Introduction and use of radar

1. Program function description

After the program runs, drive the lidar, turn on the radar scanning data, and visualize the lidar scanning data in rviz.

2. Program code reference path

The source code of this function is located at,

```
#pi4version
#MS200RADAR
/home/pi/cartographer_ws2/src/oradar_lidar/launch/ms200_scan.launch.py
#MS200 Radar Visualization
/home/pi/cartographer_ws2/src/oradar_lidar/launch/ms200_scan_view.launch.py

#pi5version
#MS200RADAR
/root/yahboomcar_ws/src/oradar_lidar/launch/ms200_scan.launch.py
#MS200 Radar Visualization
/root/yahboomcar_ws/src/oradar_lidar/launch/ms200_scan_view.launch.py
```

3. Program startup

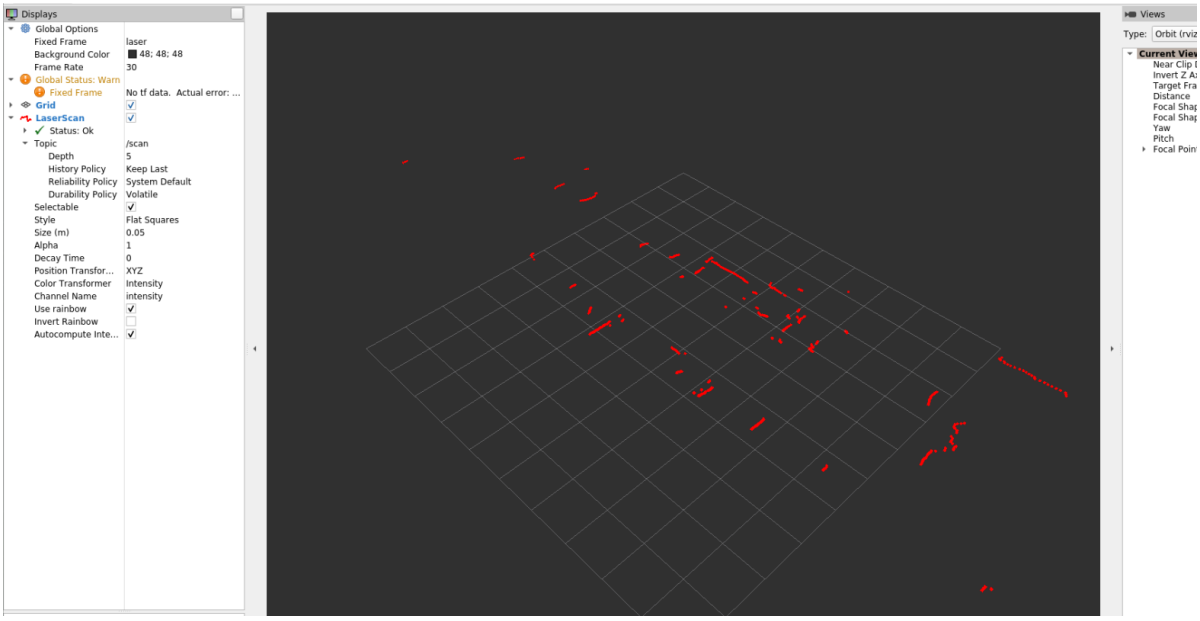
PI4 version driver:

Since the radar chassis has started automatically after powering on, if you want to start the radar separately, please stop the self-starting service first and enter the command in the terminal:

```
sudo systemctl stop YahboomStart.service
```

```
cd ~/cartographer_ws2
source install/setup.bash
#Start MS200 radar
ros2 launch oradar_lidar ms200_scan.launch.py
#Start MS200 radar + rviz visualization data
ros2 launch oradar_lidar ms200_scan_view.launch.py
```

Run screenshot, take starting "MS200 Radar + Visualization" as an example,



You can print radar scan data through the following command,

```
ros2 topic echo /scan
```

```
header:
  stamp:
    sec: 1681983563
    nanosec: 123403675
  frame_id: laser
angle_min: -3.1241390705108643
angle_max: 3.1415927410125732
angle_increment: 0.005806980188935995
time_increment: 0.00011245403584325686
scan_time: 0.1213379055261612
range_min: 0.15000000596046448
range_max: 12.0
ranges:
- 3.0320000648498535
- 3.0399999618530273
- 3.055999994277954
- 2.559999942779541
- 2.559999942779541
- 2.559999942779541
- 2.5480000972747803
- 2.5480000972747803
- 2.5399999618530273
```

PI5 version driver:

Open a terminal in the root directory of the Raspberry Pi and enter the following command to enter docker:

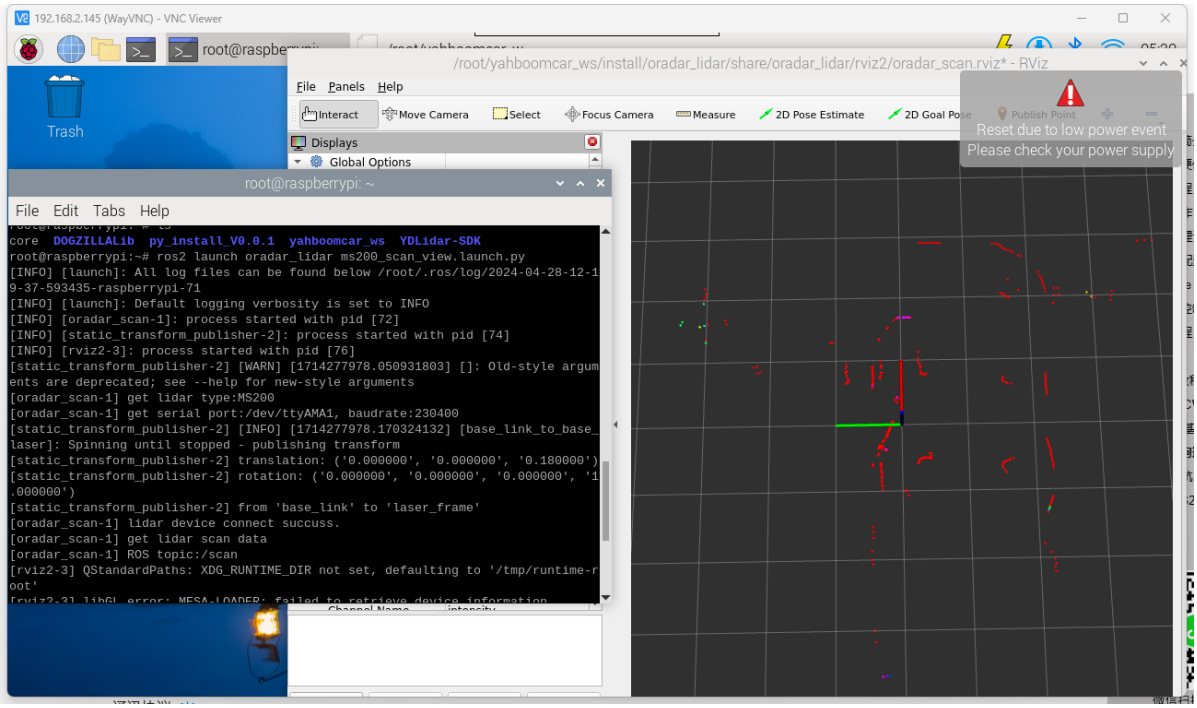
```
./run_humble.sh
```

```
pi@raspberrypi:~ $ ./run_humble.sh
access control disabled, clients can connect from any host
root@raspberrypi:/# cd
root@raspberrypi:~# ls
core  DOGZILLALib  py_install_V0.0.1  yahboomcar_ws  YDLidar-SDK
root@raspberrypi:~#
```

Then enter the command in the docker terminal:

```
#Start MS200 radar
ros2 launch oradar_lidar ms200_scan.launch.py
#Start MS200 radar + rviz visualization data
ros2 launch oradar_lidar ms200_scan_view.launch.py
```

Run screenshot, take starting "MS200 Radar + Visualization" as an example,



You need to enter the same docker container before you can print the radar scan data.

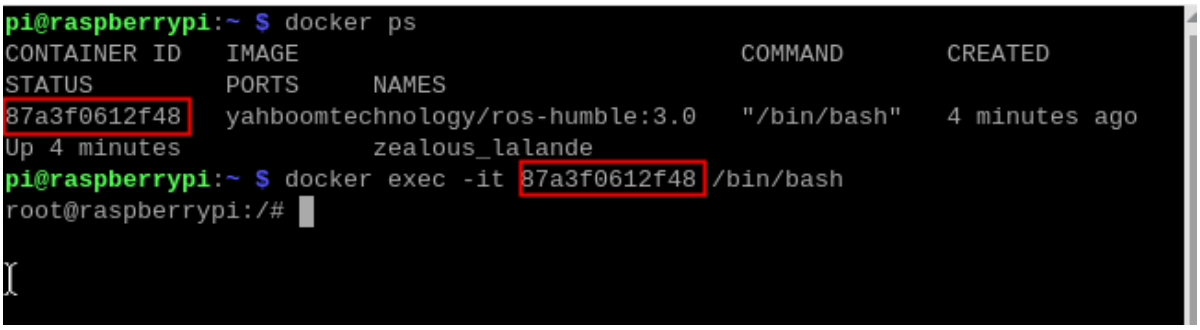
Enter the same docker step:

Open a terminal in the root directory and enter the command to view the ID of the currently running docker container.

```
docker ps
```

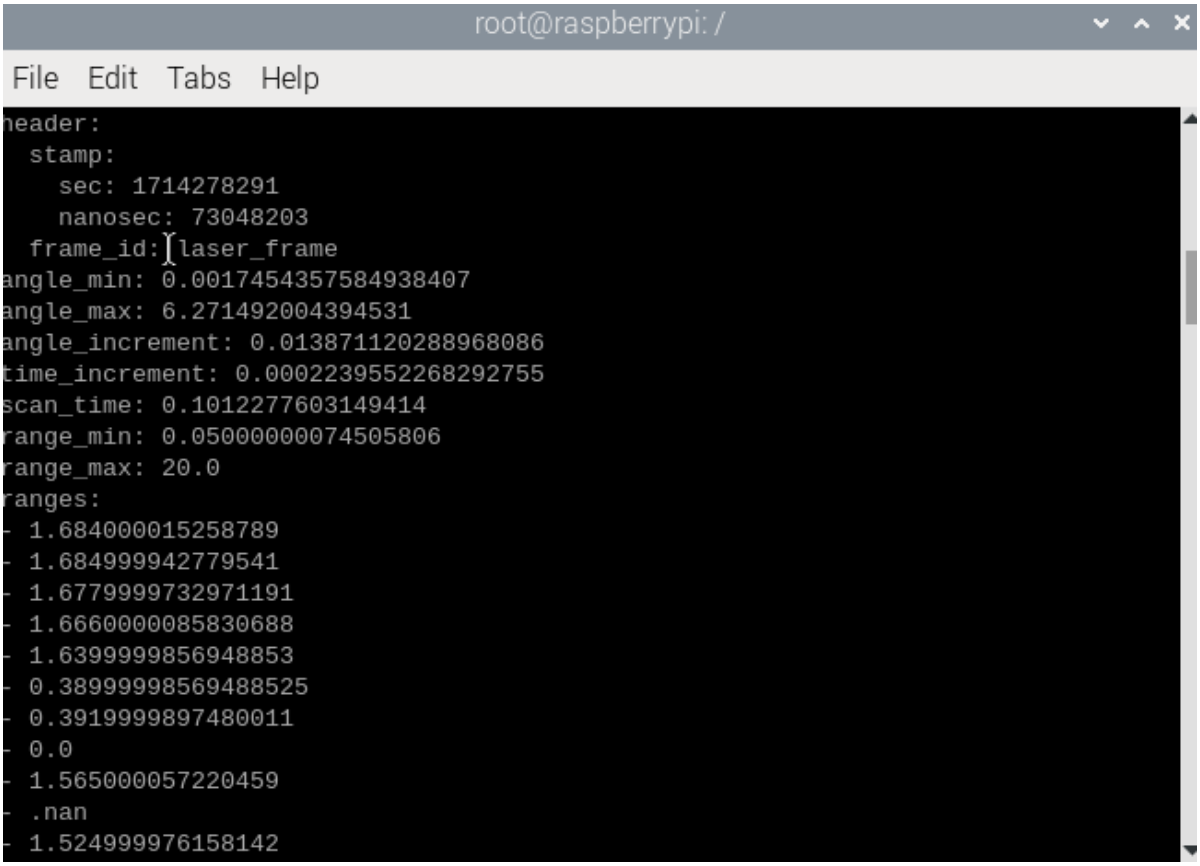
You can know that the ID shown in the box is, then enter the following command to enter the same docker,

```
docker exec -it 87a3f0612f48 /bin/bash
```



You can then print the radar scan data through the following command:

```
ros2 topic echo /scan
```



4. Introduction to Silan Radar

4.1. Overview

Single-line lidar refers to a radar whose line beam emitted by the laser source is a single line. It is divided into triangular ranging and TOF lidar. It is mainly used for robots.

Most field applications. It has fast scanning speed, strong resolution and high reliability. Compared with multi-line lidar, single-line lidar has better scanning speed at angular frequency and

The sensitivity is faster, so the distance and accuracy of measuring obstacles are also more accurate.

4.2. Principle of ranging

The A1 radar uses the triangulation ranging method, and the S2 radar uses the tree TOF ranging method.

- Trigonometric odometry

  The laser triangulation ranging method mainly uses a beam of laser to illuminate the measured target at a certain incident angle. The laser is reflected and scattered on the target surface.

  The reflected laser is focused and imaged using a lens at another angle, and the spot is imaged on a CCD (Charge-coupled Device, Photosensitive Coupled Device)

  component) on the position sensor. When the measured object moves along the direction of the laser, the light spot on the position sensor will move, and its displacement will be large.

Small corresponds to the moving distance of the measured object, so the distance between the measured object and the baseline can be calculated from the spot displacement distance through algorithm design.

Since the incident light and reflected light form a triangle, the geometric triangle theorem is used to calculate the spot displacement, so this measurement method is called laser

Triangulation.

- TOF ranging method

  TOF lidar is based on measuring the flight time of light to obtain the distance of the target. Its working principle is mainly as follows: through laser emission

  The detector emits a modulated laser signal. The modulated light is received by the laser detector after being reflected by the object being measured. By measuring the emitted laser and received laser

  The phase difference of light can be used to calculate the distance of the target.

4.3. Baud rate used

The baud rate of A1 radar is 115200, and the baud rate of S2 radar is 1000000.

4.4. Differences in various lidar models

<table>
<tr><td>系列</td><td colspan="4">三角测距</td><td colspan="2">TOF测距</td></tr>
<tr><td rowspan="2">型号</td><td>A1M8</td><td>A2M8</td><td colspan="2">A3M1</td><td>S1M1</td><td>S2M1(IP65)</td></tr>
<tr><td></td><td></td><td>增强模式</td><td>室外模式</td><td></td><td></td></tr>
<tr><td>推荐应用</td><td>智能扫地机、家用机器人（室内）</td><td>商用或消费类机器人3D建模（室内）</td><td>高性能（室内）</td><td>高可靠性，可靠的抗日光能力（室内外）</td><td>可靠的抗日光能力（室内外）</td><td>可靠的抗日光能力（室内外）</td></tr>
<tr><td colspan="7">供电电压：5V　　扫描范围：360°</td></tr>
<tr><td rowspan="2">测量半径</td><td rowspan="2">0.15m - 12m</td><td rowspan="2">0.2m - 16m</td><td>白色物体：25m</td><td>白色物体：20m</td><td>白色物体：40m</td><td>白色物体：0.05~30m</td></tr>
<tr><td>黑色物体：10m</td><td>黑色物体：待定</td><td>黑色物体：10m</td><td>黑色物体：0.05~10m</td></tr>
<tr><td>测量盲区</td><td>无参考值</td><td>无参考值</td><td colspan="2">0.2m</td><td>0.1m</td><td>0.05m</td></tr>
<tr><td>通讯速率</td><td colspan="2">115200bps</td><td colspan="3">256000bps</td><td>1M</td></tr>
<tr><td>采样频率</td><td colspan="2">8K</td><td>16K</td><td>10K</td><td>9.2K</td><td>32K</td></tr>
<tr><td>扫描频率</td><td>5.5Hz-10Hz</td><td>5Hz-15Hz</td><td colspan="2">15Hz（10Hz-20Hz可调）</td><td colspan="2">8Hz-15Hz</td></tr>
<tr><td>角分辨率</td><td>≤1°</td><td>0.9°</td><td colspan="2">0.225°</td><td>0.391°</td><td>0.12°</td></tr>
<tr><td>机械尺寸</td><td>96.8mm*70.3mm*55mm</td><td>⌀76mm*41mm</td><td colspan="2">⌀76mm*41mm</td><td>55.5mm*55.5mm*51mm</td><td>77.1mm*77mm*38.85mm</td></tr>
</table>

供电电流	100mA	450mA - 600mA	400mA	
功耗	0.5W	2.25W-3W	> 2W	
输出	UART 串口(3.3V电平)			
工作温度	0℃~40℃		(-5℃-45℃)	(-10℃~50℃)
测距精度	实际距离的 1%(≤3 m) 实际距离的 2%(3-5 m) 实际距离的 2.5%(>5m)		±5cm	±3cm

As can be seen from the above figure, parameters such as measurement radius, sampling speed, scanning frequency, and angular resolution are important indicators of radar performance.

指标	描述
测距半径	雷达的测量距离范围
测距采样率	一秒内进行多少次测距输出
扫描频率	一秒内雷达进行多少次扫描
角分辨率	两个相邻测距的角度步进
测量分辨率/精度	可以感知到距离变化最小值

A higher **scanning frequency** can ensure that the robot equipped with lidar can move at a faster speed and ensure the quality of map construction. But to

Increasing the scanning frequency is not simply a matter of accelerating the rotation of the lidar's internal scanning motor. It also requires increasing the ranging sampling rate.

Otherwise, when the sampling frequency is fixed, faster scanning speed will only reduce the angular resolution. In addition to measuring distance and scanning frequency, measuring

Parameters such as quantitative resolution and mapping accuracy are equally important to lidar performance. These are important to ensure that the robot can have stable performance.

Need parameters.