1、Lidar basics

- For different types of radar

Before using the lidar, it is necessary to declare the [RPLIDAR_TYPE] variable in advance in the [.bashrc] file according to different radar models. Open the [.bashrc] file

```
sudo vim ~/.bashrc
```

If there is no following sentence in [.bashrc], you need to manually add it according to the purchased radar model. If there is this sentence, modify the radar model directly. Example: 4ROS lidar

```
export RPLIDAR_TYPE=4ROS   # a1, a2, a3, s1, s2, 4ROS, X3
```

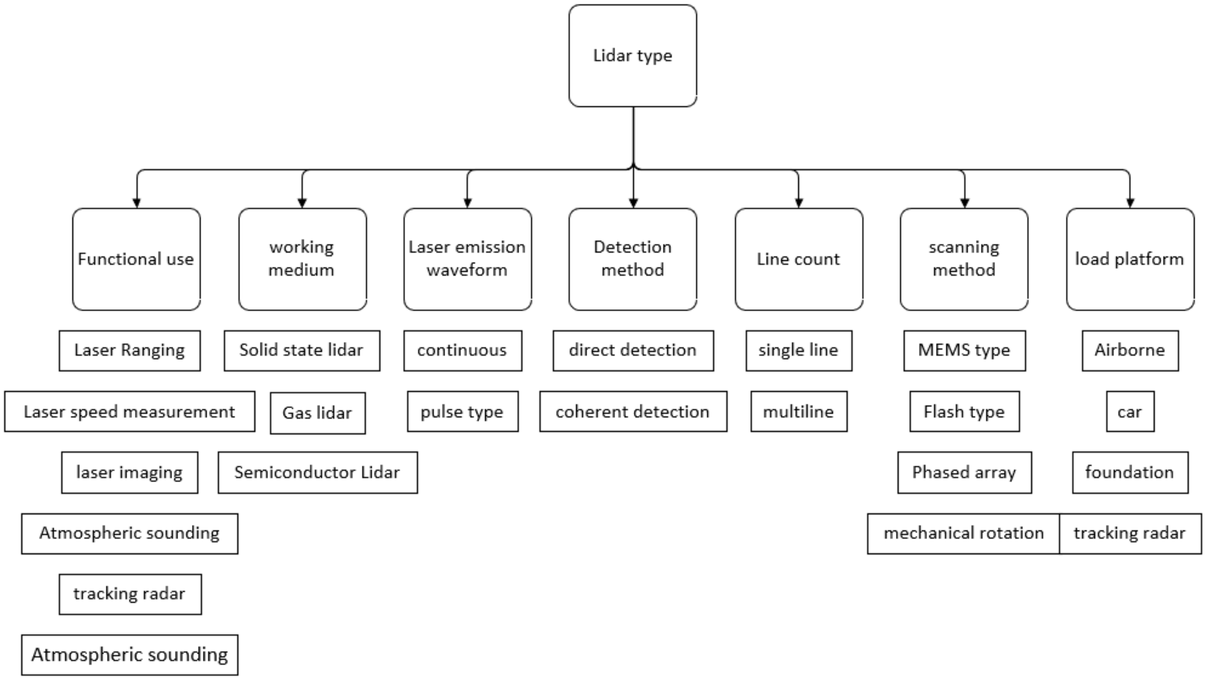
Note: For rosmaster series cars equipped with X3 or X3Pro radar, the two radars start in the same way, just change them to X3.

After modification, refresh the environment variables

```
source ~/.bashrc
```

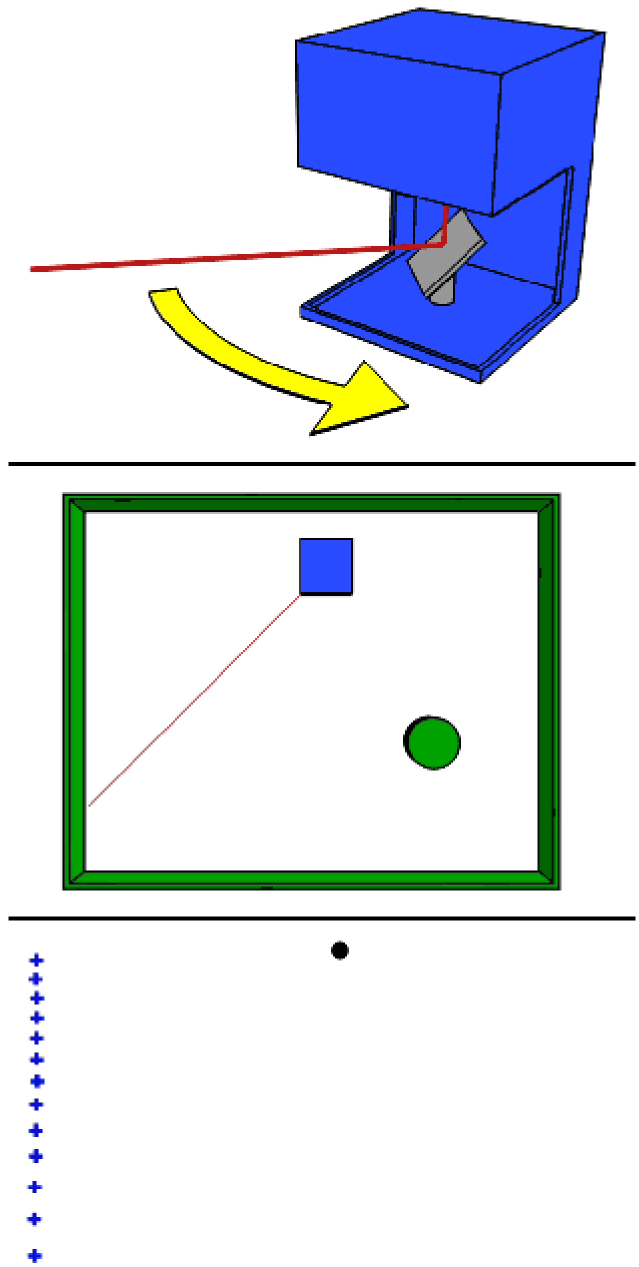
1.1、Overview

Single-line LiDAR refers to the single-line radar that the beam emitted by the laser source is divided into triangular ranging and TOF LiDAR, and is mainly used in the field of robotics. It has fast scanning speed, strong resolution and high reliability. Compared with multi-line lidar, single line lidar has faster response in angular frequency and sensitivity, so it is more accurate in ranging distance and accuracy of obstacles.



1.2、Single-line lidar principle

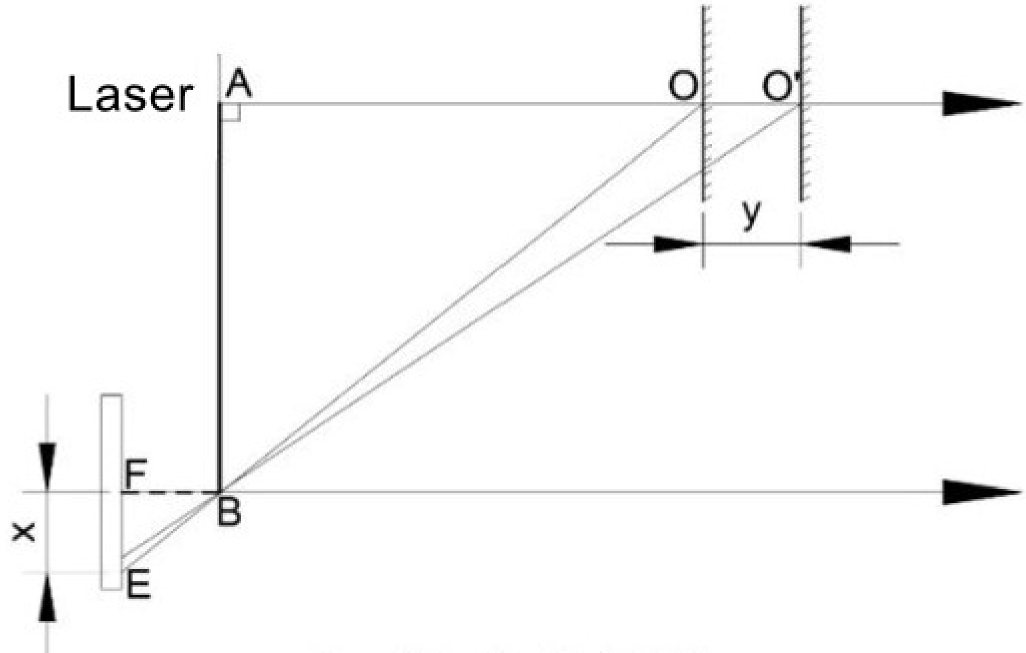
Working principle of the single-line lidar, as shown below.：



1.2.1、Trigonometric ranging

According to the angle relationship between the incident beam and the surface normal of the measured object, the laser triangulation method can be divided into two types: oblique type and direct type.

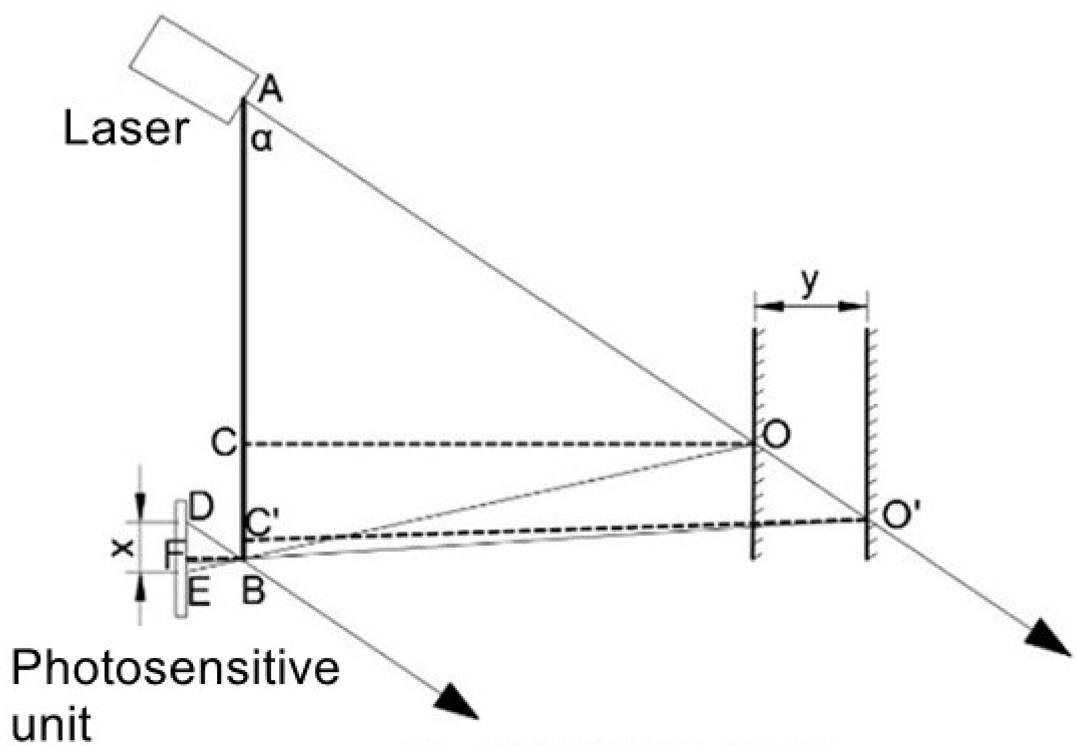
1、Direct shot



As shown below, when the laser beam is perpendicular to the surface of the object to be measured, that is, when the incident light beam is collinear with the normal to the surface of the object to be measured, it is a direct laser triangulation method.

2、Oblique shot

When the angle between the incident laser beam and the normal to the surface of the object to be measured in the optical path system is less than 90°, the incident method is oblique. The optical path diagram shown in FIG. 2 is an oblique light path diagram of the laser triangulation method.



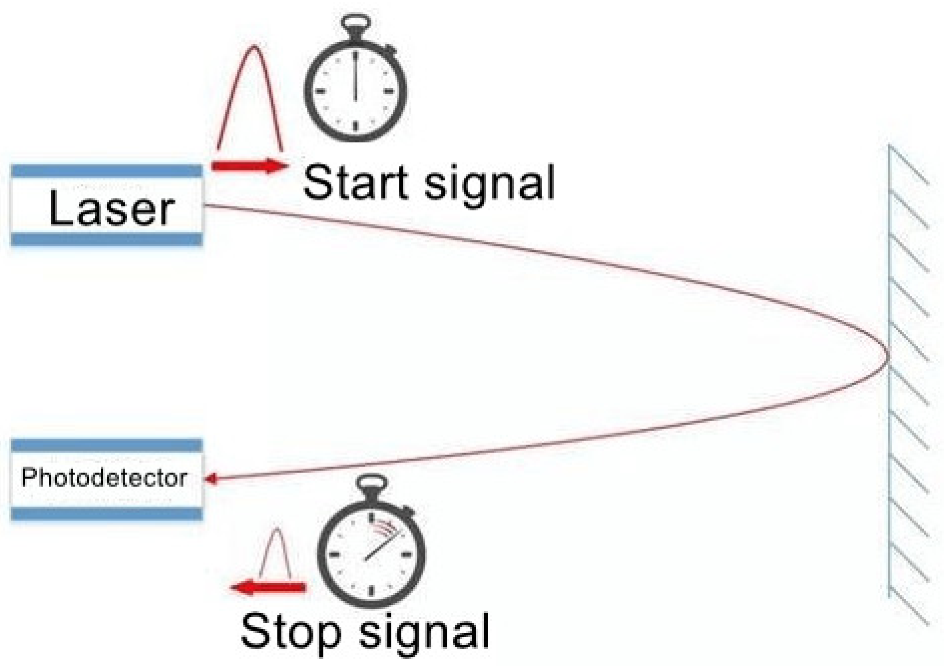
The laser light emitted by the laser is incident on the surface of the measured object at a certain angle with the normal line of the object surface, and the reflected (scattered) light is converged and imaged by the lens at B, and finally collected by the photosensitive unit.

Whether it is a direct beam or an oblique laser triangulation method, it can achieve high-precision, non-contact measurement of the measured object, but the resolution of the direct beam is not as high as that of the oblique beam.

The RPLIDAR series lidar of Si Lan Technology also adopts the oblique laser triangulation ranging method. During each ranging process, the RPLIDAR series lidar will emit a modulated infrared laser signal, and the reflected light generated by the laser signal after it hits the target object will be received by the RPLIDAR's visual acquisition system, and then processed by the DSP embedded in the RPLIDAR The real-time calculation by the sensor, the distance between the irradiated target object and the RPLIDAR and the current angle information will be output from the communication interface. Driven by the motor mechanism, the ranging core of RPLIDAR will rotate clockwise, thereby realizing 360-degree omni-directional scanning and ranging detection of the surrounding environment.

1.2.2、TOF (Time-of-flight) ranging

TOF lidar is based on measuring the time of flight of light to obtain the distance of the target. Its working principle is mainly as follows: a beam of modulated laser signal is sent out through the laser transmitter, the modulated light is reflected by the measured object and received by the laser detector, and the distance to the target can be calculated by measuring the phase difference between the emitted laser and the received laser.



Under the condition of distant objects, its measurement accuracy is still accurate and stable. At the same time, due to the characteristics of ultra-short light pulse, TOF radar is not inferior in anti-light interference ability, and can realize stable ranging and high-precision mapping even under the strong light of 60Klx outdoors.

Generally speaking, triangular ranging lidar and TOF lidar have their own difficulties in realization. In principle, TOF radar has a longer ranging distance. In some occasions where distance is required, TOF radar is basically the majority, while The manufacturing cost of triangular ranging lidar is relatively low, and the accuracy can meet the requirements of most industrial-level civilians, so it has also attracted the attention of the industry.

1.3、Using 4ROS lidar

1.3.1、4ROS radar

Run following command in terminal.

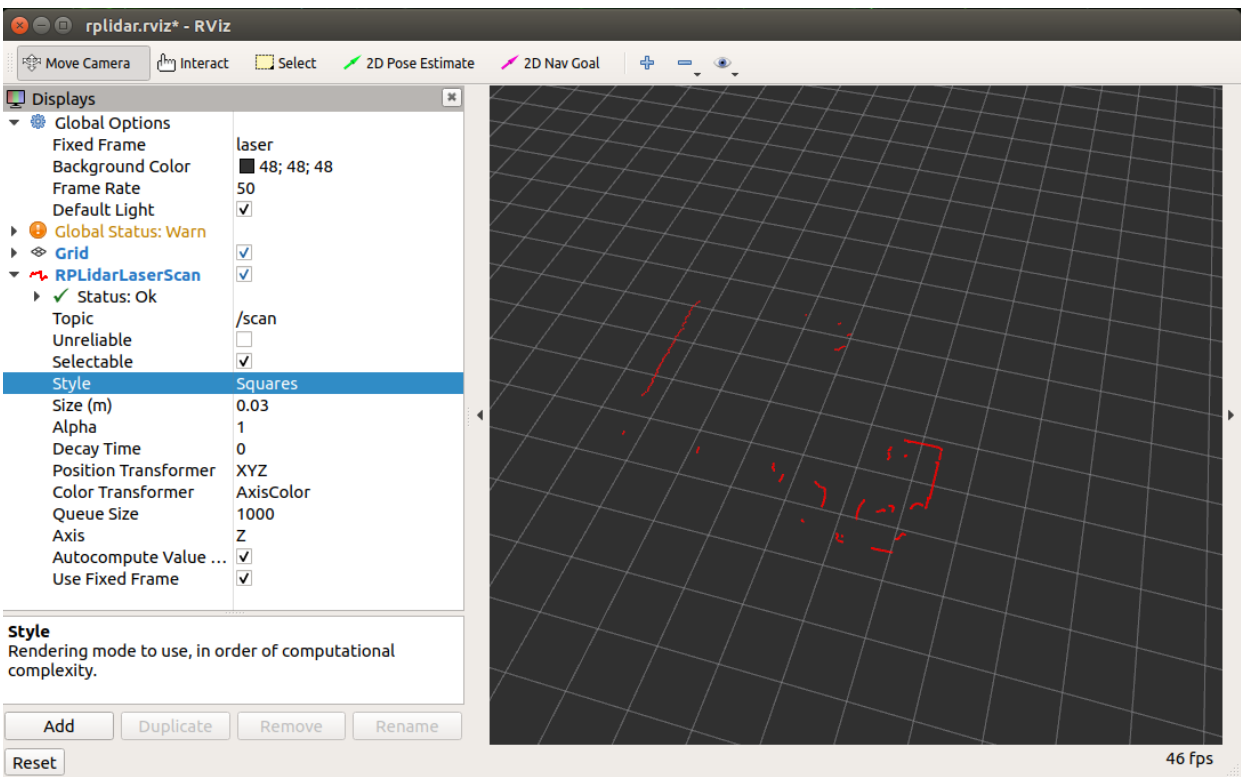
```
roslaunch ydlidar_ros_driver TG.launch
```

Run following command in terminal. (We can print the topic data through the terminal to check whether the radar starts normally)

```
rostopic echo /scan
```

If you want to view the scan results in RVIZ, type in the terminal.

```
roslaunch ydlidar_ros_driver lidar_view.launch
```



1.3.2、X3/X3Pro Radar

Run following command in terminal.

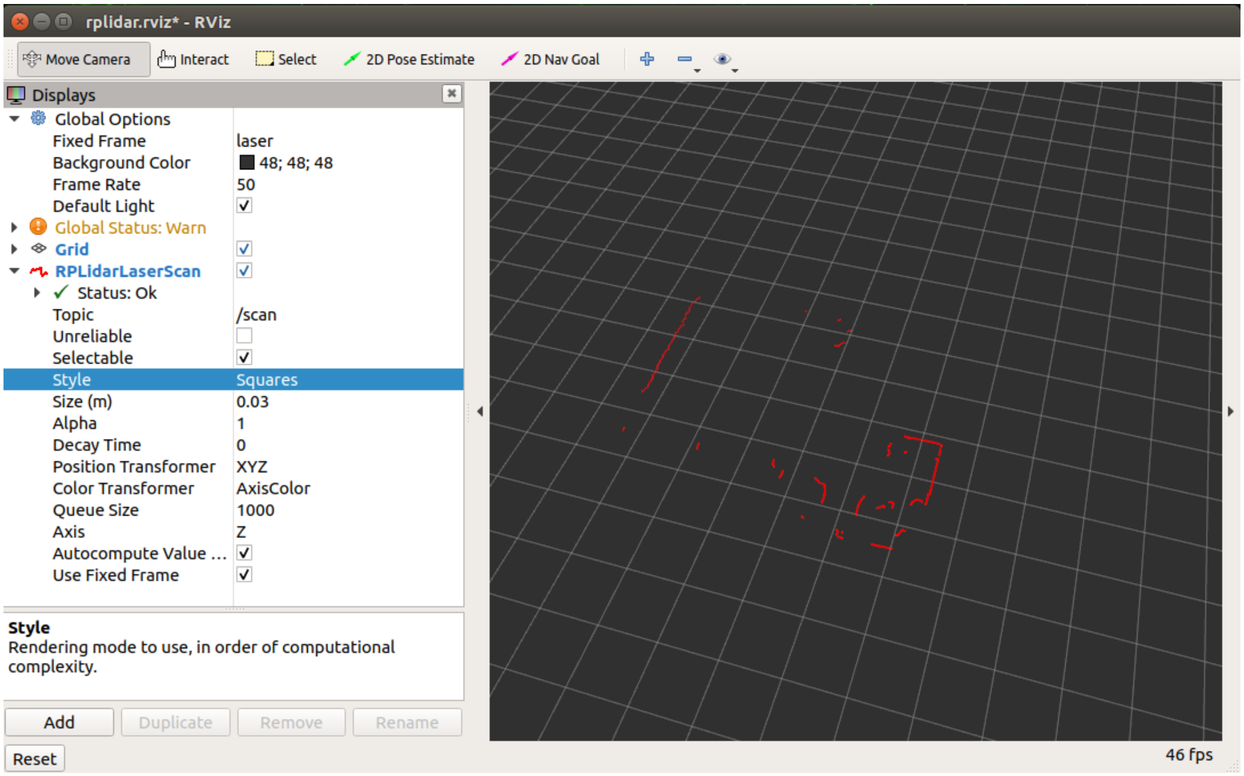
```
roslaunch ydlidar_ros_driver X2.launch
```

Run following command in terminal. (We can print the topic data through the terminal to check whether the radar starts normally)

```
rostopic echo /scan
```

If you want to view the scan results in RVIZ, type in the terminal.

```
roslaunch ydlidar_ros_driver lidar_view.launch
```



1.4、 launch analysis

path： ~/software/library_ws/src/ydlidar_ros_driver-master/launch

TG.launch document

```
<launch>
  <arg name="frame_id" default="laser"/>
  <node name="ydlidar_lidar_publisher"  pkg="ydlidar_ros_driver"
 type="ydlidar_ros_driver_node" output="screen" respawn="false" >
    <!-- string property -->
    <param name="port"         type="string" value="/dev/ydlidar"/>
    <param name="frame_id" type="string" value="$(arg frame_id)"/>
    <!--param name="ignore_array"     type="string" value="-90,90"/-->
    <param name="ignore_array"     type="string" value=""/>
    <!--remap from="scan" to="scan_raw"/-->

    <!-- int property -->
    <param name="baudrate"         type="int" value="512000"/>
    <!-- 0:TYPE_TOF, 1:TYPE_TRIANGLE, 2:TYPE_TOF_NET -->
    <param name="lidar_type"       type="int" value="0"/>
    <!-- 0:YDLIDAR_TYPE_SERIAL, 1:YDLIDAR_TYPE_TCP -->
    <param name="device_type"         type="int" value="0"/>
    <param name="sample_rate"         type="int" value="20"/>
    <param name="abnormal_check_count"         type="int" value="4"/>
```

```xml
    <!-- bool property -->
    <param name="resolution_fixed"    type="bool"   value="true"/>
    <param name="auto_reconnect"    type="bool"   value="true"/>
    <param name="reversion"    type="bool"   value="true"/>
    <param name="inverted"    type="bool"   value="true"/>
    <param name="isSingleChannel"    type="bool"   value="false"/>
    <param name="intensity"    type="bool"   value="false"/>
    <param name="support_motor_dtr"    type="bool"   value="false"/>
    <param name="invalid_range_is_inf"    type="bool"   value="true"/>
    <param name="point_cloud_preservative"    type="bool"   value="false"/>

    <!-- float property -->
    <param name="angle_min"    type="double" value="-90" />
    <param name="angle_max"    type="double" value="90" />
    <param name="range_min"    type="double" value="0.01" />
    <param name="range_max"    type="double" value="50.0" />
    <param name="frequency"    type="double" value="10.0"/>
  </node>
  <!--node pkg="tf" type="static_transform_publisher" name="base_link_to_laser4"
    args="0.0 0.0 0.2 3.14 0.0 0.0 /base_footprint /laser 40" /-->
</launch>
```

Main debugging parameters：

- angle_min parameters: radar left angle
- angle_max parameters: Radar right angle

Other parameters can refer to the official document,

[ydlidar_ros_driver/README.md at master · YDLIDAR/ydlidar_ros_driver · GitHub]