# How to use lidar

**Note: The baud rate is different between A1/A2<115200>, A3/S1<256000> and S2<1000000>.**

**Note: The information of the lidar M2M2 and the radar of this course (A1/A2/A3/S1/S2) are different, please view the information according to the corresponding model**

**Note: "Slan Lidar Course" is based on the use of Transbot crawler vehicles, for reference only! ! !**



Lidar technology support Email：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

Lidar website：http://www.slamtec.com/cn/Support

Test the PC computer：https://www.slamtec.com/cn/RoboStudio

# 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.

# 2、Silan lidar components

Take SLAMTec lidar as an example, which is mainly composed of 4 core components: laser, receiver, signal processing unit and rotating mechanism.

## 2.1、Laser

The laser is the laser emitting mechanism in the lidar. During work, it will light up in pulses.

The RPLIDAR A3 series lidar of  SLAMTec  will turn on and off 16000 times per second.

## 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.

## 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.

## 2.4、Rotating mechanism

The above three components constitute the core part of the measurement.

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.

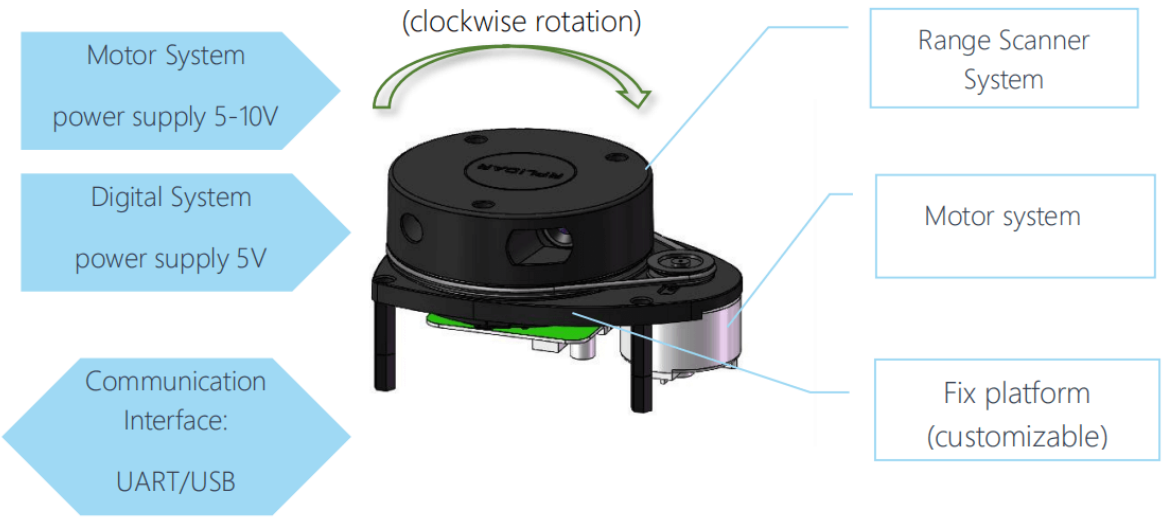
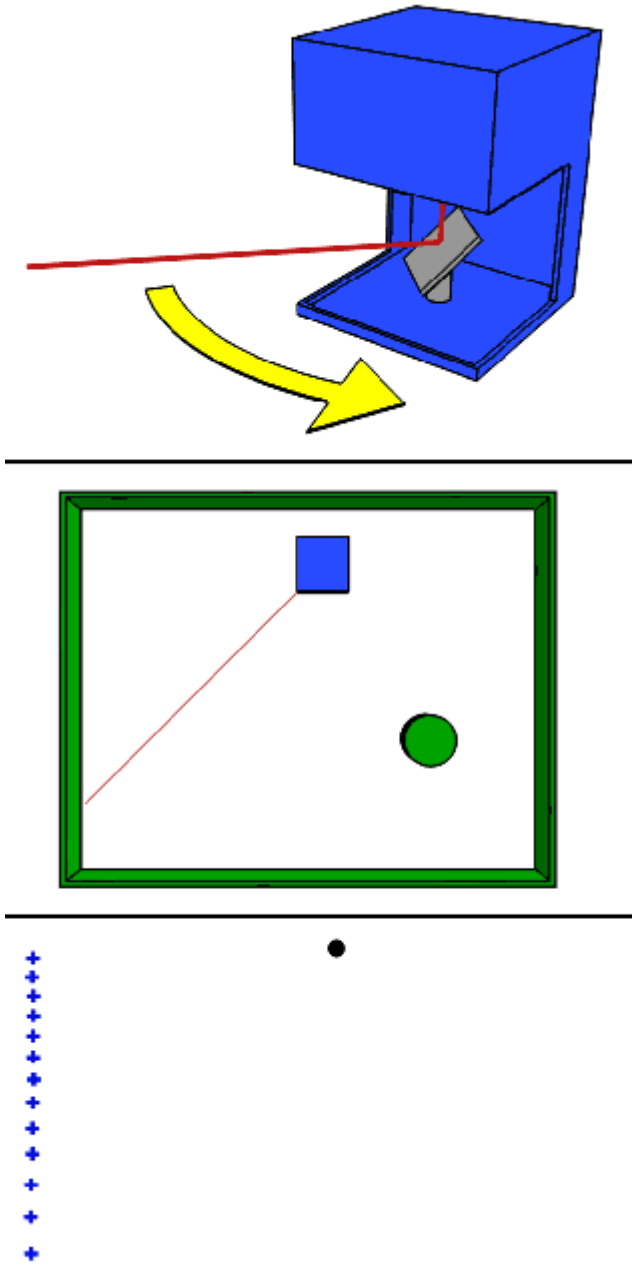



*Figure 1-1 RPLIDAR A1 System Composition*

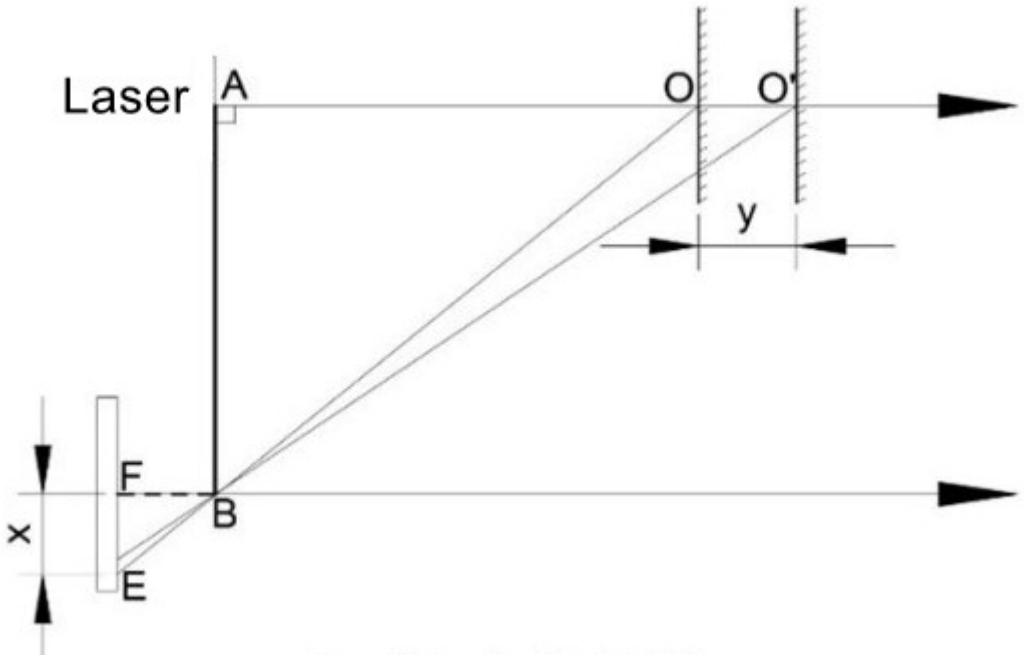
# 3、Principle of single-line lidar

The working principle of the radar is shown in the figure below:

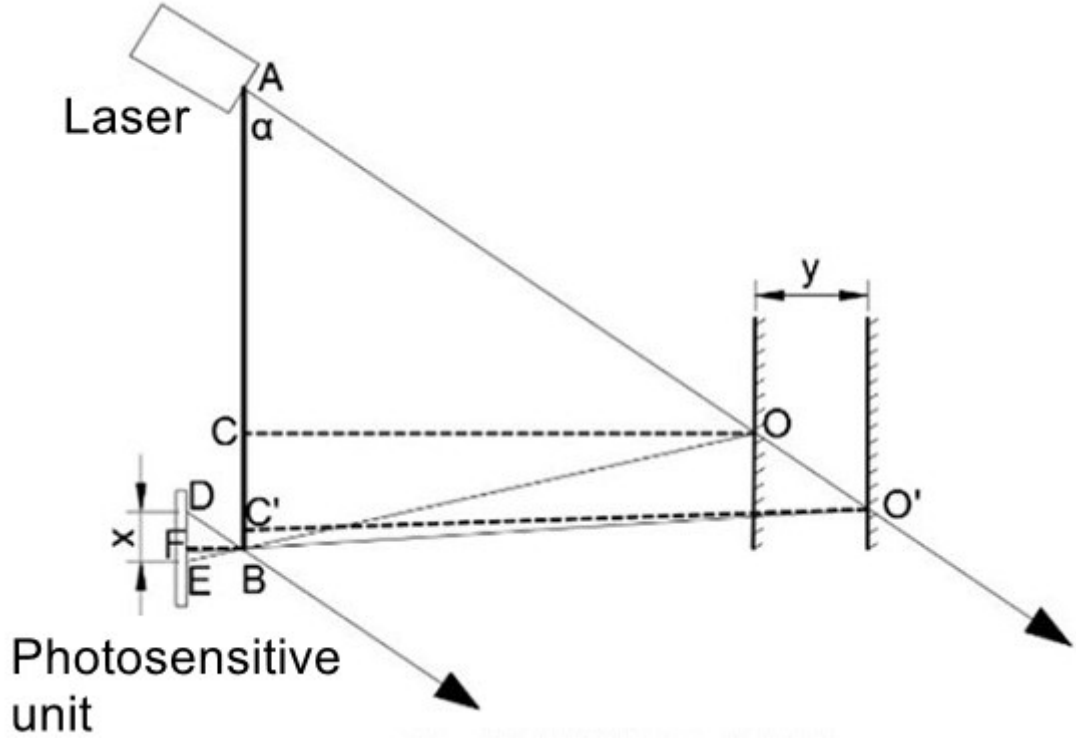


## 3.1、Triangular Ranging Method

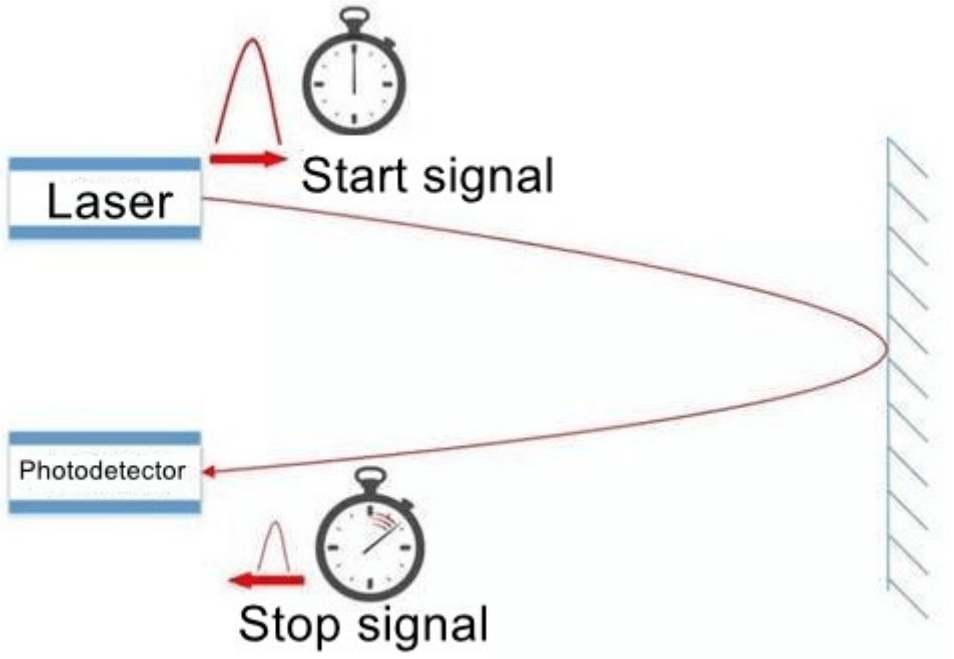
### 3.1.1、Direct shot




### 3.1.2、Oblique shot



## 3.2、TOF Ranging Method



# 4、Lidar parameter comparison

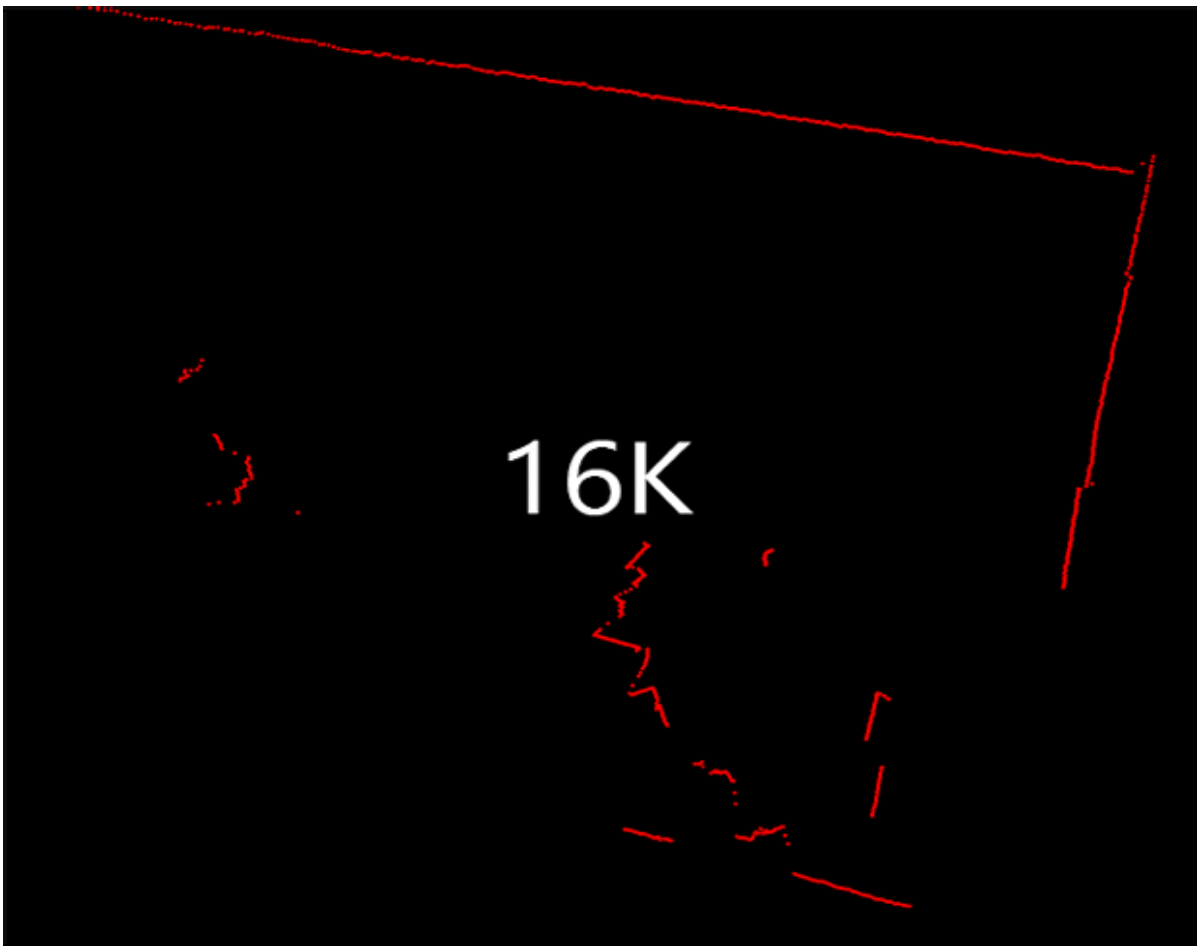
## RPLIDAR Parameter comparison

| Series | Triangular Ranging | | | | TOF ranging | | |
|---|---|---|---|---|---|---|---|
| Model | A1M8 | A2M8 | A3M1 Enhanced mode | A3M1 Outdoor mode | S1M1 | S2M1(IP65) | M2M2 |
| |  |  |  | |  |  |  |
| Recommended Applications | Smart sweeper, household robot (indoor) | Commercial or consumer robot 3D modeling (indoor) | High performance (indoor) | Stable performance, strong ability to resist sunlight (indoor/outdoor) | Strong ability to resist sunlight (indoor/outdoor) | Strong ability to resist sunlight (indoor/outdoor) | Commercial robot environmental mapping, hand-held measurement (indoor/outdoor) |
| Measuring radius | 0.15m - 12m | 0.2m - 16m | White object: 25m<br>Black object: 10m | White object: 20m | White object: 40m<br>Black object: 10m | White object: 0.05~30m<br>Black object: 0.05~10m | 0.1m~40m |
| Measurement dead zone | No reference value | No reference value | 0.2m | | 0.1m | 0.05m | No reference value |
| Communication rate | 115200bps | | 256000bps | | | 1M | |
| Sampling frequency | 8K | | 16K | 10K | 9.2K | 32K | 9.2K |
| Scanning frequency | 5.5Hz-10Hz | 5Hz-15Hz | 15Hz (10Hz-20Hz Adjustable) | | 8Hz-15Hz | | |
| Angular resolution | ≤1° | 0.9° | 0.225° | | 0.391° | 0.12° | 0.391° |
| Mechanical dimensions (unit: mm) | 96.8*70.3*55 | ⌀76*41 | ⌀76*41 | | 55.5*55.5*51 | 77.1*77*38.85 | 77.1*57*74.9 |
| Supply current | 100mA | 450mA - 600mA | | | 400mA | | 750mA - 1300mA |
| Power consumption | 0.5W | 2.25W-3W | | | > 2W | | 3.75W-6.5W |
| Output | UART serial port (3.3V leve) | | | | | | Ethernet/WiFi |
| Operating temperature | 0℃~40℃ | | | | (-5℃-45℃) | (-10℃~50℃) | (-5℃-45℃) |
| Ranging accuracy | Actual distance 1% (≤3 m)<br>Actual distance 2% (3-5 m)<br>Actual distance 2.5% (>5m) | | | | ±5cm | ±3cm | ≤5cm (Within the range) |
| Supply voltage: 5V Scanning Range: 360° | | | | | | | |

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

| Performance | 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 |

| Performance | Description |
| --- | --- |
| Angular resolution | Angular steps of two adjacent ranging |
| Measurement resolution/accuracy | Can perceive the minimum distance change |




# 5、Application scenarios

Lidar plays an indispensable role in many fields such as autonomous robot positioning and navigation, spatial environment mapping, and security.

# 6、Run rplidar node

## 6.1、Build the rplidar ros package

Function download link：https://github.com/Slamtec/rplidar_ros/

Clone this feature pack to your workspace src folder

Run catkin_make to build rplidarNode and rplidarNodeClient

Note: If you do not write the update environment variable to【.bahsrc】, you must update the environment variable before each execution of the running program.

```
source devel/setup.bash  # Update environment variables
```

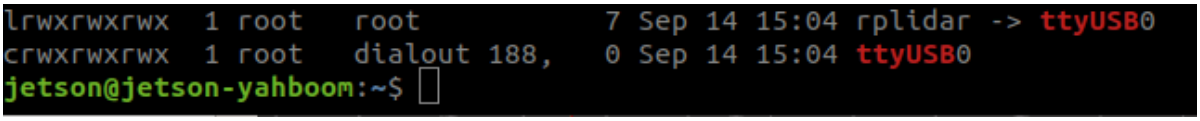
## 6.2、Remap the USB serial port

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

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

Use the following command to modify the remapping:

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




After changing the USB port and remapping, change the startup file related to 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>
```

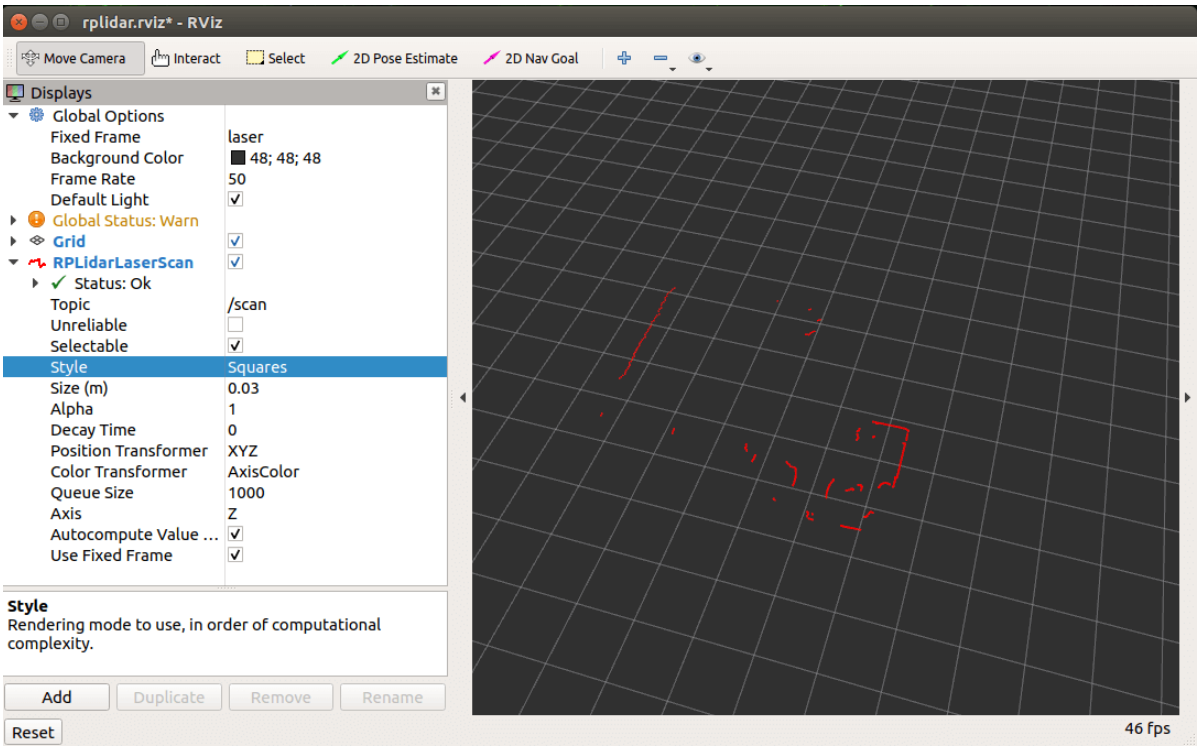
## 6.3、Run rplidar ros package

- Method 1

Run rplidar node, view in rviz

```
roslaunch rplidar_ros view_rplidar.launch    # RPLIDAR A1/A2
roslaunch rplidar_ros view_rplidar_a3.launch # RPLIDAR A3
roslaunch rplidar_ros view_rplidar_s1.launch # RPLIDAR S1
roslaunch rplidar_ros view_rplidar_s2.launch # RPLIDAR S2
roslaunch rplidar_ros view_rplidar_s3.launch # RPLIDAR S2
```

You can see rplidar scan results in rviz.




- Method 2

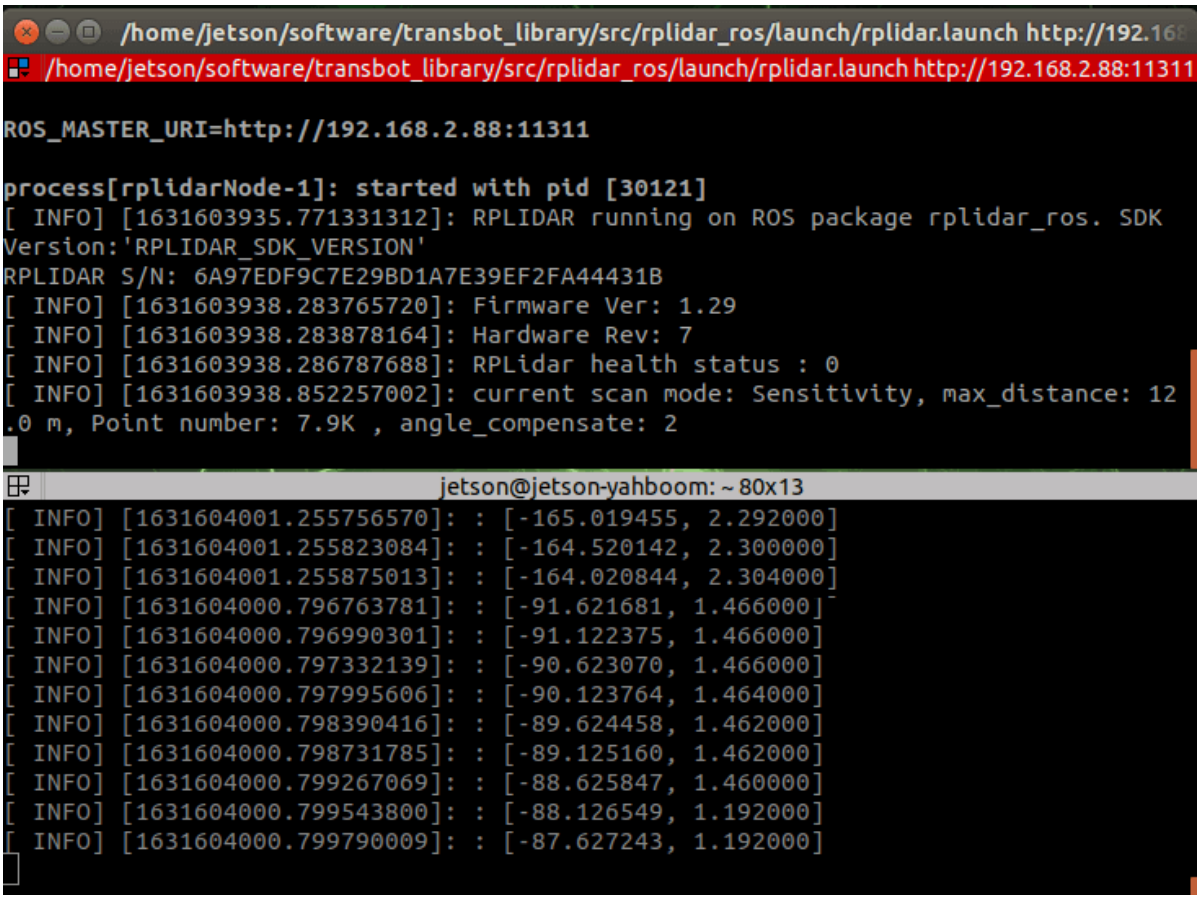
Run rplidar node

```
roslaunch rplidar_ros rplidar.launch    # RPLIDAR A1/A2
roslaunch rplidar_ros rplidar_a3.launch # RPLIDAR A3
roslaunch rplidar_ros rplidar_s1.launch # RPLIDAR S1
roslaunch rplidar_ros rplidar_s2.launch # RPLIDAR S2
roslaunch rplidar_ros rplidar_s3.launch # RPLIDAR S3
```

Start the test application

```
rosrun rplidar_ros rplidarNodeClient
```

You should see rplidar scan results in the console




# 7、RoboStudio test

Test tool download link：https://www.slamtec.com/cn/RoboStudio

Take S1M1 radar as an example, other models are similar.

## 7.1、Install

Double-click robostudio icon to install, and continue to the next step until the installation is complete. Adjust the radar to the corresponding baud rate [A1/A2: 115200, A3/S1: 256000, S2: 1000000].

Using the original data cable to connect the device (for example: PC).

## 7.2、View device


由上图可知道，激光雷达的端口是【COM2】。

## 7.3、Log in

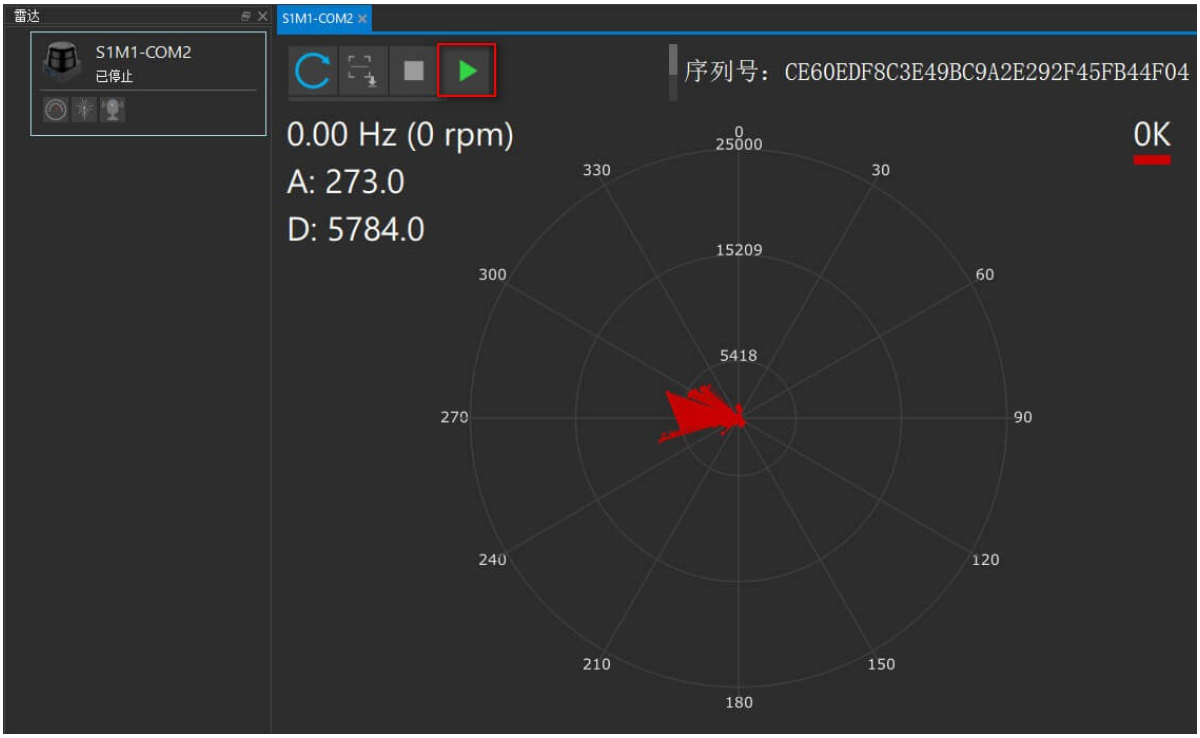
Log in for the first time, you need to register before you can use it. Select [Radar], right-click in the blank area of the radar bar, and select [Manually connect to radar...].

## 7.4、Connect

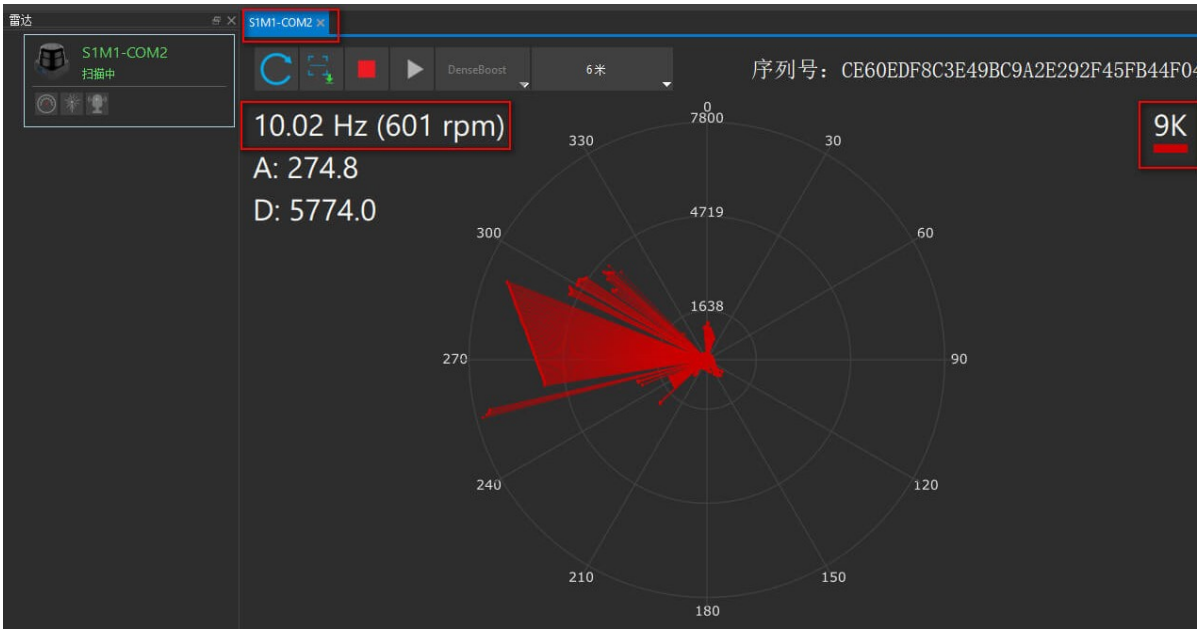
Select the corresponding [COM2], and click [Connect].


## 7.5、Test

Enter the test interface, click the green triangle to start the lidar test.




We can view the basic information of the radar: model [S1M1], sampling frequency [9K], scanning frequency [10.02Hz], etc.



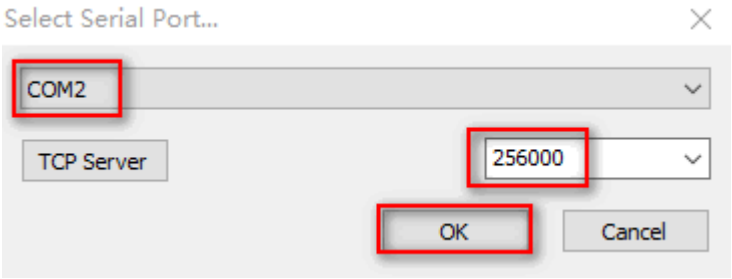
# 8、frame_grabber

## 8.1、View device

The operation is the same as in 7.2.

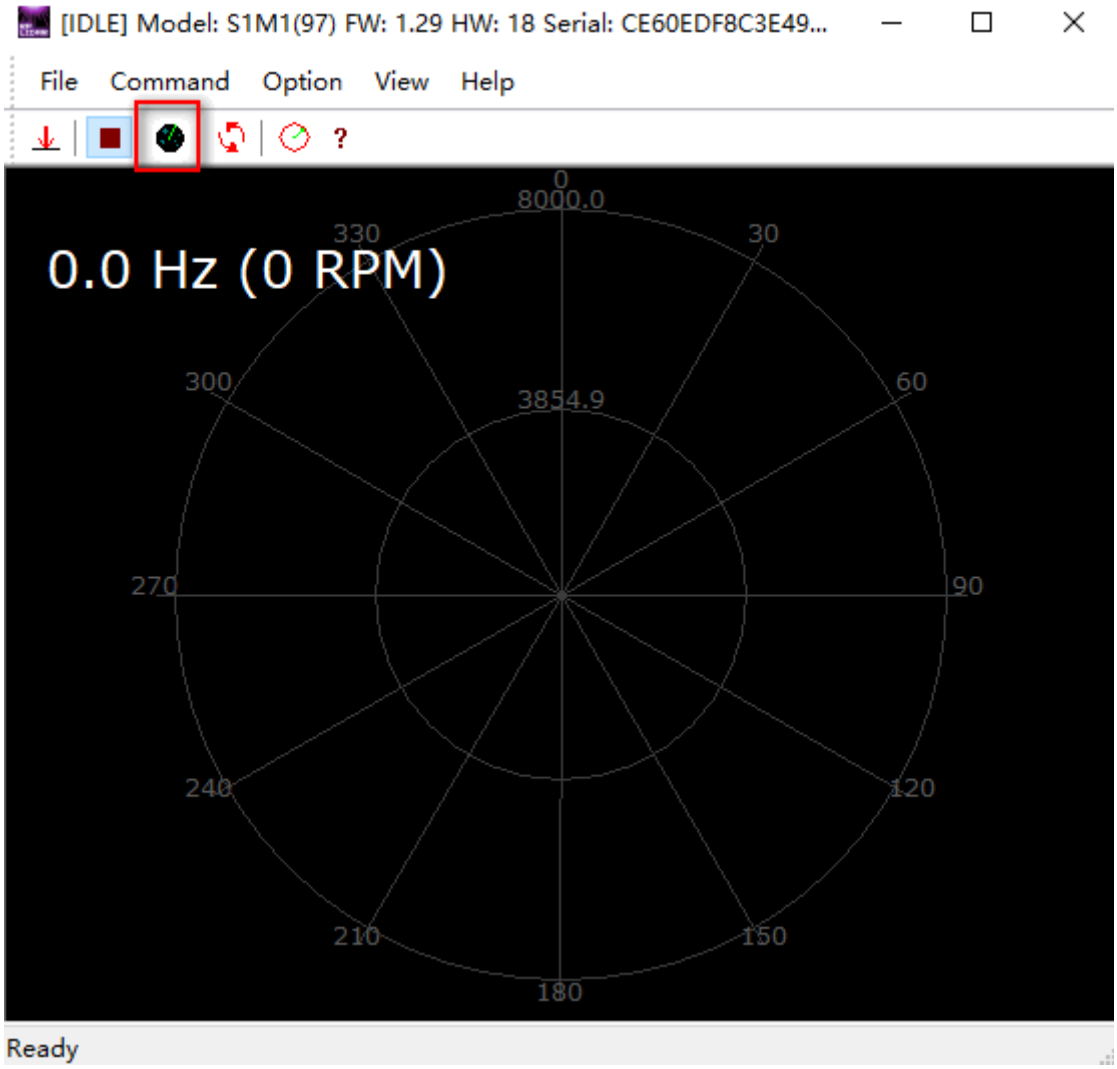
## 8.2、connect

Select the corresponding port [COM2] and baud rate [256000], and click [OK].

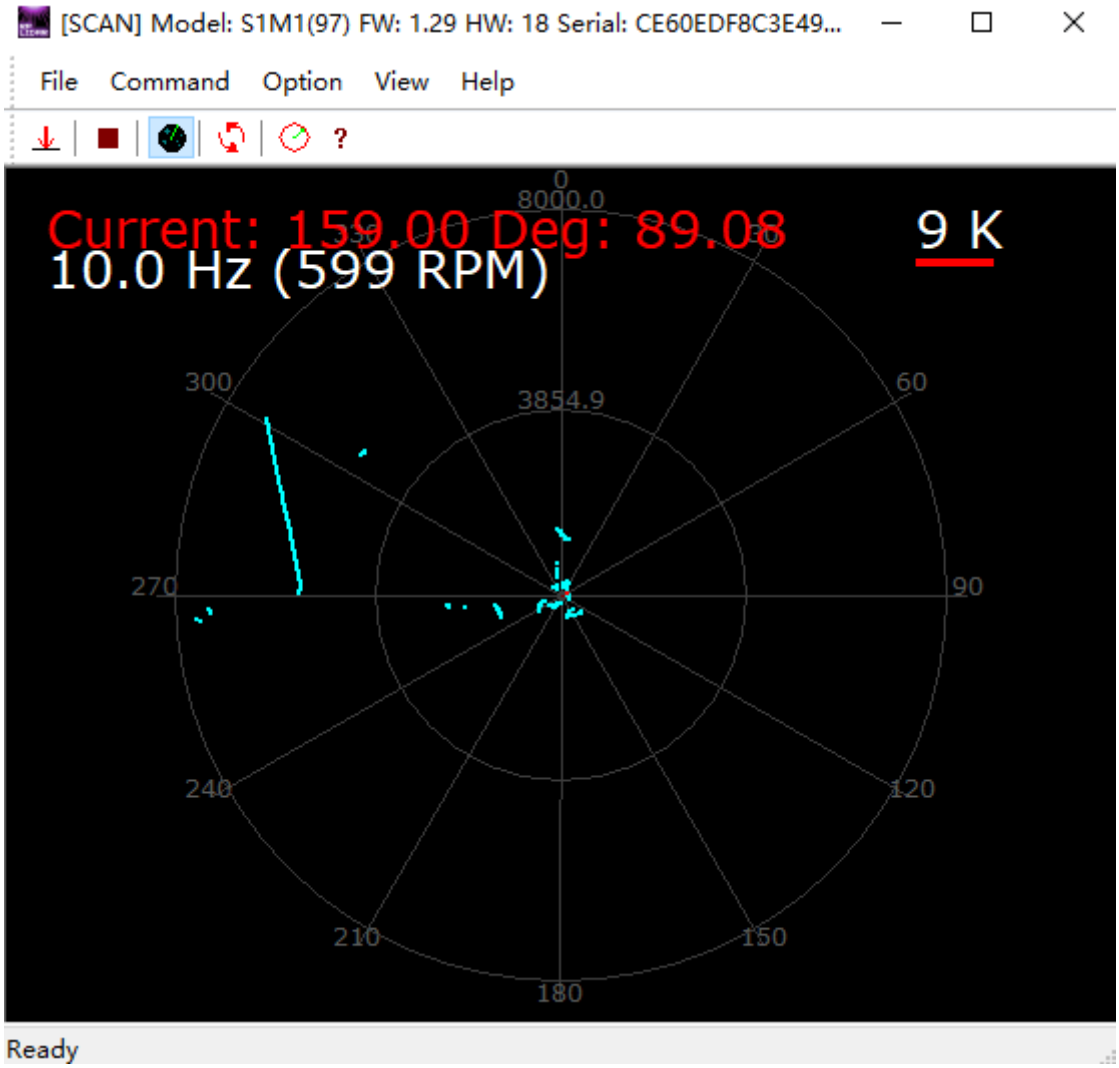



## 8.3、Start up

Click as shown in the figure below to activate the button.




The effect diagram is as follows.


[SCAN] Model: S1M1(97) FW: 1.29 HW: 18 Serial: CE60EDF8C3E49...
File
Command
Option
View
Help
?
Current: 159.00 Deg: 89.08
10.0 Hz (599 RPM)
9 K
0
8000.0
30
60
300
3854.9
270
90
240
120
210
150
180
Ready