)
```

{launch_filename}.launch.py

- Copy the contents in:
  https://raw.githubusercontent.com/linzhangUCA/homeplater/4-gazebo-plain/hpr_gazebo/launch/sim_homeplater.launch.py to <gazebo_pacakge_name>/launch/<launch_filename>.launch.py
- Change line 12, 13, 65 according to your own configurations:

URDF: Physical Properties

```
<?xml version="1.0"?>
<robot xmlns:xacro="http://www.ros.org/wiki/xacro" name="robot_name">
    ...

    <xacro:macro name="box_inertia" params="m d w h">
        <inertial>
            <origin xyz="0 0 0" rpy="${pi/2} 0 ${pi/2}" />
            <mass value="${m}" />
            <inertia ixx="${(m/12) * (h*h + w*w)}" ixy="0.0" ixz="0.0" iyy="${(m/12) * (d*d + h*h)}" iyz="0.0" izz="${(m/12) * (w*w + d*d)}" />
        </inertial>
    </xacro:macro>

    <link name="base_link">
        <visual>
            <geometry>
                <box size="${base_depth} ${base_width} ${base_height}"/>
            </geometry>
        </visual>

        <collision>
            <geometry>
                <box size="${base_depth} ${base_width} ${base_height}"/>
            </geometry>
        </collision>

        <xacro:box_inertia m="${base_mass}" d="${base_depth}" w="${base_width}" h="${base_height}" />
    </link>

    ...
</robot>
```

Gazebo reference

```
<?xml version="1.0"?>
<robot xmlns:xacro="http://www.ros.org/wiki/xacro" name="robot_name">
    ...

    <gazebo reference="caster">
        <mu1>0.0001</mu1>
        <mu2>0.0001</mu2>
        <material>Gazebo/Gray</material>
    </gazebo>

    ...
</robot>
```

Reference link/joint

Friction coefficients

Color

Gazebo Plugins Examples

- diff_drive: https://github.com/ros-simulation/gazebo_ros_pkgs/wiki/ROS-2-Migration:-Diff-drive
- imu_sensors: https://github.com/ros-simulation/gazebo_ros_pkgs/wiki/ROS-2-Migration:-IMU-Sensors
- camera: https://github.com/ros-simulation/gazebo_ros_pkgs/wiki/ROS-2-Migration:-Camera
- ray(lidar): https://github.com/ros-simulation/gazebo_ros_pkgs/wiki/ROS-2-Migration:-Camera

gazebo_ros_diff_drive Plugin

```xml
<?xml version="1.0"?>
<robot xmlns:xacro="http://www.ros.org/wiki/xacro" name="robot_name">
    ...

    <gazebo>
        <plugin name="joint_states" filename="libgazebo_ros_joint_state_publisher.so">
            <joint_name>right_wheel_joint</joint_name>
            <joint_name>left_wheel_joint</joint_name>
        </plugin>

        <plugin name="diff_drive_name" filename="libgazebo_ros_diff_drive.so">
            <ros>
                <namespace>/robot_name</namespace>
                <!-- <argument>cmd_vel:=cmd_demo</argument>
                <argument>odom:=odom_demo</argument> -->
            </ros>
            <!-- wheels -->
            <left_joint>left_wheel_joint</left_joint>
            <right_joint>right_wheel_joint</right_joint>
            <!-- kinematics -->
            <wheel_separation>0.19</wheel_separation>
            <wheel_diameter>0.065</wheel_diameter>
            <!-- tfs -->
            <publish_odom>true</publish_odom>
            <publish_odom_tf>true</publish_odom_tf>
            <publish_wheel_tf>true</publish_wheel_tf>
            <odometry_frame>odom</odometry_frame>
            <!-- limits -->
            <max_wheel_torque>20</max_wheel_torque>
            <max_acceleration>1.0</max_acceleration>
            <!-- miscs -->
            <robot_base_frame>base_link</robot_base_frame>
            <update_rate>50</update_rate>
        </plugin>
    </gazebo>

    ...
</robot>
```

Full Examples

- Full URDF example with Gazebo add-ons:
  https://github.com/linzhangUCA/homeplater/blob/5-gazebo_plugin/hpr_description/urdf/homeplater.urdf.xacro
- URDF breakdown example:
  https://github.com/linzhangUCA/homeplater/blob/6-model_breakdown/hpr_description/urdf/