M10 Plus

User Manual

V3.0.1   2023.02

Safety Instruction

Before using the product, please read and follow the instructions of this manual carefully, and refer to relevant national and international safety regulations.

ΔAttention

Please do not disassemble or modify the lidar privately. If you need special instructions, please consult our technical support staff.

ΔLaser Safety Level

The laser safety of this product meets the following standards:
- IEC 60825-1:2014
- 21 CFR 1040.10 and 1040.11 standards, except for the deviations (IEC 60825-1, third edition) stated in the Laser Notice No. 56 issued on May 8, 2019. Please do not look directly at the transmitting laser through magnifying devices (such as microscope, head-mounted magnifying glass, or other forms of magnifying glasses).

Eye Safety

The product design complies with Class 1 human eye safety standards. However, to maximize self-protection, please avoid looking directly at running products.

ΔSafety Warning

In any case, if the product is suspected to have malfunctioned or been damaged, please stop using it immediately to avoid injury or further product damage.

Housing

The product contains high-speed rotating parts, please do not operate unless the housing is fastened. Do not use a product with damaged housing in case of irreparable losses. To avoid product performance degradation, please do not touch the photomask with your hands.

Operation

This product is composed of metal and plastic, which contains precise circuit electronic components and optical devices. Improper operations such as high temperature, drop, puncture or squeeze may cause irreversible damage to the product.

Power Supply

Please use the connecting cable and matching connectors provided with the lidar to supply power. Using cables or adapters that are damaged or do not meet

the power supply requirements, or supply power in a humid environment may cause abnormal operation, fire, personal injury, product damage, or other property loss.

Light Interference

Some precise optical equipment may be interfered with by the laser emitted by this product, please pay attention when using it.

Vibration

Please avoid product damage caused by strong vibration. If the product's mechanical shock and vibration performance parameters are needed, please contact us for technical support.

Radio Frequency Interference

The design, manufacture and test of this product comply with relevant regulations on radiofrequency energy radiation, but the radiation from this product may still cause other electronic equipment to malfunction.

Deflagration and Other Air Conditions

Do not use the product in any area with potentially explosive air, such as areas where the air contains high concentrations of flammable chemicals, vapours or particles (like fine grains, dust or metal powder). Do not expose the product to the environment of high-concentration industrial chemicals, including near evaporating liquefied gas (like helium), so as not to impair or damage the product function.

Maintenance

Please do not disassemble the lidar without permission. Disassembly of the product may cause its waterproof performance to fail or personal injury.

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1 Product Profile

1.1 Overview

Based on TOF (time of flight), the M10 Plus lidar can two-dimensionally scan and detect the environment across 360°. The lidar uses wireless power supply and wireless communication internally, and the pulse repetition frequency (PRF) is 20KHz. The lidar reaches a measurement accuracy of ±3 cm with a maximum range of 25 m. With such high performance, the lidar mainly applies to scenarios that require precise location and obstacle avoidance, including indoor service robots, AGV, cleaning and sterilization robots, drones, and so on.

1.2 Mechanism

1.2.1 Time of Flight

Based on the ToF (time of flight) methodology, the M10 Plus lidar measures the distance between a target object and the sensor, by calculating the difference between the emission and return times of modulated laser. The laser emitter sends out the modulated pulse laser, and an internal timer starts timing(t1). The laser encounters the target object, part of the energy returns. When the lidar receives the return laser signal, the timer will stop timing(t2). The formula for distance between the lidar and the target object:

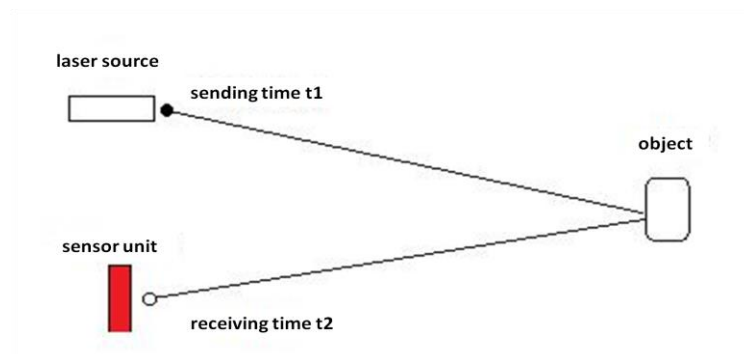Distance = Speed of Light*(t2 – t1)/2

Figure 1.1 Mechanism of M10 Plus

1.2.2 Grid Map Presentation

You can get the 2D grid map information of the surrounds across 360° within

the detecting distance, based on the combination of the distance value calculated in real-time by the signal processing unit embedded in the M10 Plus and the angle information output by the highly accurate self-adjusted angle measuring module.
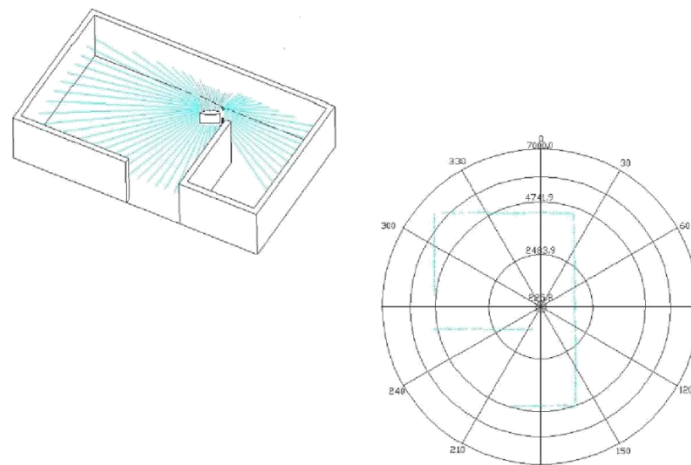

Figure 1.2 Demonstration of Ranging Function

***Note:** The figures only demonstrate the function of the distance measuring system. They are not proportional.

1.3 Specifications

Table 1.1 Specifications of M10 Plus

Model	M10 Plus
scanning angle	360°
PRF	20 KHz
Data Generating Rate	20,000 pts/sec
Angular Resolution	0.09°~0.36°;
Scanning Rate	5~20 Hz (5/6/8/10/12/15/20 Hz can be chosen)
Measurement Accuracy	±3 cm
Output Data Resolution	1 mm
Wavelength	905 nm
Laser Safety Level	CLASS I
Detection Range	25 m @70%
Data Content	Azimuth, Distance
Network Power Supply	5 V ~ 15 VDC
Operating Temperature	-10℃ ~ 50℃
Noise	Starting-up: <60 dB, Operating:<50 dB
Motor	Built-in Brushless Motor
Communication Interface	Standard Serial Port (Baud Rate: 921600 bps)
Shock Test	500 m/sec², lasting for 11 ms

Vibration Test	5 Hz～2000 Hz, 3G rms
Dimensions	Φ79.3*39 mm
Weight	About 200 g

1.4 Dimensions

A set of laser transmitting and receiving devices is fixed to the rotor of the lidar, which is rotated by an internal motor to achieve a 360° scan in the horizontal direction.
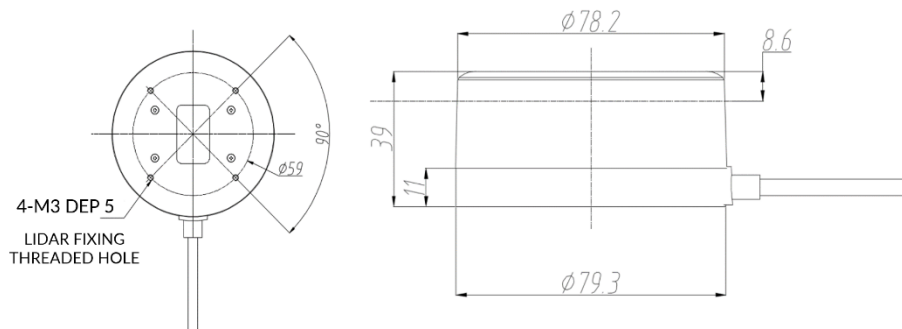

Figure 1.3 Lidar Mounting and Mechanical Dimensions (unit: mm)

1.5 Interface Definition

The specification of M10 Plus's base connector is HY2.0-6P. The M10 Plus lidar gets data transmission, system power and data communication via a network interface box.
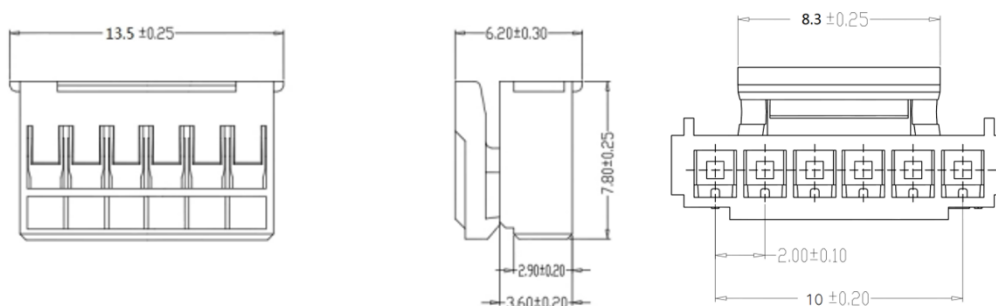
1.5.1 LiDAR Base Connector

Figure 1.4 Dimensions of Lidar Base Connector (unit: mm)

The M10 Plus lidar supports GPS function. See the GPS port definition below:
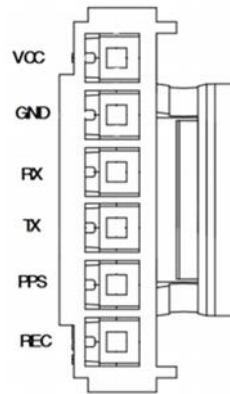
Figure 1.5 Lidar GPS Port

Table 1.2 GPS Port Definition

Pin	Description	Typical Value	Range	Remark
VCC	Power+	5 V	4.75~5.25 V	Ripple within 80 mV
GND	Power-	0 V	0 V	-
RX	System serial input	-	TTL	Data Stream: External Device → LiDAR
TX	System serial output	-	TTL	Data Stream: LiDAR → External Device
PPS	GPS second signal	-	-	-
REC	GPS latitude, longitude, hour, minute and second	-	-	-

1.5.2 Interface Box

A TTL to Ethernet adapter module is available for the M10 Plus lidar to enable the conversion of TTL to network data. This Interface box is not a necessary accessory for lidar operation. The function of each port of the box is described as follows:

● Power port: system power supply.

● Standard Ethernet port: connection of the lidar to the host computer network port via a network cable.

● Lidar port: connection to the lidar.

● GPS port: connection to the GPS module.

The GPS port specification of the interface box is JST company's SM06B-SRSS-TB. It is recommended to use JST's SHR-06V-S-B as the external GPS module.
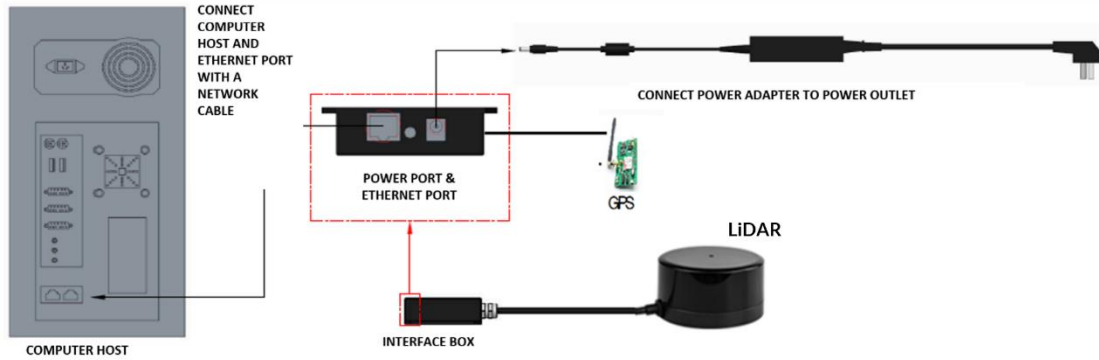
Figure 1.6 Connect All Modules Through Interface Box

Table 1.3 GPS Port Definition

Pin	Definition	I/O	Description
1	PPS Sync Signal	I	TTL level range from 3.3 V to 12 V; its cycle is 1 second, and the recommended pulse width is more than 5 ms
2	GPS Power Supply 5 V	O	No hot plug or unplug
3	GPS_GND	O	Good contact
4	GPS (latitude/longitude, hour/minute/second)	I	RS232 level, baud rate 9600 bps
5	GPS_GND	O	Good contact
6	NC	-	-

2 Electrical Parameters

The M10 Plus lidar is composed of a high frequency ranging core, a wireless transmission system, and a rotating subsystem. The rotating subsystem is driven by a brushless DC motor spinning inside the system. The signal cable of M10 Plus can be interfaced with the UART port of the FPGA/DSP/ARM/SCM without the need for the conversion of RS232, 422 chips. You connect an external system and the lidar and follow the communication protocol of the lidar system to obtain the scanned point cloud data, device information and status, and set the working mode in real-time.

Table 2.1 Electrical Parameters

Item	Minimum	Recommended	Maximum	Note
Power Supply Voltage	4.75 V	5 V	5.25 V	The power supply not in the range may lead to inaccurate ranging or irreversible damage. The output of external power supply should be at least 5 W.
Voltage Ripple	-	-	80 mV	Too much ripple can cause irreversible damage to the hardware.

Operating Current	-	450 mA	-	Lidar's power consumption (the typical operating current of lidar plus the network interface box is 850 mA)
High Signal Level	2.0 V	-	3.3 V	Threshold value: 2 V
Low Signal Level	0 V	-	0.8 V	Threshold value: 0.8 V
Baud Rate		921600 bps		Note the stability of data communication
GPS PPS	3 V		12 V	Cycle time 1 second, recommended pulse width over 5 ms
GPS REC	3 V		12 V	RS232 level, baud rate: 9600 bps

3 Communication Protocol

When the M10 Plus is working, each set of data is output through the communication interface. The output data has uniform message formats. If you need the detailed communication protocol, please contact LSLiDAR support.

4 Optical Features

4.1 Laser Feature

Dependent on a 905 nm laser, M10 Plus emits high-frequency pulsed lasers through the optical assembly, receives the laser signal through the optical assembly, and completes the photoelectric conversion by the receiver board. The distance value calculation is completed by the master control chip and the laser optical parameters are as follows:

Table 4.1 Laser Optical Parameters

Item	Minimum	Recommended	Maximum	Note
Wavelength	895 nm	905 nm	915 nm	-
Peak Power	-	25 W	-	-
Average Power	-	0.8 mW	-	-
FDA		Class I		IEC 60825-1:2014

4.2 Light Spot

The light spot of the M10 Plus lidar is a vertical oval. Its vertical divergence angle is 6.8 mrad, and the horizontal divergence angle is 2.5 mrad. The spot size at any

distance can be calculated by multiplying the divergence angle by the distance.

For example, the calculation of a spot at 10 m is as follows:

Vertical direction at 10 m: $10*6.8*10^{-3}=68$ mm

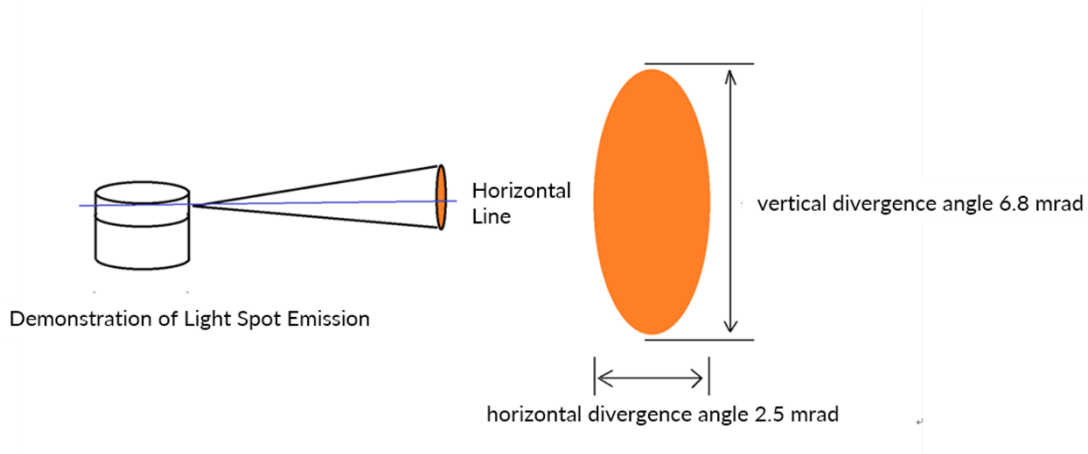Horizontal direction at 10 m: $10*2.5*10^{-3}=25$ mm

Figure 4.1 Light Spot Demonstration

4.3 Optical Structure

The M10 Plus lidar uses a telescopic optical structure with the receiver and transmitter placed horizontally side by side. When designing the lidar installation and robot system integration, it is necessary to focus on the internal optical structure of the lidar so that the effective detection angle of the lidar can be designed accurately. To facilitate your use, especially in terms of the calculation of geometric relationships, we defined a polar coordinate system with the center point of the lidar as the pole, clockwise as positive, and the opposite direction to the lidar base connector as the zero-degree angle.

The internal optical structure (unit: mm) and the polar coordinates of M10 Plus as shown in the figure below (top view):
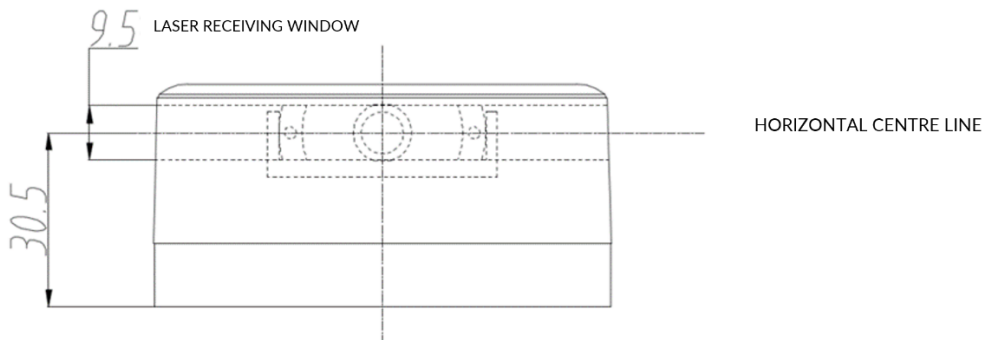

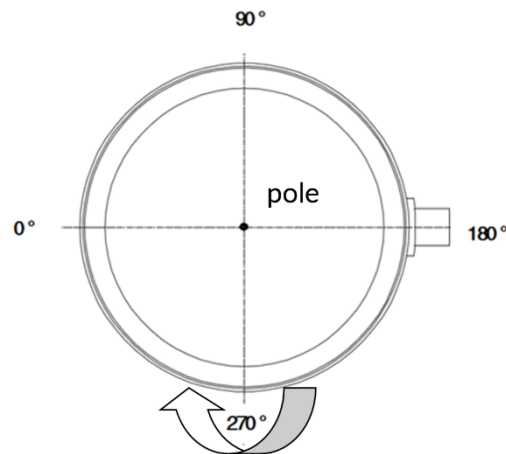Figure 4.2 Internal Optical Structure (unit: mm)

Figure 4.3 Lidar's Polar Coordinate

5   Development tools and supports

Made for the M10 Plus lidar, LSLiDAR provides you with the SDK capable of processing scan data in real-time and displaying it as an image. This SDK facilitates you to get familiar with the lidar and helps to shorten the project development cycle. At present, LSLiDAR only provides SDK for Linux, ROS, and Windows X86. We will release versions for Android, Mac OS, and other platforms later. Please follow the official website of LSLiDAR for the latest information.

5.1 Point Cloud Display Software on Windows

This section introduces the point cloud display and software usage of M10 Plus lidar on Windows OS. This point cloud display software can be used for parameter configuration, simple lidar testing, etc.

5.1.1 Software Interface Introduction

The software interface contains a menu area, a toolbar area, a 3D view area, a data table area, a company website link, etc.
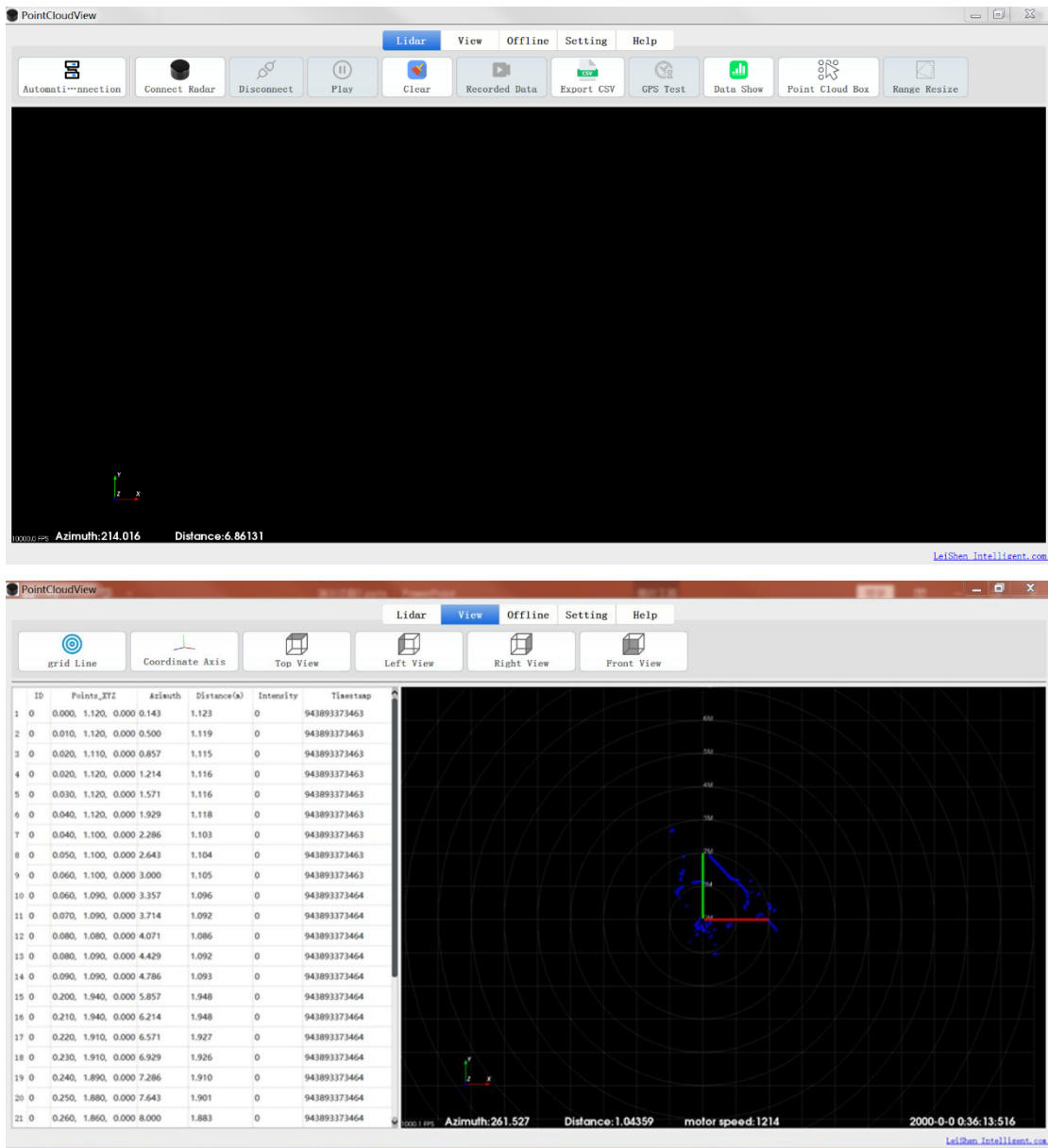
Figure 5.1 Software Interface

5.1.2 Software Operation

After connecting the lidar to the power and network cables, click automatic connection button for real-time lidar data reception.

The data table contains PointID, Points_m_XYZ, Azimuth, Distance, Intensity, Laser_id, and timestamp. PointID is the point number and Points_m_XYZ is the spatial x, y, and z coordinates. Azimuth indicates the azimuth angle, Distance indicates the distance between the lidar and the measured target, Intensity indicates the reflection intensity of the measured target, Laser_id indicates which laser channel, and timestamp indicates the time.

5.1.3 Software Function Introduction

The point cloud display software has five function modules: "lidar", "view", "offline", "setting" and "help".

The point cloud display interface supports the following actions:

1) Scroll the mouse wheel to zoom in/out the display image; you can also hold the right mouse button and drag the image up/down to zoom in/out the display image.

2) Hold the left mouse button and drag the display image to adjust the viewing angle.

3) Hold the mouse wheel and drag the image to move the display image; you can also hold both the shift key on the keyboard and the left mouse button to move the display image.

4) Right-click the mouse to initialize the point cloud select function, and click again to exit.

5) After a successful connection, click "record data" to record data packets.

6) After a successful connection, click "export CVS" to export the coordinate, azimuth and intensity of the current point cloud. If part of the point cloud is selected, only the information of the selected point cloud will be exported.

7) For the lidar supporting GPS, this software provides a GPS test function. You can click "GPS Test" to test whether the time interval between the current point cloud frame is correct.

8) Click "Point Cloud Box" or right-click the mouse to initialize the point cloud select function, the selected point cloud will be displayed in white and the exact information of the selected point cloud will be displayed on the right side.

9) When the point cloud is selected, you can click "Range Resize" to reset the current selection range.

■ "Lidar" Menu Buttons

Table 5.1 "Lidar" Menu Button Description

Button	Description
	Automatically connect the lidar
	Manually choose the lidar model and connection method to connect the lidar
	Disconnect the lidar
	Control the point cloud display

	Clear point cloud interface
	Record lidar's offline data packets
CSV	Save the data in .csv format
	Select point cloud
	Reset the range of point cloud selected

■ **"View" Menu Buttons**

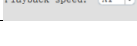The angle of the lidar point cloud display interface and the display of gridlines and axes can be set.

Table 5.2 "View" Menu Button Description

Button	Description
◎	Set the gridlines of the point cloud interface
	Show the axes on the point cloud interface
Top View Left View Right View Front View	Adjust the display view of the current point cloud interface

■ **"Offline" Menu Buttons**

The offline module can be used to play offline point cloud files, click on the "Open offline data" button to load the offline data. After loading the data, the "play" button, the "previous frame" and the "next frame" buttons will light up and you can play frame by frame.

Table 5.3 "Offline" Menu Button Description

Button	Description
	Open offline data
◁ ▷ ▷▷	Play/pause the point cloud
①	Loop playback
Playback speed: X1	Adjust the playback speed of the offline data
0 /100	The playback progress of the current offline data, pull the progress bar or set the number of frames to jump to the progress you want

■ **"Setting" Menu Buttons**

The setting module is for adjusting the speed of the lidar (if the lidar supports it), setting the filtering function, the network and the point cloud display angle.

Table 5.4 "Setting" Menu Button Description

Button	Description
⚙	Open the setting window
	Set the network parameter
Intensity	Set the display mode of the point cloud
Angle display range: 0.00 ~ 360.00	Set the angle display range

■ **"Help" Menu Buttons**

In this module, you can set the display language, check the current software version and restart the point cloud display software.

Table 5.5 "Help" Menu Button Description

Button	Description
↺	Restart the software
ⓘ	Check the current software version
language: 🇨🇳 中文	Switch language

5.2 Notes

■ Notice about the lidar setting and usage

1) It is not possible to use the M10 Plus Windows client to receive data in two processes (open twice at the same time) on the same computer. The port occupancy of the PC is generally exclusive, so after a process is bound to a specified port number, the other software using the same process or the same port number cannot work normally. When the M10 Plus Windows client detects that the port is occupied, it will prompt that the communication network port configuration has failed, and automatically close the software. You need to close the software process that occupied the port, and reopen the M10 Plus Windows client to use it normally.

2) Meanwhile, since Qt is adopted in the low-level software development, please create English paths when naming files and path folders.

3) The default IP of the network interface box is 192.168.1.102. You can use the network configuration tool provided by LSLiDAR to configurate the IP.

■ Notice about computer graphics settings

The information about dual graphics cards can be viewed in the computer configuration. In My Computer > Right Click > Properties > Device Manager, you can see the computer's display adapter information:

You need to manually set a high-performance discrete graphics card as the applicable graphics card of the software. The setting steps are as follows:

1) Take a laptop with Intel(R)HD Graphics 530 integrated graphics and NVIDIA GeForce GTX 960 discrete graphics as an example. Right-click on a blank space on the desktop to pop up a right-click menu and select "NVIDIA Control Panel".

2) Select the "Manage 3D Settings" in the NVIDIA Control Panel interface.

3) Click the "Program Settings" button in the Manage 3D Settings interface.

4) Click the "Add" button on the Manage 3D Settings interface.

5) Click the "Browse" button in the pop-up interface.

6) Find the application file (.exe file) of the software according to its installation path in the pop-up browsing interface.

7) Click "OK" to automatically return to the NVIDIA control panel, select the high-performance NVIDIA processor in the combo box of the preferred graphics processor for this program in Option -2., and click "Apply" in the lower right corner. After the computer application is set, close the NVIDIA Control Panel to complete the setting.

6 ROS Driver Operation Under Linux OS

This section introduces the point cloud display and driver usage of LSLiDAR M10 lidar on Linux. You can acquire the ROS driver from LSLiDAR technical support. The M10 ROS driver is applicable for point cloud display, parameter configuration, etc.

6.1 Hardware Connection and Test

1) Connect the lidar to the internet and power supply

2) Set the computer wired IP according to the destination IP of the lidar (you can use the ifconfig command to check whether the computer wired IP is set successfully. As shown in the figure, the destination IP is 192.168.1.102)


```
ls-yy@lsyy-All-Series:~$ ifconfig
enp3s0    Link encap:Ethernet  HWaddr 88:d7:f6:42:4c:a2
          inet addr:192.168.1.102  Bcast:192.168.1.255  Mask:255.255.255.0
          inet6 addr: fe80::548a:d3bd:713f:1bd4/64 Scope:Link
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:124400 errors:0 dropped:0 overruns:0 frame:0
          TX packets:36210 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:45490512 (45.4 MB)  TX bytes:4469863 (4.4 MB)
```

Figure 6.1 ifconfig Command Feedback

Note: The default destination IP of the lidar is 192.168.1.102, and the computer must be configured according to the actual lidar destination IP. (By default, the lidar is not activated when powered up.)

3) After the lidar is powered on and started, check the wired connection icon of the computer to see whether it is connected properly.

4) Open the terminal: ping the lidar IP, and test whether the hardware is connected normally. If the ping is successful, then the data is received, otherwise check the hardware connection.

5) Use "sudo tcpdump -n -i enp3s0" (here enp3s0 is the name of the wired network device, see the device name of ifconfig wired connection display for details) to view the data packets sent by the lidar (as shown in the figure, there are 92-byte data packets sent by the M10 lidar to the destination port, which means that the lidar data is sent normally). M10P and M10 Plus send different number of bytes of data packets to the destination port, please refer to the corresponding communication protocol for the exact number of bytes.


```
09:45:18.712576 IP 192.168.1.200.2369 > ls-All-Series.2368: UDP, length 92
09:45:18.716699 IP 192.168.1.200.2369 > ls-All-Series.2368: UDP, length 92
09:45:18.720956 IP 192.168.1.200.2369 > ls-All-Series.2368: UDP, length 92
09:45:18.725076 IP 192.168.1.200.2369 > ls-All-Series.2368: UDP, length 92
09:45:18.729198 IP 192.168.1.200.2369 > ls-All-Series.2368: UDP, length 92
09:45:18.733389 IP 192.168.1.200.2369 > ls-All-Series.2368: UDP, length 92
09:45:18.737501 IP 192.168.1.200.2369 > ls-All-Series.2368: UDP, length 92
09:45:18.741665 IP 192.168.1.200.2369 > ls-All-Series.2368: UDP, length 92
09:45:18.745819 IP 192.168.1.200.2369 > ls-All-Series.2368: UDP, length 92
09:45:18.749954 IP 192.168.1.200.2369 > ls-All-Series.2368: UDP, length 92
09:45:18.754084 IP 192.168.1.200.2369 > ls-All-Series.2368: UDP, length 92
09:45:18.758281 IP 192.168.1.200.2369 > ls-All-Series.2368: UDP, length 92
09:45:18.762513 IP 192.168.1.200.2369 > ls-All-Series.2368: UDP, length 92
```

Figure 6.2 sudo tcpdump -n -i enp3s0 Command Feedback

6) If you want to stop the lidar, please input the stop instruction: rostopic pub -1 /lslidar_difop_switch std_msgs/Int8 "data: 0".

6.2 Software Operation Example

1) **Establish a workspace and build a compilation environment**

mkdir -p ~/leishen_ws/src

Note: The workspace can be named arbitrarily. (But the path of workspace shall be in English only.) For example, "leishen_ws" can be changed to any name.

2) **Download the LiDAR ROS driver**

The ROS driver can also be obtained directly from our website or customer service. Copy the obtained driver file to the newly created workspace "src", and decompress it.

3) **Compile and package**

cd ~/leishen_ws

catkin_make

4) Run the program

source devel/setup.bash

roslaunch lslidar_x10_driver lslidar_x10_net.launch


```
started core service [/rosout]
process[lslidar_m10_driver_node-2]: started with pid [14799]
process[lslidar_m10_decoder_node-3]: started with pid [14805]
[ INFO] [1632907605.840754669]: Opening UDP socket: address 192.168.1.200
[ INFO] [1632907605.840809794]: Opening UDP socket: port 2368
[ INFO] [1632907605.840832413]: expected frequency: 238.095 (Hz)
[ INFO] [1632907605.843174618]: Opening UDP socket: port 2368
[ INFO] [1632907605.843207558]: Initialised lslidar m10 without error
[ WARN] [1632907607.845344559]: lslidar poll() timeout
[ WARN] [1632907609.847535987]: lslidar poll() timeout
```

Figure 6.3 ROS Program Running

Input starting instruction: rostopic pub -1 /lslidar_difop_switch std_msgs/Int8 "data: 1"

Note: If timeout appears, it means that the driver has no data reception. Please check whether the IPs and terminals of the hardware connection and the launch file are the same.

Open a new terminal and execute the command: rviz

5) Display the data detected by the LiDAR

In the "Displays Window" that pops up, modify the value of "Fixed Frame" to "laser_link". Click the "Add" button at the same time, and click "LaserScan" under "By topic" to add a single-beam point cloud node.

6) Set parameters

In the file "/src/lsx10/lslidar_x10_driver/launch/lslidar_x10_net.launch", you can set the IP port, maximum and minimum distance values and angle cutting, etc.

7 LiDAR Maintenance

7.1 Shipping Requirements

LSLiDAR has customized the package for the M10 Plus lidar to withstand a certain amount of vibration and impact. Special packages must be used for long-distance transportation to avoid irreversible damage during transportation.

7.2 Installation

Fix the lidar to the base using screws that meet the specifications, and pay attention to the base heat dissipation. Wear powder-free and clean gloves when installing, so as not to cause the optical window to be dirty, and not to cause mechanical damage to the optical window.

7.3 Cleaning

When using the lidar, if the optical window is polluted by fingerprints, mud, leaves, insect corpses, etc., it will affect the lidar ranging effect. Please follow the following steps for cleaning.

Tools: PVC gloves, dust-free cloth, anhydrous ethanol (99%)

Environment: ventilated and dry, away from fire sources

1) Wear the PVC gloves and secure the lidar base with your fingers; For a stain that is not stubborn, use a dust-free cloth to gently wipe it off or dry air to blow it off.

2) For a stubborn stain, fill the spray bottle with ethanol, spray evenly on the stain, wait for a while until the stain is dissolved, and then use a dust-free cloth dipped in ethanol to gently wipe the optical window. If the dust-free cloth is polluted, replace it immediately. After cleaning off the stain, use a new dust-free cloth to wipe off the remaining liquid.

Revision History

Rev.	Release Date	Revised Content	Issued/Revised By
V3.0.0	2022-11-14	Initial version	LS1286
V3.0.1	2023-02-07	6.1 Hardware Connection and Test modified	LS1286

LSLIDAR

Make Safer Driving, Smarter Machine, and Better Life!

Headquarters

LeiShen Intelligent System Co., Ltd.

Floor 4-5, Yunhua Times Building,

Shajing Street, Bao'an District

Shenzhen City, Guangdong Province

China

TEL: +86-0755-23242821

Factory

Building R, Dongbao Industrial Zone

Shasi Community, Shajing Street, Bao'an District

Shenzhen City, Guangdong Province

China

TEL: +86-0755-27190511

French Office

60 Rue Saint Antoine

75004 Paris,

France

TEL: 0033-(0)749044832

Eric Chen

Sales Email: sales@lslidar.com

After-Sales Email: support@lslidar.com

Company Website: www.lslidar.com