Solidworks to URDF: A Brief Tutorial

Bismaya Sahoo,
University of Waterloo.
E_mail: bsahoo@uwaterloo.ca

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1 A tutorial on Solidworks to URDF export

This document presents a tutorial on creation of a Solidworks model of a robot and its export to Gazebo for simulation and its integration with ROS.

1. Get the blueprints of the robot model that you want to create. Blueprints help a great deal in CAD development. They allow us to be approximate about the dimensions while keeping the relative orientation and positions of several parts and subparts. Example blueprints are shown in the Fig 1 and 2.

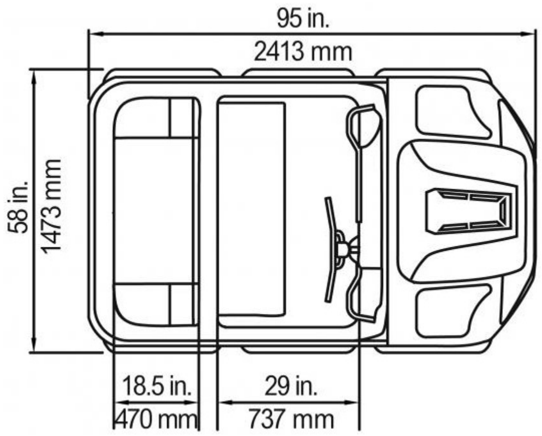

Figure 1: Blueprint TOP

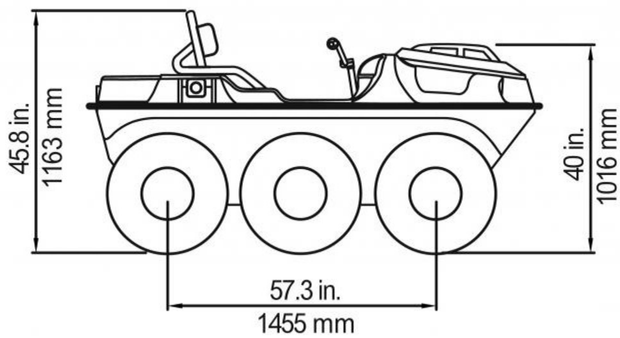

Figure 2: Blueprint RIGHT

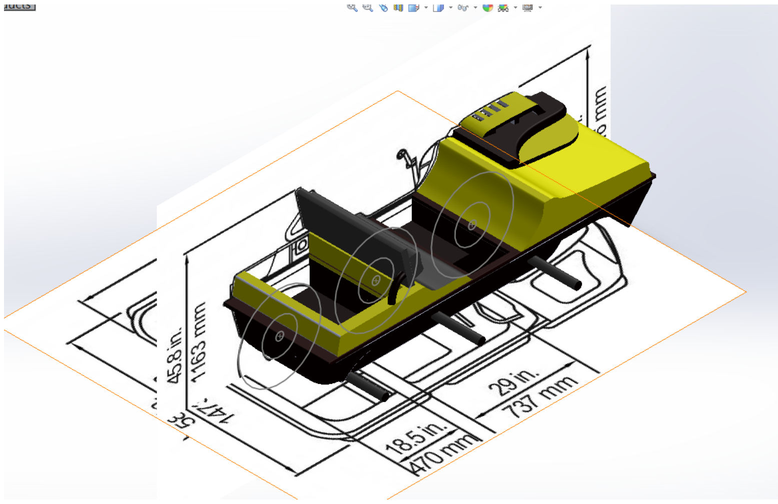

Figure 3: Base Visual Model

2. Gazebo requires two models for its simulation. A visual model and a collison model. The visual model appeals to the aesthetic appearance and the collison model is used for calculation of collison between objects in the Gazebo environment. It is inituitive that the collison model should be as simple as possible and should not contain complex structures to simplify the calculation as much as possible.

3. Develop the solidworks visual model on top of the blueprints. An example is shown in Fig 3 and 4.

4. Take the dimensions of the wheels and develop a wheel part. Make sure it has appropriate mating surfaces to lock it in place.

5. Create a new assembly and mate the different parts. Make sure each part has its associated degrees of freedom. e.g. the wheels should rotate in its place.

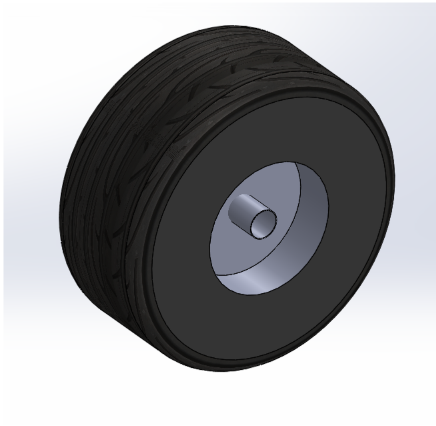

Figure 4: Wheel Visual Model

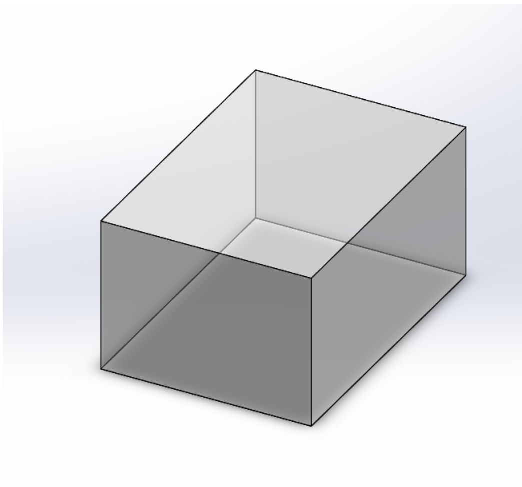

Figure 5: Base Collison Model

6. We will develop the collison models now. The collison model for the base will be a box and a solid cylinder for the wheels.

7. Take the outside measurements and build the base collison model.

8. Similarly, take measurements for the wheels and build a wheel collison model.

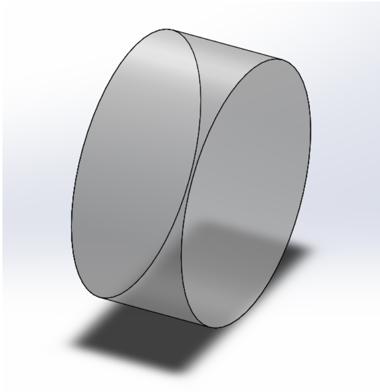

Figure 6: Wheel Collison Model

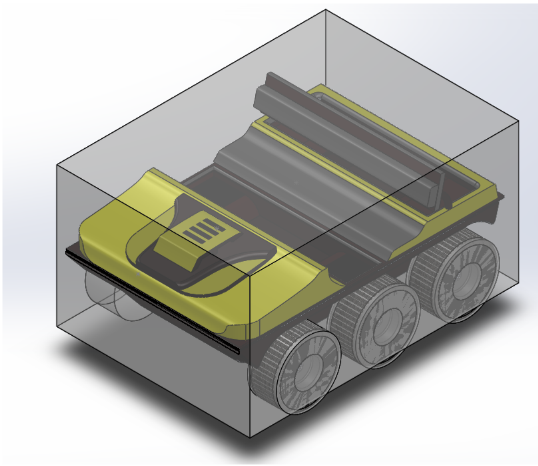

Figure 7: Overlayed Models

9. Overlay the collison and visual models on top of each other to see if they are of proper scale and shown in Fig.7

10. Next we demonstrate the export process. Open an empty instance of Solidworks and make sure the plugin is installed. The installation process is described at sw_urdf_exporter in ROS tutorials.

11. Make sure the plugin is selected before opening the mated "assembly" file. The option is available under "TOOLS" > "Addins".

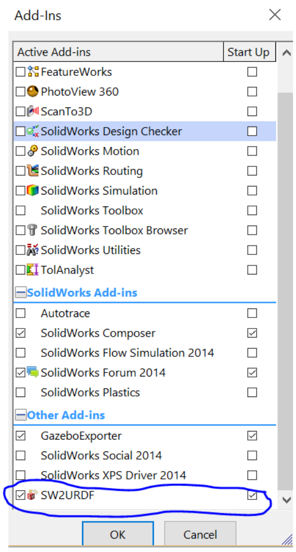

Figure 8: Select Add in

12. Open your assembly and Go to "Files" > "SW to URDF exporter".

13. Define the axes and Coordinate Systems consistent with ROS TFs since the coordinate system of ROS is different from Solidworks. Fig. 9 shows such coordinates and axes. Make sure to define a global coordinates at the approximate location of the Centre of Mass. Notice the difference in the axes definations at the wheels and the Global Coordinates at the com.

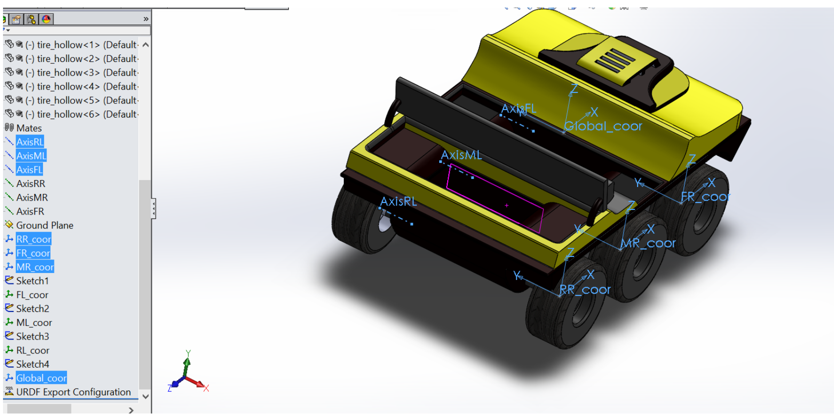

Figure 9: Axes and Coordinates

14. Select the base link as the chasis of the vehicle. Note this selects a whole "part" file at a time. If you need multiple colors, model them as separate parts before mating them in the assembly. Also, make sure all the parts

are connected as "fixed links" and "fixed joints" and attached as child links to the base link. This is shown in Fig.10.

15. Select the Child links and joints. The joints are the mating surfaces of the wheel and the wheel axle. Make sure to select the appropriate axes and the coordinate systems. The Joint type will be continous for the wheels and fixed for the base frame. This is shown in Fig. 11.
16. Now open up the collison model and repeat the steps 13 and 14. This is shown in Fig. 12 and Fig 13. The settings are the same as above.
17. Clicking "Preview and Export" will bring up the Joint Property manager. Click through them to make sure every entry is filled. Shown in Fig.12
18. Clicking "Next" will bring up the "Link Properties" window. Here the mass and inertia properties can be filled up. Consult the datasheet of your vehicle and update accordingly. Shown in Fig.13.
19. Click Finsh. Give a location and a "Name" to complete the export process.
20. **Necessary:** Due to a bug in the exporter, it is essential to check if the export process completed correctly. Open up the directory and check if all files are present, all files occupy considerable sizes. Open them up in a 3D viewer to check the scale and orientation are alright. The files in our case are shown in Fig. 14.
21. Repeat the same procedure for the Collison files. Save the file as "NAME_col". This will be important later on.
22. Copy the contents of the meshes directory in "NAME_col"and paste into meshes directory in "NAME" folder as shown in Fig. 15.
23. Open up the "NAME.urdf" in the robots folder. Add entries to the collison properties as shown in Fig. 16. Change the filepath under the collison properties to reflect the copied collision files as indicated.
24. The whole "NAME" directory can be exported as a model into Gazebo. If noticed closely it already has a gazebo.launch and display.launch files in the directory.
25. Open ROS. Create a new catkin_package preferrably as "yourRobotName_description".
26. Copy the contents on "NAME" into "yourRobotName_description".
27. Compile the package.
28. roslaunch the gazebo.launch file in the "yourRobotName_description" package. This should display the robot in gazebo. Firing up rviz should also display this robot.
29. If you notice the gazebo model is glass instead of reflecting appropriate colors, open up the URDF file and change the "rgba" value in color property under colors to upto 3-4 decimal places.

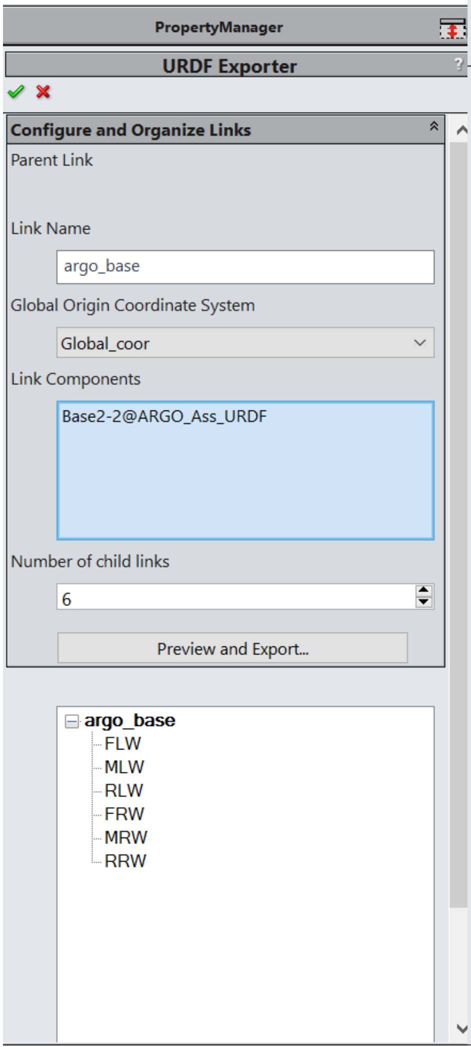

Figure 10: Base Link Selection

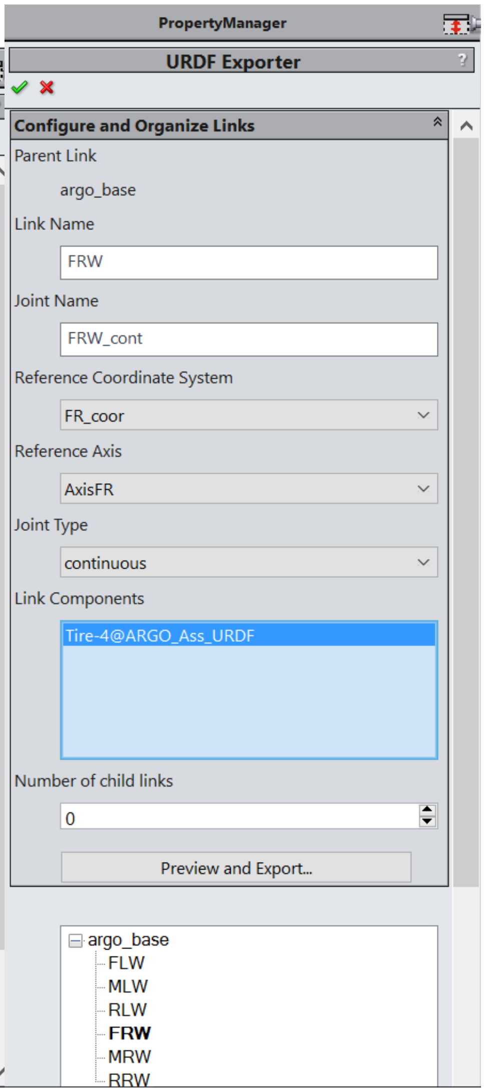

Figure 11: Child Link Selection

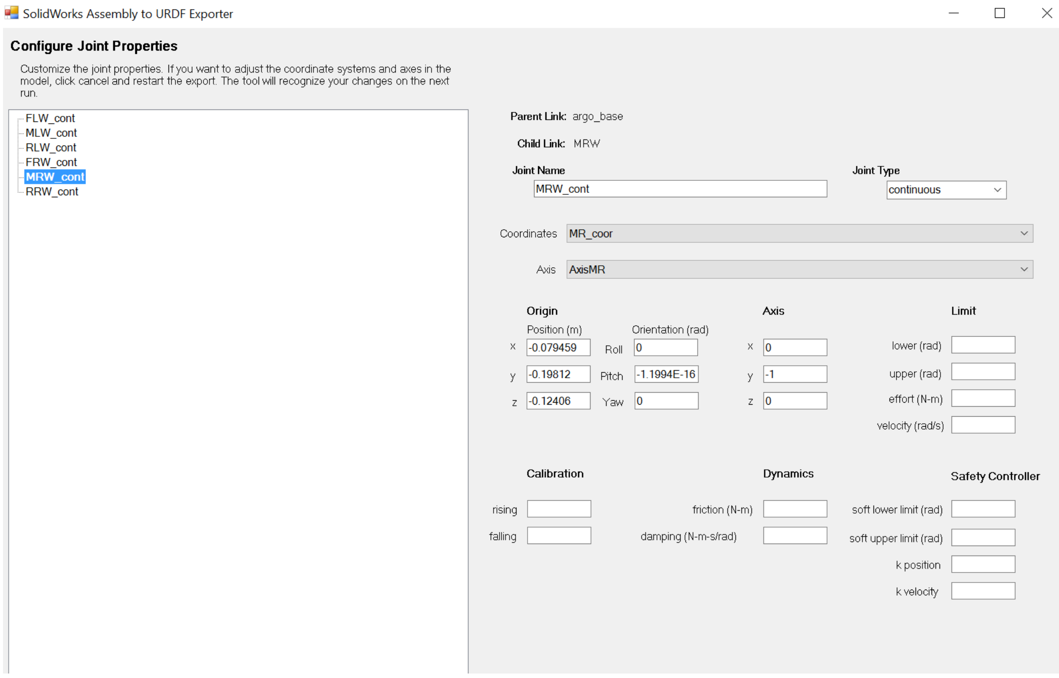

Figure 12: Joint Property Window

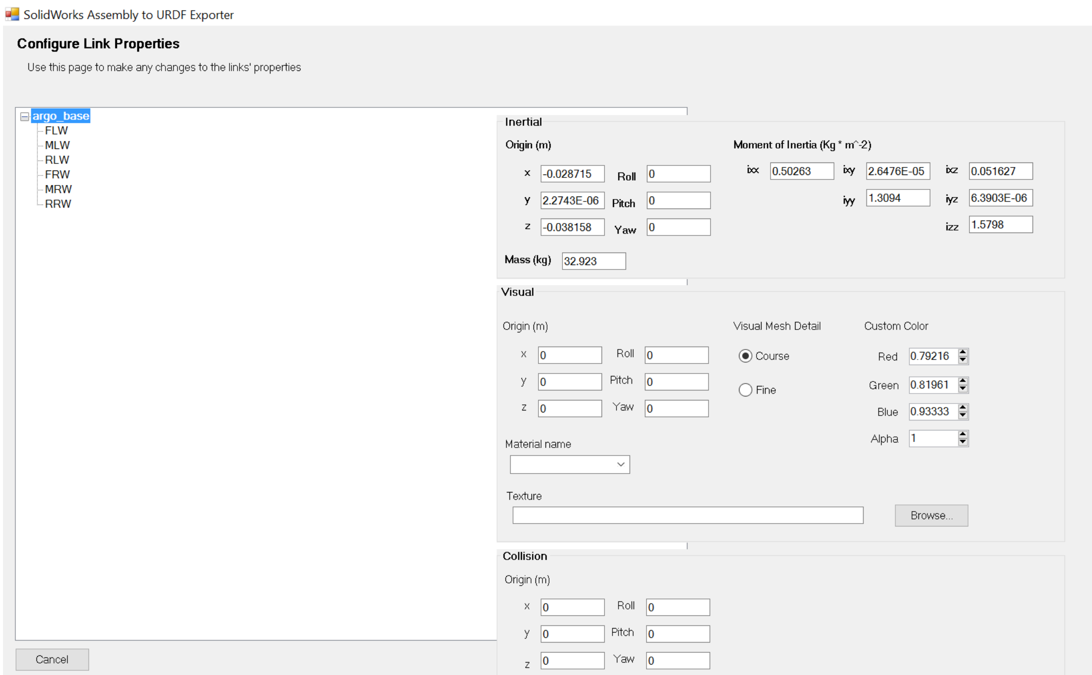

Figure 13: Link Property Window

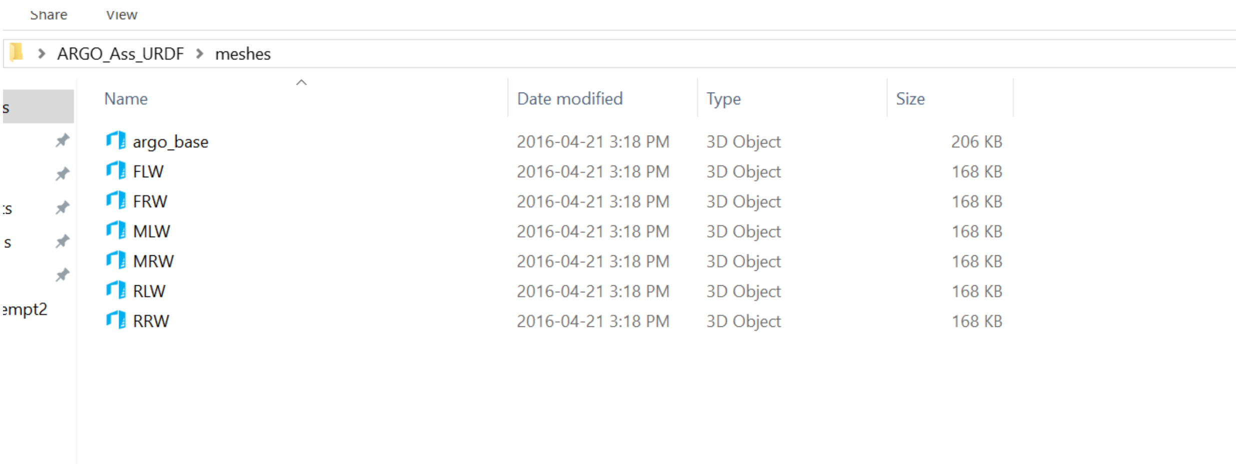

Figure 14: Generated Visual Meshes

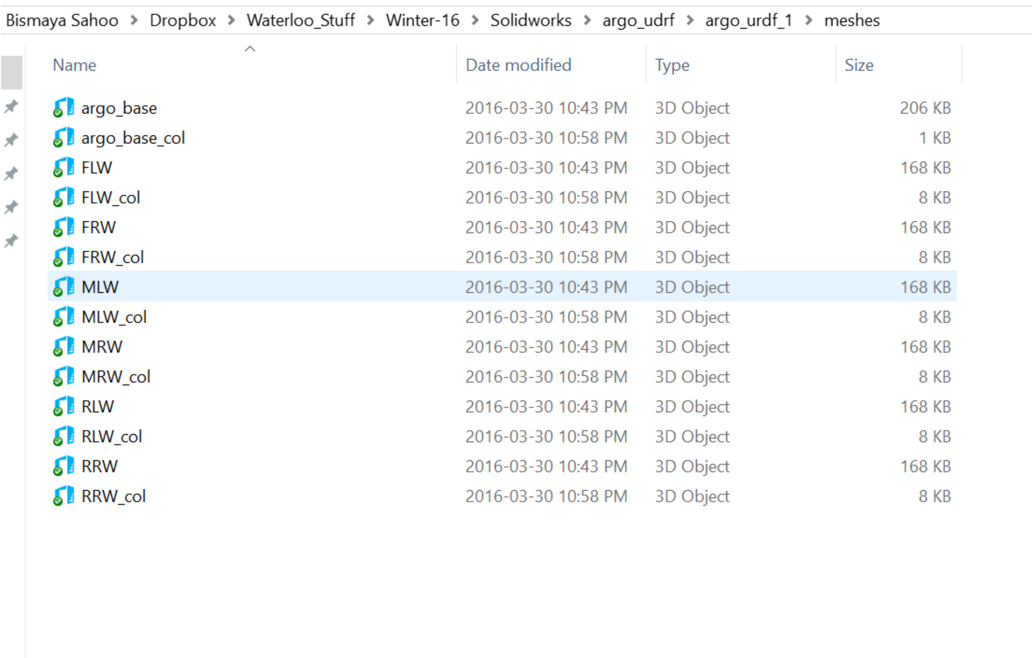

Figure 15: Generated Visual and Collison Meshes

```
      rpy="0 0 0" />
    <geometry>
      <mesh
        filename="package://argo_urdf_1/meshes/argo_base.STL" />
    </geometry>
    <material
      name="">
      <color
        rgba="0.792156862745098 0.819607843137255 0.933333333333333 1" />
    </material>
  </visual>
  <collision>
    <origin
      xyz="0 0 0"
      rpy="0 0 0" />
    <geometry>
      <mesh
        filename="package://argo_urdf_1/meshes/argo_base_col.STL" />
    </geometry>
  </collision>
</link>
<link
  name="FLW">
  <inertial>
```

Figure 16: Add Collison Properties

Bugs Unfortunately, this tool is still quite buggy but we have outlined a few workarounds.

- Ensure that the plugin in enabled before the CAD assembly is opened.
- Ensure the whole process is one continous flow and the previous entries are not revisited. If something goes wrong, start over.
- If the joint configuration page, any link/joint has missing entries, start over.
- After the export, ensure that the "stl" files in the "meshes" folder have reasonable files size.
- Open the "stl" files in a 3D viewer and ensure they are all of proper sizes and oriented properly.

Conclusion We have outlined the whole export process. This should be enough to integrate your robot into the gazebo and rviz in ROS. Follow the Gazebo tutorials to integrate sensors into your model. This portion is left out intentionally as the sensor configurations would be different for different robots and there is no point being specific about this vehicle. The gazebo tutorials are descriptive enough to enable the developer add in sensor plugins to the robot. Feel free to contact for suggestions to improve this document.