1. Introduction and use of radar

1. Program function description

After the program runs, drive Silan's laser radar, turn on the radar scanning data, and visualize the laser radar scanning data in rviz.

2. Program code reference path

Raspberry Pi PI5 master control, you need to enter the docker container first,

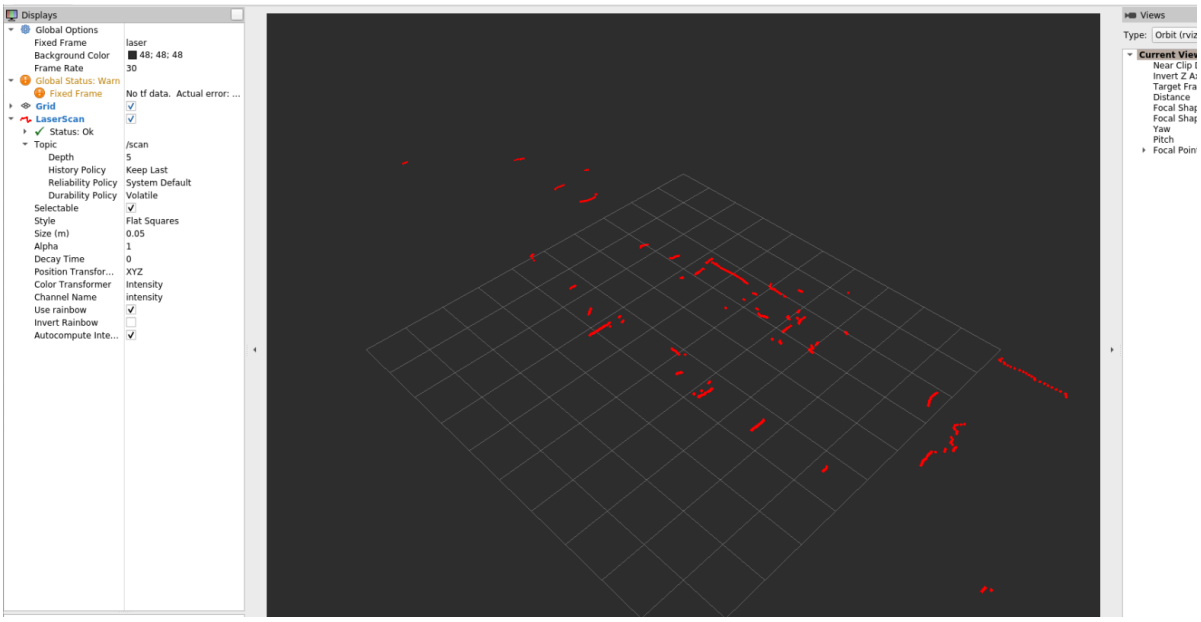
The location of the function source code is,

```
#A1 radar
~/yahboomcar_ros2_ws/software/library_ws/src/sllidar_ros2/launch/sllidar_launch.p
y
#S2 radar
~/yahboomcar_ros2_ws/software/library_ws/src/sllidar_ros2/launch/s
llidar_s2_launch.py
#A1 radar visualization
~/yahboomcar_ros2_ws/software/library_ws/src/sllidar_ros2/launch/view_sllidar_lau
nch.py
#S2 radar visualization
~/yahboomcar_ros2_ws/software/library_ws/src/sllidar_ros2/launch/view_sllidar_s2_
launch.py
```

3. Program startup

```
#Start A1 radar
ros2 launch sllidar_ros2 sllidar_launch.py
#Start A1 radar + rviz visualization data
ros2 launch sllidar_ros2 view_sllidar_launch.py
#Start S2 radar
ros2 launch sllidar_ros2 sllidar_s2_launch.py
#Start S2 radar + rviz visualization data
ros2 launch sllidar_ros2 view_sllidar_s2_launch.py
```

Run screenshot, take the start of "A1 radar + visualization" as an example,



You can use the following command to print the data scanned by the radar,

```
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
```

4. Introduction to Silan Radar

4.1. Overview

Single-line laser radar refers to a radar whose laser source emits a single-line beam. It is divided into triangulation and TOF laser radar, and is mainly used in the field of robots. It has fast scanning speed, high resolution and high reliability. Compared with multi-line laser radar, single-line laser radar has faster response in angular frequency and sensitivity, so it is more accurate in the distance and accuracy of obstacle measurement.

4.2. Distance measurement principle

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

- Triangulation distance measurement method

Laser triangulation distance measurement method mainly uses a laser beam to illuminate the target at a certain incident angle. The laser is reflected and scattered on the target surface. The reflected laser is focused and imaged at another angle by a lens. The light spot is imaged on the CCD (Charge-coupled Device) position sensor. When the object to be measured moves along the laser direction, the light spot on the position sensor will move. The displacement size corresponds to the moving distance of the object to be measured. Therefore, the distance value between the object to be measured and the baseline can be calculated by algorithm design based on the light spot displacement distance.

Since the incident light and the reflected light form a triangle, the calculation of the light spot displacement uses the geometric trigonometric theorem, so this measurement method is called laser triangulation distance measurement method.

- TOF distance measurement method

TOF laser radar is based on measuring the flight time of light to obtain the distance of the target object. Its working principle is mainly manifested in that a beam of modulated laser signal is emitted by a laser transmitter, and the modulated light is received by the laser detector after being reflected by the measured object. The distance of the target can be calculated by measuring the phase difference between the emitted laser and the received laser.

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 between various laser radar models

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

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 working 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 the LiDAR can move at a faster speed and ensure the quality of map construction. However, increasing the scanning frequency is not as simple as simply accelerating the rotation of the scanning motor inside the LiDAR. The corresponding distance sampling rate needs to be increased. Otherwise, when the sampling frequency is fixed, a faster scanning speed will only reduce the angular resolution. In addition to the ranging distance and scanning frequency, parameters such as measurement resolution and mapping accuracy are equally important for the performance of the LiDAR. These are important parameters to ensure that the robot can have stable performance.