HRI MOBILE ROBOT DOCUMENTATION

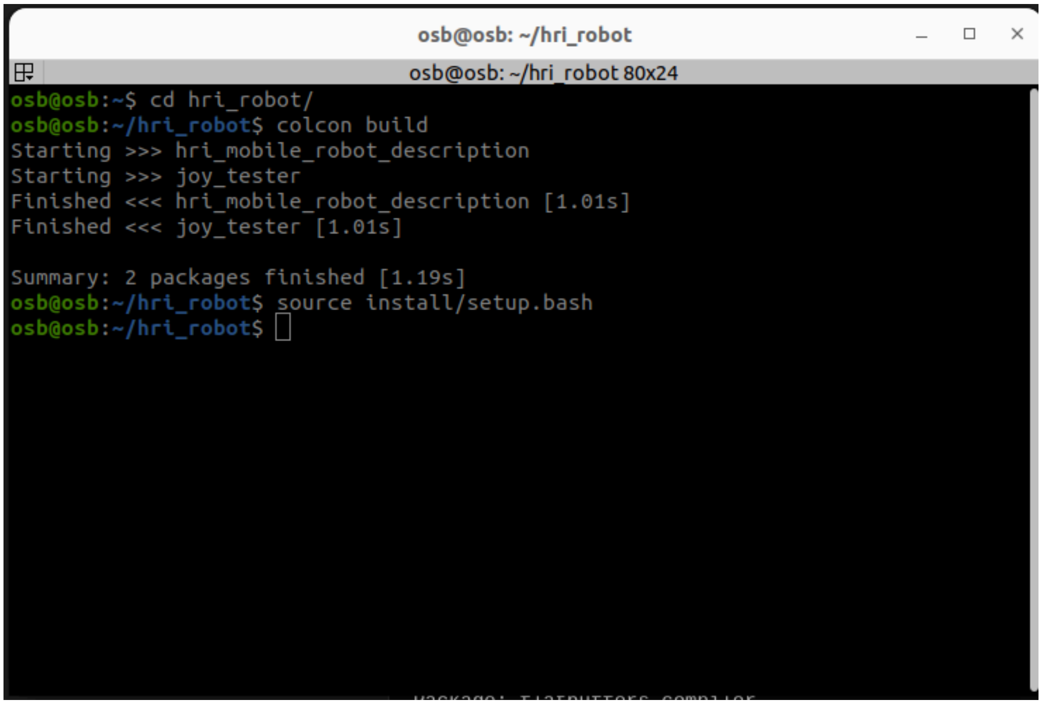
Prerequsites

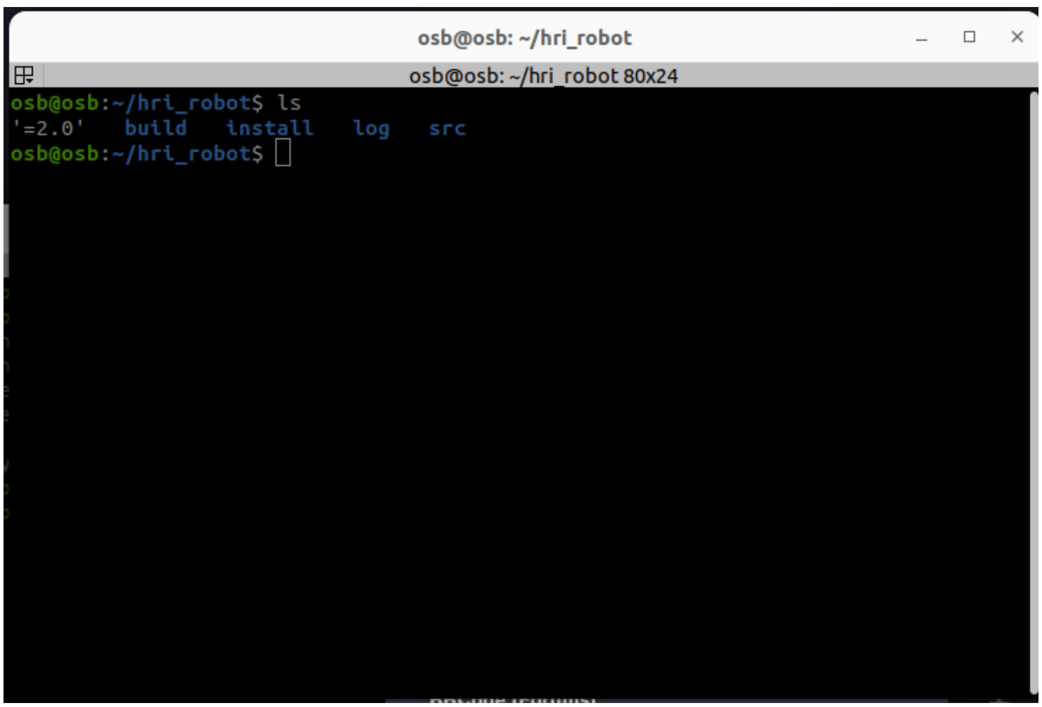
- Mediapipe library version 0.10.5 (command to install mediapipe library `pip install mediapipe==0.10.5`).
- Protobuf library version 3.19.0 (command to install mediapipe library `pip install protobuf==3.19.0`).
- Flatbuffers library version 24.3.25 (command to install mediapipe library `pip install flatbuffers==24.3.25`).
- Tensorflow library version 2.9.3 (command to install mediapipe library `pip install tensorflow==2.9.3`).
- Code works best with **ROS2 Humble and Gazebo 11(Classic)**.

Project Package

- Download `hri_robot` workspace and unzip it.
- Now open terminal and go to the *hri_robot* path.
- First enter `cd hri_robot` then `colcon build` and once build is complete source the install folder by typing `source install/setup.bash` as illustrated in below image.

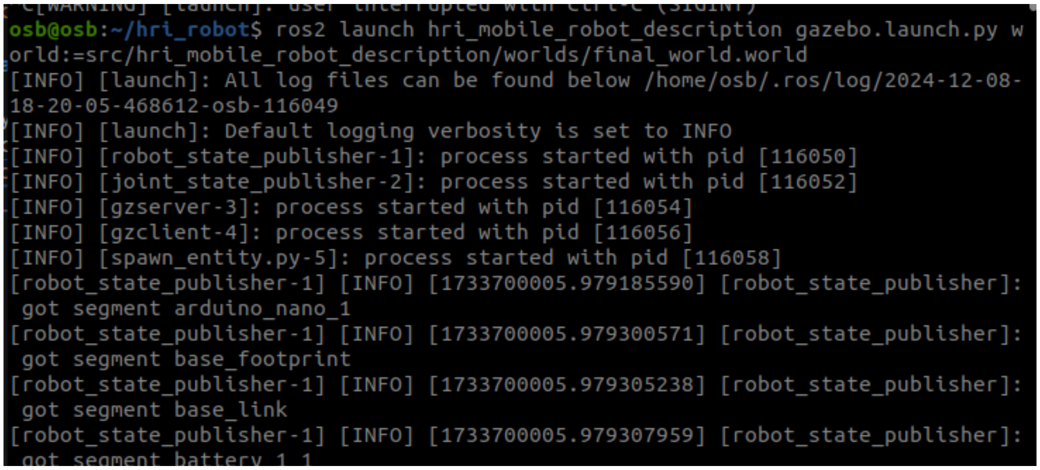
> **Note**: Never build workspace inside src folder.



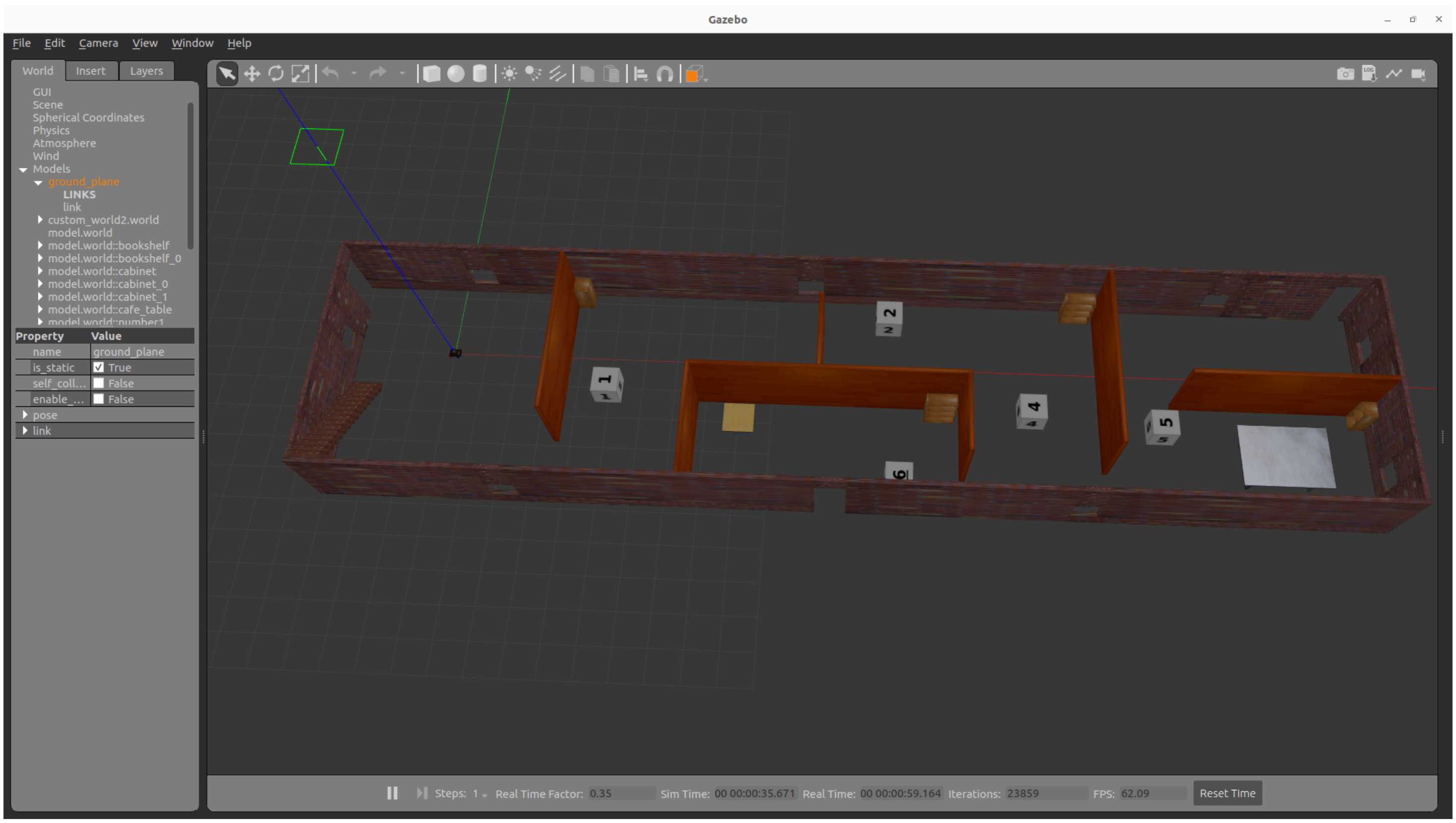


Running Gazebo

- After sourcing the **install/setup.bash** type `ros2 launch hri_mobile_robot_description gazebo.launch.py world:= src/hri_mobile_robot_description/worlds/final_world.world` to spwan gazebo model in our custom world file.



- This will spawn robot in gazebo and it will look like image similar to demonstrated below.

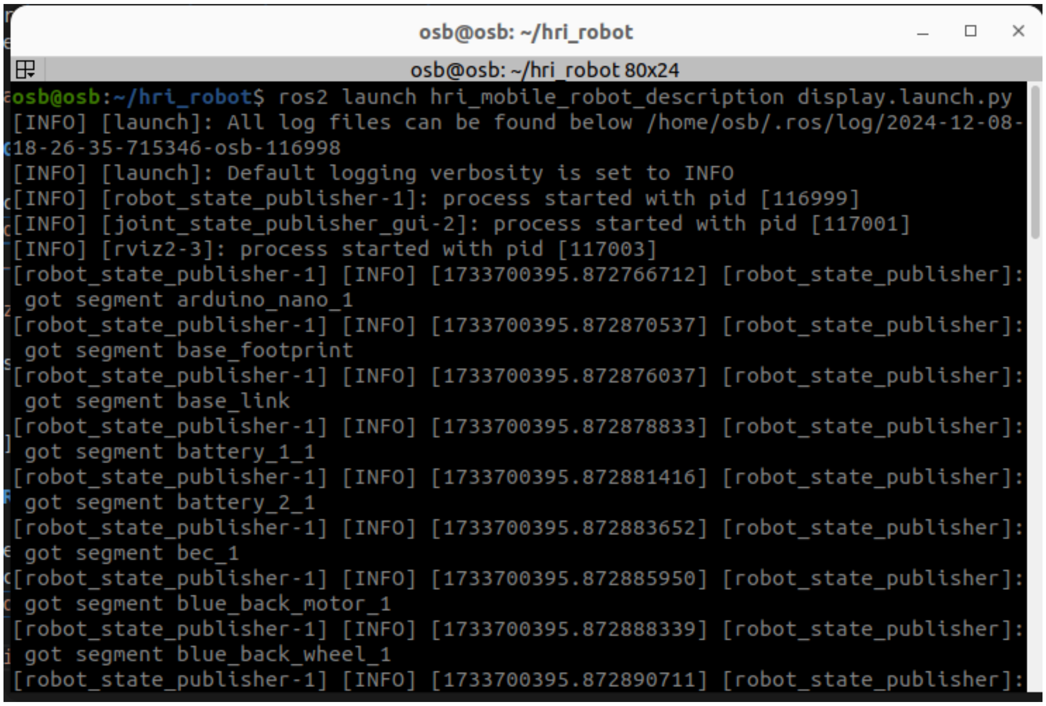


> **Note**: Gazebo will be already in the play phase. So, no need to play the simulation manually.

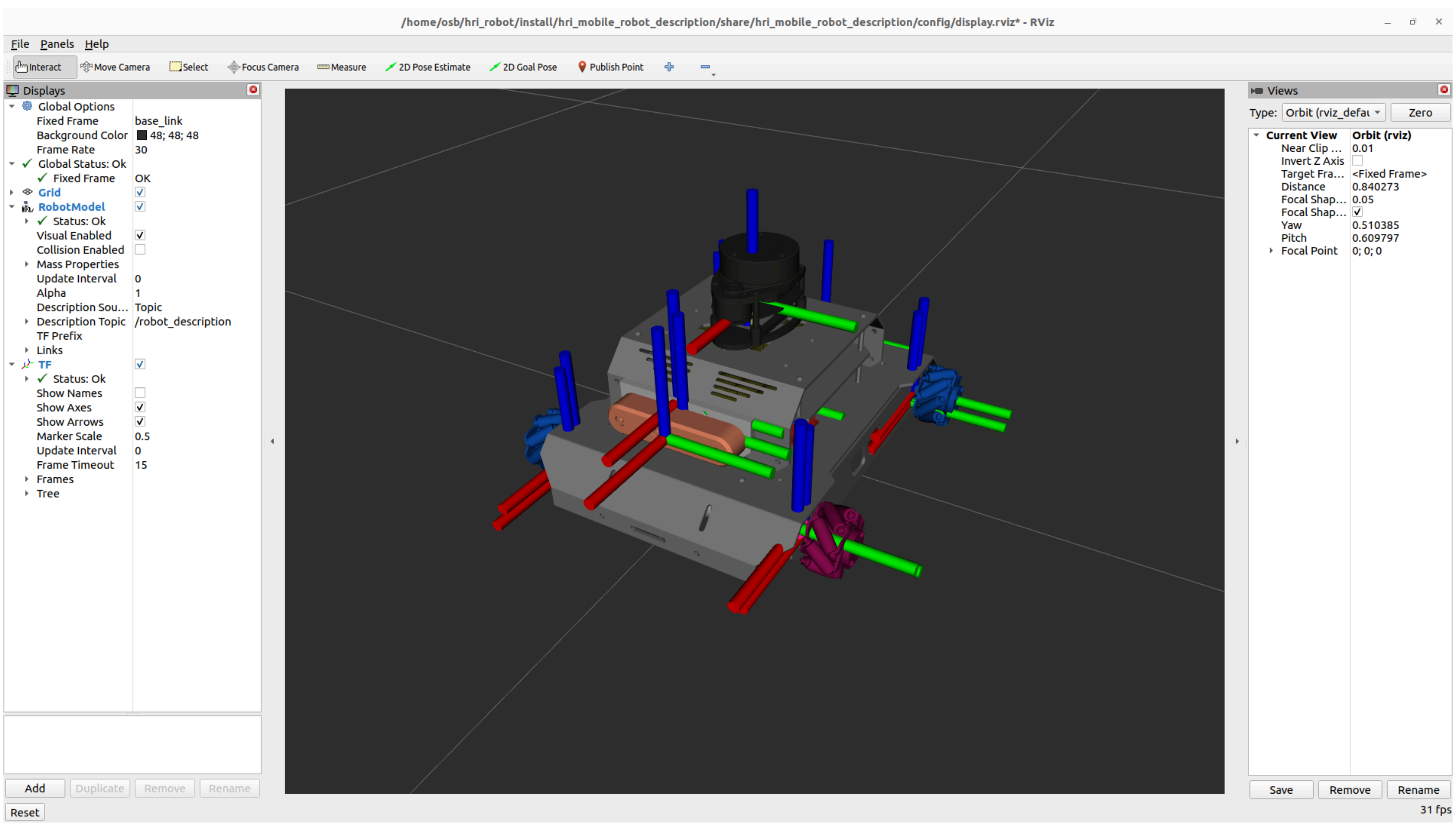
Running Rviz

> **Note**: Run *Gazebo* first to visualize model in Rviz.

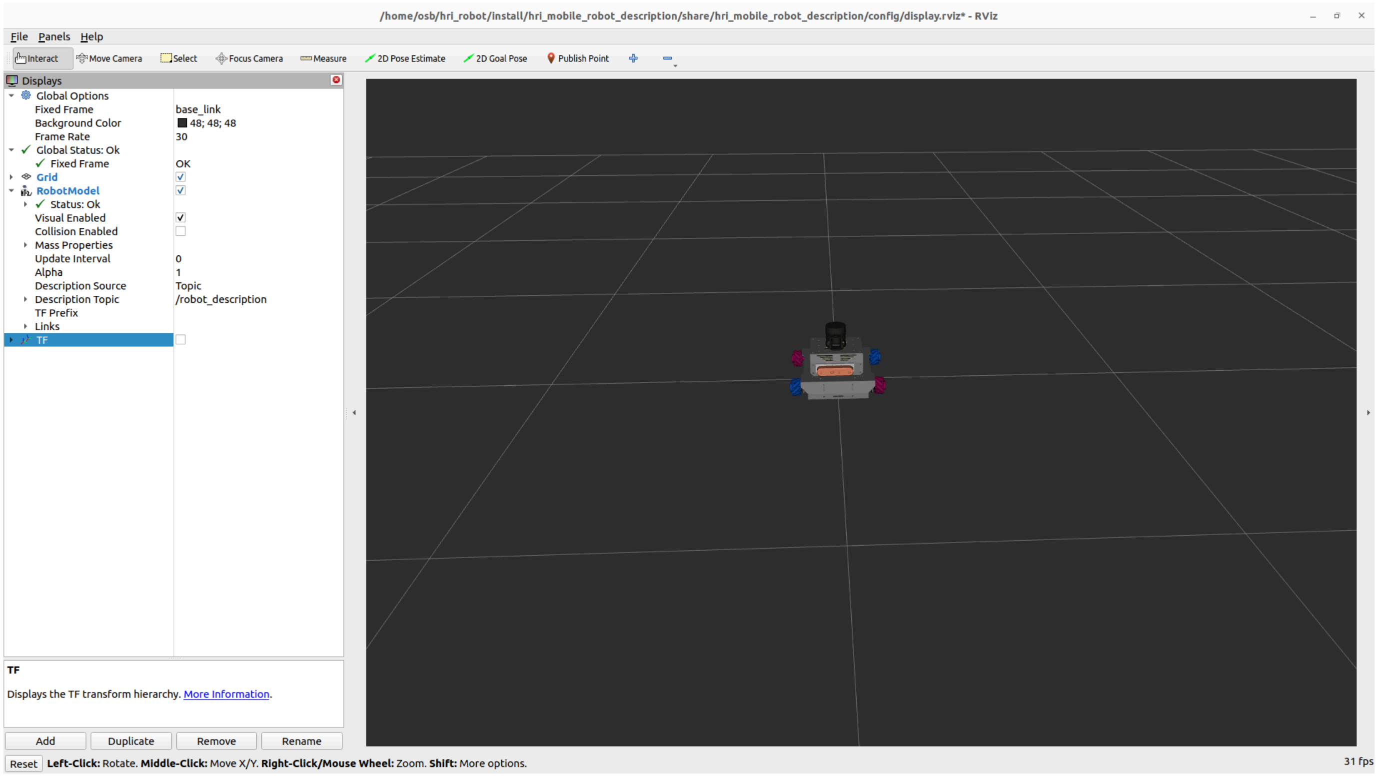
- Open new terminal and source the terminal.
- After sourcing the **install/setup.bash** type `ros2 launch hri_mobile_robot_description display.launch.py` to visualise the model in rviz.



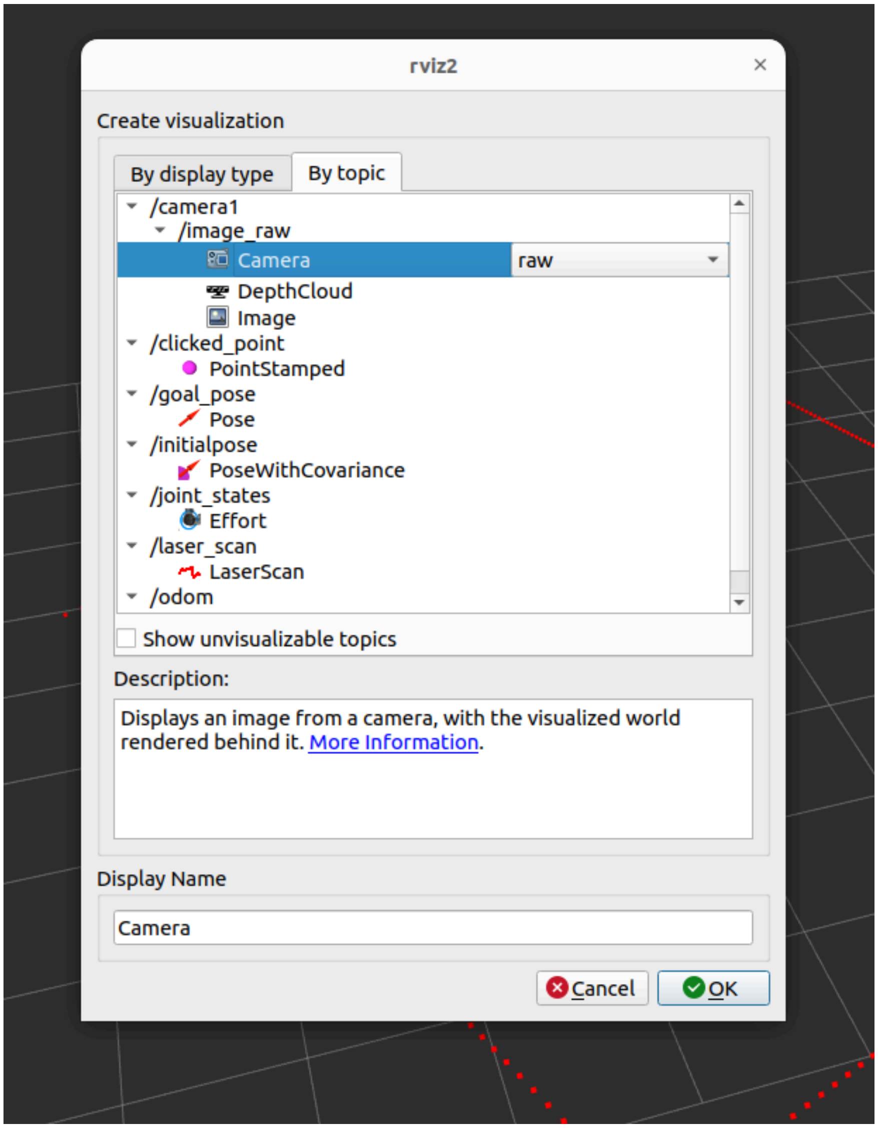
- This will visualize robot in Rviz and it will look like image similar to as demonstrated below.



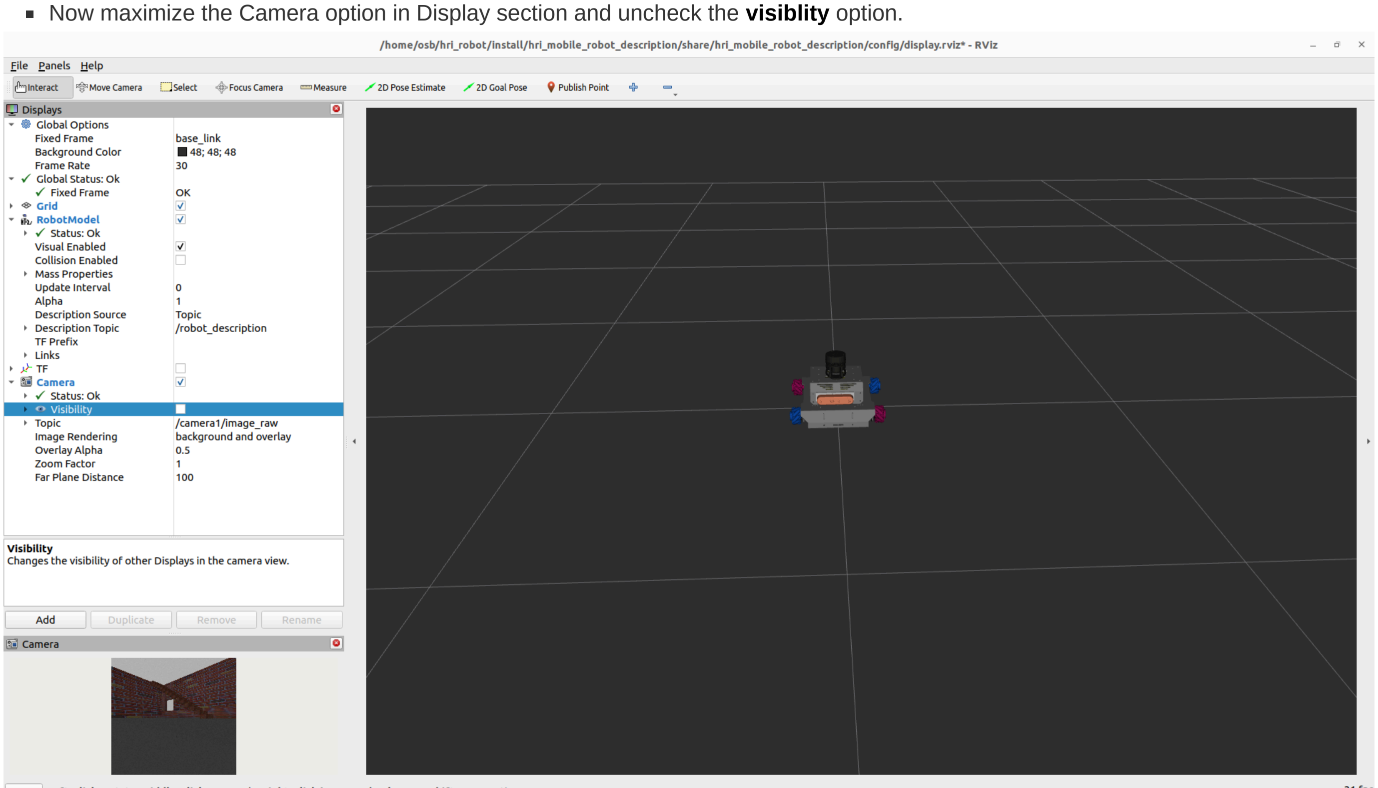
- Indeed, there are some steps as shown below to setup Rviz
    - **TF**
        - Close tf by unchecking the box in Rviz.



- **Camera**
  - In bottom left there is a add button click the button which will open a pop up same as below.
  - Select `By topic` option and click on the `Camera(raw)` which will activate the *OK* button at bottom of dialogue box.
  - Click ok button to visualize camera feed.

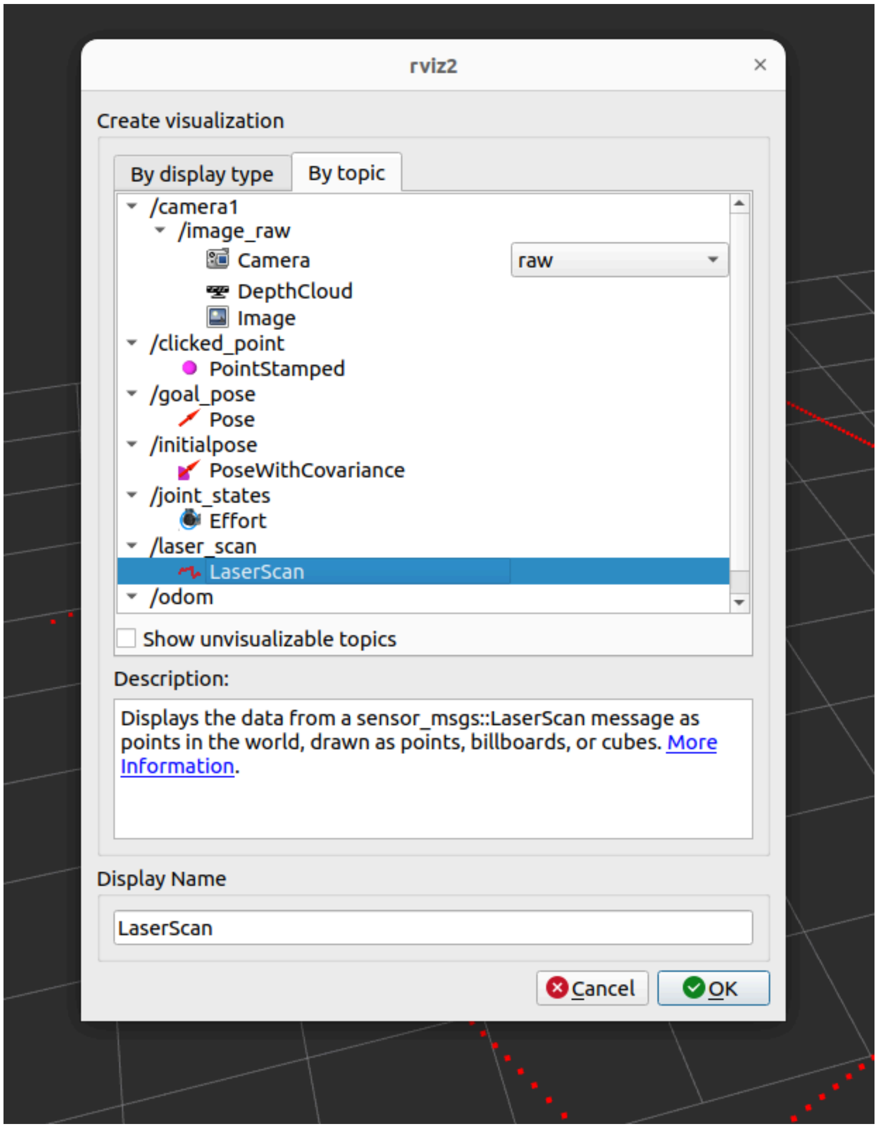


- Now maximize the Camera option in Display section and uncheck the **visiblity** option.

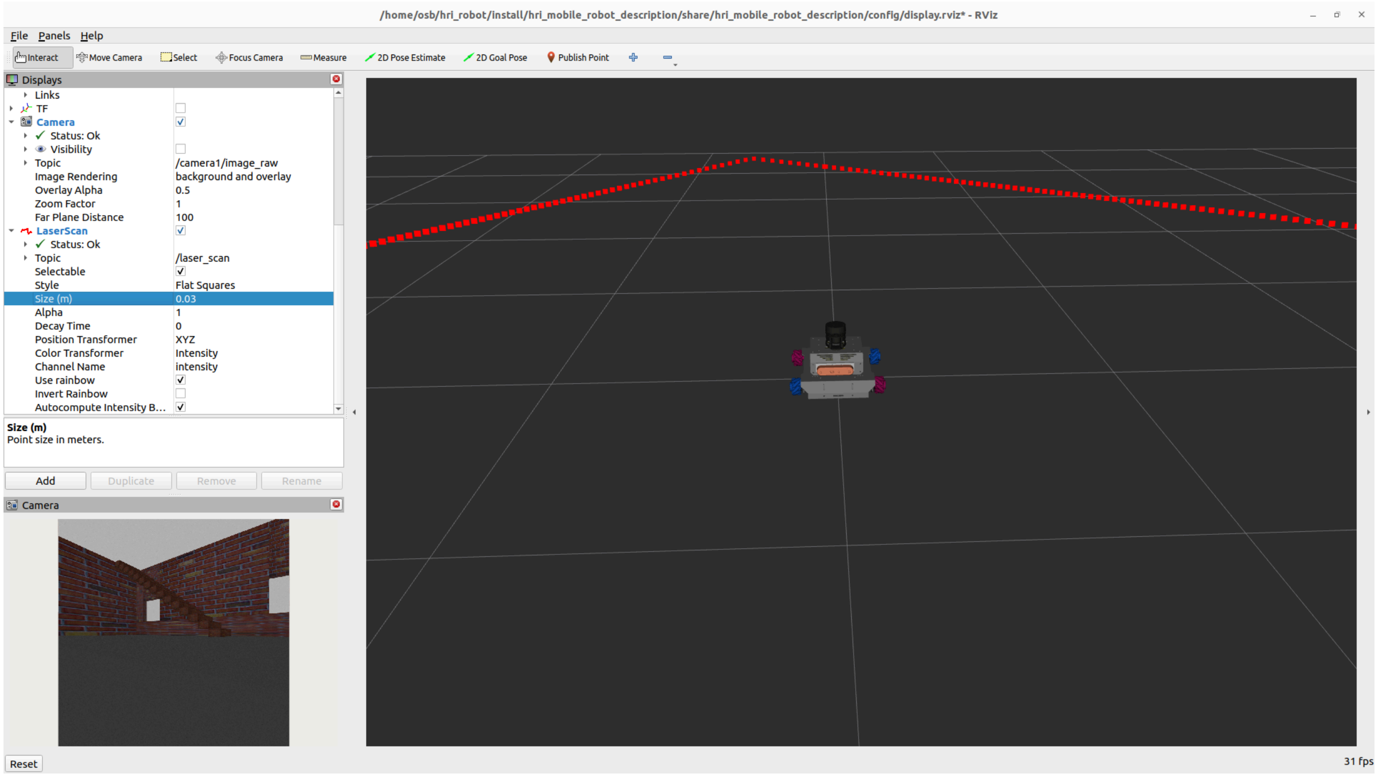


- **Lidar**

- In bottom left there is a add button click the button which will open a pop up same as below.
- Select `By topic` option and click on the `LaserScan` which will activate the *OK* button at bottom of dialogue box.
- Click ok button to visualize laser scan or lidar mapping.



- Maximize the Laser option in Display section and increase the size of laser points.



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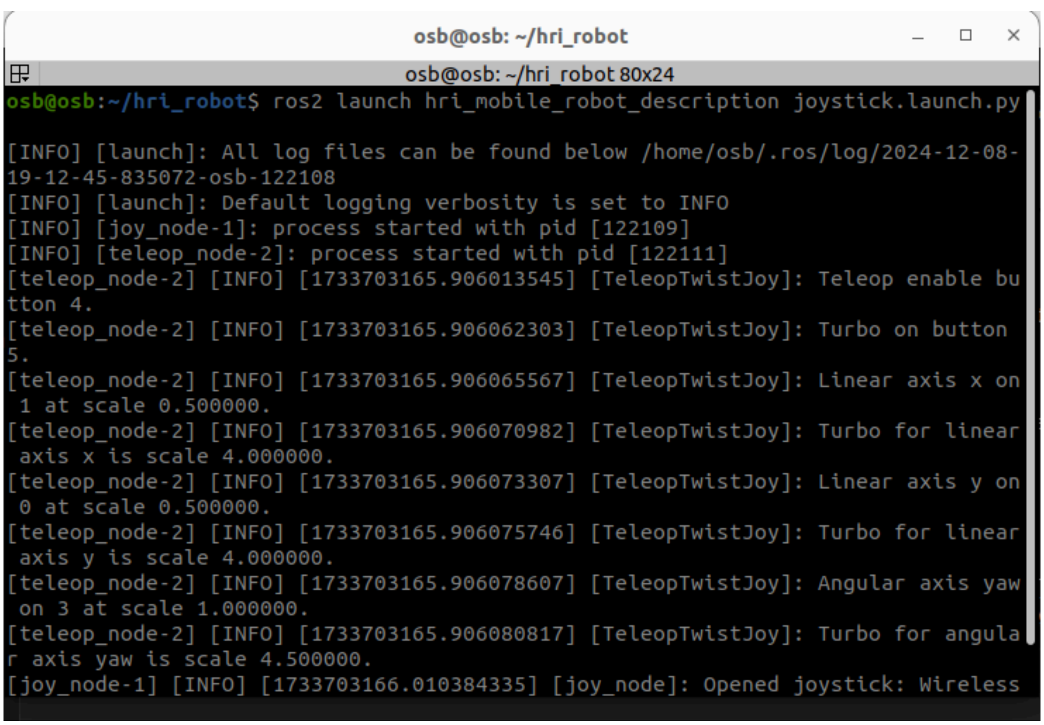
Teleoperation with Joystick

- Connect joystick with PC/Laptop.
- Once the **Gazebo** and **Rviz** are running fine, open new terminal and run launch file by typing following command

  `ros2 launch hri_mobile_robot_description joystick.launch.py`



```
osb@osb: ~/hri_robot
osb@osb: ~/hri_robot 80x24
osb@osb:~/hri_robot$ ros2 launch hri_mobile_robot_description joystick.launch.py

[INFO] [launch]: All log files can be found below /home/osb/.ros/log/2024-12-08-
19-12-45-835072-osb-122108
[INFO] [launch]: Default logging verbosity is set to INFO
[INFO] [joy_node-1]: process started with pid [122109]
[INFO] [teleop_node-2]: process started with pid [122111]
[teleop_node-2] [INFO] [1733703165.906013545] [TeleopTwistJoy]: Teleop enable bu
tton 4.
[teleop_node-2] [INFO] [1733703165.906062303] [TeleopTwistJoy]: Turbo on button
5.
[teleop_node-2] [INFO] [1733703165.906065567] [TeleopTwistJoy]: Linear axis x on
 1 at scale 0.500000.
[teleop_node-2] [INFO] [1733703165.906070982] [TeleopTwistJoy]: Turbo for linear
 axis x is scale 4.000000.
[teleop_node-2] [INFO] [1733703165.906073307] [TeleopTwistJoy]: Linear axis y on
 0 at scale 0.500000.
[teleop_node-2] [INFO] [1733703165.906075746] [TeleopTwistJoy]: Turbo for linear
 axis y is scale 4.000000.
[teleop_node-2] [INFO] [1733703165.906078607] [TeleopTwistJoy]: Angular axis yaw
 on 3 at scale 1.000000.
[teleop_node-2] [INFO] [1733703165.906080817] [TeleopTwistJoy]: Turbo for angula
r axis yaw is scale 4.500000.
[joy_node-1] [INFO] [1733703166.010384335] [joy_node]: Opened joystick: Wireless
```

- The Joystick node has successfully start. Moving further, switch to gazebo tab and follow the below image of joystick to operate robot.
  - **Linear x** axis is maped to **axis 1** of the joystick.

- **Linear y** axis is maped to **axis 0** of the joystick.
- **Angular z** axis is maped to **axis 3** of the joystick.
- There are two modes Turbo Mode and Normal Mode for robot.
  - Turbo Mode enables fast movements.
  - Normal Mode is used for make precise movements.

> **Note**: To move the robot, it is necessary to hold down a mode button. For example, if you press and hold the L1 (Turbo mode) button while using the joystick axis to control movement, the robot will move. However, if you release the L1 button, the robot will immediately stop moving, even if the joystick axis is still being operated.

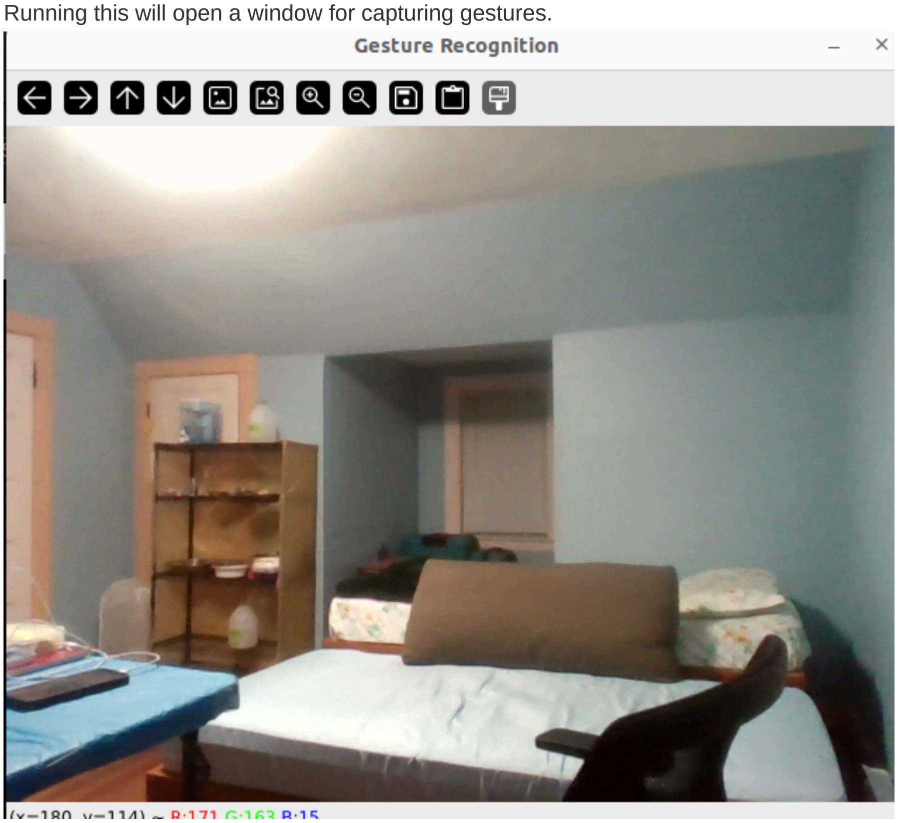
Teleoperation with Gesture

- Run Gazebo and Rviz meanwhile close the terminal running joystick launch file.
- Once the Gazebo and Rviz is initiated successfully open new terminal and run launch file by typing following command

```
ros2 launch hri_mobile_robot_description gesturerec.launch.py
```

```
osb@osb: ~/hri_robot
osb@osb: ~/hri_robot 80x24
osb@osb:~/hri_robot$ ros2 launch hri_mobile_robot_description gesturerec.launch.
py
[INFO] [launch]: All log files can be found below /home/osb/.ros/log/2024-12-08-
19-52-19-288107-osb-125520
[INFO] [launch]: Default logging verbosity is set to INFO
[INFO] [index_node-1]: process started with pid [125521]
[INFO] [cmd_node-2]: process started with pid [125523]
[index_node-1] 2024-12-08 19:52:20.284049: I tensorflow/core/util/util.cc:169] o
neDNN custom operations are on. You may see slightly different numerical results
 due to floating-point round-off errors from different computation orders. To tu
rn them off, set the environment variable `TF_ENABLE_ONEDNN_OPTS=0`.
[index_node-1] 2024-12-08 19:52:20.287206: W tensorflow/stream_executor/platform
/default/dso_loader.cc:64] Could not load dynamic library 'libcudart.so.11.0'; d
lerror: libcudart.so.11.0: cannot open shared object file: No such file or direc
tory; LD_LIBRARY_PATH: /home/osb/.local/lib/python3.10/site-packages/cv2/../../l
ib64:/usr/lib/x86_64-linux-gnu/gazebo-11/plugins:/opt/ros/humble/opt/rviz_ogre_v
endor/lib:/opt/ros/humble/lib/x86_64-linux-gnu:/opt/ros/humble/lib
[index_node-1] 2024-12-08 19:52:20.287218: I tensorflow/stream_executor/cuda/cud
art_stub.cc:29] Ignore above cudart dlerror if you do not have a GPU set up on y
our machine.
[cmd_node-2] 2024-12-08 19:52:20.348708: I tensorflow/core/util/util.cc:169] one
DNN custom operations are on. You may see slightly different numerical results d
ue to floating-point round-off errors from different computation orders. To turn
 them off, set the environment variable `TF_ENABLE_ONEDNN_OPTS=0`.
```

- Running this will open a window for capturing gestures.



- There are total 6 gestures as shown below.
  i. stop
  ii. forward
  iii. backward
  iv. sideway left
  v. sideway right
  vi. z clockwise
  vii. z counterclockwise

> **Note**: The node will stop and throw resize error if the hand distance from camera crosses a limit. The error will look as shown below. To resolve it run the launch file again.

```
osb@osb: ~/hri_robot
osb@osb: ~/hri_robot 80x24
[index_node-1] Traceback (most recent call last):
[index_node-1]   File "/home/osb/hri_robot/install/hri_mobile_robot_description/
lib/hri_mobile_robot_description/index_node", line 33, in <module>
[index_node-1]     sys.exit(load_entry_point('hri-mobile-robot-description==0.0.
0', 'console_scripts', 'index_node')())
[index_node-1]   File "/home/osb/hri_robot/install/hri_mobile_robot_description/
lib/python3.10/site-packages/hri_mobile_robot_description/gesture_cal.py", line
98, in main
[index_node-1]     gesture_recognition_node.run()
[index_node-1]   File "/home/osb/hri_robot/install/hri_mobile_robot_description/
lib/python3.10/site-packages/hri_mobile_robot_description/gesture_cal.py", line
83, in run
[index_node-1]     gesture_index = self.process_frame(img)
[index_node-1]   File "/home/osb/hri_robot/install/hri_mobile_robot_description/
lib/python3.10/site-packages/hri_mobile_robot_description/gesture_cal.py", line
54, in process_frame
[index_node-1]     img_resize = cv2.resize(img_crop, (w_cal, self.img_size))
[index_node-1] cv2.error: OpenCV(4.10.0) /io/opencv/modules/imgproc/src/resize.c
pp:4152: error: (-215:Assertion failed) !ssize.empty() in function 'resize'
[index_node-1]
[ERROR] [index_node-1]: process has died [pid 25237, exit code 1, cmd '/home/osb
/hri_robot/install/hri_mobile_robot_description/lib/hri_mobile_robot_description
/index_node --ros-args -r __node:=gesture_cal'].
```