# Creating a vehicle model for Autoware

## Introduction

This page introduces the following packages for the vehicle model:

1. `<YOUR-VEHICLE-NAME>_vehicle_description`
2. `<YOUR-VEHICLE-NAME>_vehicle_launch`

Previously, we forked our vehicle model at the creating autoware repositories page step. For instance, we created tutorial_vehicle_launch as an implementation example for the said step. Please ensure that the _vehicle_launch repository is included in Autoware, following the directory structure below:

```
<YOUR-OWN-AUTOWARE-DIR>/
  └─ src/
       └─ vehicle/
            └─ <YOUR-VEHICLE-NAME>_vehicle_launch/
                 ├─ <YOUR-VEHICLE-NAME>_vehicle_description/
                 └─ <YOUR-VEHICLE-NAME>_vehicle_launch/
```

If your forked Autoware meta-repository doesn't include `<YOUR-VEHICLE-NAME>_vehicle_launch` with the correct folder structure as shown above, please add your forked `<YOUR-VEHICLE-NAME>_vehicle_launch` repository to the autoware.repos file and run the vcs import src < autoware.repos command in your terminal to import the newly included repositories at autoware.repos file.

Now, we are ready to modify the following vehicle model packages for our vehicle. Firstly, we need to rename the description and launch packages:

```
<YOUR-VEHICLE-NAME>_vehicle_launch/
- ├─ sample_vehicle_description/
+ ├─ <YOUR-VEHICLE-NAME>_vehicle_description/
- └─ sample_vehicle_launch/
+ └─ <YOUR-VEHICLE-NAME>_vehicle_launch/
```

After that, we will change our package names in the package.xml file and CMakeLists.txt file of the sample_vehicle_description and sample_vehicle_launch packages. So, open the package.xml file

and CMakeLists.txt file with any text editor or IDE of your preference and perform the following changes:

Change the `<name>` attribute at `package.xml` file:

```
<package format="3">
- <name>sample_vehicle_description</name>
+ <name><YOUR-VEHICLE-NAME>_vehicle_description</name>
  <version>0.1.0</version>
  <description>The vehicle_description package</description>
  ...
  ...
```

Change the `project()` method at `CmakeList.txt` file.

```
  cmake_minimum_required(VERSION 3.5)
- project(sample_vehicle_description)
+ project(<YOUR-VEHICLE-NAME>_vehicle_description)

  find_package(ament_cmake_auto REQUIRED)
...
...
```

Remember to apply the name changes and project method for **BOTH** `<YOUR-VEHICLE-NAME>_vehicle_description` and `<YOUR-VEHICLE-NAME>_vehicle_launch` ROS 2 packages. Once finished, we can proceed to build said packages:

```
colcon build --symlink-install --cmake-args -DCMAKE_BUILD_TYPE=Release --
packages-up-to <YOUR-VEHICLE-NAME>_vehicle_description <YOUR-VEHICLE-
NAME>_vehicle_launch
```

## Vehicle description

The main purpose of this package is to describe the vehicle dimensions, 3D model of the vehicle, mirror_dimensions of the vehicle, simulator model parameters and URDF of the vehicle.

The folder structure of vehicle_description package is:

```
<YOUR-VEHICLE-NAME>_vehicle_description/
   ├─ config/
   │     ├─ mirror.param.yaml
   │     ├─ simulator_model.param.yaml
   │     └─ vehicle_info.param.yaml
   ├─ mesh/
   │     ├─ <YOUR-VEHICLE-MESH-FILE>.dae (or .fbx)
```

```
    │     ├─ ...
    └─ urdf/
          └─ vehicle.xacro
```

Now, we will modify these files according to our vehicle design.

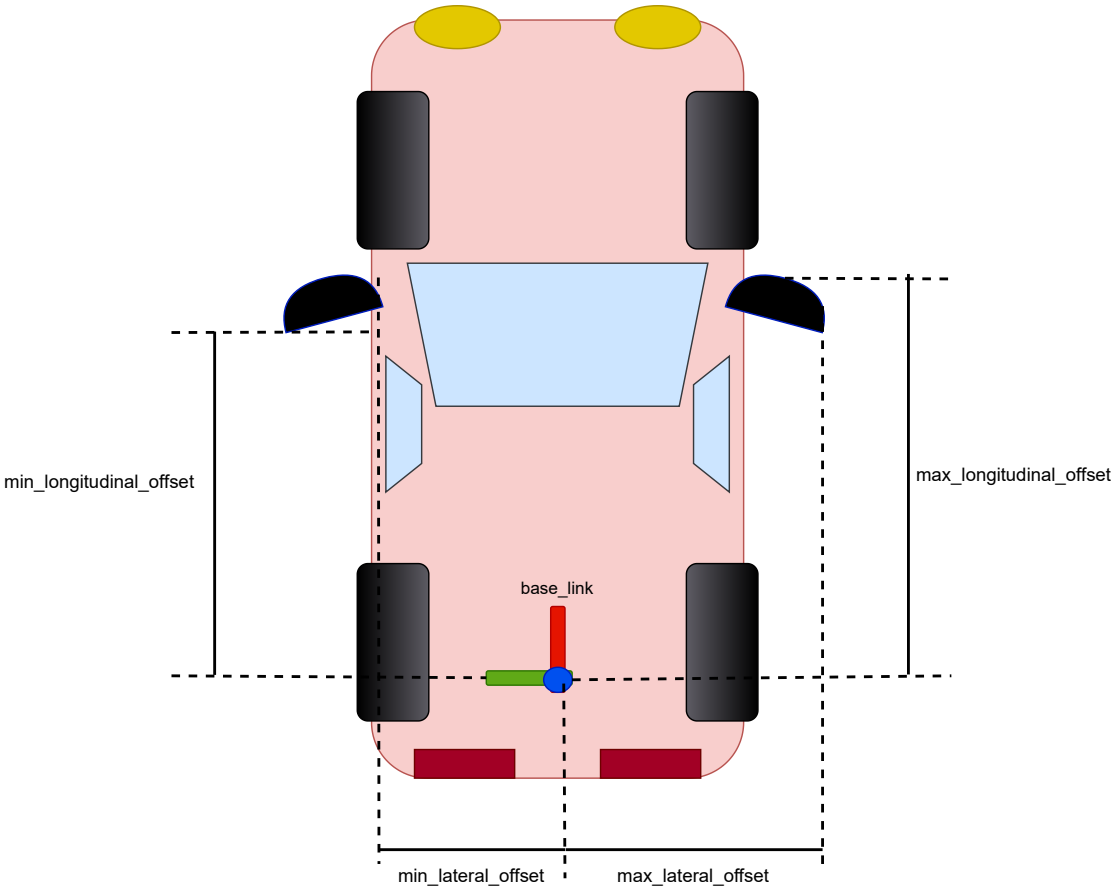
## mirror.param.yaml

This file describes your vehicle mirror dimension for CropBox filter of PointCloudPreprocessor. This is important for cropping mirrors from your lidar's point cloud.

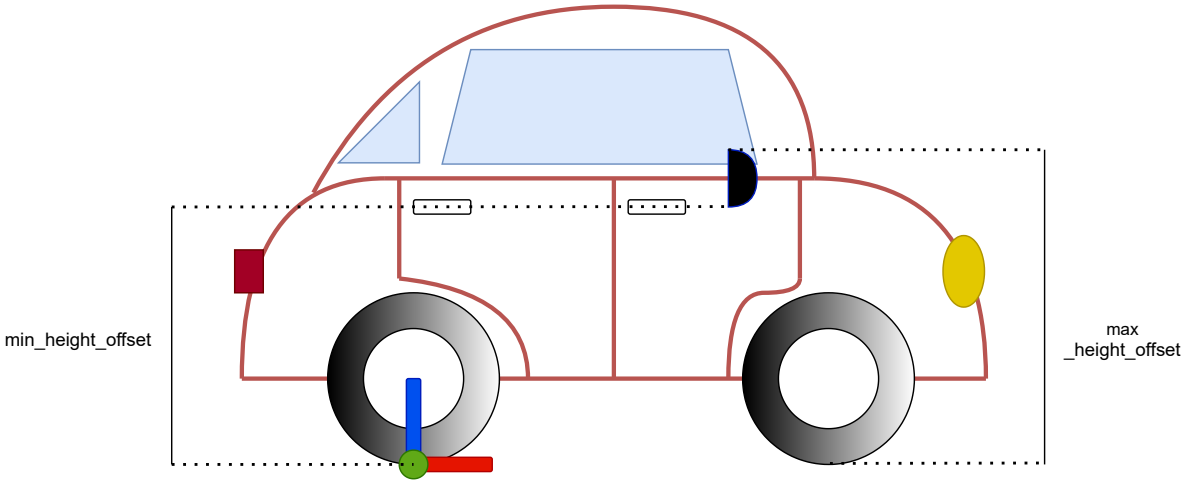
The `mirror.param.yaml` consist of the following parameters:

```yaml
/**:
  ros__parameters:
    min_longitudinal_offset: 0.0
    max_longitudinal_offset: 0.0
    min_lateral_offset: 0.0
    max_lateral_offset: 0.0
    min_height_offset: 0.0
    max_height_offset: 0.0
```

The mirror param file should be filled with this dimension information, please be careful with `min_lateral_offset` parameter, it could be negative value like the mirror dimension figure below.




***Top Down View of Vehicle***




***Right Side View of Vehicle***

*Dimension demonstration for mirror.param.yaml*

> **Warning**
>
> Since there is no mirror in `tutorial_vehicle`, all values set to 0.0. If your vehicle does not have mirror, you can set these values 0.0 as well.

### simulator_model.param.yaml

This file is a configuration file for the simulator environment. Please update these parameters according to your vehicle specifications. For detailed information about variables, please check the simple_planning_simulator package. The file consists of these parameters:

```
/**:
  ros__parameters:
    simulated_frame_id: "base_link" # center of the rear axle.
    origin_frame_id: "map"
    vehicle_model_type: "DELAY_STEER_ACC_GEARED" # options: IDEAL_STEER_VEL /
IDEAL_STEER_ACC / IDEAL_STEER_ACC_GEARED / DELAY_STEER_ACC /
DELAY_STEER_ACC_GEARED
    initialize_source: "INITIAL_POSE_TOPIC" #  options: ORIGIN /
INITIAL_POSE_TOPIC
    timer_sampling_time_ms: 25
    add_measurement_noise: False # the Gaussian noise is added to the simulated
results
    vel_lim: 50.0 # limit of velocity
    vel_rate_lim: 7.0 # limit of acceleration
    steer_lim: 1.0 # limit of steering angle
    steer_rate_lim: 5.0 # limit of steering angle change rate
    acc_time_delay: 0.1 # dead time for the acceleration input
    acc_time_constant: 0.1 # time constant of the 1st-order acceleration dynamics
    steer_time_delay: 0.24 # dead time for the steering input
    steer_time_constant: 0.27 # time constant of the 1st-order steering dynamics
    x_stddev: 0.0001 # x standard deviation for dummy covariance in map
coordinate
    y_stddev: 0.0001 # y standard deviation for dummy covariance in map
coordinate
```

### vehicle_info.param.yaml

This file stores the vehicle dimensions for Autoware modules. Please update it with your vehicle information. You can refer to the vehicle dimensions page for detailed dimension demonstration. Here is the `vehicle_info.param.yaml` for sample_vehicle:

```
/**:
  ros__parameters:
    wheel_radius: 0.383 # The radius of the wheel, primarily used for dead
```

```
reckoning.
    wheel_width: 0.235 # The lateral width of a wheel tire, primarily used for
dead reckoning.
    wheel_base: 2.79 # between front wheel center and rear wheel center
    wheel_tread: 1.64 # between left wheel center and right wheel center
    front_overhang: 1.0 # between front wheel center and vehicle front
    rear_overhang: 1.1 # between rear wheel center and vehicle rear
    left_overhang: 0.128 # between left wheel center and vehicle left
    right_overhang: 0.128 # between right wheel center and vehicle right
    vehicle_height: 2.5
    max_steer_angle: 0.70 # [rad]
```

Please update `vehicle_info.param.yaml` with your vehicle information.

## 3D model of vehicle

You can use .fbx or .dae format as a 3D model with autoware. For the tutorial_vehicle, we exported our 3D model as a .fbx file in the tutorial_vehicle_launch repository. We will set the .fbx file path at `vehicle.xacro` file.

## vehicle.xacro

This .xacro file links the base_link of the vehicle to the 3D mesh. Therefore, we need to make some modifications in this file.

```
<?xml version="1.0"?>
<robot xmlns:xacro="http://ros.org/wiki/xacro">
  <!-- load parameter -->
- <xacro:property name="vehicle_info" value="${xacro.load_yaml('$(find
sample_vehicle_description)/config/vehicle_info.param.yaml')}"/>
+ <xacro:property name="vehicle_info" value="${xacro.load_yaml('$(find <YOUR-
VEHICLE-NAME>_vehicle_description)/config/vehicle_info.param.yaml')}"/>

  <!-- vehicle body -->
  <link name="base_link">
    <visual>
      <origin xyz="${vehicle_info['/**']['ros__parameters']['wheel_base']/2.0} 0
0" rpy="${pi/2.0} 0 ${pi}"/>
      <geometry>
-       <mesh filename="package://sample_vehicle_description/mesh/lexus.dae"
scale="1 1 1"/>
+       <mesh filename="package://<YOUR-VEHICLE-
NAME>_vehicle_description/mesh/<YOUR-3D-MESH-FILE>" scale="1 1 1"/>
      </geometry>
    </visual>
  </link>
</robot>
```

You can also modify roll, pitch, yaw, x, y, z and scale values for the correct position and orientation of the vehicle.

Please build vehicle_description package after the completion of your _vehicle_description package.

```
cd <YOUR-AUTOWARE-DIR>
colcon build --symlink-install --cmake-args -DCMAKE_BUILD_TYPE=Release --
packages-up-to <YOUR-VEHICLE-NAME>_vehicle_description <YOUR-VEHICLE-
NAME>_vehicle_launch
```

## Launching vehicle interface

If your vehicle interface is ready, then you can add your vehicle_interface launch file in `vehicle_interface.launch.xml`. Please check the creating vehicle interface page for more info.

## Launch planning simulator with your own vehicle

After completing the sensor_model, individual_parameters and vehicle model of your vehicle, you are ready to launch the planning simulator with your own vehicle. If you are not sure if every custom package in your Autoware project folder is built, please build all packages:

```
cd <YOUR-AUTOWARE-DIR>
colcon build --symlink-install --cmake-args -DCMAKE_BUILD_TYPE=Release
```

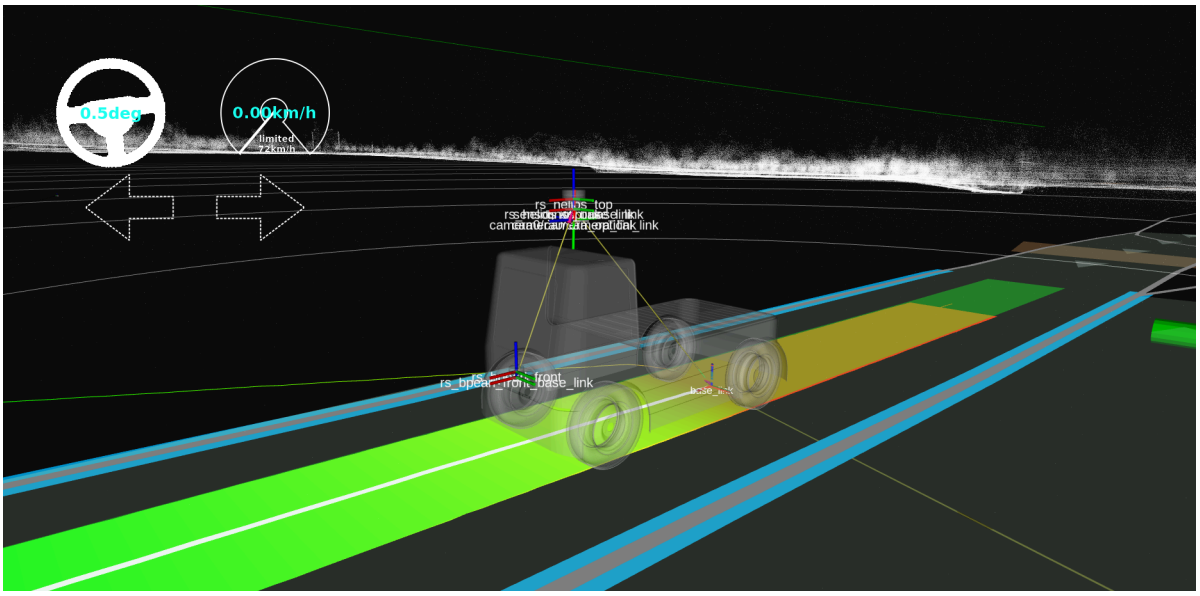
To launch the planning simulator, source the install/setup.bash file in your Autoware project folder and run this command in your terminal:

```
ros2 launch autoware_launch planning_simulator.launch.xml
map_path:=$HOME/Files/autoware_map/sample-map-planning/ vehicle_model:=<YOUR-
VEHICLE-MODEL> sensor_model:=<YOUR-SENSOR-KIT> vehicle_id:=<YOUR-VEHICLE-ID>
```

For example, if we try planning simulator with the tutorial_vehicle:

```
ros2 launch autoware_launch planning_simulator.launch.xml
map_path:=$HOME/Files/autoware_map/sample-map-planning/
vehicle_model:=tutorial_vehicle sensor_model:=tutorial_vehicle_sensor_kit
vehicle_id:=tutorial_vehicle
```

The planning simulator will open, and you can give an initial pose to your vehicle using `2D Pose Estimate` button or by pressing the `P` key on your keyboard. You can click everywhere for vehicle initialization.




*Our tutorial_vehicle on rviz with TF data*