XACRO Basics

Estimated time to completion: **15 minutes**

7.6 Macros

A macro is a special XACRO element that can be used to define URDF elements that appear multiple times across the robot model. Imagine a hexapod. Instead of hard coding the same elements for each leg of the robot repeatedly, you could create a macro that defines one leg and then call that macro six times at different locations to create the six legs. If you decide you want to change the size of the legs, you would only need to change the macro that defines one leg rather than every leg's code.

The following code block contains an exemplary macro definition:

In [ ]:
```
<xacro:macro name="caster_wheel">
    ... macro body ...
</xacro:macro>
```

You must always provide a **name** attribute that creates a unique name for the macro. In this case, the name is **caster_wheel**. Within the XACRO element, you define URDF elements like links and joints, and create visual and collision elements, amongst other things. You can place anything exactly as in URDF.

To use a macro, instantiate it by using the name you specified earlier in the name attribute. In the previous example, it will look like this:

In [ ]:
```
<xacro:caster_wheel />
```

Macros with parameters

Macros are extremely useful when statements are repeated or reused with modifications defined by parameters.

The following macro contains a parameterized form of a wheel definition:

In [ ]:
```
<xacro:macro name="wheel" params="wheel_name">
  <link name="${wheel_name}">
      <visual>
        <origin rpy="0 1.5707 1.5707" xyz="0 0 0"/>
        <geometry>
          <cylinder length="0.001" radius="0.035"/>
        </geometry>
        <material name="red"/>
      </visual>

      <collision>
        <origin rpy="0 1.5707 1.5707" xyz="0 0 0"/>
        <geometry>
          <cylinder length="${wheel_length}" radius="${wheel_radius}"/>
        </geometry>
      </collision>

      <inertial>
        <origin rpy="0 1.5707 1.5707" xyz="0 0 0"/>
        <mass value="0.05"/>
        <inertia ixx="1.531666666666667e-05" ixy="0" ixz="0" iyy="1.531666666666667e-05" iyz="0" izz="3.0625000000000006e-05"/>
      </inertial>

  </link>

</xacro:macro>
```

This can be used with the code:

In [ ]:
```
<xacro:wheel wheel_link_name="right_wheel" />
<xacro:wheel wheel_link_name="left_wheel" />
```

In addition to the example shown, you can write macros that take in as many parameters as needed. The only requirement is that a space must separate the parameters.

- Exercise 7.5.1 -

Task:

- Modify the box_bot XACRO description from the previous exercise and define a parameterized macro that creates both the left and right wheels.

- End of Exercise 7.5.1 -

- Solution to Exercise 7.5.1 -

box_bot.xacro

In [ ]:

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

<xacro:property name="body_width" value="0.1"/>
<xacro:property name="body_lenght" value="0.1"/>
<xacro:property name="body_height" value="0.1"/>
<xacro:property name="wheel_width" value="0.001"/>
<xacro:property name="wheel_radius" value="0.035"/>

<link name="base_link">
  </link>

  <joint name="base_link_joint" type="fixed">
    <origin rpy="0 0 0" xyz="0 0 0" />
    <parent link="base_link" />
    <child link="chassis" />
  </joint>

  <link name="chassis">
    <visual>
      <geometry>
        <box size="${body_width} ${body_lenght} ${body_height}"/>
      </geometry>
    </visual>

    <collision>
      <geometry>
        <box size="${body_width} ${body_lenght} ${body_height}"/>
      </geometry>
    </collision>

    <inertial>
      <mass value="0.5"/>
      <origin rpy="0 0 0" xyz="0 0 0"/>
      <inertia ixx="0.0008333333333333335" ixy="0" ixz="0" iyy="0.0008333333333333335" iyz="0" izz="0.0008333333333333335"/>
    </inertial>

  </link>
```

```
<!-- Wheel Macro -->
<xacro:macro name="wheel" params="wheel_name">
  <link name="${wheel_name}">
      <visual>
        <origin rpy="0 1.5707 1.5707" xyz="0 0 0"/>
        <geometry>
          <cylinder length="${wheel_width}" radius="${wheel_radius}"/>
        </geometry>
      </visual>

      <collision>
        <origin rpy="0 1.5707 1.5707" xyz="0 0 0"/>
        <geometry>
          <cylinder length="${wheel_width}" radius="${wheel_radius}"/>
        </geometry>
      </collision>

      <inertial>
        <origin rpy="0 1.5707 1.5707" xyz="0 0 0"/>
        <mass value="0.05"/>
        <inertia ixx="1.531666666666667e-05" ixy="0" ixz="0" iyy="1.531666666666667e-05" iyz="0" izz="3.0625000000000006e-05"/>
      </inertial>
  </link>
</xacro:macro>


  <!-- Wheel Left -->
 <xacro:wheel wheel_name="left_wheel" />

  <!-- Wheel Right -->
  <xacro:wheel wheel_name="right_wheel" />

  <joint name="joint_left_wheel" type="continuous">
    <origin rpy="0 0 0" xyz="0 0.05 -0.025"/>
    <child link="left_wheel"/>
    <parent link="chassis"/>
    <axis rpy="0 0 0" xyz="0 1 0"/>
    <limit effort="10000" velocity="1000"/>
    <joint_properties damping="1.0" friction="1.0"/>
  </joint>
```

```
<joint name="joint_right_wheel" type="continuous">
  <origin rpy="0 0 0" xyz="0 -0.05 -0.025"/>
  <child link="right_wheel"/>
  <parent link="chassis"/>
  <axis rpy="0 0 0" xyz="0 1 0"/>
  <limit effort="10000" velocity="1000"/>
  <joint_properties damping="1.0" friction="1.0"/>
</joint>

<!-- Caster Wheel Front -->
<link name="front_yaw_link">
    <visual>
      <origin rpy="0 1.5707 1.5707" xyz="0 0 0"/>
      <geometry>
        <cylinder length="0.001" radius="0.0045000000000000005"/>
      </geometry>
    </visual>

    <collision>
      <origin rpy="0 1.5707 1.5707" xyz="0 0 0"/>
      <geometry>
        <cylinder length="0.001" radius="0.0045000000000000005"/>
      </geometry>
    </collision>

    <inertial>
        <origin rpy="0 1.5707 1.5707" xyz="0 0 0"/>
        <mass value="0.001"/>
        <inertia ixx="5.145833333333334e-09" ixy="0" ixz="0" iyy="5.145833333333334e-09" iyz="0" izz="1.0125000000000003e-08"/>
    </inertial>

</link>

<joint name="front_yaw_joint" type="continuous">
  <origin rpy="0 0 0" xyz="0.04 0 -0.05" />
  <parent link="chassis" />
  <child link="front_yaw_link" />
  <axis xyz="0 0 1" />
  <limit effort="1000.0" velocity="100.0" />
```

```
  <dynamics damping="0.0" friction="0.1"/>
</joint>

<link name="front_roll_link">
    <visual>
      <origin rpy="0 1.5707 1.5707" xyz="0 0 0"/>
      <geometry>
        <cylinder length="0.001" radius="0.0045000000000000005"/>
      </geometry>
    </visual>

    <collision>
      <origin rpy="0 1.5707 1.5707" xyz="0 0 0"/>
      <geometry>
        <cylinder length="0.001" radius="0.0045000000000000005"/>
      </geometry>
    </collision>

    <inertial>
        <origin rpy="0 1.5707 1.5707" xyz="0 0 0"/>
        <mass value="0.001"/>
        <inertia ixx="5.145833333333334e-09" ixy="0" ixz="0" iyy="5.145833333333334e-09" iyz="0" izz="1.0125000000000003e-08"/>
    </inertial>
</link>

<joint name="front_roll_joint" type="continuous">
  <origin rpy="0 0 0" xyz="0 0 0" />
  <parent link="front_yaw_link" />
  <child link="front_roll_link" />
  <axis xyz="1 0 0" />
  <limit effort="1000.0" velocity="100.0" />
  <dynamics damping="0.0" friction="0.1"/>
</joint>


<link name="front_pitch_link">
  <visual>
    <origin rpy="0 1.5707 1.5707" xyz="0 0 0"/>
    <geometry>
      <sphere radius="0.010"/>
```

```
      </geometry>
    </visual>

    <collision>
      <origin rpy="0 1.5707 1.5707" xyz="0 0 0"/>
      <geometry>
        <sphere radius="0.010"/>
      </geometry>
    </collision>

    <inertial>
        <origin rpy="0 1.5707 1.5707" xyz="0 0 0"/>
        <mass value="0.001"/>
        <inertia ixx="4e-08" ixy="0" ixz="0" iyy="4e-08" iyz="0" izz="4e-08"/>
    </inertial>
  </link>

  <joint name="front_pitch_joint" type="continuous">
    <origin rpy="0 0 0" xyz="0 0 0" />
    <parent link="front_roll_link" />
    <child link="front_pitch_link" />
    <axis xyz="0 1 0" />
    <limit effort="1000.0" velocity="100.0" />
    <dynamics damping="0.0" friction="0.1"/>
  </joint>

<!-- Caster Wheel Back -->
  <link name="back_yaw_link">
    <visual>
        <origin rpy="0 1.5707 1.5707" xyz="0 0 0"/>
        <geometry>
          <cylinder length="0.001" radius="0.0045000000000000005"/>
        </geometry>
      </visual>

      <collision>
        <origin rpy="0 1.5707 1.5707" xyz="0 0 0"/>
        <geometry>
          <cylinder length="0.001" radius="0.0045000000000000005"/>
        </geometry>
```

```
    </collision>

    <inertial>
        <origin rpy="0 1.5707 1.5707" xyz="0 0 0"/>
        <mass value="0.001"/>
        <inertia ixx="5.145833333333334e-09" ixy="0" ixz="0" iyy="5.145833333333334e-09" iyz="0" izz="1.0125000000000003e-08"/>
    </inertial>
</link>

<joint name="back_yaw_joint" type="continuous">
  <origin rpy="0 0 0" xyz="-0.04 0 -0.05" />
  <parent link="chassis" />
  <child link="back_yaw_link" />
  <axis xyz="0 0 1" />
  <limit effort="1000.0" velocity="100.0" />
  <dynamics damping="0.0" friction="0.1"/>
</joint>


<link name="back_roll_link">
    <visual>
      <origin rpy="0 1.5707 1.5707" xyz="0 0 0"/>
      <geometry>
        <cylinder length="0.001" radius="0.0045000000000000005"/>
      </geometry>
    </visual>

    <collision>
      <origin rpy="0 1.5707 1.5707" xyz="0 0 0"/>
      <geometry>
        <cylinder length="0.001" radius="0.0045000000000000005"/>
      </geometry>
    </collision>

    <inertial>
        <origin rpy="0 1.5707 1.5707" xyz="0 0 0"/>
        <mass value="0.001"/>
        <inertia ixx="5.145833333333334e-09" ixy="0" ixz="0" iyy="5.145833333333334e-09" iyz="0" izz="1.0125000000000003e-08"/>
    </inertial>
</link>
```

```
<joint name="back_roll_joint" type="continuous">
  <origin rpy="0 0 0" xyz="0 0 0" />
  <parent link="back_yaw_link" />
  <child link="back_roll_link" />
  <axis xyz="1 0 0" />
  <limit effort="1000.0" velocity="100.0" />
  <dynamics damping="0.0" friction="0.1"/>
</joint>


<link name="back_pitch_link">
  <visual>
    <origin rpy="0 1.5707 1.5707" xyz="0 0 0"/>
    <geometry>
      <sphere radius="0.010"/>
    </geometry>
  </visual>

  <collision>
    <origin rpy="0 1.5707 1.5707" xyz="0 0 0"/>
    <geometry>
      <sphere radius="0.010"/>
    </geometry>
  </collision>

  <inertial>
      <origin rpy="0 1.5707 1.5707" xyz="0 0 0"/>
      <mass value="0.001"/>
      <inertia ixx="4e-08" ixy="0" ixz="0" iyy="4e-08" iyz="0" izz="4e-08"/>
  </inertial>
</link>

<joint name="back_pitch_joint" type="continuous">
  <origin rpy="0 0 0" xyz="0 0 0" />
  <parent link="back_roll_link" />
  <child link="back_pitch_link" />
  <axis xyz="0 1 0" />
  <limit effort="1000.0" velocity="100.0" />
  <dynamics damping="0.0" friction="0.1"/>
```

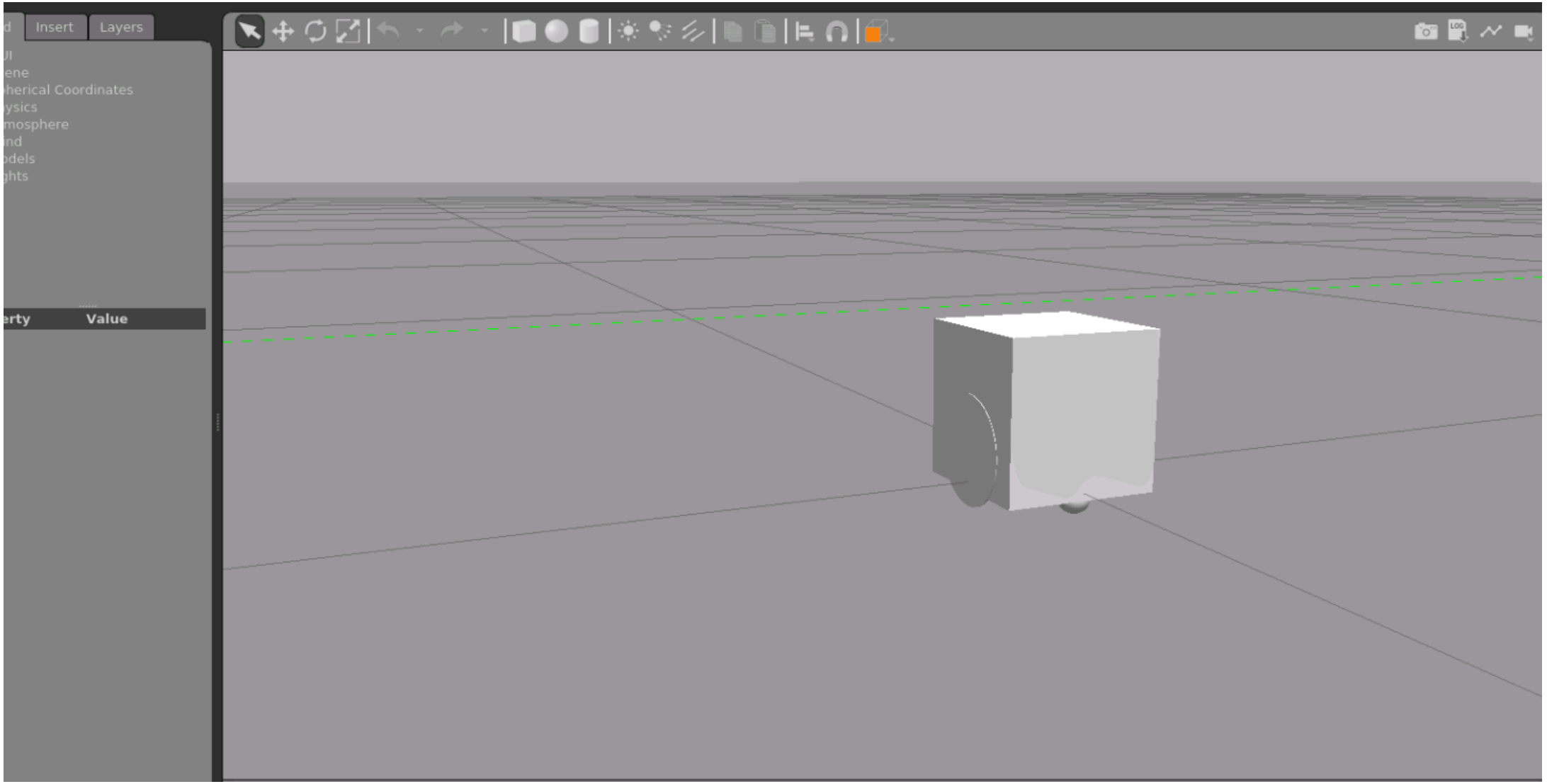
```
  </joint>


</robot>
```

▶ Execute in Webshell 1

In [ ]:
```
cd ~/ros2_ws && colcon build && source install/setup.bash
```

In [ ]:
```
ros2 launch my_box_bot_description box_bot_xacro.launch.py
```

It appears to be the same cube with wheels, like before:



- End of Solution to Exercise 7.5.1 -

16/11/2023