1、Lidar basics

SLAM Lidar tutorials： https://www.slamtec.com/en/Support

SLAM Lidar Technical Support E-mail： support@slamtec.com

Lidar wiki： http://wiki.ros.org/rplidar

Lidar SDK： https://github.com/Slamtec/rplidar_sdk

Lidar ROS： https://github.com/Slamtec/rplidar_ros

Lidar tutorials： https://github.com/robopeak/rplidar_ros/wiki

1.1、Overview

Single-line lidar refers to a single-line laser beam emitted by the laser source. It is divided into triangular ranging and TOF lidar. It is mainly used in the field of robotics.

Its scanning speed is fast, the resolution is strong, and the reliability is high. Compared with the multi-line lidar, the single-line lidar reacts more quickly in angular frequency and sensitivity, so it is more accurate in the distance and accuracy of obstacle distance measurement.

1.2、SLAM lidar components

SLAM single-line lidar as an example, which is mainly composed of 4 core components: laser, receiver, signal processing unit and rotating mechanism.

1.2.1、Laser

The laser is the laser emitting mechanism of the lidar. During work, it will light up in pulses. The RPLIDAR A3 series SLAM lidar will turn on and off 16000 times per second.

1.2.2、Receiver

After the laser emitted by the laser hits the obstacle, the reflected light will be converged on the receiver through the lens group through the reflection of the obstacle.

1.2.3、Signal processing unit

The signal processing unit is responsible for controlling the emission of the laser and processing the signal received by the receiver. Based on this information, the distance information of the target object is calculated.

1.2.4、Rotating mechanism

The rotating mechanism is responsible for rotating the above-mentioned core components at a stable speed, so as to realize the scanning of the plane and generate real-time plan information.

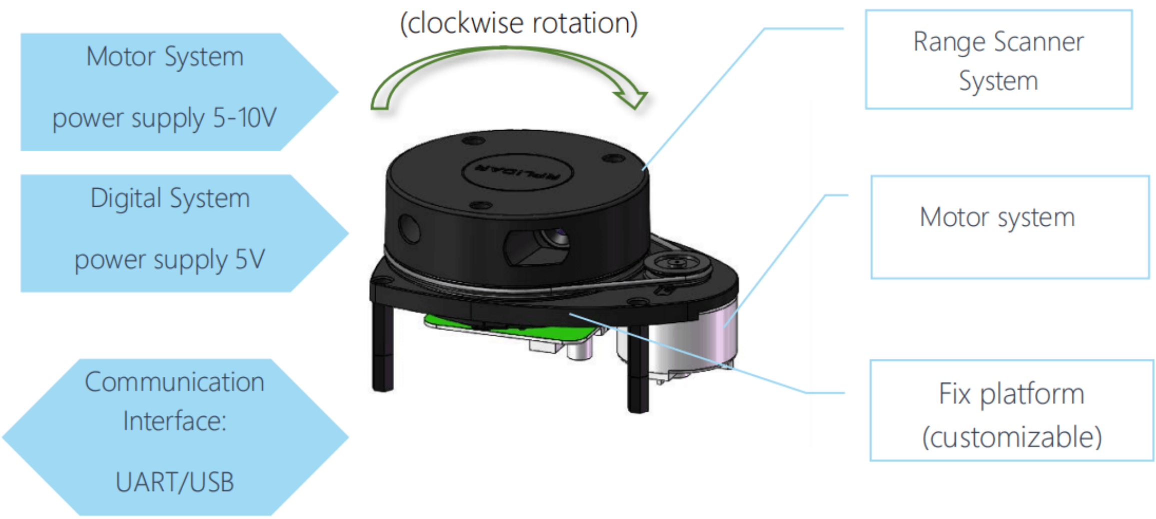
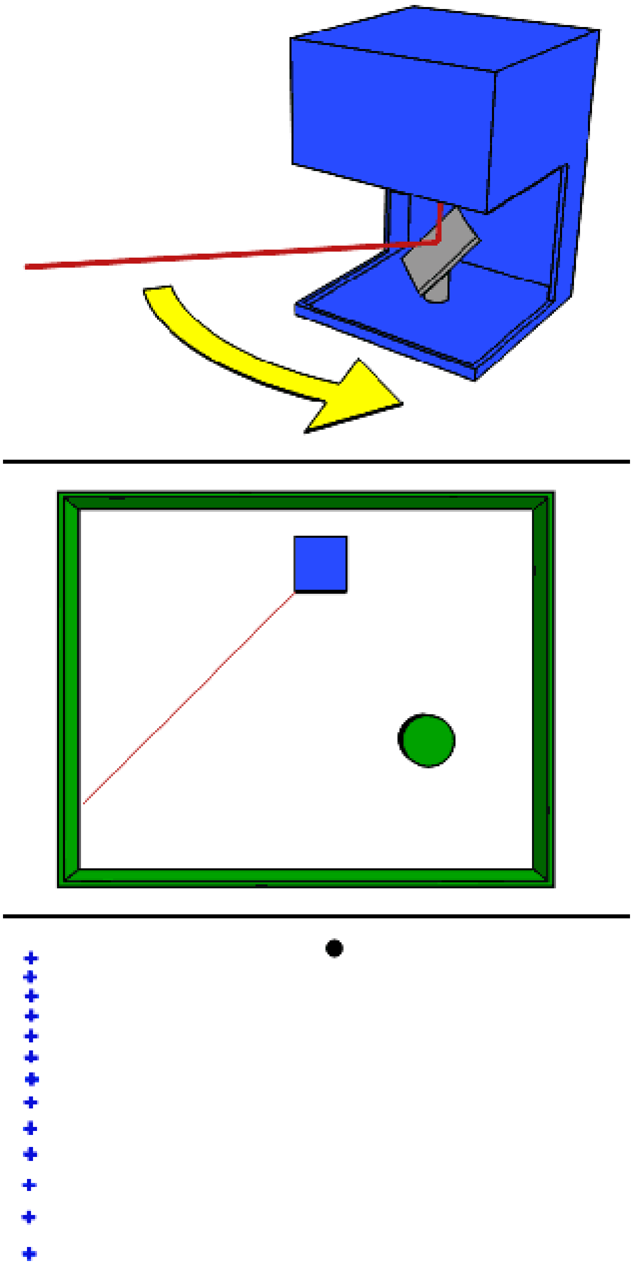


Figure 1-1 RPLIDAR A1 System Composition

1.3、Principle of single-line lidar

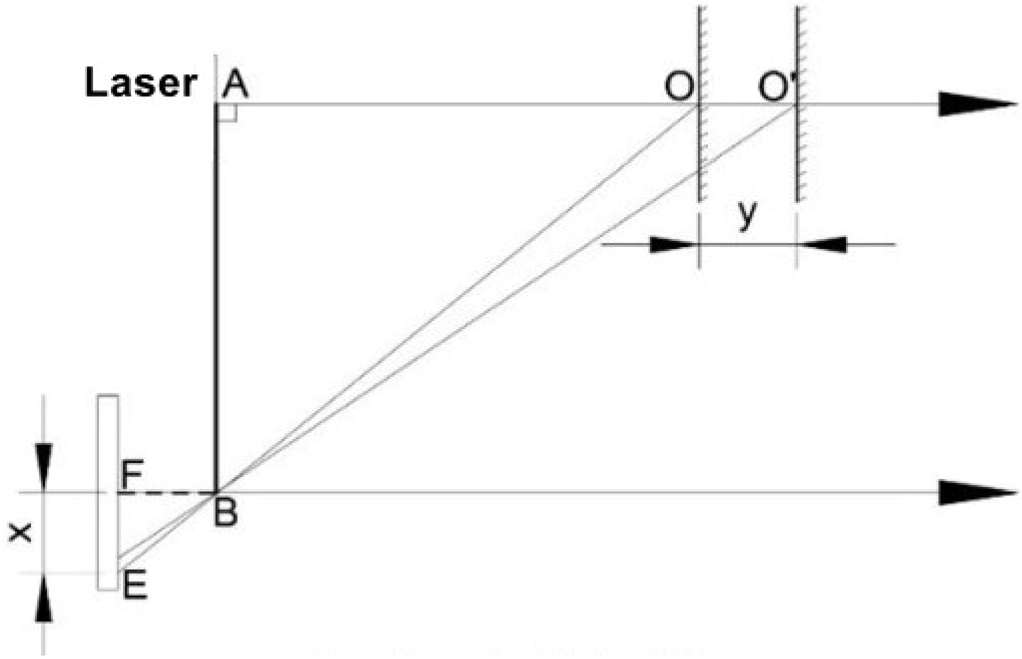
Working principle of the single-line mechanical rotating mechanism lidar, as shown below.



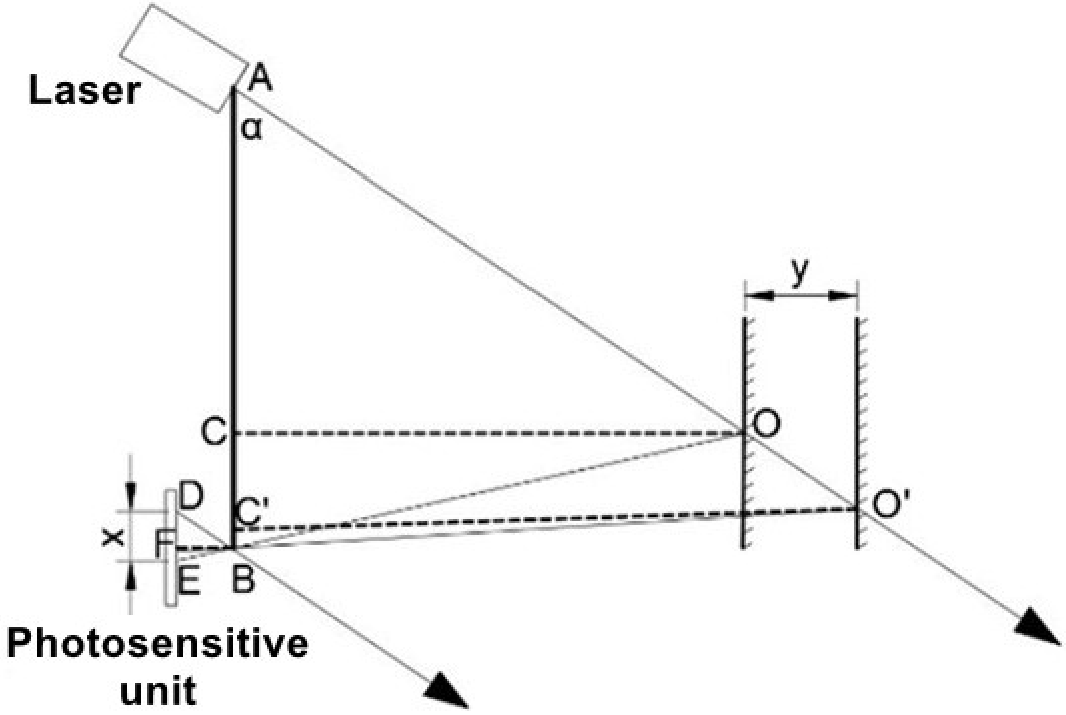
1.3.1、Triangular Ranging Method

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

1、Direct shot



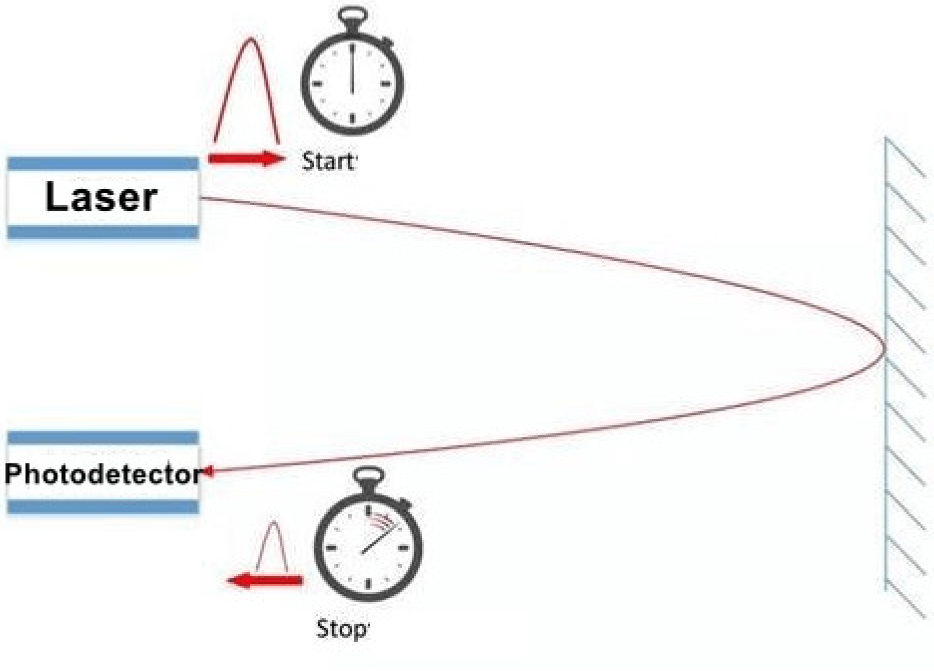
2、Oblique shot



SLAM RPLIDAR series lidar uses the oblique laser triangulation ranging method.

1.3.2、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 expressed as a laser transmitter sends out a modulated laser signal, the modulated light is reflected by the measured object and then received by the laser detector. The distance to the target can be calculated by measuring the phase difference between the emitted laser and the received laser. .



1.4、Lidar A1M8

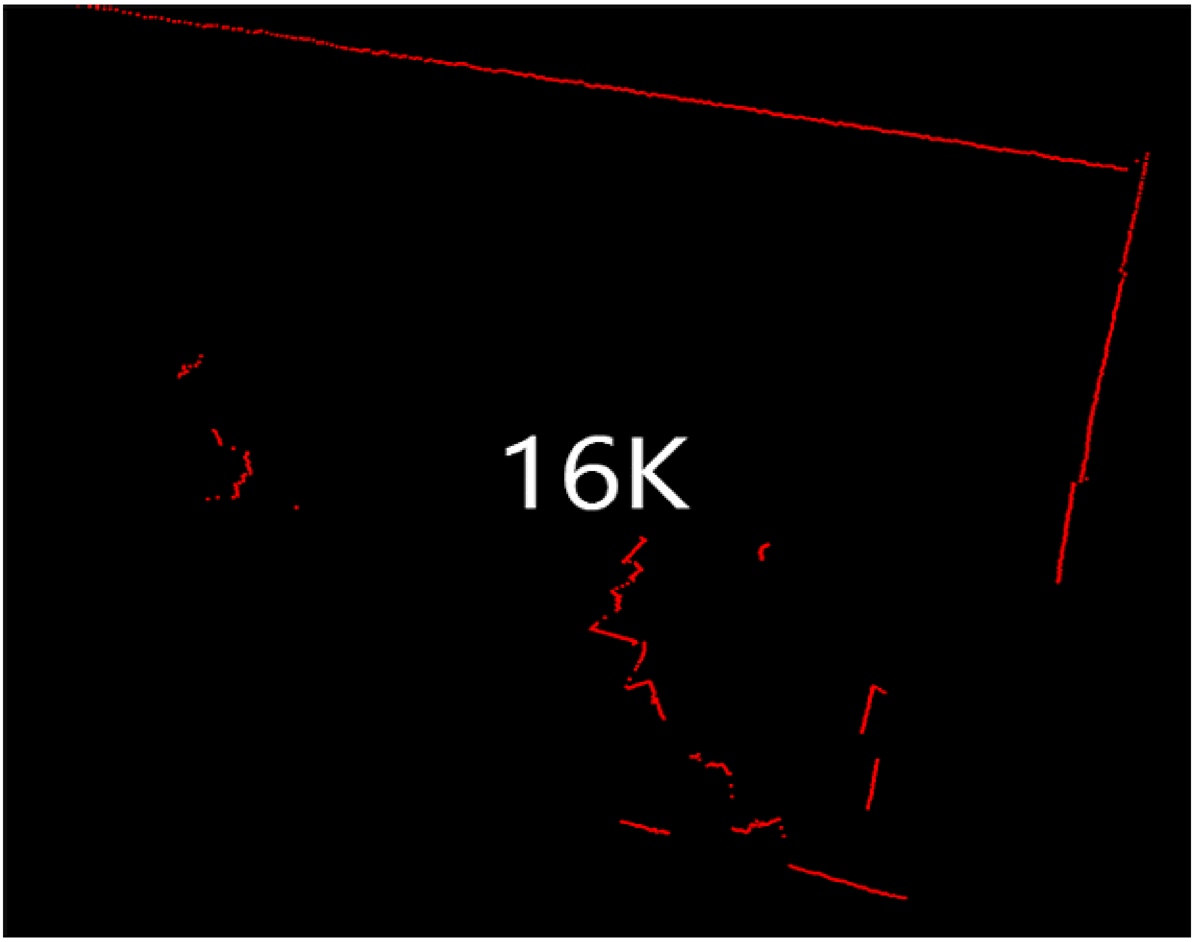
- For Model A1M8 Only

Item	Unit	Min	Typical	Max	Comments
Distance Range	Meter(m)	TBD	0.15-12	TBD	White objects
Angular Range	Degree	n/a	0-360	n/a	
Scan Field Flatness	Degree	-1.5		1.5	
Distance Resolution	mm	n/a	<0.5 <1% of the distance	n/a	<1.5 meters All distance range*
Angular Resolution	Degree	n/a	≤1	n/a	5.5Hz scan rate
Sample Duration	Millisecond(ms)	n/a	0.125	n/a	
Sample Frequency	Hz	n/a	≥8000	8010	
Scan Rate	Hz	1	5.5	10	Typical value is measured when RPLIDAR A1 takes 360 samples per scan

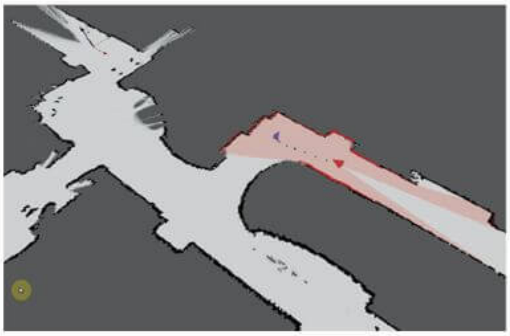
Figure 2-1 RPLIDAR A1 Performance

It can be seen from the figure above that parameters such as measurement radius, sampling speed, rotation speed, and angular resolution are important information of lidar performance.

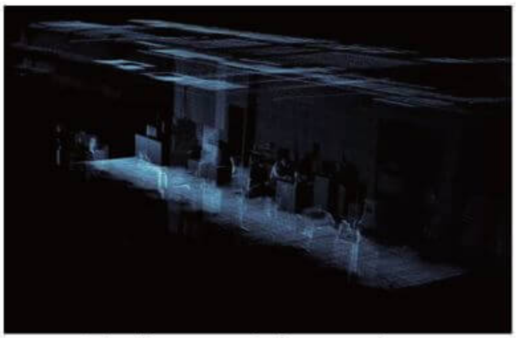
Information	Description
Ranging radius	Radar measurement range
Ranging sampling rate	How many ranging outputs are performed in one second
Scanning frequency	How many scans the radar does in one second
Angular resolution	Angular steps of two adjacent ranging
Measurement resolution/accuracy	Can perceive the minimum distance change



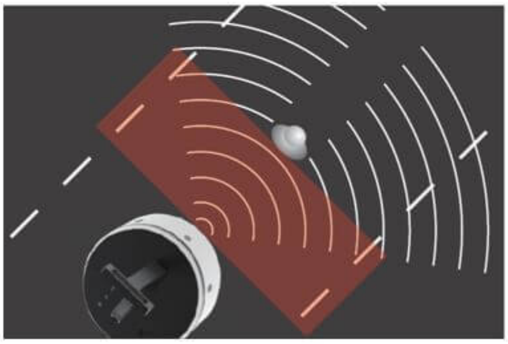
1.5、Application scenario



Robot simultaneous positioning and mapping scan



Environmental scanning and 3D reconstruction



Obstacle detection

Multi-touch and human-computer interaction

1.6、Using of A1M8

1.6.1、Build rplidar ros package

Clone this project to your catkin's workspace src folder

Run catkin_make to build rplidarNode and rplidarNodeClient

1.6.2、Run rplidar ros package

View the permissions of the rplidar serial port:

```
ls -l /dev |grep ttyUSB
```

Add write permission:（such as /dev/ttyUSB0）

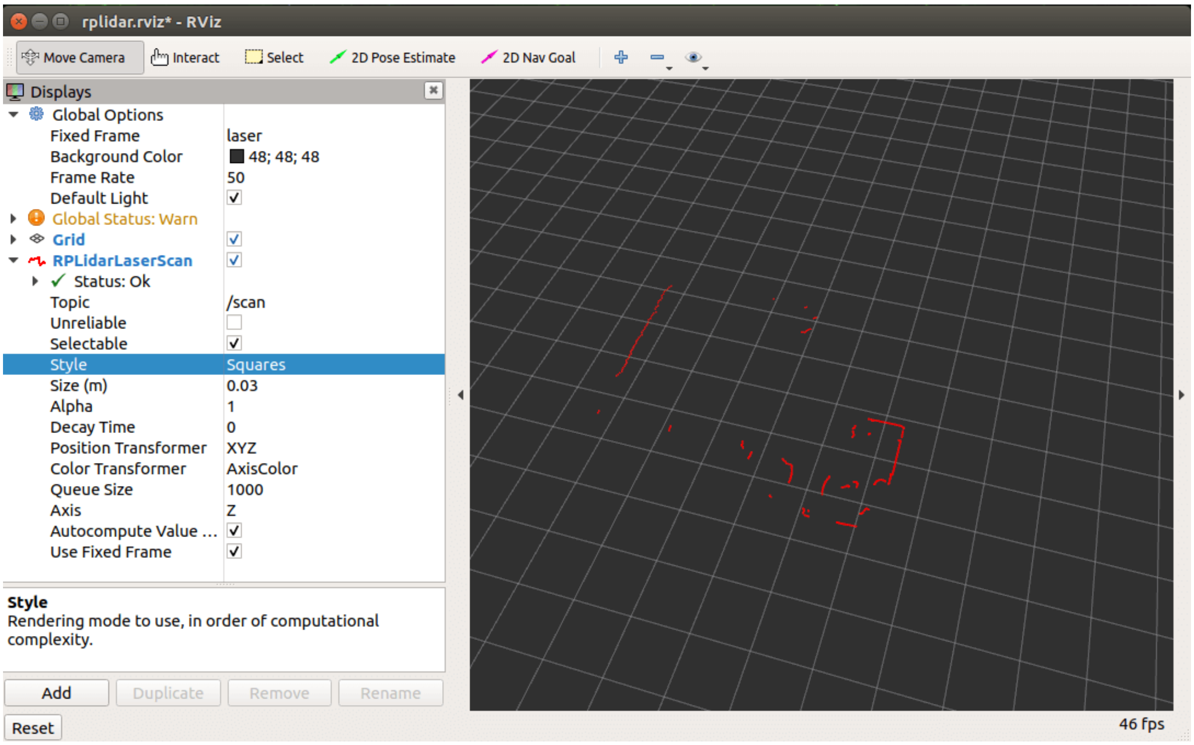
```
sudo chmod 666 /dev/ttyUSB0
```

There are two ways to run the rplidar ros package

- Run rplidar node, view in rviz

```
roslaunch rplidar_ros view_rplidar.launch
```

You can see rplidar scan results in the rviz



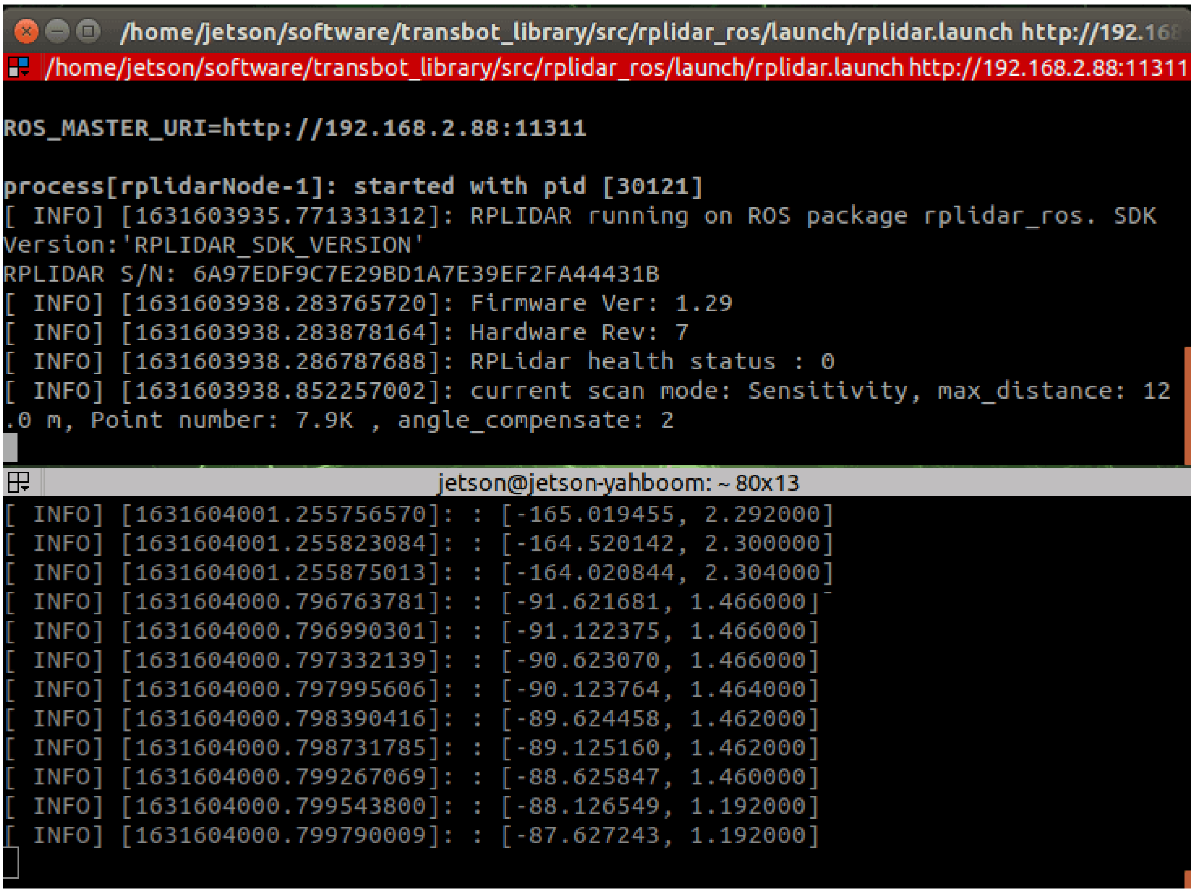
```
Global Options
  Fixed Frame               laser
  Background Color          48; 48; 48
  Frame Rate                50
  Default Light             ✓
Global Status: Warn
Grid                        ✓
RPLidarLaserScan            ✓
  Status: Ok
  Topic                     /scan
  Unreliable                □
  Selectable                ✓
  Style                     Squares
  Size (m)                  0.03
  Alpha                     1
  Decay Time                0
  Position Transformer      XYZ
  Color Transformer         AxisColor
  Queue Size                1000
  Axis                      Z
  Autocompute Value ...     ✓
  Use Fixed Frame           ✓
```

Style
Rendering mode to use, in order of computational complexity.

- Run the rplidar node and use the test application to view

```
roslaunch rplidar_ros rplidar.launch
rosrun rplidar_ros rplidarNodeClient
```

You can see rplidar scan results in the console


/home/jetson/software/transbot_library/src/rplidar_ros/launch/rplidar.launch http://192.168
jetson@jetson-yahboom: ~ 80x13

```
/home/jetson/software/transbot_library/src/rplidar_ros/launch/rplidar.launch http://192.168.2.88:11311

ROS_MASTER_URI=http://192.168.2.88:11311

process[rplidarNode-1]: started with pid [30121]
[ INFO] [1631603935.771331312]: RPLIDAR running on ROS package rplidar_ros. SDK
Version:'RPLIDAR_SDK_VERSION'
RPLIDAR S/N: 6A97EDF9C7E29BD1A7E39EF2FA44431B
[ INFO] [1631603938.283765720]: Firmware Ver: 1.29
[ INFO] [1631603938.283878164]: Hardware Rev: 7
[ INFO] [1631603938.286787688]: RPLidar health status : 0
[ INFO] [1631603938.852257002]: current scan mode: Sensitivity, max_distance: 12
.0 m, Point number: 7.9K , angle_compensate: 2
```

```
[ INFO] [1631604001.255756570]: : [-165.019455, 2.292000]
[ INFO] [1631604001.255823084]: : [-164.520142, 2.300000]
[ INFO] [1631604001.255875013]: : [-164.020844, 2.304000]
[ INFO] [1631604000.796763781]: : [-91.621681, 1.466000]
[ INFO] [1631604000.796990301]: : [-91.122375, 1.466000]
[ INFO] [1631604000.797332139]: : [-90.623070, 1.466000]
[ INFO] [1631604000.797995606]: : [-90.123764, 1.464000]
[ INFO] [1631604000.798390416]: : [-89.624458, 1.462000]
[ INFO] [1631604000.798731785]: : [-89.125160, 1.462000]
[ INFO] [1631604000.799267069]: : [-88.625847, 1.460000]
[ INFO] [1631604000.799543800]: : [-88.126549, 1.192000]
[ INFO] [1631604000.799790009]: : [-87.627243, 1.192000]
```

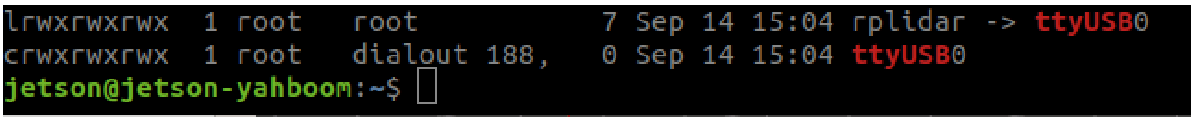
1.6.3、Remapping the USB serial port

In the path of rplidar_ros function package, install USB port remapping:

```
./scripts/create_udev_rules.sh
```

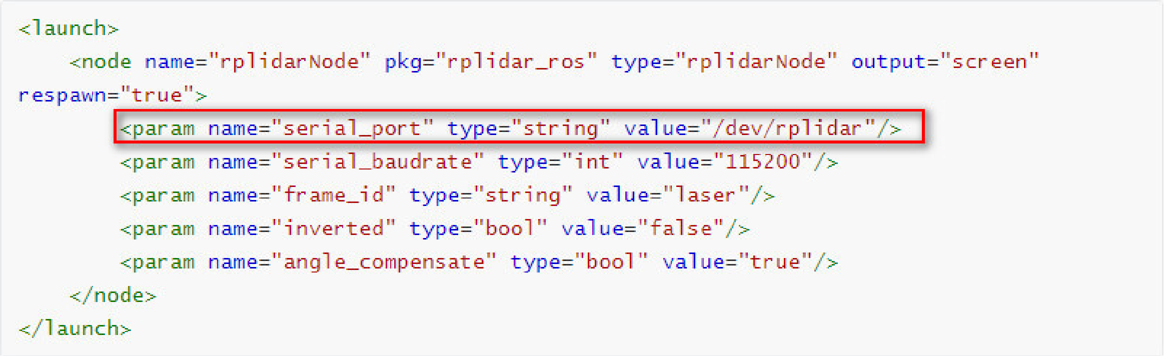
Input following command to modify re-mapping:

```
ls -l /dev | grep ttyUSB
```



```
lrwxrwxrwx  1 root   root        7 Sep 14 15:04 rplidar -> ttyUSB0
crwxrwxrwx  1 root   dialout 188,  0 Sep 14 15:04 ttyUSB0
jetson@jetson-yahboom:~$ 
```

After changing the USB port remapping, we need to change the startup file about the serial_port value.



```
<launch>
    <node name="rplidarNode" pkg="rplidar_ros" type="rplidarNode" output="screen"
respawn="true">
        <param name="serial_port" type="string" value="/dev/rplidar"/>
        <param name="serial_baudrate" type="int" value="115200"/>
        <param name="frame_id" type="string" value="laser"/>
        <param name="inverted" type="bool" value="false"/>
        <param name="angle_compensate" type="bool" value="true"/>
    </node>
</launch>
```