DATASHEET
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ORBBEC® Pulsar Series LiDAR

ORBBEC Inc.

ME450

Revision History

Version	Data	Note
V1.0	2025.07.12	● Internal initial releases

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1 Description and specifications

Pulsar ME450 is an extremely cost-effective laser ranging sensor, it uses direct Time of Flight (dToF) ranging technology, and features a precision MEMS + rotating-mirror optical scanning system, combined with high-frequency laser pulse generation technology and precise optomechanical structure design, it can achieve fast and accurate scanning measurements within a horizontal field of view of 270° and a vertical field of view of 60°. The LiDAR can be widely used in many fields, including robot positioning and navigation, obstacle perception and avoidance, area security, logistics, environmental scanning, and 3D reconstruction.

Product Specification

Product	**Pulsar ME450**	**Remarks**
Measurement principle	dToF	Direct Time of Flight
Measurement range	0.1~45.0m@90% 0.1~15.0m@10%	
Accuracy [1]	±30mm	At least 100 times data statistics are collected. The accuracy is the difference between the mean and true value of the data, and the precision is the standard deviation value of the data (1σ).
Precision [2]	≤20mm	
Output data	Distance, angle, reflectivity	
Horizontal FOV	270°	
Vertical FOV	60°, can be set as 45°/ 30°	The centerline is +23°, the default angle range is [-7°, +53°], and it can be set as [+0.5°, +45.5°] or [+8°, +38°].
Measurement frequency [3]	200kHz	Measurements per second
Horizontal rotation frequency	10Hz/15Hz/20Hz	Default 20Hz
Vertical scanning frequency	1100Hz ± 25Hz	
Laser wave length	905±10nm	
IMU	Built-in IMU, 6-axis	
Time synchronization	PTP, GPS, PPS	
Ambient light limit [4]	>80,000Lux	
Operating voltage	24V(9~28V DC)	
Power consumption	Typ.＜6W	
Interface type	8-pin aviation connector, 100 Mbps network	
Dimensions	65mm×65mm×83mm	L×W×H (without connection cable)
Weight	~270g	Without connection cable

Degree of protection	IP67	IEC 60529:2013; GB/T 4208-2017
EMC		EN IEC 61000-6-1:2019 EN IEC 61000-6-3:2021
Laser class	Class1	IEC 60825-1：2014
Ambient operation temperature [5]	-20℃~55℃	
Storage temperature	-40℃~70℃	
Relative humidity	0~85%	No moisture condensation
Certification	CE-EMC/ FCC/ RoHS2.0/ REACH, Class1, FDA registration	

Note:

The ranging performance is derived from laboratory tests, which is under standard diffuse reflective target plates, precision guide rails, temperature control at 25°C and indoor ambient light conditions. Please contact for detailed data and test reports. LiDAR is a precision photoelectric sensor, and its test results are related to the installation method, temperature, humidity, vibration, environment, and other factors. Please pay attention to protection when using the sensor and refer to the guidance given by technical support staff for operation.

1. **Measurement accuracy**: the absolute error within 15 and 45 meters under laboratory conditions with 10% and 90% reflectivity, respectively.
2. **Measurement precision**: the relative error under laboratory conditions at 10% and 90% reflectivity, and working distances within 15 and 45 meters, respectively. The measurement results may be affected by environmental factors such as target distance and reflectivity.
3. **Measurement frequency**: output frequency of measurement data calculated with a 360° horizontal field of view.
4. **Ambient light limit**: this refers to the ability of the LiDAR to function normally for distance measurement under the specified ambient light conditions, but the accuracy and precision of its measurement results may slightly diminish as the light intensity increases. It is also necessary to avoid direct exposure of strong light to the LiDAR's optical area.
5. **Temperature**: this refers to the range of temperatures within which the LiDAR can ensure normal operation. At the extreme limits of this range, there is a possibility of slight deviations in accuracy performance.

2 Introduction

2.1 Purpose

This document describes the specifications and some design details of ORBBEC® Pulsar Series 3D LiDAR product ME450, as well as for developers to understand and use the related products.

2.2 Working Principle

The measurement principle of this LiDAR is the direct time of flight method (Direct Time of Flight, dToF). The distance measurement formula is:

$$d = \frac{ct}{2}$$

Where d denotes the distance, c denotes the speed of light, and t denotes the time of flight.

When the ranging module works, the laser transmitter sends out a laser pulse, which is projected onto the surface of the object and reflected. The ranging system receives reflected light and accurately calculates the distance from the target object to the LiDAR by measuring the flight time of the laser beam in the air. By using a built-in brushless motor to drive a horizontal rotating mirror and vertical MEMS high-frequency oscillation, the distance and intensity (reflectivity) at different angles in 3D space can be measured, and the contour of the surrounding environment point cloud can be scanned.

3 Product Composition

3.1 Component Composition

Pulsar ME450's Component description shown in the figure below:

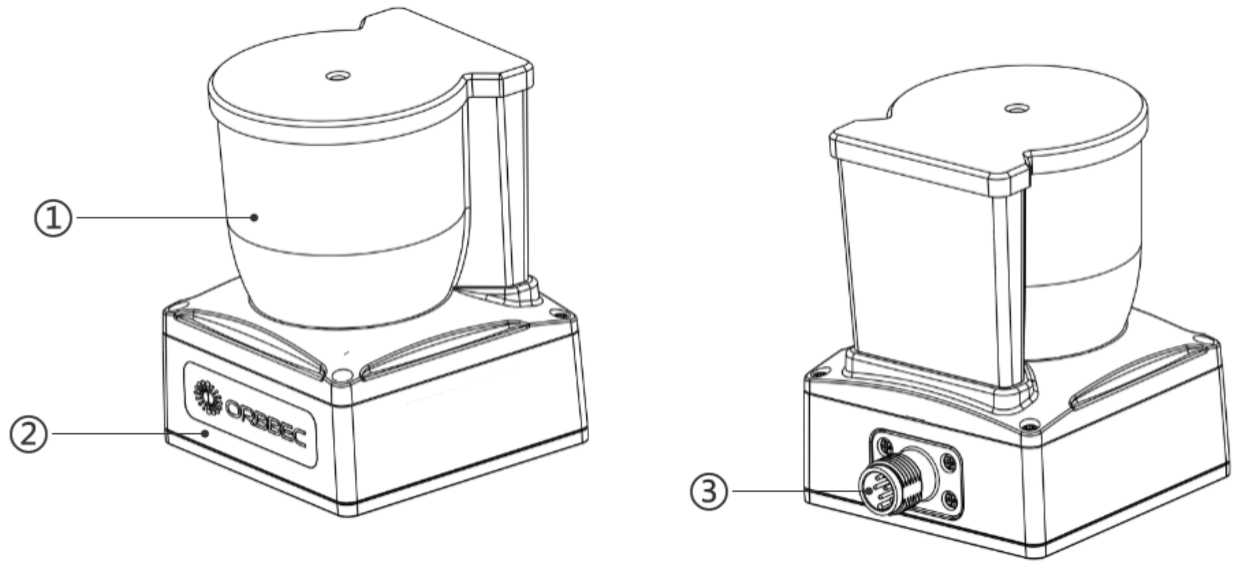

Figure 3-1-1 ME450 Component description

① **Optical window**

The laser pulse is emitted through the window to scan the object within the scanning range. When installing, please pay attention to the laser transmission and reception area to avoid blocking it, which may affect its use. For detailed dimensions, refer to the installation dimensions.

② **Metal mounting base**

A metal base equipped with mounting holes, which also serves as a heat dissipation component. Heat dissipation design should be considered during installation.

③ **Aviation connector**

M12 8P aviation connector, used for LiDAR power supply and data communication. Please refer to the pinout diagram for details

3.2 Interface Definition

The external electrical and communication interface of the LiDAR is an M12 8P aviation connector (male, with pins). Among them, 4 pins are for network communication, and the other 4 pins are for power supply and signal I/O.

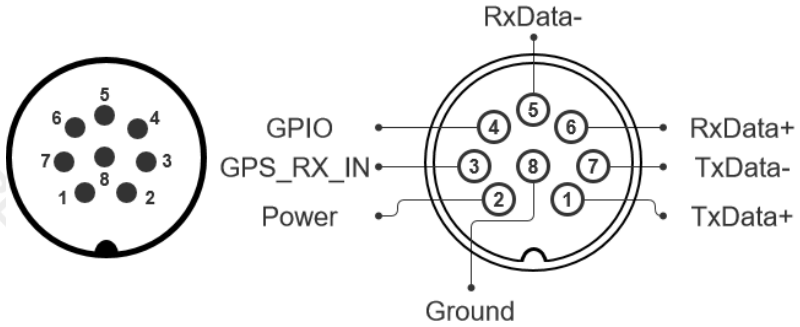

Figure 3-2-1 pinout of the aviation connector

Table 3-2-1 cable pinout

Pin NO.	Signal	In/ Out	Description	Cable
1	TxData+	Out	Network data output+	RJ45
2	Power	In	DC 9~28V	Black
3	GPS_RX_IN	In	GPS signal	Blue
4	GPIO	In/ Out	Input: PPS second pulse Output: TTL pulses, configurable trigger conditions	White
5	RxData-	In	Network data input-	RJ45
6	RxData+	In	Network data input+	RJ45
7	TxData-	Out	Network data output-	RJ45
8	Ground	Ground	Ground of power/signal	Green

The wiring harness is an optional accessory, with a length of 1 meter. The starting end is an M12 8P aviation female connector, and the terminal end is a split cable. Pins 2 to 4 and 8 are extended as open wires, while pins 1 and 5 to 7 are extended as an RJ45 network male connector, shown in the figure below:

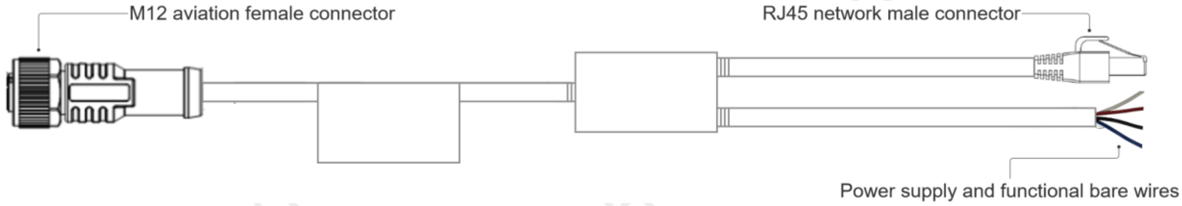

Figure 3-2-2 Accessory harness style

3.3 Installation instruction

3.3.1 Installation Dimension

Pulsar ME450 has 4 effective M3 installation holes with a depth of 4.5mm at its bottom, as well as 2~4 positioning holes with a depth of 1.8mm for installation. Users can install the LiDAR at the appropriate position according to the size shown in the diagram and the size of the installation holes.

Among them, point O serves as the optical origin and the coordinate origin of the point cloud data.

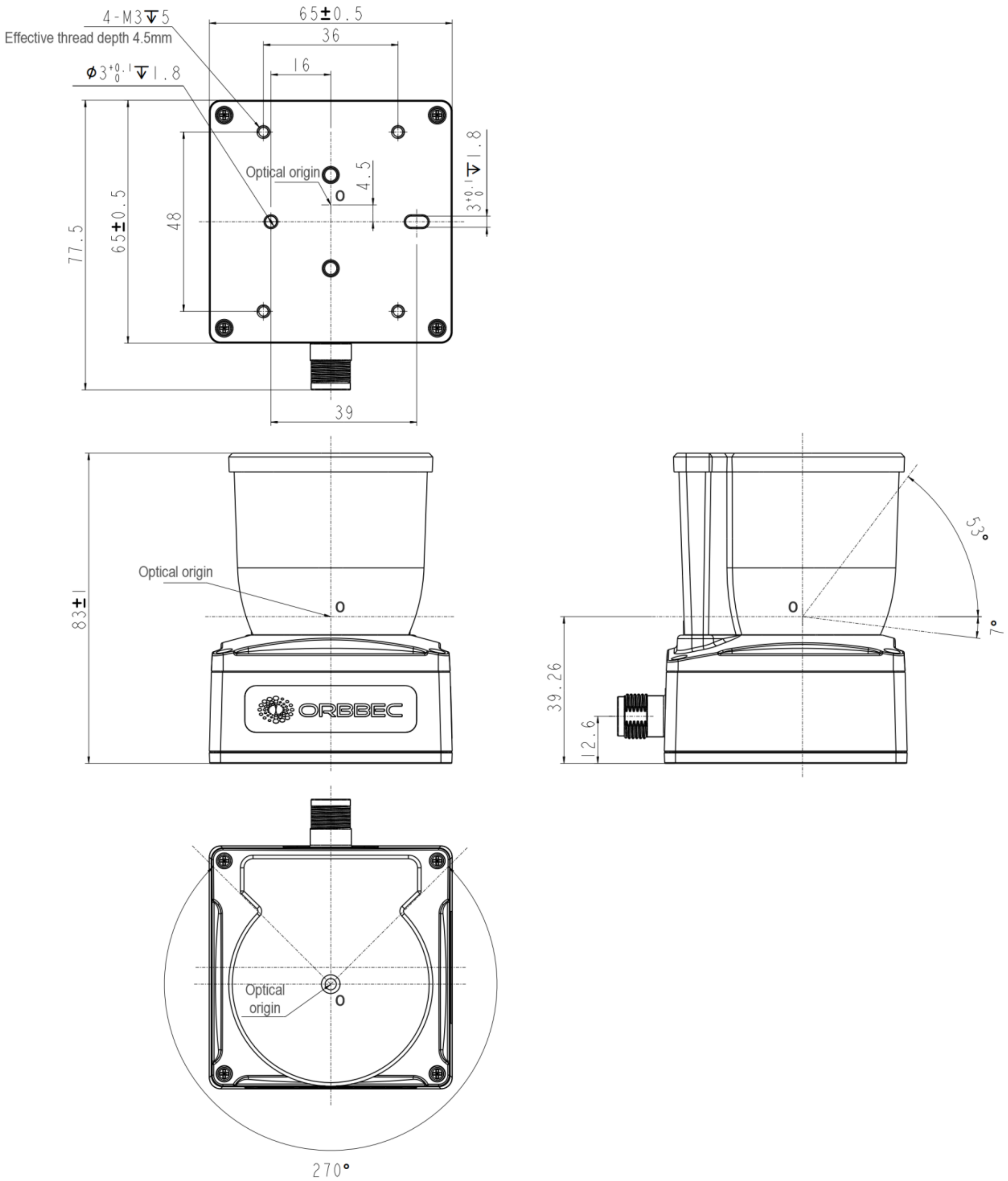

Figure 3-3-1 Pulsar ME450 Dimensional Structure

3.3.2 Optical Area Description

The LiDAR has a certain range of optical area. Within this optical area, structural interference should be avoided. When designing the structure, one can refer to the CAD file that include the optical path area.

4 Operation Mechanism

4.1 System Workflow

ME450 is set up with 2 operating modes: ranging mode and standby mode.

Ranging mode: LiDAR is activated and working properly, with the capability to control the output of point cloud data.

Standby Mode: The LiDAR is activated, but the laser pulse has not yet been emitted

The brief workflow diagram of LiDAR is shown in the figure below:

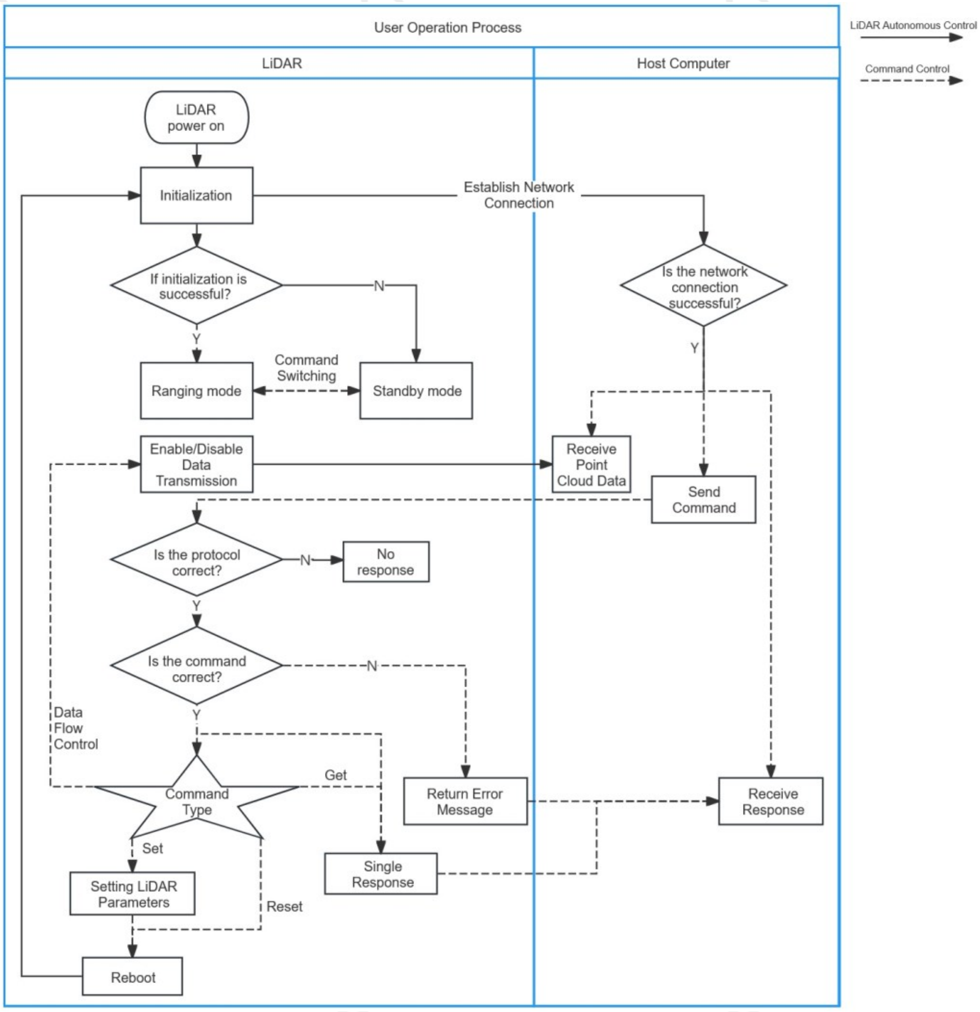

Figure 4-1-1 LiDAR system workflow diagram

4.2 LiDAR Scanning Mode

Pulsar ME450 has a flexible and configurable scanning mode. It can be broadly classified into non-repetitive scanning mode and repetitive scanning mode. The repetitive mode can further be divided into repetitive scanning (non-dense), repetitive scanning (2x dense), and repetitive scanning (4x dense).

Taking the repetitive scanning (non-dense) mode as an example, when the horizontal motor and the vertical MEMS move together, the laser scanning path of the Pulsar ME450 is similar to a sine wave. The laser emission time intervals are consistent, and the laser scanning positions in each circle are repetitively along the path. The distribution of the laser scanning path positions is similar to that shown in the figure below:

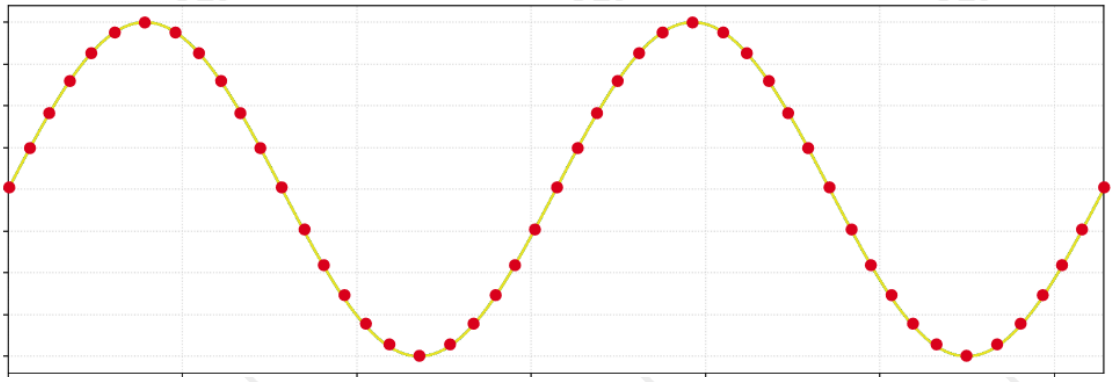

Figure 4-2-1 the non-dense repetitive scanning laser point movement path

When switching to repetitive scanning (2x dense) or repetitive scanning (4x dense), the motor will adjust the phase at 1/2 or 1/4 of the cycle after each horizontal revolution, so that the laser can be directed to different paths. As a result, the time for covering the maximum laser density is 2 times or 4 times, as shown in the figure below:

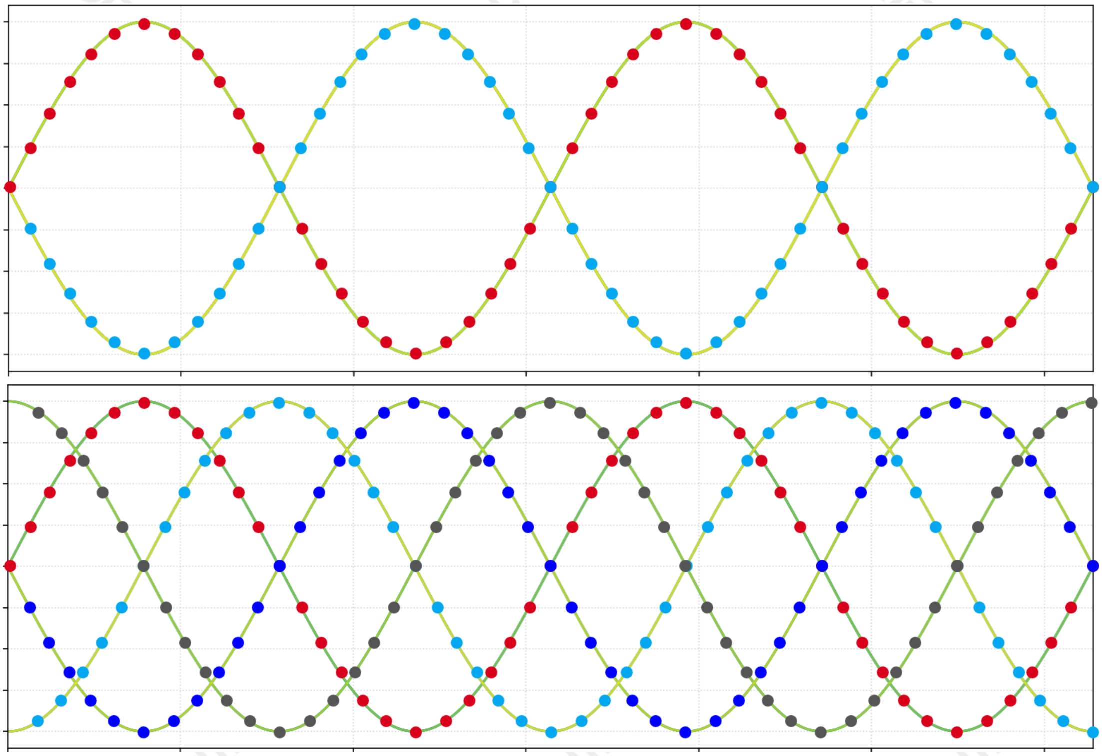

Figure 4-2-2 the multi -dense repetitive scanning laser point movement path

When switching to non-repetitive scanning, the phase change of the laser will no longer be periodic. Therefore, theoretically, if the accumulated time (number of frames) is sufficient, the point cloud can cover all positions in the FOV space.

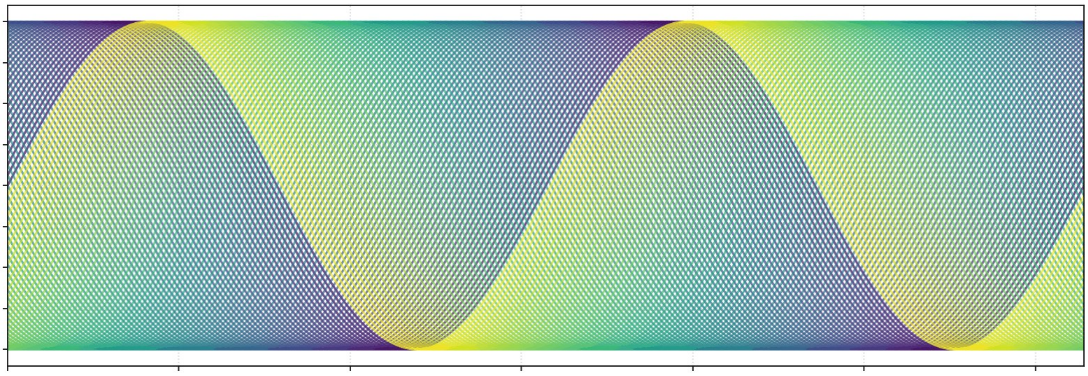

Figure 4-2-3 the non-repetitive scanning laser point movement path

4.3 LiDAR Communication

The ME450 point cloud data is transmitted outward via Ethernet UDP or TCP protocol with factory default IP address 192.168.1.100 and default network port number 2401, default IMU network port number 8000.The LiDAR adopts a passive point cloud data upload method with the host computer. That is, under the condition that the host computer and the LiDAR can communicate normally over the network, the host computer opens the LiDAR according to the LiDAR's IP to obtain point cloud data. The specific operation method is as follows:

1. After the LiDAR is powered on and initialized, the internal ranging engine starts working normally. The host computer must first send a connection command to establish a connection with the LiDAR;
2. After the host computer successfully connects to the LiDAR, point cloud data can be obtained. The host computer can send commands to control the start and stop of point cloud transmission;
3. Each time the LiDAR receives a control command, it will reply with an acknowledgment message as the result of the command execution.

Figure 4-3-1 Command Interaction Diagram

4.4 Data Composition and Protocol

4.4.1 Data Composition

Pulsar ME450 can output point cloud data based on the scanning results. Each point cloud contains position information, feature information, etc. The position information can be configured in either Cartesian coordinates (x, y, z) or polar coordinates(R, φ, θ), R represents the distance of the point cloud from the origin; φ is the azimuth angle, which is the angle formed by the projection on the horizontal plane and the positive direction of the x-axis; θ is the vertical pitch angle, which is the angle between the vertical direction and the horizontal plane. The coordinate system of the LiDAR is defined as follows:

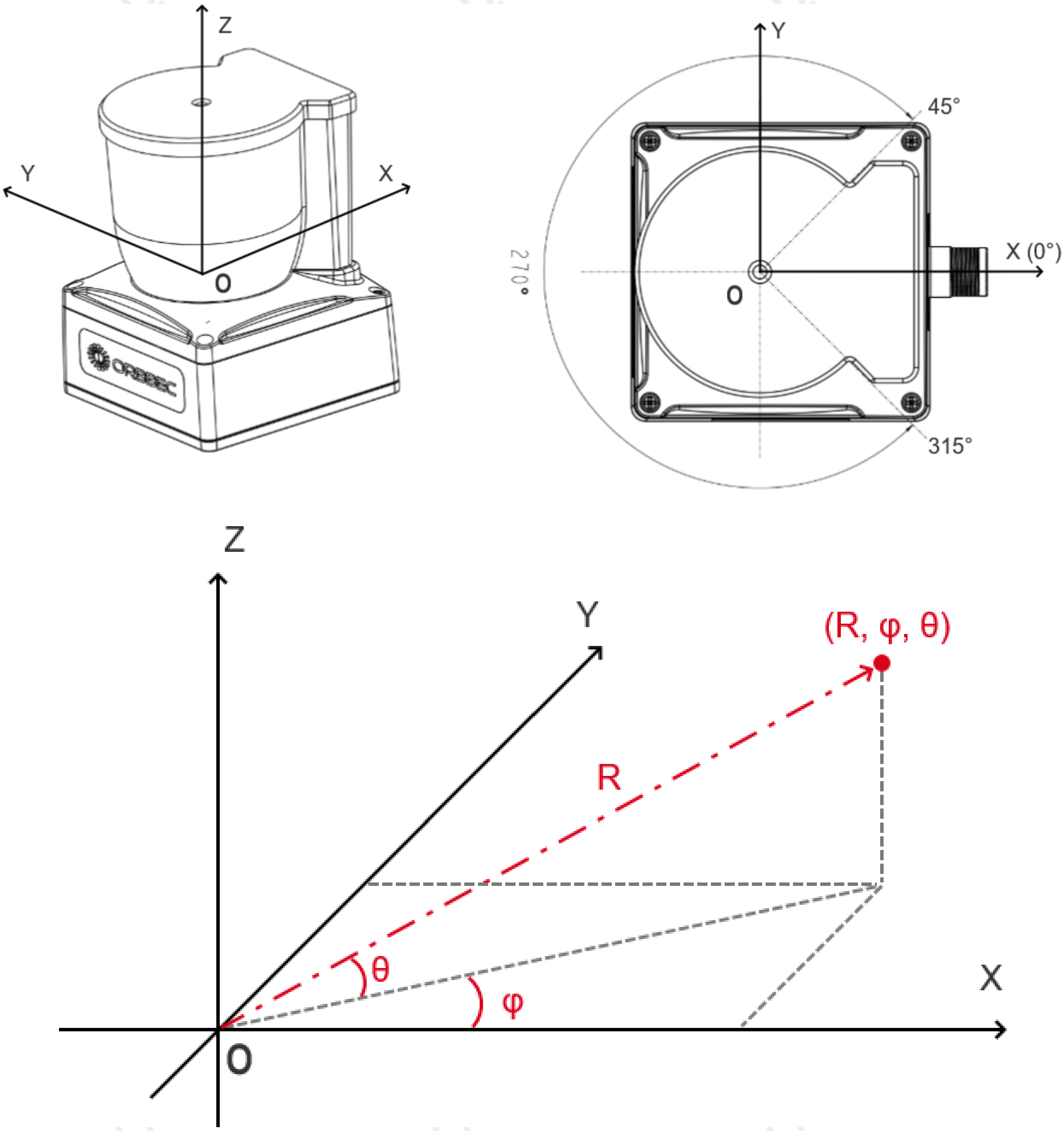

Figure 4-4-1 LiDAR Coordinate System Definition

The conversion formulas for the two coordinate systems are:

$$X = R \times cos\theta \times cos\varphi$$

$$Y = R \times cos\theta \times sin\varphi$$

$$Z = R \times sin\theta$$

The point cloud data output rate of the LiDAR is fixed at 200 kHz (for a 360° range). Therefore, the length of the point cloud data block varies with the scanning frequency. The following table shows the correspondence of point cloud data at different scanning frequencies:

Table 4-4-1 Information of data protocol frames

Rotation frequency	Number of point cloud data points per frame (N)	Length of point cloud data block per frame (Bytes)	Number of frames per scan cycle (M)	Number of point clouds per revolution	Horizontal angular resolution
10 Hz	125	1044	120	15000	0.018°
15 Hz	125	1044	80	10000	0.027°
20 Hz	125	1044	60	7500	0.036°

In ranging mode, the length of each point cloud frame is fixed, containing information from 125 measurement points. Depending on the rotation speed, the number of point cloud frames per revolution varies.

For example, at 20 Hz, the number of point cloud frames in one scan cycle is 60 frames, with each frame containing 125 valid point clouds. The horizontal angular resolution is 0.036°, and the length of one point cloud frame is 1044 bytes.

4.4.2 Point Cloud Data Protocol

The detailed structure of the point cloud data block is described in the following table:

Table 4-4-2 the detailed structure of the point cloud data block

Byte	Name	Description	Byte contents	Byte length
1-6	Frame header	Fixed byte	4D 53 02 F4 EB 90	6
7-8		Frame length of the whole data block	04 14	2
9	Data block information	LiDAR model	01: Pulsar ME450	1
10		Information type	02: point cloud frame at 10Hz 03: point cloud frame at 15Hz 04: point cloud frame at 20Hz	1
11~12		Data block number	01~M; M is the number of frames per scan cycle	2
13~14		Data block sequence	01~FF FF	2
15		Data type flag	00: IMU data 02: Polar coordinates data	1
16~23	Timestamp information	Timestamp	0~3600e^9 with unit as 1us indicates the laser emitting time of the first scan point	8
24		Timestamp sync mode	00: Free-running mode 01: External sync mode 02: PTP sync mode	1
25~28	Status Information	Warning Message	Reference warning information instructions	4
29		Reserved	-	1
30~31		Horizontal rotation speed	Unit is RPM	2
32~33		Vertical frequency	Unit is 0.1hz	2
34~35		APD temperature	Unit is 0.01℃, The most significant bit represents the sign: bit15 = 0: Positive;	2

			bit15 = 1: Negative.	
36~40		Reserved	-	5
41~ 40+N*8	Point cloud information	point cloud information	Refer to the detailed table of point cloud data definitions	N*8
41+N*8~ 44+N*8	Frame footer	Fixed byte	FE FE FE FE	4

The data format is used to describe the specific content of the point cloud message data. There are 2 types of data in total: IMU data, point cloud data in polar coordinates.

When the data type flag is 02, it indicates that the output is polar coordinates point cloud data, is defined as shown in the table below:

Table 4-4-3 polar coordinates point cloud data

Byte	Name	Description	Byte contents	Byte length
41~42	Point cloud information	Point 1 Distance R	uint16_t, unit is 2mm	2
43~44		Point 1 azimuth angle φ	uint16_t, unit is 0.01°	2
45~46		Point 1 pitch angle θ	int16_t, unit is 0.01°	2
47~48		Point 1 feature	uint16_t	2
……		……	……	
33+N*8~ 34+N*8		Point N Distance	uint16_t, unit is 2mm	2
35+N*8~ 36+N*8		Point N azimuth angle φ	uint16_t, unit is 0.01°	2
37+N*8~ 38+N*8		Point N pitch angle θ	int16_t, unit is 0.01°	2
39+N*8~ 40+N*8		Point N feature	uint16_t	2

The data in the Cartesian coordinate system can be converted and obtained through formulas.

When the data type flag is 00, it indicates that the output is IMU data, which is in the IMU data format:

Table 4-4-4 IMU data

Field	Data Name	Data Content	Data Length (Byte)
GYRO_X	X-axis angular velocity	float, unit: rad/s	4
GYRO_Y	Y-axis angular velocity	float, unit: rad/s	4
GYRO_Z	Z-axis angular velocity	float, unit: rad/s	4
ACC_X	X-axis acceleration	float, unit: g	4
ACC_Y	Y-axis acceleration	float, unit: g	4
ACC_Z	Z-axis acceleration	float, unit: g	4

4.4.3 Data Information Extraction

Calculate the data information of each point. Taking polar coordinate data as an example, the calculation is as follows:

1. Each point cloud has an 8-byte length. Extract the point cloud data information of the nth point cloud from the point cloud data block: e.g., 0x13, 0x14, 0x05, 0x25, 0x01, 0x37, 0x78, 0x00;
2. Extract 1~2 bytes from the point cloud data information, which represents the distance: 0x1314 =522, 522*2mm =1044mm;
3. Extract 3~4 bytes from the point cloud data information, which represents the azimuth angle: 0x0525 =1317, 1317*0.01°=13.17°;

4. Extract 5~6 bytes from the point cloud data information, which represents the pitch angle: 0x0137 =311, 311*0.01°=3.11°;
5. Extract 7~8 bytes from the point cloud data information, which represents the feature information, which can be calculated to obtain the reflectivity and data label information;
6. The polar coordinate information of this point is [1044mm, 13.17°, 3.11°].

5 Instructions for Device Connection

The Ethernet cable is used for data transmission, while the multi-core cable provides external power supply and time synchronization functions. For pinout of the aviation connector and cable, please refer to the Interface Definition section.

When powering the Pulsar ME450, it is recommended to use a 24V/1A power supply. The Ethernet cable communicates data via Ethernet (UDP or TCP), connecting directly to a computer. The IP address is 192.168.1.100, and the subnet mask is 255.255.255.0.

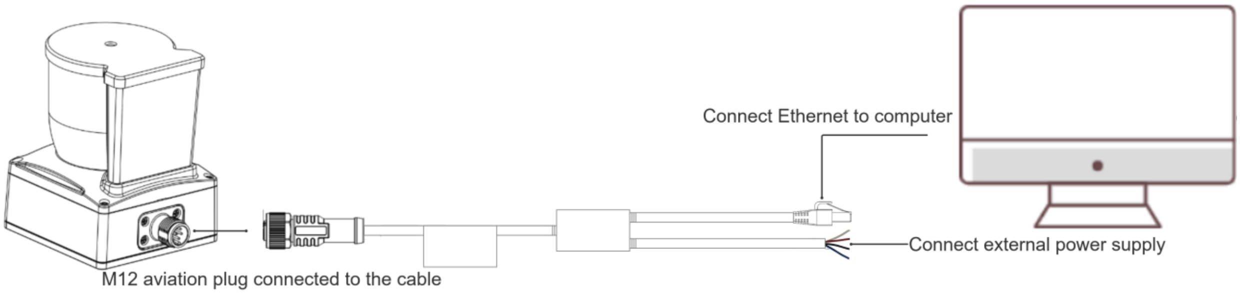

Figure 5-1-1 Device Connection

When using it for the first time, the host computer IP should be configured. The setting method for Windows system is as follows:

a. In Control Panel, enter "Network and Sharing Center";
b. Click "Ethernet" to jump to the Ethernet status interface and click the "Attribute" button to enter the Ethernet attribute setting interface;
c. Double-click "Internet Protocol Version 4 (TCP/IPV4)";
d. Set the IP address to 192.168.1.XX (e.g., 192.168.1.10, not the LiDAR address 192.168.1.100), set the subnet mask to 255.255.255.0, and click the "Confirm" button to complete setting the static address of the computer.

6 Viewer Introduction and Usage

6.1 Introduction

Orbbec provides users with operational software Orbbec Viewer, which enables real-time display, recording and analysis of point clouds. It is a software tool for the entire process of equipment debugging, analysis and visualization, supporting equipment connection, 3D point cloud data interaction and in-depth analysis via PC. It can be used to connect the LiDAR to the PC. Through this upper computer software, users and debuggers can conveniently view the quality of point clouds, record and store as well as replay the number of point clouds, which is convenient for subsequent use. At the same time, it can analyze and calculate the point cloud data, which can improve the efficiency of testing and verification. The software can be obtained through salespeople or online links.

6.2 Environmental Preparation

This software currently supports Windows 10/11 (64-bit), x86 Linux, and ARM Linux operating systems. It is recommended that the PC have an independent graphics card and a resolution of 1280 × 720 or higher (not zoomed).

Since the LiDAR devices connected to Orbbec Viewer communicate via the network, please turn off the computer firewall before collecting the point cloud. Simply adding the software to the whitelist is not sufficient; the firewall blocks the LiDAR data, not the software.

After connecting the device via the network interface, set the PC's network interface IP to the same subnet as the device's IP: For example, if the LiDAR's default IP is 192.168.1.100, set the computer's IP address to 192.168.1.XX (such as 192.168.1.10, but not the LiDAR's address 192.168.1.100), and set the subnet mask to 255.255.255.0.

6.3 Software Interface and Function Introduction

6.3.1 Main Interface

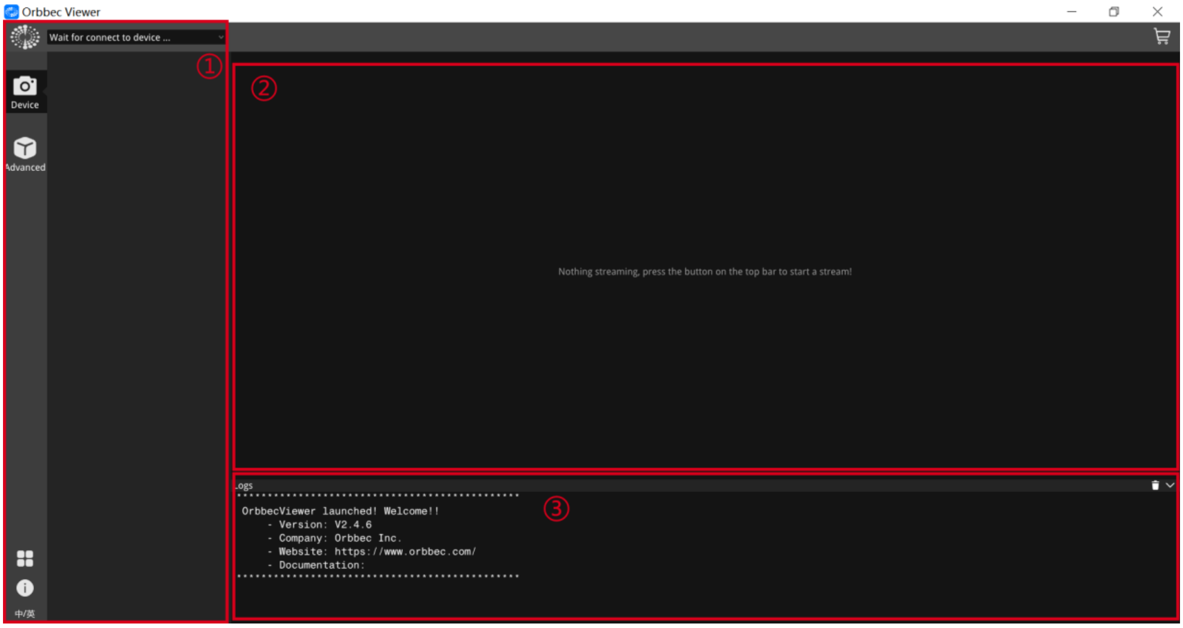

Figure 6-3-1 Software main interface division

The main page of the software is shown in the above picture. The general functions of each area are introduced in the following table. For detailed functions, please refer to the descriptions in the respective chapters at the end:

Table 6-3-1 introduction to the functions of the interface area

Number	**Name**	**Function Description**
①	Device Management	Automatically enumerate the network information of devices on the computer; After successful connection, display the basic information of the connected devices, as well as the parameter configuration box; Supports continuous recording and playback of point cloud data
②	Point Cloud Display Area	Preview real-time point cloud from the LiDAR or local point cloud files; Includes a data list, and supports selecting data for statistics
③	Log List	Operation log display area

6.3.2 Device Management

This area is the device management area. The current version only supports single-device connection for now. After the operating environment is properly prepared, the software will automatically enumerate the LiDAR devices that are physically connected on the PC and add them to the device list for waiting for selection and connection, as shown in the following figure:

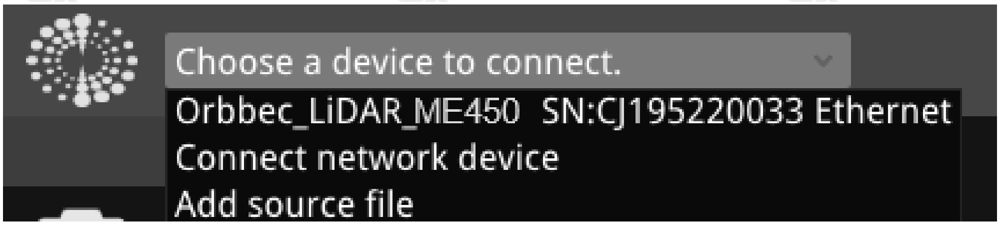

Figure 6-3-2 Device Optional List

When the device is successfully connected, the interface will change to the one shown below:

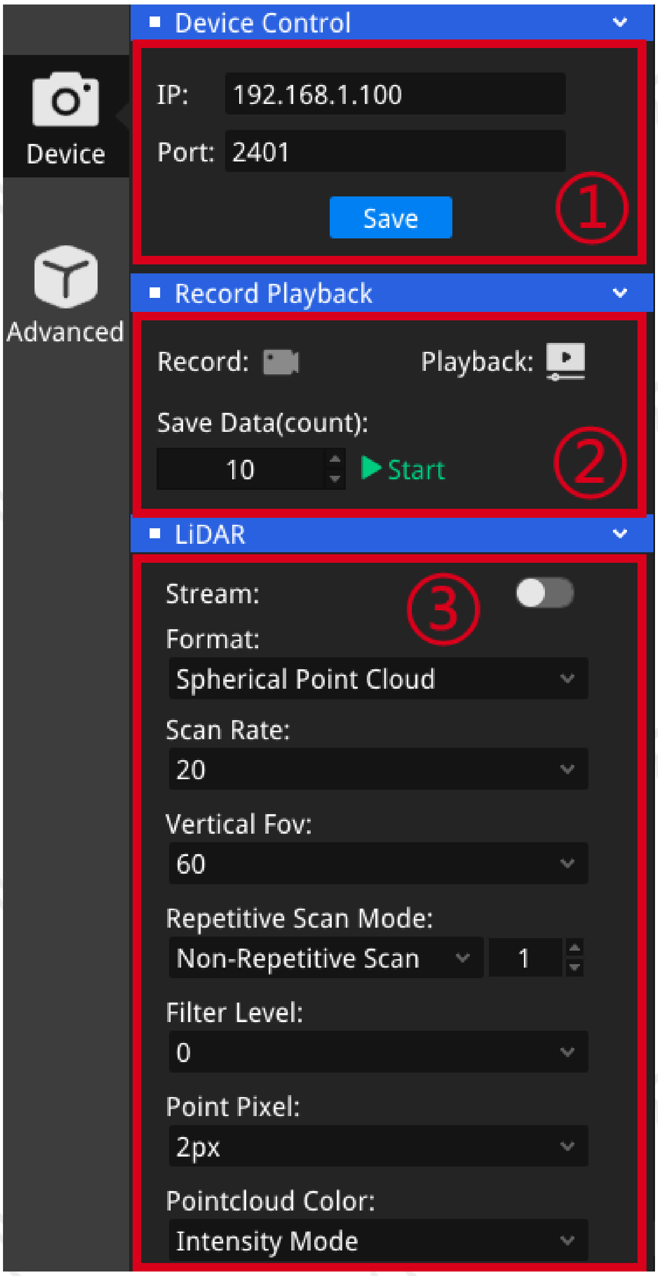

Figure 6-3-3 Device Management

Table 6-3-2 introduction to the functions of the interface area

Number	Function Description
①	Network information display and modification of lidar
②	Recording and playback of point cloud data
③	Control of lidar point cloud parameters

Users can enable/disable the point cloud data through the "Stream" button; can also set parameters such as the point cloud data format, scanning mode and cumulative frame count of the LiDAR, and observe the point cloud effect.

6.3.3 Point Cloud Display Area

Once the point cloud data stream is activated or the correct format recording file is imported and played, a real-time point cloud effect will be displayed in the display area. Moreover, it supports the display of a data table during real-time collection and pause. Users can select data by holding down the Shift key and dragging the left mouse button to move the selection box. The selected data will be displayed and counted on the right side of the point cloud display panel, as shown in the figure below:

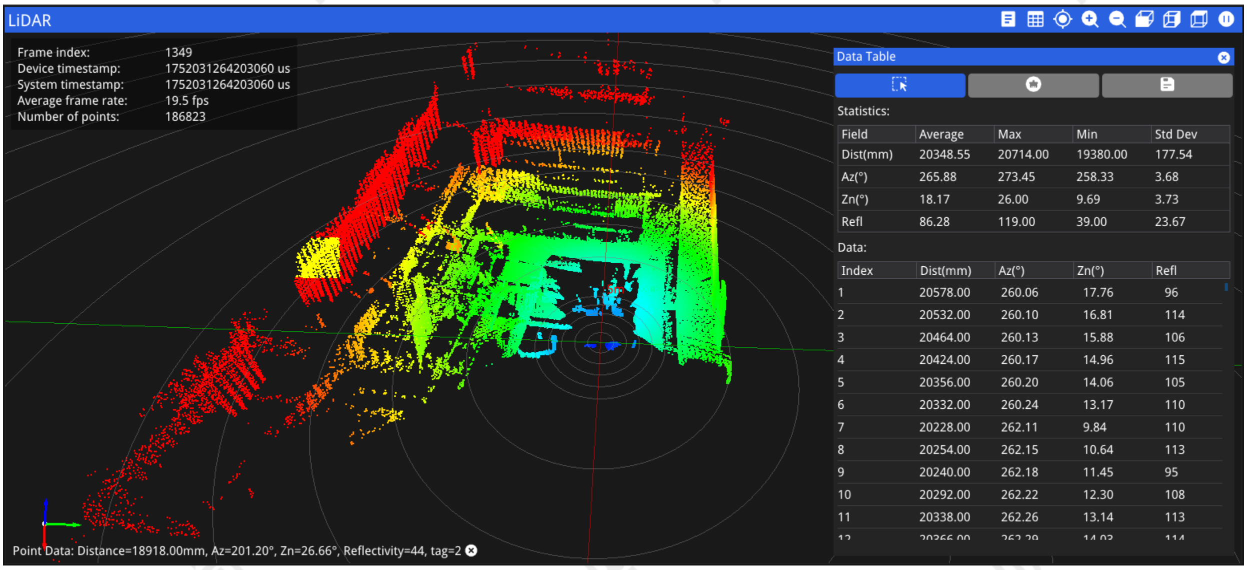

Figure 6-3-4 Device Management

6.3.4 Log List

During software operation and device response, logs will be recorded and displayed in the log list box, which can be used by users and developers to obtain and analyze some necessary information.

7 SDK

In addition to the above-mentioned real-time point cloud data using the Viewer, users can also apply the point cloud data obtained from the LiDAR to various custom scenarios through the Software Development Kit (SDK). Users can perform algorithm development based on the Orbbec_SDK to improve development efficiency. The Orbbec_SDK is a cross-platform (Windows, Linux) software development kit designed for Orbbec products, providing device parameter configuration, data stream reading, and processing. It also includes ROS/ROS2 wrapper to help users quickly and conveniently understand and use Orbbec LiDARs. After purchasing the hardware, users can obtain the accompanying SDK from the Orbbec official website.

Among them, before compiling and using the ROS/ROS2 driver, it is recommended to carefully read the operation steps described in the README.md file in the folder to ensure that the driver runs properly and publishes point cloud data.

8 Regulatory Compliance

The product is certified as follows:

1. RoHS Certification

Figure 8-1 RoHS Certification

2. FDA registration

Figure 8-2 FDA registration

3. Class 1 Laser Product under the EN/IEC 60825-1:2014

CLASS 1
LASER PRODUCT

Figure 8-3 Class 1

4. CE Certification

Figure 8-4 CE Certification

5. FCC Certification

Figure 8-5 FCC Certification

9 System Integration Guide

Before choosing Pulsar Series for development, users should contact Orbbec sales staff to obtain the user manual and apply for the SDK development kit; through evaluation, debugging and verification steps to confirm whether the solution meets the mass production requirements.

We provide SDK compatible with various software platforms for the Pulsar series LiDARs. You will need the SDK for the corresponding platform to develop and use the hardware. The LiDAR SDK supports Windows and Linux operating systems. The LiDAR SDK is a secondary development package specifically designed for Orbbec's LiDAR products. After purchasing the product, users can obtain the SDK package from the Orbbec official website and directly acquire point cloud data from the LiDAR. With the driver and SDK suite, users can further develop applications for the product.

Suggested Process:

1. Read the Pulsar series product specification
2. Buy the Pulsar LiDAR through official channels
3. Before development, you should get in touch with the sales staff of Orbbec to obtain the user manual and apply for the SDK development kit.
4. Choose the right development platform
5. According to the function of product development, encounter technical problems, please contact with Orbbec staff in time
6. Confirm the mass production plan of the product
7. Mass production of the products according to mass production plan

10 Cautions

1. Please follow the guidelines to operate the device correctly, such as illegal operation may lead to damage to internal components.
2. Do not drop or hit this product to prevent damage to the internal components and loss of accuracy.
3. Do not attempt to modify or disassemble this product in any way during assembly and use, as this may cause damage to the LiDAR and loss of accuracy and precision.
4. The product temperature rises after a period of use, which is a normal phenomenon.
5. Please do not dirty or scrape the optical cover, so as not to leave a foreign objects or marks on it and thus affect the effect of laser ranging.
6. Do not place the product in a place where children or animals can touch it to avoid accidents.
7. If you can't recognize the device, please check whether the cable meets the power supply requirements and re-plug to check.
8. Although this product uses a Class 1 laser (a harmless, control-free laser), we do not recommend looking directly at the laser emitter for more than 20 seconds to avoid discomfort.