6. ORB_SLAM2 PCL Mapping

This example is implemented on Orin NX, and cannot be implemented on a virtual machine. It just explains how the process is implemented. If you want to implement this function on your own motherboard, you need to compile the entire function package and connect related peripherals.

pcl official website address: http://pointclouds.org

pcl_ros wiki: https://wiki.ros.org/pcl_ros

pcl_ros github: https://github.com/ros-perception/perception_pcl

The operating environment and reference configuration of software and hardware are as follows:

- Reference vehicle: ROSMASTER X3
- Robot hardware configuration: Arm series master control, Silan A1 laser radar, depth camera
- Robot system: Ubuntu 20.04
- PC virtual machine: Ubuntu (20.04) + ROS2 (Foxy)
- Usage scenario: Use on a relatively clean 2D plane

6.1, Introduction

PCL (The Point Cloud Library) is a large open source project for 2D/3D image and point cloud processing. The PCL framework consists of many advanced algorithms, including filtering, feature estimation, surface reconstruction, registration, model stitching and segmentation. These algorithms have many applications, such as filtering outliers from noisy data, merging multiple sets of 3D point clouds, segmenting related parts of a scene, extracting key points and calculating geometric descriptors for object recognition, creating and visualizing object surfaces using point clouds, and so on. PCL has been successfully compiled and configured on Linux, MacOS, Windows, and Android/iOS platforms. To simplify development, PCL is divided into a series of small code libraries that can be compiled separately.

Basic concepts of the point cloud library and the PCL interface of ROS:

Point cloud library: provides a set of data structures and algorithms for processing 3D data;

ROS PCL interface: provides a set of messages and conversion functions between messages and PCL data structures.

From a C++ perspective, PCL contains a very important data structure, which is the point cloud. This data structure is designed as a template class, which takes the type of point as a parameter of the template class. The point cloud class is actually a container that contains all the common information required by the point cloud, regardless of the type of point. The following are the most important public fields in the point cloud:

header: This field is of type pcl:PCLHeader. Specifies the time when the point cloud was acquired.

points: This field is of type std::vector<PointT...>, which is a container for all points. PointT in the vector definition corresponds to the template parameter of the class, i.e. the type of point.

width: This field specifies the width of the point cloud when it is organized into an image, otherwise it contains the number of points in the cloud.

height: This field specifies the height of the point cloud when it is organized into an image, otherwise it is always 1.

is_dense: This field specifies whether there are invalid values (infinite or NaN values) in the point cloud.

sensor origin: This field is of type Eigen::Vector4f, and defines the pose of the sensor according to the translation relative to the origin.

sensororientation: This field is of type Eigen::Ouaternionf, and defines the pose of the sensor when it is rotated.

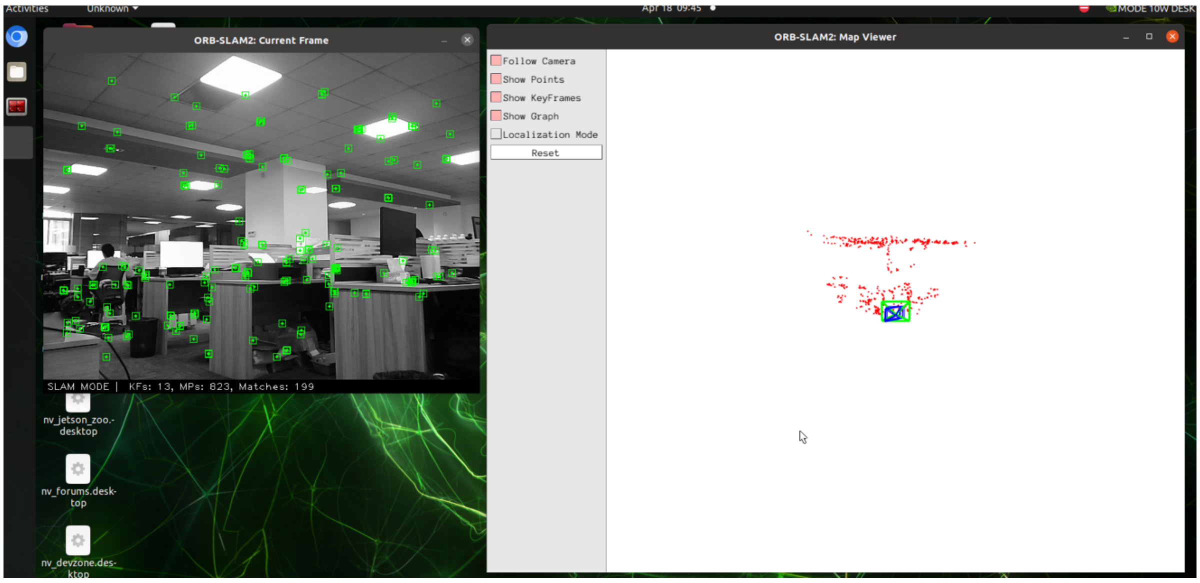
6.2, Use

1. Start the camera

```
#gemini camera start
ros2 launch astra_camera gemini.launch.xml
```

2. Start orbslam to publish the camera pose, color image and depth image. Depending on the performance of different master controllers, the waiting time here is about 10 seconds

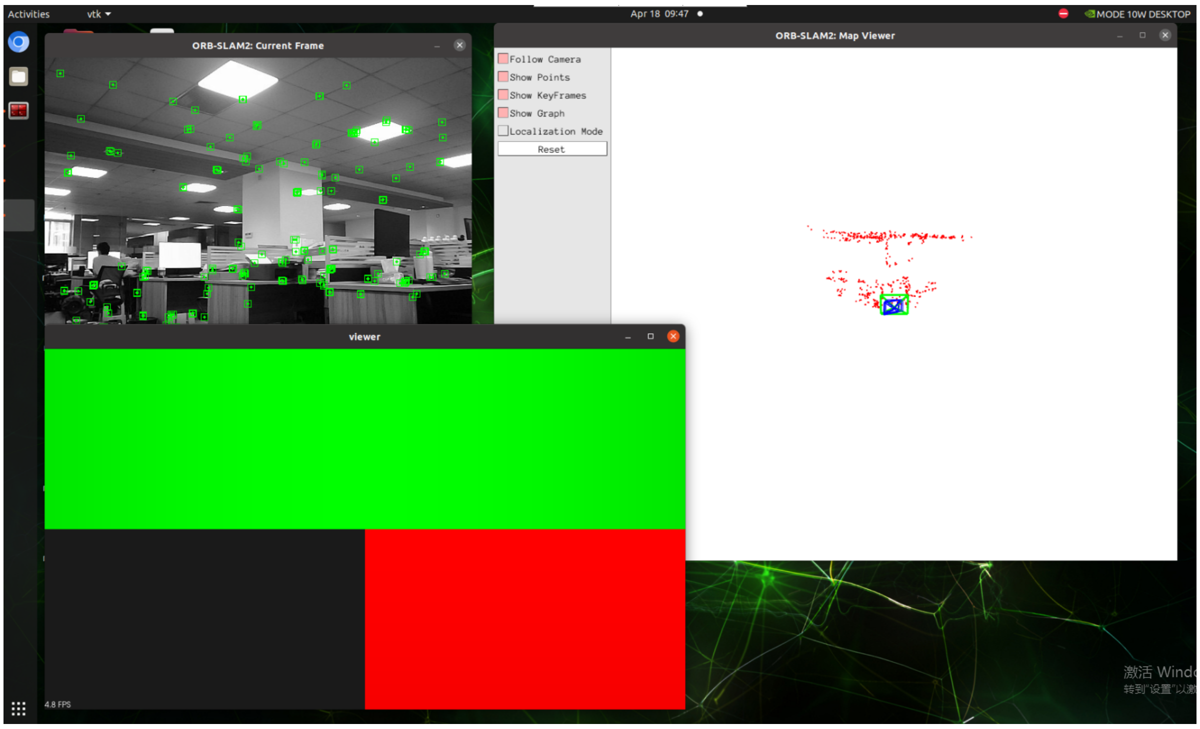
```
ros2 launch yahboomcar_slam orbslam_base_launch.py
```



3. Start point cloud mapping

```
ros2 launch yahboomcar_slam orbslam_pcl_map_launch.py
```

After opening, the [viewer] window will pop up. Slowly move the camera. When a picture appears, it will be as shown below:



You need to scale and rotate the coordinate system until it is as shown below

Slide the wheel: zoom in and out

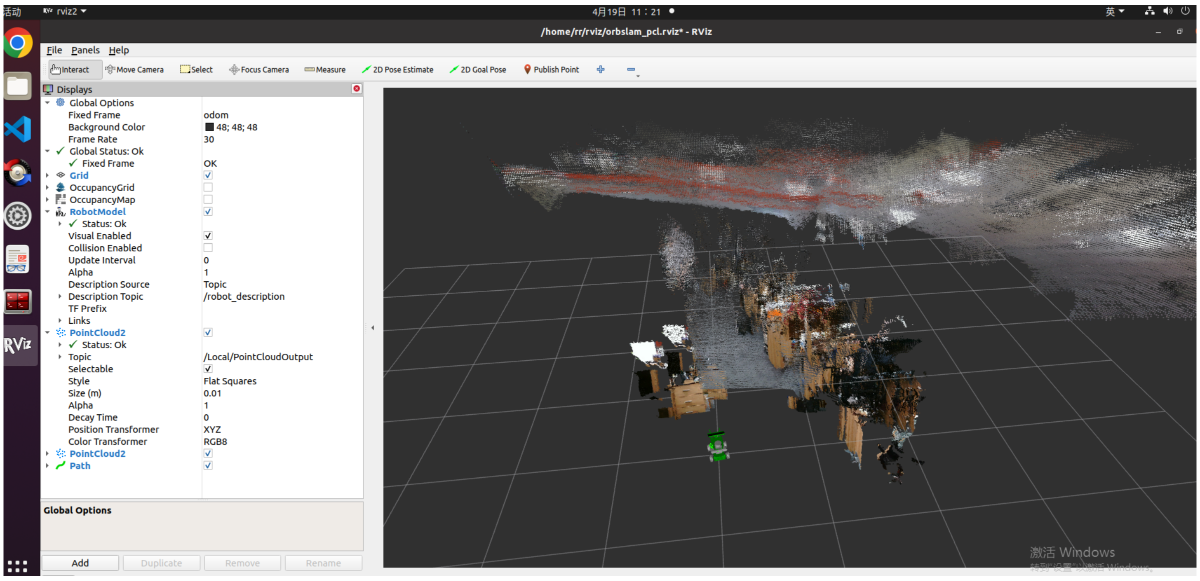
Press and hold the wheel: pan

Left mouse button: rotate

Right mouse button: zoom in and out

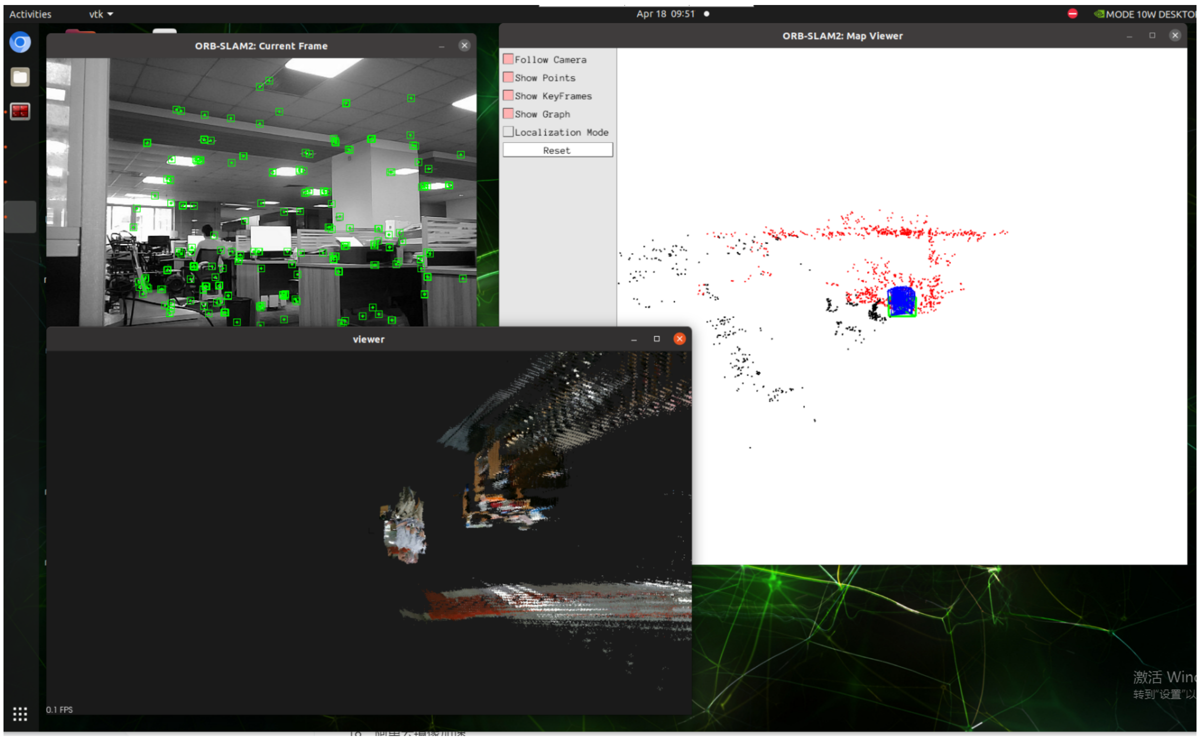
You can open rviz at the same time to view the real-time point cloud mapping effect. Considering the huge CPU and memory overhead during point cloud mapping, it is recommended to use the virtual machine to open rviz to view:

```
ros2 launch yahboomcar_slam display_pcl_launch.py
```



Global Options	
Fixed Frame	odom
Background Color	■ 48; 48; 48
Frame Rate	30
✓ Global Status: Ok	
✓ Fixed Frame	OK
Grid	✓
OccupancyGrid	☐
OccupancyMap	☐
RobotModel	✓
✓ Status: Ok	
Visual Enabled	✓
Collision Enabled	☐
Update Interval	0
Alpha	1
Description Source	Topic
Description Topic	/robot_description
TF Prefix	
Links	
PointCloud2	✓
✓ Status: Ok	
Topic	/Local/PointCloudOutput
Selectable	✓
Style	Flat Squares
Size (m)	0.01
Alpha	1
Decay Time	0
Position Transformer	XYZ
Color Transformer	RGB8
PointCloud2	✓
Path	✓

Global Options



4. Slowly move the camera to build the map as shown below. After building, press [Ctrl+c] to close and automatically save the pcd point cloud file resultPointCloudFile.pcd. The path is as follows:

```
~/orbbec_ws/src/yahboomcar_slam/pcl/resultPointCloudFile.pcd
```

5. View the resultPointCloudFile.pcd file

(1) Method 1: Use the pcl_viewer tool

Install the pcl_viewer command:

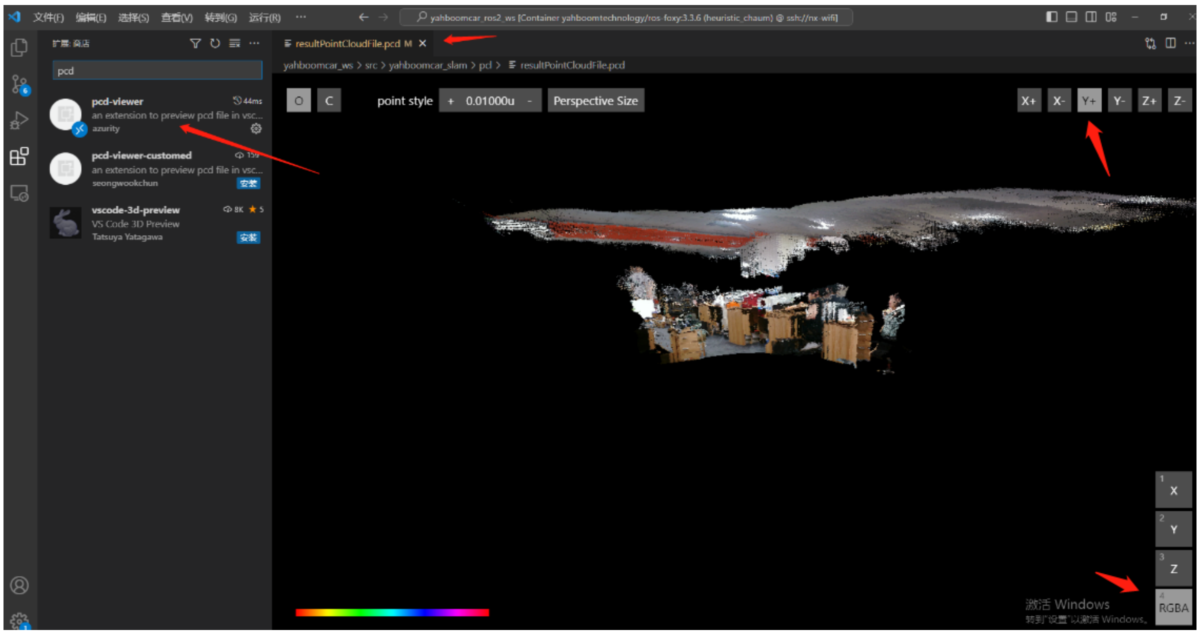
```
sudo apt-get install pcl-tools
```

Enter the directory where the pcd file is located and enter the following command to view the pcd point cloud image

```
pcl_viewer resultPointCloudFile.pcd
```

(2) Method 2: Use the pcd-viewer plug-in of vscode [Recommended]

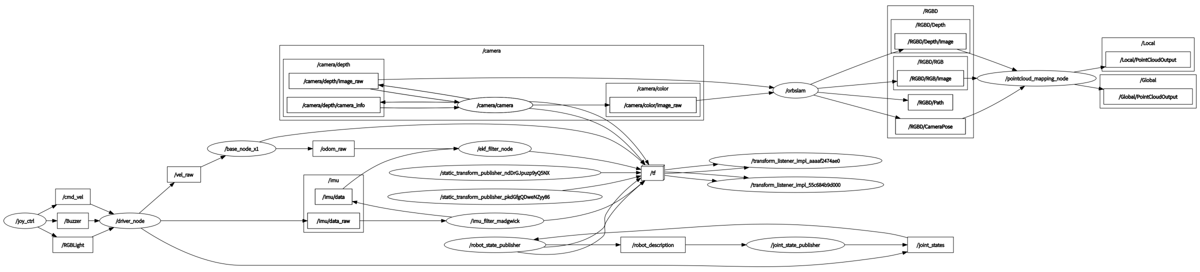
First install the pcd-viewer plug-in in vscode, then open resultPointCloudFile.pcd to view the pcd point cloud image. Here, directly select the Y+ direction and the RGBA mode at the bottom to quickly rotate the image to the main view



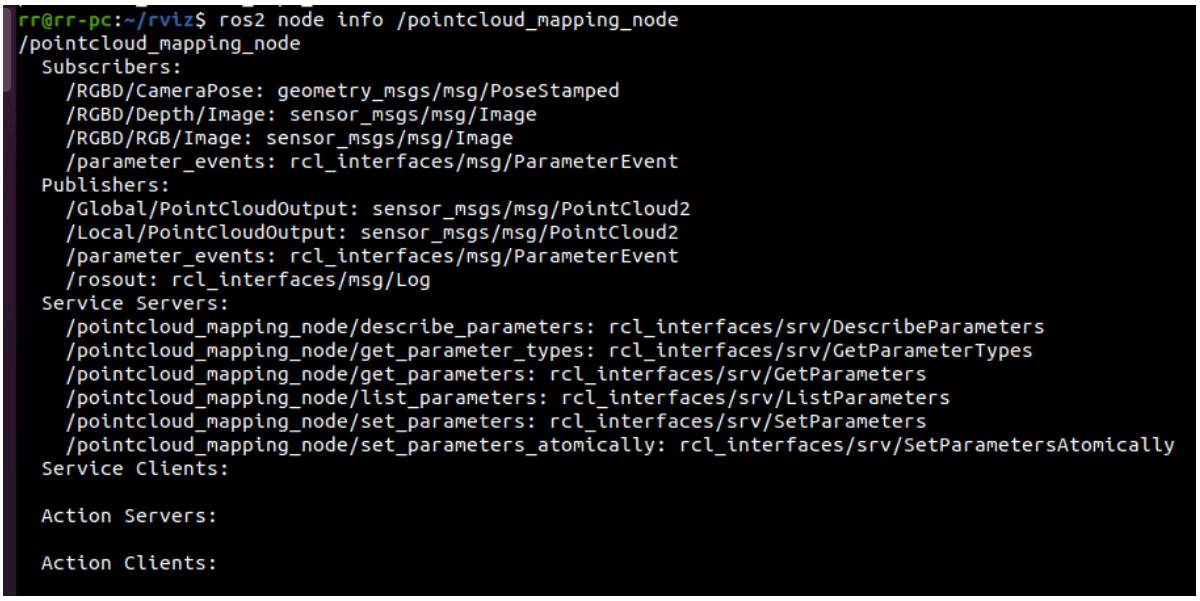
6.3, Node analysis

6.3.1, Display calculation graph

```
rqt_graph
```



6.3.2, pointcloud_mapping node details

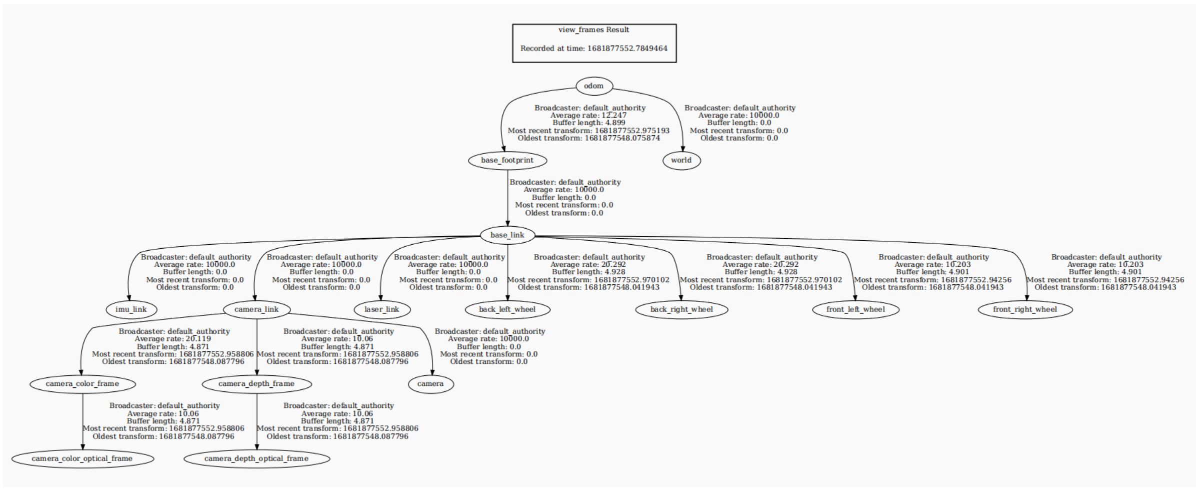

```
rr@rr-pc:~/rviz$ ros2 node info /pointcloud_mapping_node
/pointcloud_mapping_node
  Subscribers:
    /RGBD/CameraPose: geometry_msgs/msg/PoseStamped
    /RGBD/Depth/Image: sensor_msgs/msg/Image
    /RGBD/RGB/Image: sensor_msgs/msg/Image
    /parameter_events: rcl_interfaces/msg/ParameterEvent
  Publishers:
    /Global/PointCloudOutput: sensor_msgs/msg/PointCloud2
    /Local/PointCloudOutput: sensor_msgs/msg/PointCloud2
    /parameter_events: rcl_interfaces/msg/ParameterEvent
    /rosout: rcl_interfaces/msg/Log
  Service Servers:
    /pointcloud_mapping_node/describe_parameters: rcl_interfaces/srv/DescribeParameters
    /pointcloud_mapping_node/get_parameter_types: rcl_interfaces/srv/GetParameterTypes
    /pointcloud_mapping_node/get_parameters: rcl_interfaces/srv/GetParameters
    /pointcloud_mapping_node/list_parameters: rcl_interfaces/srv/ListParameters
    /pointcloud_mapping_node/set_parameters: rcl_interfaces/srv/SetParameters
    /pointcloud_mapping_node/set_parameters_atomically: rcl_interfaces/srv/SetParametersAtomically
  Service Clients:

  Action Servers:

  Action Clients:
```

6.3.3, TF transformation

```
ros2 run tf2_tools view_frames.py
```


view_frames Result
Recorded at time: 1681877552.7849464
odom
Broadcaster: default_authority Average rate: 12.247 Buffer length: 4.899 Most recent transform: 1681877552.975193 Oldest transform: 1681877548.075874
Broadcaster: default_authority Average rate: 10000.0 Buffer length: 0.0 Most recent transform: 0.0 Oldest transform: 0.0
base_footprint
world
Broadcaster: default_authority Average rate: 10000.0 Buffer length: 0.0 Most recent transform: 0.0 Oldest transform: 0.0
base_link
Broadcaster: default_authority Average rate: 10000.0 Buffer length: 0.0 Most recent transform: 0.0 Oldest transform: 0.0
Broadcaster: default_authority Average rate: 10000.0 Buffer length: 0.0 Most recent transform: 0.0 Oldest transform: 0.0
Broadcaster: default_authority Average rate: 10000.0 Buffer length: 0.0 Most recent transform: 0.0 Oldest transform: 0.0
Broadcaster: default_authority Average rate: 20.292 Buffer length: 4.928 Most recent transform: 1681877552.970102 Oldest transform: 1681877548.041943
Broadcaster: default_authority Average rate: 20.292 Buffer length: 4.928 Most recent transform: 1681877552.970102 Oldest transform: 1681877548.041943
Broadcaster: default_authority Average rate: 10.203 Buffer length: 4.901 Most recent transform: 1681877552.94256 Oldest transform: 1681877548.041943
Broadcaster: default_authority Average rate: 10.203 Buffer length: 4.901 Most recent transform: 1681877552.94256 Oldest transform: 1681877548.041943
imu_link
camera_link
laser_link
back_left_wheel
back_right_wheel
front_left_wheel
front_right_wheel
Broadcaster: default_authority Average rate: 20.119 Buffer length: 4.871 Most recent transform: 1681877552.958806 Oldest transform: 1681877548.087796
Broadcaster: default_authority Average rate: 10.06 Buffer length: 4.871 Most recent transform: 1681877552.958806 Oldest transform: 1681877548.087796
Broadcaster: default_authority Average rate: 10000.0 Buffer length: 0.0 Most recent transform: 0.0 Oldest transform: 0.0
camera_color_frame
camera_depth_frame
camera
Broadcaster: default_authority Average rate: 10.06 Buffer length: 4.871 Most recent transform: 1681877552.958806 Oldest transform: 1681877548.087796
Broadcaster: default_authority Average rate: 10.06 Buffer length: 4.871 Most recent transform: 1681877552.958806 Oldest transform: 1681877548.087796
camera_color_optical_frame
camera_depth_optical_frame