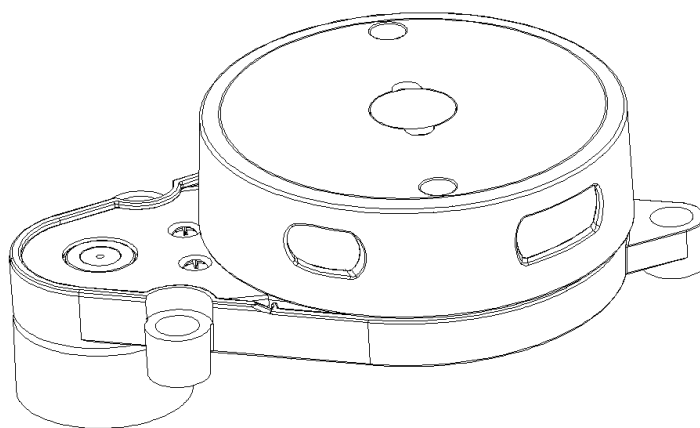


LDROBOT

Move Smarter

LiDAR Sensor LD14

Development Manual



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深圳乐动机器人有限公司
SHENZHEN LDROBOT CO.,LTD.

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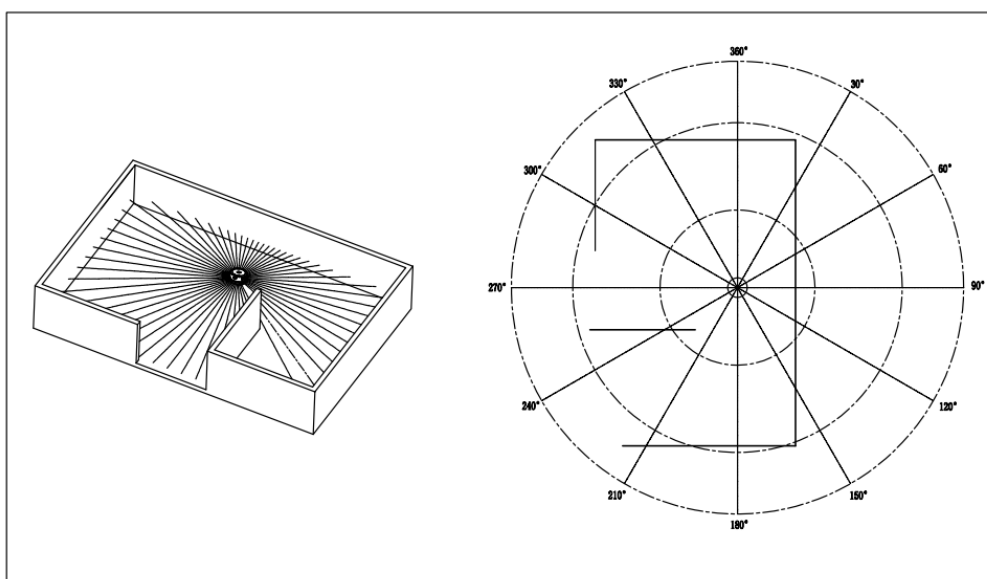
1. PRODUCT DESCRIPTION

The LD14 is mainly composed of laser ranging core, wireless telex unit, wireless communication unit, angle measurement unit, motor drive unit and mechanical casing.

The LD14 ranging core uses triangulation technology, which can measure 2,300 times per second. Each time the distance is measured, the LD14 emits infrared laser light from a fixed angle, and the laser light is reflected to the receiving unit after encountering the target object. The distance is calculated through the triangular relationship formed by the laser, the target object and the receiving unit.

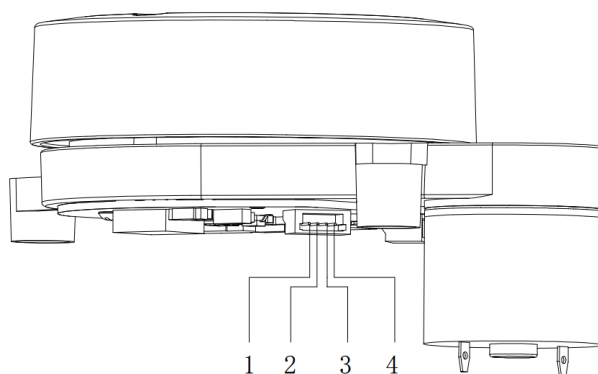
After obtaining the distance data, LD14 will combine the angle values measured by the angle measurement unit to form point cloud data, and then send the point cloud data to the external interface through wireless communication. At the same time, the motor drive unit will drive the motor and control it to the specified speed through the closed-loop PID algorithm.

An illustration of the environmental scan formed by the LD14 point cloud data is shown below:



2. COMMUNICATION INTERFACE

The LD14 uses a 1.25mm 4PIN connector to connect with external systems to achieve power supply and data reception. The specific interface definition and parameter requirements are shown in the following figure/table:



port number	signal name	type	description	minimum	typical	maximum
1	PWM	input	motor control	0V	-	3.3V
2	GND	power supply	negative	-	0V	-
3	Tx	output	LiDAR data output	0V	3.3V	3.5V
4	P5V	power supply	positive	4.5V	5V	5.5V

The LD14 supports internal speed control and external speed control. When the PWM pin is grounded or floating, the default is internal speed regulation, and the default speed is 6Hz. For external speed control, a square wave signal needs to be connected to the PWM pin, and the start, stop and speed of the motor can be controlled through the duty cycle of the PWM signal. Conditions for triggering external speed control: a. Input PWM frequency 15-30K, 24K is recommended; b. Duty cycle is within (45%, 55%) interval (excluding 45% and 55%), and at least 100ms

continuous input time. After the external speed control is triggered, it is always in the external speed control state, and the internal speed control will be restored unless the power is turned off and restarted; at the same time, the speed control can be performed by adjusting the PWM duty cycle. Due to the individual differences of each product motor, the actual speed may be different when the duty cycle is set to a typical value. To accurately control the motor speed, it is necessary to perform closed-loop control according to the speed information in the received data. **Note:** **When not using external speed control, the PWM pin must be grounded.**

The data communication of LD14 adopts standard universal asynchronous serial port (UART) one-way transmission, and its transmission parameters are shown in the following table:

baud rate	data length	stop bit	parity bit	flow control
115200bit/s	8 Bits	1	none	none

3. DATA PROTOCOL

3.1. Data packet format

The LD14 adopts one-way communication. After stable operation, it starts to send measurement data packets without sending any commands. The measurement packet format is shown in the figure below.

Header	VerLen	Speed		Start angle		Data	End angle		Timestamp		CRC check
54H	1 Byte	LSB	MSB	LSB	MSB	.....	LSB	MSB	LSB	MSB	1 Byte

- **Header:** The length is 1 Byte, and the value is fixed at 0x54, indicating the beginning of the data packet;
- **VerLen:** The length is 1 Byte, the upper three bits indicate the packet type, which is currently fixed at 1, and the lower five bits indicate the number of measurement points in a packet, which is currently fixed at 12, so the byte value is fixed at 0x2C;
- **Speed:** The length is 2 Byte, the unit is degrees per second, indicating the speed of the lidar;
- **Start angle:** The length is 2 Bytes, and the unit is 0.01 degrees, indicating the starting angle of the data packet point;
- **Data:** Indicates measurement data, a measurement data length is 3 bytes, please refer to the next section for detailed analysis;
- **End angle:** The length is 2 Bytes, and the unit is 0.01 degrees, indicating the end angle of the data packet point;
- **Timestamp:** The length is 2 Bytes, the unit is milliseconds, and the maximum is 30000. When it reaches 30000, it will be counted again,

indicating the timestamp value of the data packet;

- **CRC check:** The length is 1 Byte, obtained from the verification of all the previous data except itself. For the CRC verification method, see the following content for details;

The data structure reference is as follows:

```
#define POINT_PER_PACK 12

#define HEADER 0x54

typedef struct __attribute__((packed)) {
    uint16_t distance;
    uint8_t intensity;
} LidarPointStructDef;

typedef struct __attribute__((packed)) {
    uint8_t header;
    uint8_t ver_len;
    uint16_t speed;
    uint16_t start_angle;
    LidarPointStructDef point[POINT_PER_PACK];
    uint16_t end_angle;
    uint16_t timestamp;
    uint8_t crc8;
} LiDARFrameTypeDef;
```

The CRC check calculation method is as follows:

```
static const uint8_t CrcTable[256] = {
    0x00, 0x4d, 0x9a, 0xd7, 0x79, 0x34, 0xe3,
    0xae, 0xf2, 0xbf, 0x68, 0x25, 0x8b, 0xc6, 0x11, 0x5c, 0xa9, 0xe4, 0x33,
    0x7e, 0xd0, 0x9d, 0x4a, 0x07, 0x5b, 0x16, 0xc1, 0x8c, 0x22, 0x6f, 0xb8,
    0xf5, 0x1f, 0x52, 0x85, 0xc8, 0x66, 0x2b, 0xfc, 0xb1, 0xed, 0xa0, 0x77,
```

```

0x3a, 0x94, 0xd9, 0x0e, 0x43, 0xb6, 0xfb, 0x2c, 0x61, 0xcf, 0x82, 0x55,
0x18, 0x44, 0x09, 0xde, 0x93, 0x3d, 0x70, 0xa7, 0xea, 0x3e, 0x73, 0xa4,
0xe9, 0x47, 0x0a, 0xdd, 0x90, 0xcc, 0x81, 0x56, 0x1b, 0xb5, 0xf8, 0x2f,
0x62, 0x97, 0xda, 0x0d, 0x40, 0xee, 0xa3, 0x74, 0x39, 0x65, 0x28, 0xff,
0xb2, 0x1c, 0x51, 0x86, 0xcb, 0x21, 0x6c, 0xbb, 0xf6, 0x58, 0x15, 0xc2,
0x8f, 0xd3, 0x9e, 0x49, 0x04, 0xaa, 0xe7, 0x30, 0x7d, 0x88, 0xc5, 0x12,
0x5f, 0xf1, 0xbc, 0x6b, 0x26, 0x7a, 0x37, 0xe0, 0xad, 0x03, 0x4e, 0x99,
0xd4, 0x7c, 0x31, 0xe6, 0xab, 0x05, 0x48, 0x9f, 0xd2, 0x8e, 0xc3, 0x14,
0x59, 0xf7, 0xba, 0x6d, 0x20, 0xd5, 0x98, 0x4f, 0x02, 0xac, 0xe1, 0x36,
0x7b, 0x27, 0x6a, 0xbd, 0xf0, 0x5e, 0x13, 0xc4, 0x89, 0x63, 0x2e, 0xf9,
0xb4, 0x1a, 0x57, 0x80, 0xcd, 0x91, 0xdc, 0x0b, 0x46, 0xe8, 0xa5, 0x72,
0x3f, 0xca, 0x87, 0x50, 0x1d, 0xb3, 0xfe, 0x29, 0x64, 0x38, 0x75, 0xa2,
0xef, 0x41, 0x0c, 0xdb, 0x96, 0x42, 0x0f, 0xd8, 0x95, 0x3b, 0x76, 0xa1,
0xec, 0xb0, 0xfd, 0x2a, 0x67, 0xc9, 0x84, 0x53, 0x1e, 0xeb, 0xa6, 0x71,
0x3c, 0x92, 0xdf, 0x08, 0x45, 0x19, 0x54, 0x83, 0xce, 0x60, 0x2d, 0xfa,
0xb7, 0x5d, 0x10, 0xc7, 0x8a, 0x24, 0x69, 0xbe, 0xf3, 0xaf, 0xe2, 0x35,
0x78, 0xd6, 0x9b, 0x4c, 0x01, 0xf4, 0xb9, 0x6e, 0x23, 0x8d, 0xc0, 0x17,
0x5a, 0x06, 0x4b, 0x9c, 0xd1, 0x7f, 0x32, 0xe5, 0xa8
};

uint8_t CalCRC8(uint8_t *p, uint8_t len){
    uint8_t crc = 0;
    uint16_t i;
    for (i = 0; i < len; i++){
        crc = CrcTable[(crc ^ *p++) & 0xff];
    }
    return crc;
}

```

3.2. Measurement data analysis

Each measurement data point consists of a 2-byte distance value and a 1-byte confidence value, as shown in the figure below.

Header	VerLen	Speed		Start angle		Data	End angle		Timestamp		CRC check
54H	2CH	LSB	MSB	LSB	MSB	.....	LSB	MSB	LSB	MSB	1Byte



Measuring point 1			Measuring point 2			...	Measuring point n		
distance		intensity	distance		intensity		distance		intensity
LSB	MSB	1 Byte	LSB	MSB	1 Byte	...	LSB	MSB	1 Byte

The unit of distance value is mm. The signal intensity value reflects the light reflection intensity. The higher the intensity, the larger the signal intensity value; the lower the intensity, the smaller the signal intensity value.

The angle value of each point is obtained by linear interpolation of the starting angle and the ending angle. The angle calculation method is as follows:

$$step = (end_angle - start_angle) / (len - 1);$$
$$angle = start_angle + step * i;$$

where *len* is the number of measurement points in a data packet, and the value range of *i* is [0, *len*).

3.3. Example

Suppose we receive a piece of data as shown below.

54 2C 68 08 AB 7E E0 00 E4 DC 00 E2 D9 00 E5 D5 00 E3 D3 00 E4 D0 00 E9 CD
00 E4 CA 00 E2 C7 00 E9 C5 00 E5 C2 00 E5 C0 00 E5 BE 82 3A 1A 50

We analyze it as follows:

Header	VerLen	Speed		Start angle		Data	End angle		Timestamp		CRC check
54H	2CH	68H	08H	ABH	7EH	.....	BEH	82H	3AH	1AH	50H



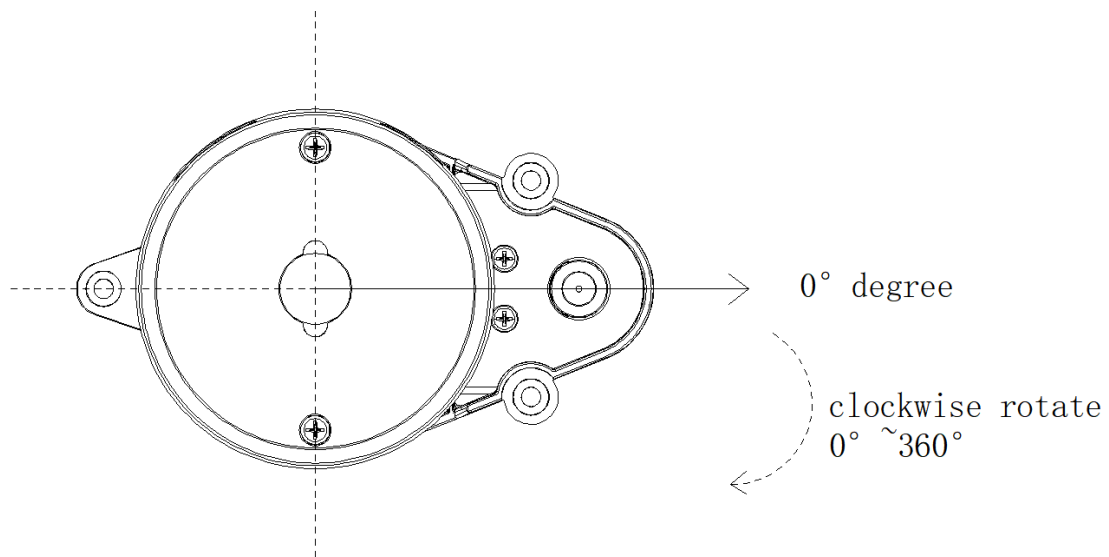
Measuring point 1			Measuring point 2			...	Measuring point 12		
distance		intensity	distance		intensity		distance		intensity
E0H	00H	E4H	DCH	00H	E2H	...	B0H	00H	EAH

Field information	Parsing process
Speed	0868H = 2152 degrees per second;
Start angle	7EABH = 32427, or 324.27 degrees;
End angle	82BEH = 33470, or 334.7 degrees;
Measuring point 1 distance	00E0H = 224mm
Measuring point 1 intensity	E4H = 228
Measuring point 2 distance	00DCH = 200mm
Measuring point 2 intensity	00E2H = 226
...	...
Measuring point 12 distance	00B0H = 176mm
Measuring point 12 intensity	EAH = 234

Due to the principle of triangulation, the above angle values are uncorrected. For details of the revision process, please refer to the Transform() function in the SDK source code transform.cpp.

4. COORDINATE SYSTEM

The LD14 uses a left-handed coordinate system, the rotation center is the coordinate origin, the front of the sensor is defined as the zero-degree direction, and the rotation angle increases clockwise, as shown in the figure below.



5. DEVELOPMENT KIT INSTRUCTIONS

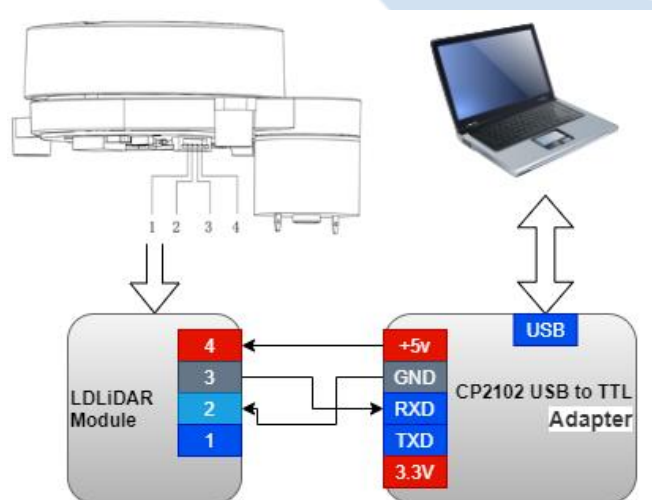
5.1. How to use the assessment tool

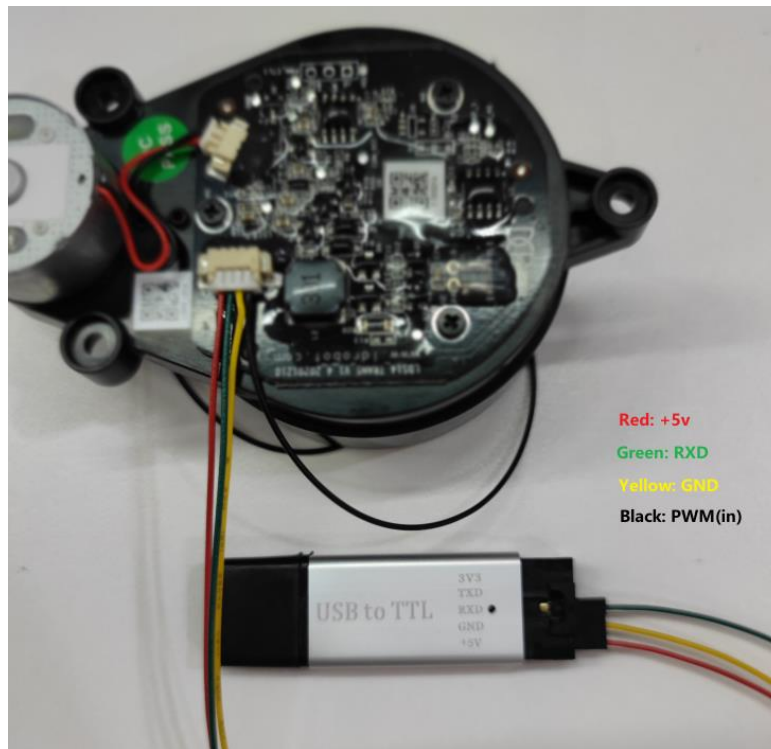
5.1.1. Hardware cable connection and description

- 1) LiDAR, wire, USB adapter board, as shown in the following figure:



- 2) Connection diagram, as shown in the figure below:





5.1.2. Driver installation under Windows

When evaluating the company's products under Windows, it is necessary to install the serial port driver of the USB adapter board. The reason is that the USB adapter board in the development kit provided by the company adopts the CP2102 USB to serial port adapter chip, and its driver can be obtained from Silicon Labs' official website:

<https://www.silabs.com/developers/usb-to-uart-bridge-vcp-drivers>

Or download it from the company's repository:

https://github.com/ldrobotSensorTeam/ld_desktop_tool/releases

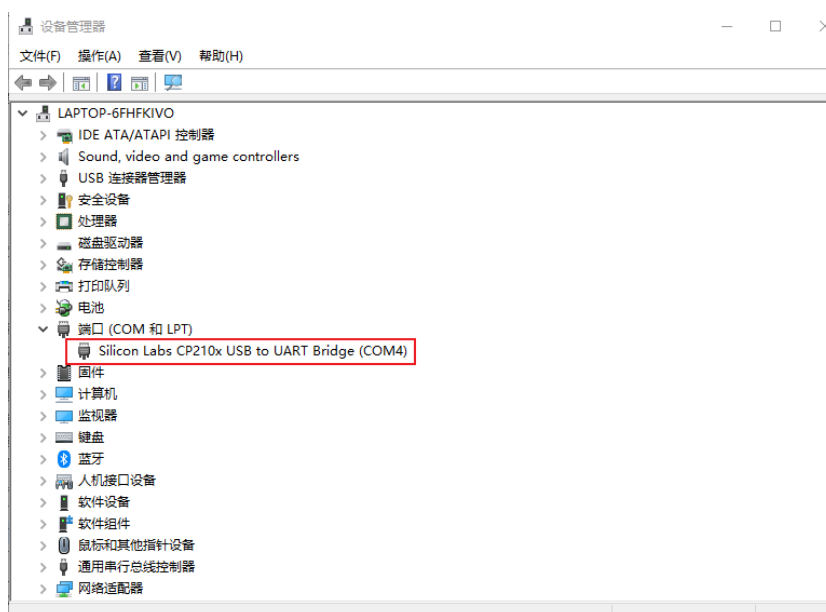
After decompressing the CP210x_Universal_Windows_Driver driver package, execute the exe file in the driver installation package directory, and select X86 (32-bit) or X64 (64-bit) according to the Windows system version.

名称	修改日期	类型	大小
arm	2018/12/8 0:06	文件夹	
arm64	2018/12/8 0:06	文件夹	
x64	2018/12/8 0:06	文件夹	
x86	2018/12/8 0:06	文件夹	
CP210x_Universal_Windows_Driver_ReleaseNotes...	2018/12/7 23:53	TXT 文件	20 KB
CP210xVCPInstaller_x64.exe	2018/5/8 6:05	应用程序	1,026 KB
CP210xVCPInstaller_x86.exe	2018/5/8 6:05	应用程序	903 KB
dpinst.xml	2018/5/8 5:46	XML 文件	12 KB
silabser.cat	2018/12/4 2:17	安全目录	13 KB
silabser.inf	2018/12/4 2:17	安装信息	10 KB
SLAB_License_Agreement_VCP_Windows.txt	2016/4/27 22:26	TXT 文件	9 KB

Double-click the exe file and follow the prompts to install it.

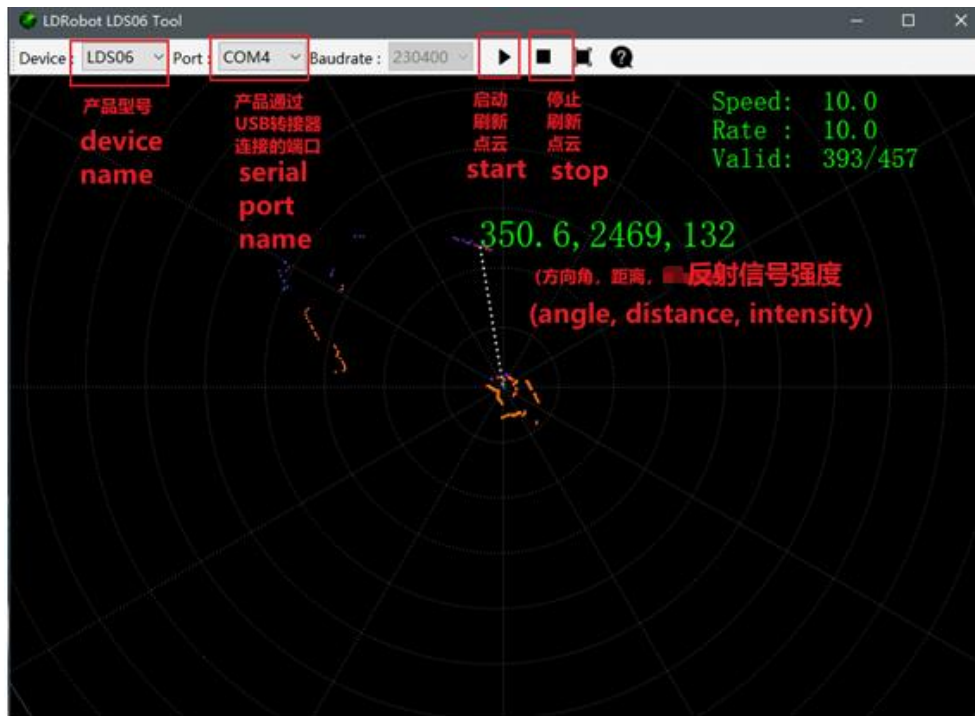


After the installation is complete, connect the USB adapter board in the development kit to the computer, right-click [My Computer], select [Properties], and in the opened [System] interface, select [Device Manager] in the left menu to enter. Go to the device manager, expand [Ports], you can see the serial port number corresponding to the recognized CP2102 USB adapter, that is, the driver is installed successfully, and the figure below is COM4.



5.1.3. Using Id_desktop software under Windows

The company provides the point cloud visualization software Id_desktop for real-time scanning of this product, and developers can use this software to visually observe the scanning renderings of this product. Before using this software, it is necessary to distinguish that the driver of the USB adapter board of this product has been installed successfully, and the product is interconnected with the USB port of the Windows system PC, then double-click the Id_desktop.exe file, and select the corresponding product model and port number, click the Start point cloud refresh button, as shown in the following figure.



In the above figure, 'Speed' represents the lidar scanning frequency, unit: Hz; 'Rate' represents the lidar data packet resolution rate; 'Valid' represents the valid point for the lidar to measure a circle.

The ld_desktop software binary package can be downloaded from the company's repository:

https://github.com/ldrobotSensorTeam/ld_desktop_tool/releases

5.2. Product 3D model file

The company provides developers with 3D model files in stp format of this product, which can be downloaded by visiting the company's open source repository:

https://github.com/ldrobotSensorTeam/Product_3D_model/releases

5.3. Operation based on ROS under Linux

5.3.1. ROS environment introduction and installation

ROS (Robot Operating System) is an open source meta-operating system for robots and middleware built on Linux. It provides the services expected of an operating system, including hardware abstraction, low-level device control, implementation of commonly used functions, message passing between processes, and package management. It also provides the tools and library functions needed to obtain, compile, write, and run code across computers. For the installation steps of each version of ROS, please refer to the official ROS website:

<http://wiki.ros.org/ROS/Installation>

The ROS function package of this product supports the following versions and environments:

- ROS Kinetic(Ubuntu16.04);
- ROS Melodic(Ubuntu18.04);
- ROS Noetic(Ubuntu20.04).

5.3.2. Get the source code of the ROS Package

The source code of the ROS function package of this product is hosted on the repository of Github and Gitee. You can download the source code of the master or main branch by accessing the repository network link, or download it through the git tool.

1) Repository website address

- https://gitee.com/ldrobotSensorTeam/ldlidar_sl_ros
- https://github.com/ldrobotSensorTeam/ldlidar_sl_ros

2) git tool download operation

```
# First open the terminal interface, you can use the shortcut key of ctrl+alt+t

# If the Ubuntu system you are using does not have the git tool installed, you can install it as follows:

$ sudo apt-get install git

# Download the source code of the product ROS function package:

$ cd ~

$ mkdir -p ldlidar_ros_ws/src

$ cd ~/ldlidar_ros_ws/src

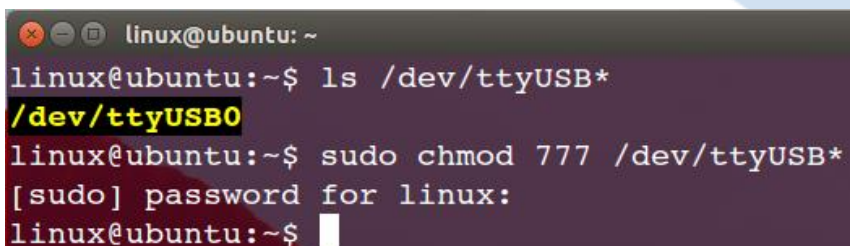
$ git clone https://gitee.com/ldrobotSensorTeam/ldlidar_sl_ros.git

# or

$ git clone https://github.com/ldrobotSensorTeam/ldlidar_sl_ros.git
```

5.3.3. Set device permissions

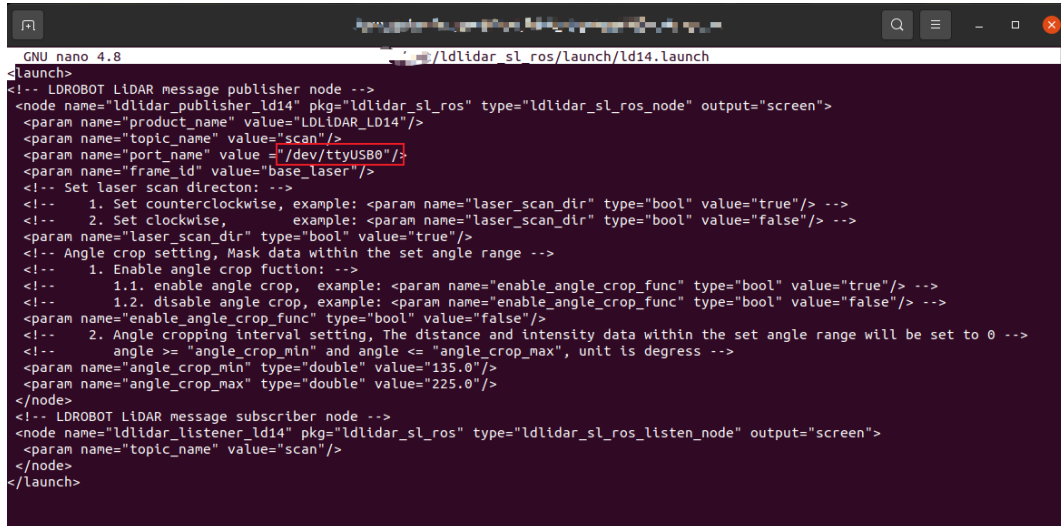
First, connect the lidar to our adapter module (CP2102 adapter), and connect the module to the computer. Then, open a terminal under the ubuntu system and enter `ls /dev/ttyUSB*` to check whether the serial device is connected. If a serial port device is detected, use the `sudo chmod 777 /dev/ttyUSB*` command to give it the highest authority, that is, give the file owner, group, and other users read, write and execute permissions, as shown in the following figure.



```
linux@ubuntu: ~
linux@ubuntu:~$ ls /dev/ttyUSB*
/dev/ttyUSB0
linux@ubuntu:~$ sudo chmod 777 /dev/ttyUSB*
[sudo] password for linux:
linux@ubuntu:~$
```

Finally, modify the `port_name` value in the `ld14.launch` file in the `~/ldlidar_ros_ws/src/ldlidar_sl_ros/launch/` directory. Take the lidar mounted in the system as `/dev/ttyUSB0` as an example, as shown below.

```
$ nano ~/ldlidar_ros_ws/src/ldlidar_sl_ros/launch/ld14.launch
```



```
GNU nano 4.8 ~/ldlidar_sl_ros/launch/ld14.launch
<launch>
<!-- LIDAR message publisher node -->
<node name="ldlidar_publisher_ld14" pkg="ldlidar_sl_ros" type="ldlidar_sl_ros_node" output="screen">
  <param name="product_name" value="LDLIDAR_LD14"/>
  <param name="topic_name" value="scan"/>
  <param name="port_name" value="/dev/ttyUSB0"/>
  <param name="frame_id" value="base_laser"/>
  <!-- Set laser scan direction: -->
  <!-- 1. Set counterclockwise, example: <param name="laser_scan_dir" type="bool" value="true"/> -->
  <!-- 2. Set clockwise, example: <param name="laser_scan_dir" type="bool" value="false"/> -->
  <param name="laser_scan_dir" type="bool" value="true"/>
  <!-- Angle crop setting, Mask data within the set angle range -->
  <!-- 1. Enable angle crop function: -->
  <!-- 1.1. enable angle crop, example: <param name="enable_angle_crop_func" type="bool" value="true"/> -->
  <!-- 1.2. disable angle crop, example: <param name="enable_angle_crop_func" type="bool" value="false"/> -->
  <param name="enable_angle_crop_func" type="bool" value="false"/>
  <!-- 2. Angle cropping interval setting, The distance and intensity data within the set angle range will be set to 0 -->
  <!-- angle >= "angle_crop_min" and angle <= "angle_crop_max", unit is degree -->
  <param name="angle_crop_min" type="double" value="135.0"/>
  <param name="angle_crop_max" type="double" value="225.0"/>
</node>
<!-- LIDAR message subscriber node -->
<node name="ldlidar_listener_ld14" pkg="ldlidar_sl_ros" type="ldlidar_sl_ros_listen_node" output="screen">
  <param name="topic_name" value="scan"/>
</node>
</launch>
```

Linux nano editor: Ctrl + O saves the edited file; Ctrl + X exits the editing interface.

5.3.4. Build and environment settings

- 1) Use the catkin compilation system to compile and build the product function package:

```
$ cd ~/ldlidar_ros_ws
$ catkin_make
```

- 2) Function package environment variable settings:

After the compilation is completed, you need to add the relevant files generated by the compilation to the environment variables, so that the ROS environment can recognize them. The execution command is as follows. This command is to temporarily add environment variables to the terminal, which means that if you reopen a new terminal, you also need to re-execute it. The following command.

```
$ cd ~/ldlidar_ros_ws
$ source devel/setup.bash
```

In order to never need to execute the above command to add environment variables after reopening the terminal, you can do the following.

```
$ echo "source ~/ldlidar_ros_ws/devel/setup.bash" >> ~/.bashrc  
$ source ~/.bashrc
```

5.3.5. Run node

Use the roslaunch tool to start the lidar node and execute the following command.

```
$ roslaunch ldlidar_sl_ros ld14.launch
```

5.3.6. Rviz display LiDAR point cloud

Rviz is a 3D visualization tool in the ROS framework, where lidar data can be displayed. After roslaunch successfully runs the lidar node, open a new terminal (Ctrl+Alt+T) and enter the following command:

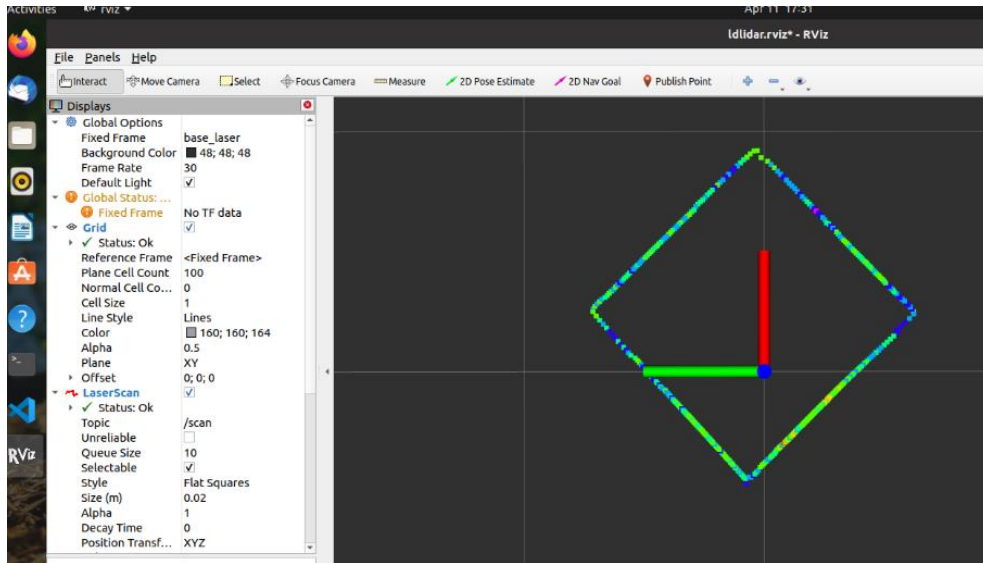
```
$ rosrun rviz rviz
```

After the interface starts, click **file->open->Config** in the menu bar of the interface, then select: **ldlidar.rviz** file in the **~/ldlidar_ros_ws/src/ldlidar_sl_ros/rviz/** directory, open the configuration file **ldlidar.rviz**, and click **LaserScan Select /scan** in the Topic.

Since the point cloud data of our lidar product follows the left-handed coordinate system (clockwise), and Rviz shows that the radar point cloud data follows the right-handed coordinate system (counterclockwise), we performed the product point cloud data in the function package source code **toLaserScan** function. The coordinate system is transformed so that it can display the point cloud normally in Rviz.

In addition, there are certain compatibility problems in the Rviz configuration

file between different ROS versions. If you still cannot view the lidar point cloud or cause the Rviz tool to crash after opening the `ldlidar.rviz` file and setting relevant parameters, you can take another new one. The Rviz configuration file mimics the settings of `ldlidar.rviz` to solve such problems.



5.4. Operation based on ROS2 under Linux

5.4.1. ROS2 environment introduction and installation

ROS (Robot Operating System) is an open source meta-operating system for robots and middleware built on Linux. It provides the services expected of an operating system, including hardware abstraction, low-level device control, implementation of commonly used functions, message passing between processes, and package management. It also provides the tools and library functions needed to obtain, compile, write, and run code across computers. The robotics and ROS community has changed a lot since ROS was launched in 2007. The goal of the ROS2 project is to adapt to these changes, leveraging the strengths of ROS1 and improving on the weaknesses. For the installation steps of ROS2, please refer to the official website of ROS2: <https://docs.ros.org/en/foxy/Installation.html>

The ROS2 function package of this product supports the use of the ROS2 Foxy (Ubuntu20.04) version environment.

5.4.2. Get the source code of ROS2 Package

The source code of the ROS2 function package of this product is hosted on the repositories of Github and Gitee. You can download the source code of the master or main branch by accessing the network link of the repository, or download it through the git tool.

- 1) Repository website address
 - https://gitee.com/ldrobotSensorTeam/ldlidar_sl_ros2
 - https://github.com/ldrobotSensorTeam/ldlidar_sl_ros2
- 2) git tool download operation

```
# First open the terminal interface, you can use the shortcut key of ctrl+alt+t

# If the Ubuntu system you are using does not have the git tool installed, you can install it as follows:

$ sudo apt-get install git

# Download the source code of the product ROS2 function package:

$ cd ~

$ mkdir -p ldlidar_ros2_ws/src

$ cd ~/ldlidar_ros2_ws/src

$ git clone https://gitee.com/ldrobotSensorTeam/ldlidar_sl_ros2.git

# or

$ git clone https://github.com/ldrobotSensorTeam/ldlidar_sl_ros2.git
```

5.4.3. Set device permissions

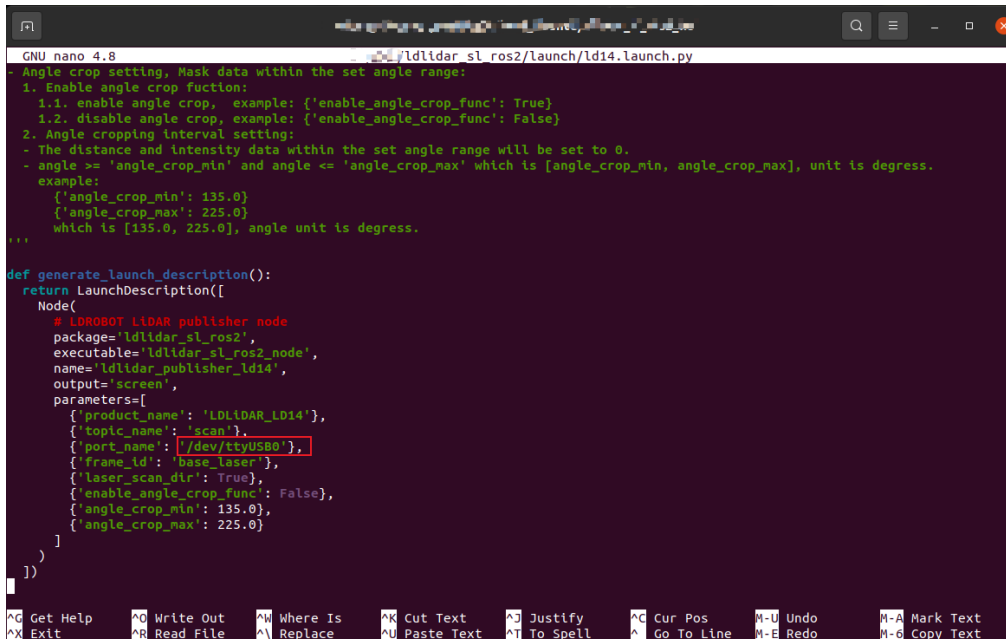
First, connect the lidar to our adapter module (CP2102 adapter), and connect the module to the computer. Then, open a terminal under the ubuntu system and enter `ls /dev/ttyUSB*` to check whether the serial device is connected. If a serial port device is detected, use the `sudo chmod 777 /dev/ttyUSB*` command to give it the highest authority, that is, give the file owner, group, and other users read, write and execute permissions, as shown in the following figure.



```
linux@ubuntu: ~
linux@ubuntu:~$ ls /dev/ttyUSB*
/dev/ttyUSB0
linux@ubuntu:~$ sudo chmod 777 /dev/ttyUSB*
[sudo] password for linux:
linux@ubuntu:~$
```

Finally, modify the `port_name` value in the `ld14.launch.py` file in the `~/ldlidar_ros2_ws/src/ldlidar_sl_ros2/launch/` directory. Take the lidar mounted in the system as `/dev/ttyUSB0` as an example, as shown below.

```
$ nano ~/ldlidar_ros2_ws/src/ldlidar_sl_ros2/launch/ld14.launch.py
```



```
GNU nano 4.8 /ldlidar_sl_ros2/launch/ld14.launch.py
- Angle crop setting, Mask data within the set angle range:
1. Enable angle crop function:
  1.1. enable angle crop, example: {'enable_angle_crop_func': True}
  1.2. disable angle crop, example: {'enable_angle_crop_func': False}
2. Angle cropping interval setting:
  - The distance and intensity data within the set angle range will be set to 0.
  - angle >= 'angle_crop_min' and angle <= 'angle_crop_max' which is [angle_crop_min, angle_crop_max], unit is degree.
  example:
  {'angle_crop_min': 135.0}
  {'angle_crop_max': 225.0}
  which is [135.0, 225.0], angle unit is degree.
...

def generate_launch_description():
    return LaunchDescription([
        Node(
            # LDROBOT LIDAR publisher node
            package='ldlidar_sl_ros2',
            executable='ldlidar_sl_ros2_node',
            name='ldlidar_publisher_ld14',
            outputs='screen',
            parameters=[
                {'product_name': 'LDLIDAR_LD14'},
                {'topic_name': 'scan'},
                {'port_name': '/dev/ttyUSB0'},
                {'frame_id': 'base_laser'},
                {'laser_scan_dir': True},
                {'enable_angle_crop_func': False},
                {'angle_crop_min': 135.0},
                {'angle_crop_max': 225.0}
            ]
        )
    ])

```

Linux nano editor: Ctrl + O saves the edited file; Ctrl + X exits the editing interface.

5.4.4. Build and environment settings

- 1) Use the colcon compilation system to compile and build the product function package:

```
$ cd ~/ldlidar_ros2_ws
$ colcon build
```

- 2) Function package environment variable settings:

After the compilation is completed, you need to add the relevant files generated by the compilation to the environment variables, so that the ROS2 environment can be recognized. The execution command is as follows. This command is to temporarily add environment variables to the terminal, which means that if you reopen a new terminal, you also need to re-execute it. The following command.

```
$ cd ~/ldlidar_ros2_ws
$ source install/setup.bash
```

In order to never need to execute the above command to add environment variables after reopening the terminal, you can do the following.

```
$ echo "source ~/ldlidar_ros2_ws/install/setup.bash" >> ~/.bashrc  
$ source ~/.bashrc
```

5.4.5. Run node

Use the ros2 launch tool to start the lidar node and execute the following command.

```
$ ros2 launch ldlidar_sl_ros2 ld14.launch.py
```

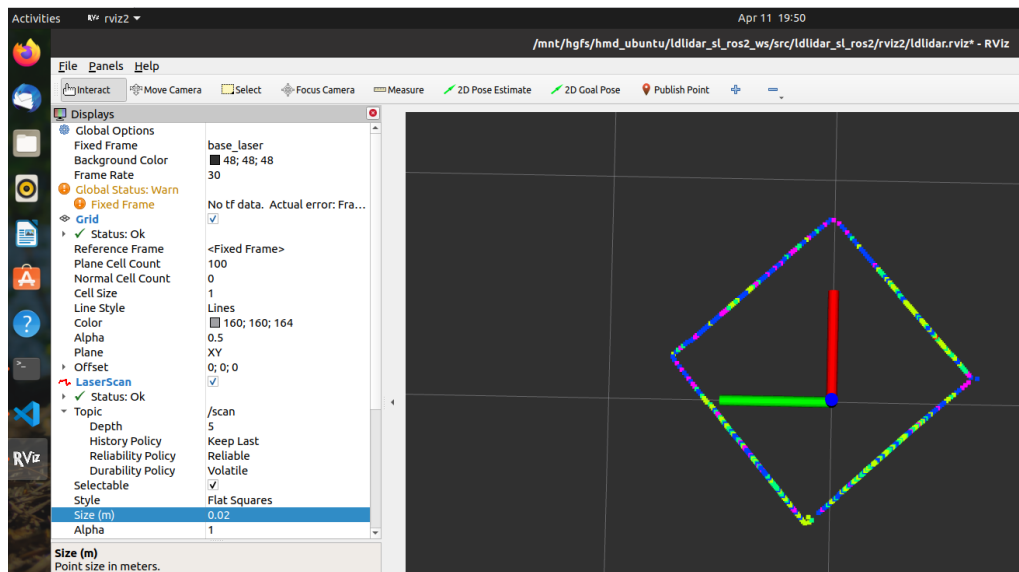
5.4.6. Rviz2 display LiDAR point cloud

Rviz2 is a 3D visualization tool in the ROS2 framework, where lidar data can be displayed. After ros2 launch successfully runs the lidar node, open a new terminal (Ctrl+Alt+T) and enter the following command:

```
$ rviz2
```

After the interface is started, click **file->open->Config** in the menu bar of the interface, and then select: **ldlidar.rviz** file in the **~/ldlidar_ros2_ws/src/ldlidar_sl_ros2/rviz2/** directory, open the configuration file **ldlidar.rviz**, and click **LaserScan Select /scan** in the Topic.

Since the point cloud data of our radar product follows the left-handed coordinate system (clockwise), and Rviz2 shows that the lidar point cloud data follows the right-handed coordinate system (counterclockwise), we performed the product point cloud data in the function package source code to **toLaserScan** function. The coordinate system is transformed so that it can display the point cloud normally in Rviz2.



5.5. Instructions for using SDK under Linux

5.5.1. Get the source code of SDK

The source code of the Linux SDK of this product is hosted on the repositories of Github and Gitee. You can download the source code of the master or main branch by accessing the network link of the repository, or download it through the git tool.

1) Repository website address

- https://gitee.com/ldrobotSensorTeam/ldlidar_sl_sdk
- https://github.com/ldrobotSensorTeam/ldlidar_sl_sdk

2) git tool download operation

First open the terminal interface, you can use the shortcut key of `ctrl+alt+t`

If the Ubuntu system you are using does not have the git tool installed, you can install it as follows:

```
$ sudo apt-get install git
```

```
# Download the source code:

$ cd ~

$ mkdir ldliar_ws

$ cd ~/ldliar_ws

$ git clone https://gitee.com/ldrobotSensorTeam/ldliar_sl_sdk.git

# or

$ git clone https://github.com/ldrobotSensorTeam/ldliar_sl_sdk.git
```

5.5.2. Set device permissions

First, connect the lidar to our adapter module (CP2102 adapter), and connect the module to the computer. Then, open a terminal under the ubuntu system and enter `ls /dev/ttyUSB*` to check whether the serial device is connected. If a serial port device is detected, use the `sudo chmod 777 /dev/ttyUSB*` command to give it the highest authority, that is, give the file owner, group, and other users read, write and execute permissions, as shown in the following figure.



```
linux@ubuntu: ~
linux@ubuntu:~$ ls /dev/ttyUSB*
/dev/ttyUSB0
linux@ubuntu:~$ sudo chmod 777 /dev/ttyUSB*
[sudo] password for linux:
linux@ubuntu:~$
```

5.5.3. Build

The source code is coded in C++11 standard C++ language and C99 standard C language. Use CMake, GNU-make, GCC and other tools to compile and build the source code. If you use Ubuntu system without the above tools installed, you can execute the following command to complete the installation.

```
$ sudo apt-get install build-essential cmake
```

If the tools indicated above already exist in the system, do the following.

```
$ cd ~/ldlidar_ws/ldlidar_sl_sdk  
  
# If the build folder does not exist in the ldlidar_sl_sdk directory, it needs to be created  
  
$ mkdir build  
  
$ cd build  
  
$ cmake ../  
  
$ make
```

5.5.4. Run binary program

```
$ cd ~/ldlidar_ws/ldlidar_sl_sdk/build  
  
$ ./ldlidar_sl LD14 <serial_number>  
  
# eg: ./ldlidar_sl LD14 /dev/ttyUSB0
```

6. REVISION HISTORY

version	revision date	modify the content
0.1	2021-03-15	Initial creation
1.0	2022-03-15	Added the content of the development kit instructions
1.1	2022-04-02	Modify the LOGO and text
1.2	2022-04-11	(1) Modify the Rviz and other icons of ROS and ROS2; (2) Modify the hardware wire diagram;