

PACECAT

V1.0

LDS-M300-E User Manual



The 360° Non-Repetitive
Scanning 3D LiDAR



Jinhua Lanhai Photoelectricity Technology Co., Ltd.

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Safety Notice

Usage Specifications

■ Please read the user manual carefully before use. Unauthorized operations are strictly prohibited. For any equipment damage caused by unauthorized operations, the user shall bear the responsibility.

■ To avoid product damage and ensure personal safety, it is strictly prohibited to operate the product in an environment with flammable and explosive substances. It is also strictly prohibited to use this product in an environment prone to corrosion or in an environment where the IP protection level of the product is exceeded.

Prohibited Operations

■ It is strictly prohibited to scratch the optical cover with hard objects. Damage to the surface will affect the ranging accuracy, leading to an increase in noisy data. To avoid the impact of dust and dirt on the ranging performance, please keep the appearance of the product clean.

■ Without the permission of JINHUA LANHAI PHOTOELECTRICITY TECHNOLOGY CO., LTD, users shall not disassemble the product without authorization. It is strictly prohibited to remove the optical cover while the product is in operation.

■ It is forbidden to supply power with a power source that exceeds the standard parameter range to prevent abnormal product operation or permanent damage caused by voltage issues.

■ The structure of the product's optical cover can only ensure its IP67 protection level and the reliability of its own operation. During the assembly and use process, please avoid abnormal operations such as dropping, collision, extrusion, and incineration.

Installation and Operation Precautions

■ Before installing the product, ensure that the installation holes are aligned with the reserved screw holes of the base, and the installation surface is flat. To prevent the deformation of the LiDAR base caused by size mismatch or protruding foreign objects on the surface, which may affect the normal operation of the LiDAR.

■ Long-term operation of the product may cause the surface temperature to rise. Please do not directly touch the product shell with your skin to prevent accidents.



■ To ensure the air flow around and at the bottom of the fuselage for proper heat dissipation of the product, the installation of the product requires an empty space design around and at the bottom. The product should be installed with the bottom suspended or on a flat metal base. It is recommended to reserve at least 10mm of empty space around the fuselage, and the reserved air convection heat dissipation area at the bottom should not be smaller than the bottom area of the fuselage.

■ When the product is in operation, it continuously emits infrared laser, which complies with the safety standard of IEC60825-1 Class I laser. To ensure safe use, please do not look directly at the emitting surface for a long time.



■ If any damage to the appearance of the product or abnormal operation is found, stop using it immediately and contact Blue Ocean Optoelectronic in a timely manner for inspection. Any maintenance or parts replacement measures must be carried out by JINHUA LANHAI PHOTOELECTRICITY TECHNOLOGY CO., LTD.

Contents

I. Introduction	2
II . Operating Principle	2
III. Product Advantage	3
IV. Product Structure and Installation	4
4.1 Mechanical dimensions	4
4.2 Effective Field of View (FOV) of the Optical Window	5
V. Parameter Performance	7
5.1 Device Physical Parameters	7
5.2 Interface Definition	9
5.3 Communication and Interface	10
5.4 Definition of the coordinate system	12
5.5 IMU Position	13
VI. Host Computer Software	14
6.1 Instructions for Host Computer Use	14
6.1.1 PaceCatView3D Installation Tutorial	14
6.1.2 PaceCatView3D connection tutorial	15
6.1.3 PaceCatView3D Description of basic functions	19
VII. Data Communication Protocol	21
7.1 The point-cloud data protocol	21
7.2 IMU Data Protocol	22
7.3 Network heartbeat protocol	23
7.4 Network Heartbeat Protocol Parsing Example	24
VIII. Development Tools & Supports	25

I. Introduction

The LDS-M300-E is a cost-effective, safe and reliable LiDAR. Can support ranging, mapping, positioning, obstacle avoidance, identification, widely used. The LDS-M300-E can detect objects of 0.05m-50m (90% reflectivity target).

The LDS-M300-E has a field of view of 360° in the horizontal direction and from -10° to 60° in the vertical direction.

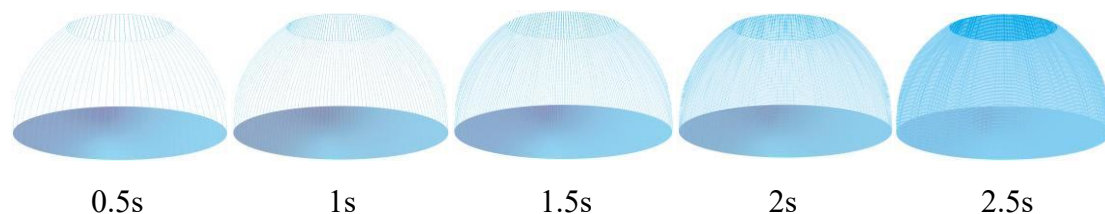
The LDS-M300-E has a built-in 3-axis accelerometer and 3-axis gyroscope. The IMU data includes the accelerations of the 3-axis and the angular velocities of the 3-axis, and the directions are consistent with those of the point cloud coordinate system.

LDS-M300-E is small in size and light in weight, and is suitable for being used on various types of robots.

II . Operating Principle

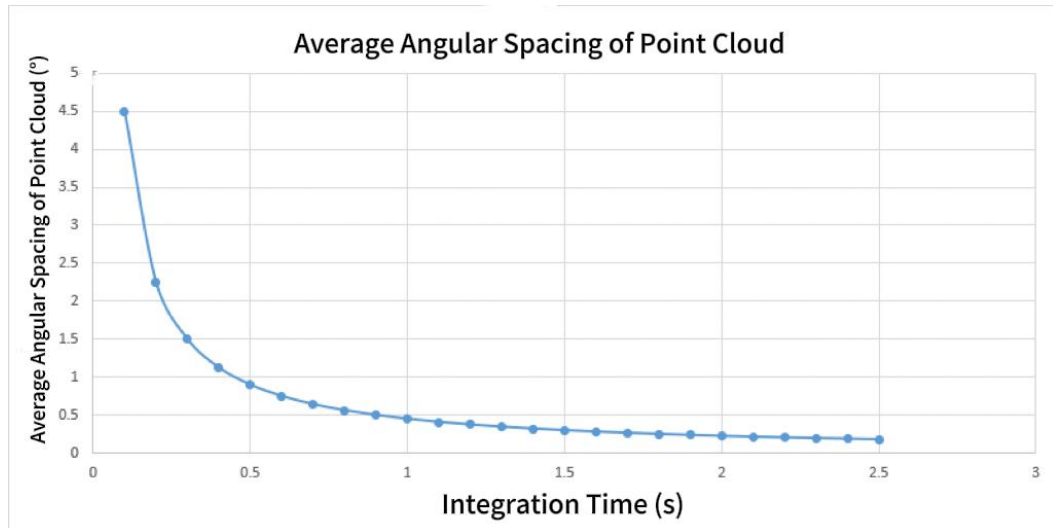
The LDS-M300-E uses the non-repetitive scanning mode. In this mode, the LDS-M300-E has a high field of view coverage rate. Moreover, as the testing time increases, the field of view coverage rate will significantly increase, enabling it to detect more details..

The following figure shows the point cloud effect diagrams of the LDS-M300-E within different integration times (0.5s, 1.0s, 1.5s, 2.0s, 2.5s) in the non-repetitive scanning mode.



Effect diagrams of point clouds of LDS-M300-E under different integration times

The following figure shows the change curve of the average angular gap of the point cloud within different integration times in the non-repetitive scanning mode. You can select the integration time according to the size and distance of the object to be detected.



The average angular gap of point clouds of LDS-M300-E at different integration times

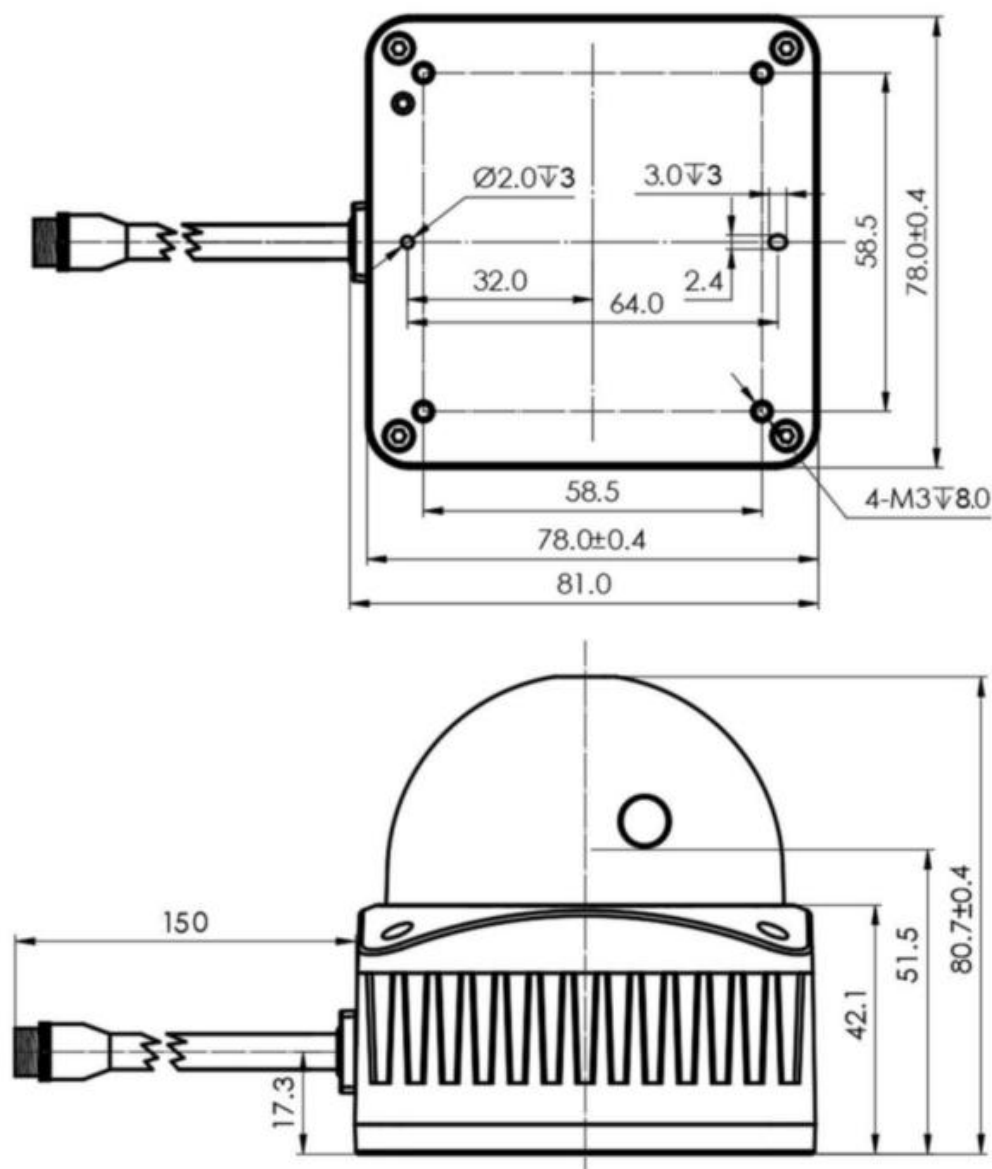
III. Product Advantage

- The LiDAR has a ranging scope of 0.05 to 50m (for targets with a reflectivity of 90%), and synchronously outputs reflectivity target intensity values ranging from 0 to 255, which can be used for algorithms to identify reflective objects;
- With an operating power consumption of less than 4W, an operating temperature range of -10°C to 60°C, and an IP67 protection level, it can meet most usage scenarios;
- It supports a coverage range of 360° horizontally and 70° vertically, and adopts a non-repetitive scanning mode to improve the field of view coverage rate;
- Special optical design, effectively improve the resistance to dirt ability.

IV. Product Structure and Installation

4.1 Mechanical dimensions

unit:mm



4.2 Effective Field of View (FOV) of the Optical Window

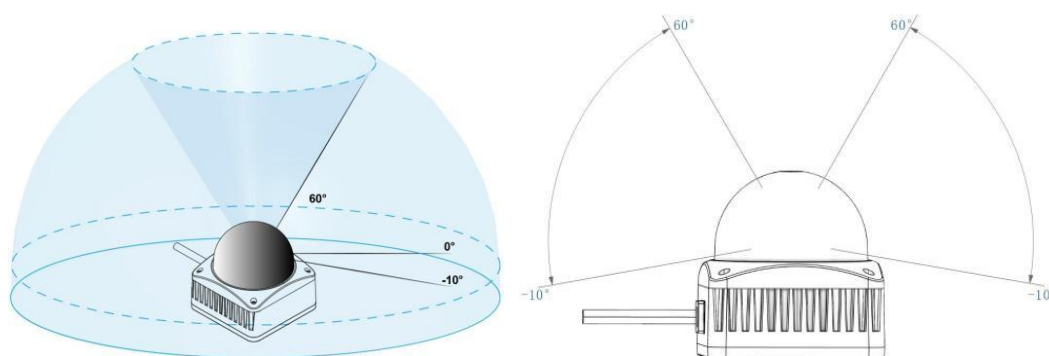
Design Consideration: Occlusion of the optical window by the outer cover will affect ranging performance and accuracy. During the design of the LDS-M300-E, PACECAT optimized the matching angle between the laser emission/reception window and the outer cover to reduce energy loss when laser penetrates the outer cover.

Installation Requirement: The product can be installed in any direction, but ensure that the FOV is completely unobstructed. Any form of occlusion will degrade the ranging performance.

Maintenance Notes:

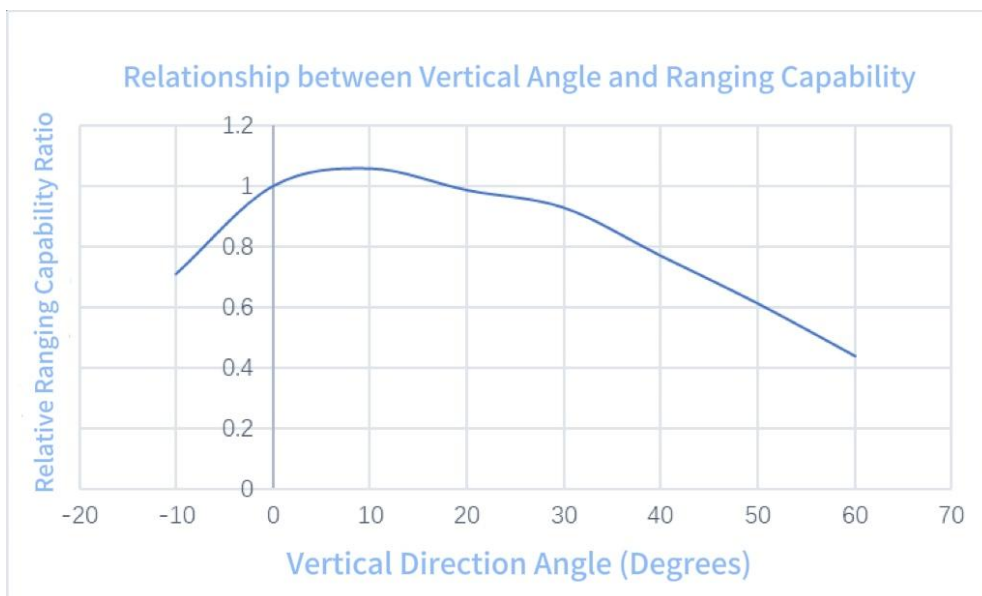
Dust, dirt, or scratches on the optical housing will affect the product's distance measurement performance. When the surface of the housing is dirty, it is recommended to clean it using an air blower for dust removal or a lens cleaning cloth with a water - based cleaning agent (such as dish soap mixed with water).

Do not apply any external force or cause damage to the housing during use or storage, to avoid degradation of distance measurement performance due to housing damage.



Effective FOV Range of LDS-M300-E

Due to the special rotating mirror design, the energy-receiving area of the receiving lens varies at different vertical angles, causing differences in effective ranging capabilities across angles. Taking the ranging capability at a vertical angle of 0° as the reference baseline (1), the relationship between different vertical angles and ranging capabilities for targets with the same reflectivity is shown in the figure below:



Ranging Capability of LDS-M300-E at Different Vertical Angles

As shown in the figure above, taking the effective ranging distance of 25m for a 10% reflectivity target at a vertical angle of 0° as the reference baseline (1), the effective ranging distance at different vertical angles can be calculated using the relative ranging capability ratio formula: Effective Ranging Distance at a Certain Angle = Effective Ranging Distance at 0° Vertical Angle × Relative Ranging Capability Ratio at That Angle.

V. Parameter Performance

5.1 Device Physical Parameters

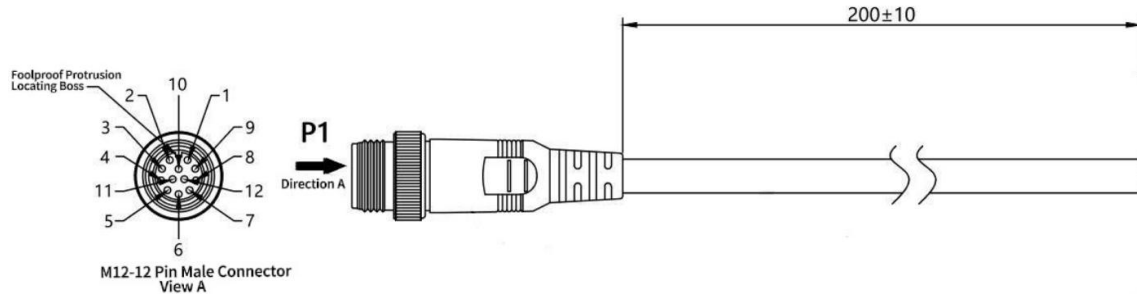
Product Features	
Model	LDS-M300-E
Laser wavelength	$\lambda=905\text{nm}\pm 15\text{nm}$
Eye Safety Class ^①	CLASS 1 (IEC 60825-1:2014)
Ranging distance	0.05m to 50m (90%) 0.1m to 25m (10%)
Near Blind Zone ^②	0.05m
Field of View (FOV)	Horizontal 360°, Vertical -10°~60°
Horizontal Angular Resolution	0.9°@0.5s, 0.45°@1s, 0.3°@1.5s, 0.225°@2s, 0.18°@2.5s
Vertical Angular Resolution	0.36°
Ranging Random Error (1 σ) ^③	$\leq 2\text{cm} (@10\text{m})$ ^④ $\leq 3\text{cm} (@0.2\text{m})$ ^⑤
Angular Random Error (1 σ)	$\leq 0.18^\circ$
Sampling Frequency	200kHz
Data Port	100 BASE-TX Ethernet
Data Synchronization	IEEE 1588-2008 (PTP v2), GPS ^⑥
Anti-Crosstalk Function	Yes
False Alarm Rate (@100klx) ^⑦	<0.01%
IMU	Built-in IMU Model: IIM-42652
Power Consumption	<4W (ambient temperature 25°C)
Power Supply Voltage Range	12~32V DC
Operating Temperature ^⑧	-10°C~+60°C
Storage Temperature	-30°C~+70°C
Protection Class	IP67

Dimensions	78mm×78mm×81mm
Weight	408±5g

- ① Do not stare directly at the laser emission port for a long time or disassemble the LDS-M300-E to avoid hazards.
- ② When the target object is 0.05 m to 0.2 m away, the LDS-M300-E can detect and output point cloud data, but detection accuracy is not guaranteed, and this data is for reference only.
- ③ To ensure effective detection of objects with different reflectivity within the measurement range, slight point cloud accuracy degradation may occur in individual positions..
- ④ Test conditions: Ambient temperature of approximately 25°C, target object reflectivity of 90%, and test distance of 10 m.
- ⑤ Test conditions: Ambient temperature of approximately 25°C, target object reflectivity of 90%, and test distance of 0.2 m. In the 0.05–1 m range, low-reflectivity objects (including but not limited to black foam, water surfaces, mirrors, glossy surfaces, or matt-treated objects) and small objects (such as thin wires) may not guarantee detection effects
- ⑥ This function is currently unavailable. If customers need to enable it, please contact our company.
- ⑦ Refers to the proportion of false alarm noise points caused by ambient stray light under 100 klx daylight conditions and an ambient temperature of approximately 25°C.
- ⑧ In high/low temperature environments, strong vibration, heavy fog, etc., the performance of LDS-M300-E will slightly decrease. Prolonged high-temperature operation may affect product performance or even cause damage. It is recommended to add effective heat dissipation measures to ensure the inner wall temperature of the housing cooling fins does not exceed 80°C. If overheated, the over-temperature protection mechanism will trigger: the LDS-M300-E will issue an over-temperature warning and stop operating in severe cases..

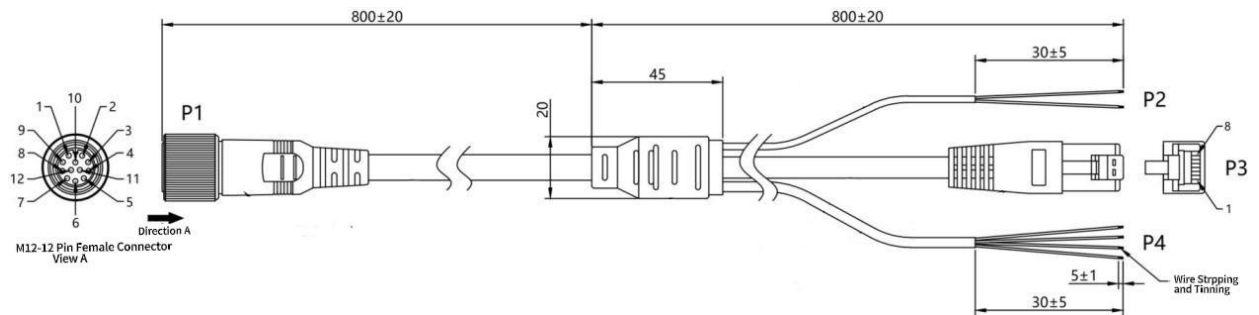
5.2 Interface Definition

The LDS-M300-E uses a 12-core M12 aviation plug. The wiring diagram and pin definitions are as follows:



The mating connector cable for LDS-M300-E is a 1-to-3 cable as shown in the figure below. P2, P3, and P4 are the power cable, RJ45 network crystal head, and function cable respectively, and the wire sequence arrangement shall refer to the interface pin definition.

The mating connector cable needs to be purchased separately. Customers can also make their own cables according to the interface pin definition.



Interface Pin Definitions			
Pin Number	LiDAR Wire Color	Mating Wire Color	Pin Definition
1	Brown	Red	12~32V DC
9	Gray	Red	12~32V DC
2	Orange	Black	GND
3	Purple	Black	GND
4	Yellow - Black	Orange	Ethernet TX+

5	Yellow	Orange - White	Ethernet TX-
6	Blue - Black	Green - White	Ethernet RX+
7	Blue	Green	Ethernet RX-
8	Black	Blue	Second Pulse (Reserved)
10	Red	Brown	GPS Input (Reserved)
11	White	White	485A (Reserved)
12	Green	Yellow	485B (Reserved)

LiDAR Wiring Method and Pin Definitions

5.3 Communication and Interface

The LDS-M300-E uses the static IP mode for data communication (UDP) via Ethernet. A standard Ethernet interface connection is used to connect the product to a computer with a network cable. To ensure normal communication between the LiDAR and the computer, they need to be in the same network segment, and the LiDAR's upload IP should match the computer's IP.

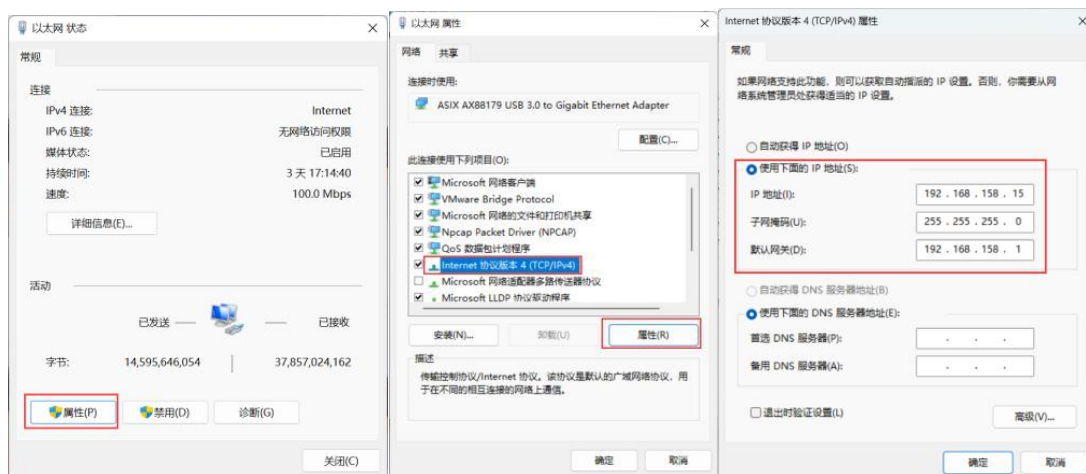
The LiDAR factory settings are as follows:

- LiDAR IP: 192.168.158.98
- LiDAR subnet mask: 255.255.255.0
- LiDAR gateway: 192.168.1.1
- Default upload address of LiDAR: 192.168.158.15

The computer network settings are as follows:

- Computer IP: 192.168.158.15
- Computer subnet mask: 255.255.255.0
- Computer gateway: 192.168.158.1

The computer IP setting process is as follows:



Notes:

When connecting the power cable and functional cables to the product, please refer to the interface definitions in 5.2 for correct wiring. Ensure the correct power polarity and voltage range. Do not connect power to the RJ45 network port or functional cables. Incorrect wiring may cause permanent damage to the product.

If multiple LDS-M300-E units need to be connected to the PC simultaneously, set each LDS-M300-E to a different IP address and connect them via a Gigabit router or Gigabit switch.

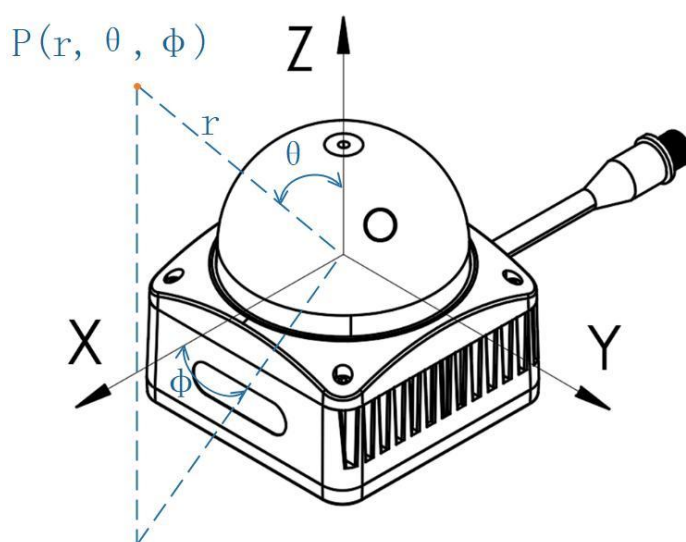
5.4 Definition of the coordinate system

The coordinate system of LDS-M300-E is shown as follows: Point O is the coordinate origin, and O-XYZ represents the point cloud coordinate system of LDS-M300-E. Since the data packet encapsulated by the LiDAR contains horizontal rotation angles and distance parameters, to present the effect of a 3D point cloud map, the spherical coordinate point cloud data (r, θ, ϕ) can be converted into Cartesian coordinates (x, y, z) using the following transformation relationships:

$$x=r*\sin(\theta)*\cos(\phi)$$

$$y=r*\sin(\theta)*\sin(\phi)$$

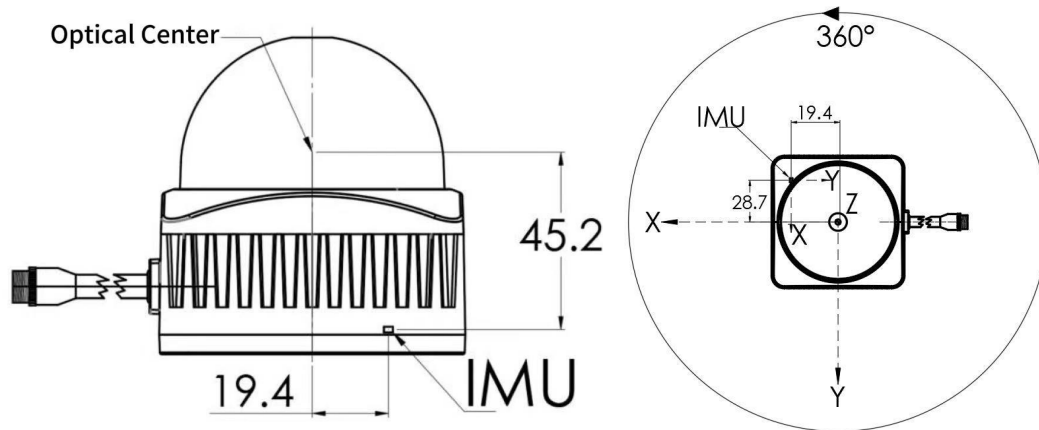
$$z=r*\cos(\theta)$$



Schematic Diagram of LiDAR Coordinate System

5.5 IMU Position

The LDS-M300-E is equipped with a built-in 3-axis accelerometer and 3-axis gyroscope. The IMU data includes 3-axis acceleration and 3-axis angular velocity. The coordinates of the IMU chip in the LiDAR point cloud coordinate system (x, y, z) are (19.4mm, -28.7mm, -45.2mm). The position of the IMU chip is shown in the figure below, and the specific data protocol refers to 6.2.

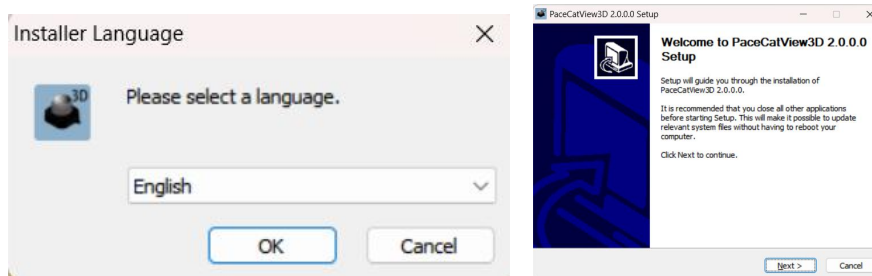


VI. Host Computer Software

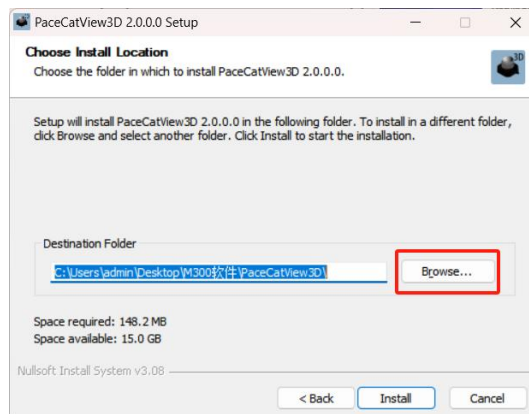
6.1 Instructions for Host Computer Use

6.1.1 PaceCatView3D Installation Tutorial

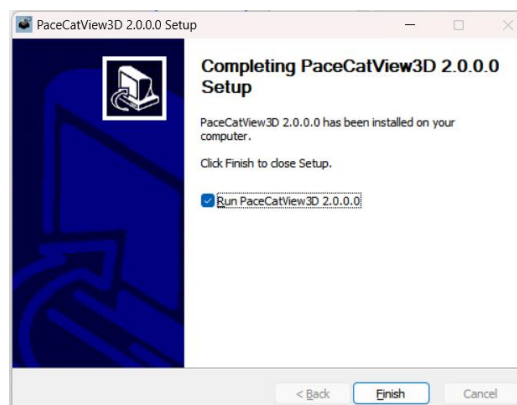
Double-click the PaceCatView3D.exe installation package. Users can select either Simplified Chinese or English as the language environment. Taking English as an example:



After selecting an appropriate installation path, click **Install**:

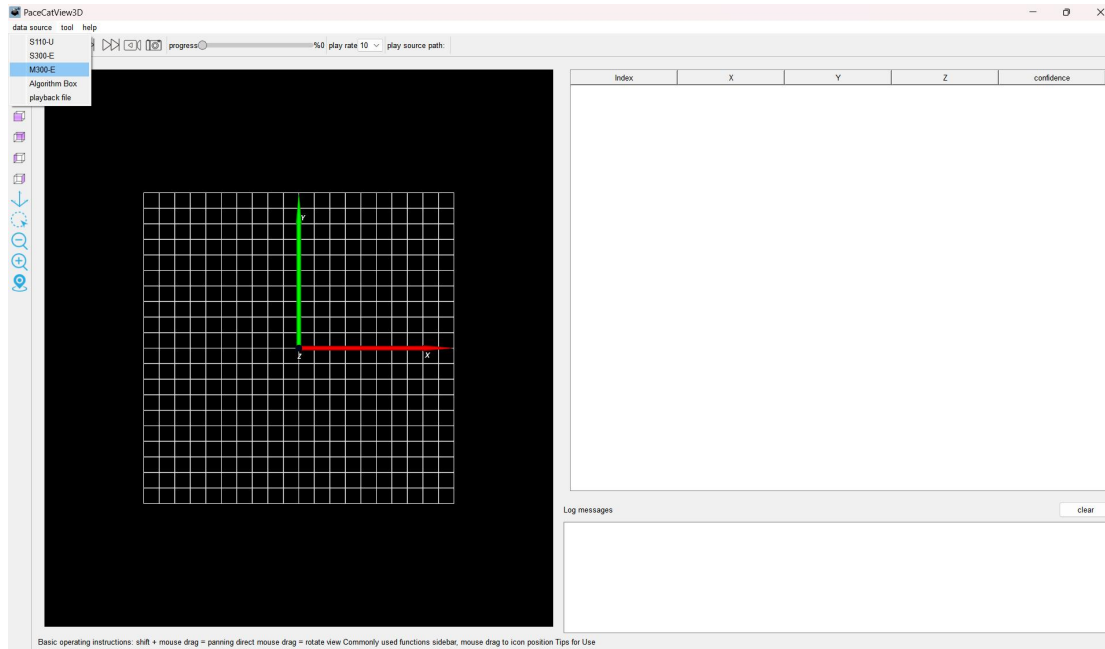


After the installation is complete, you can choose whether to open the host computer software after clicking **Finish**. In this example, select Open:

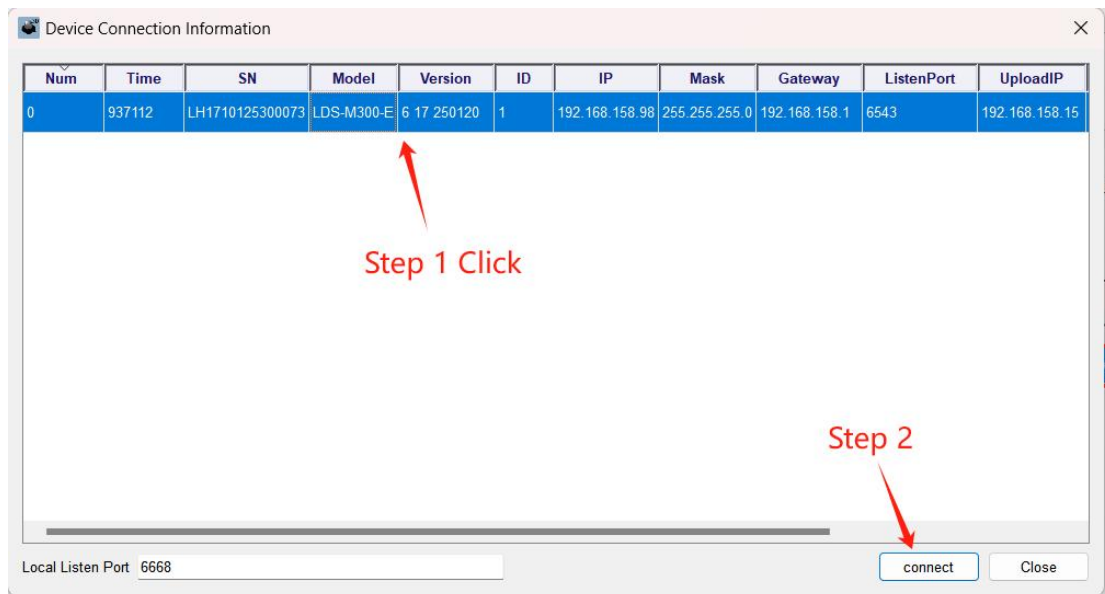


6.1.2 PaceCatView3D connection tutorial

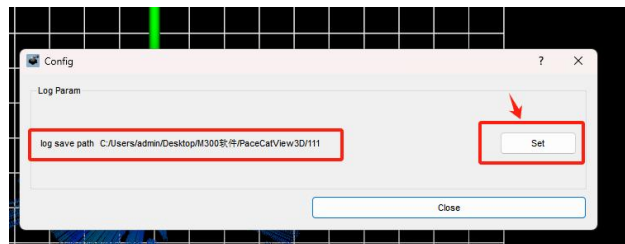
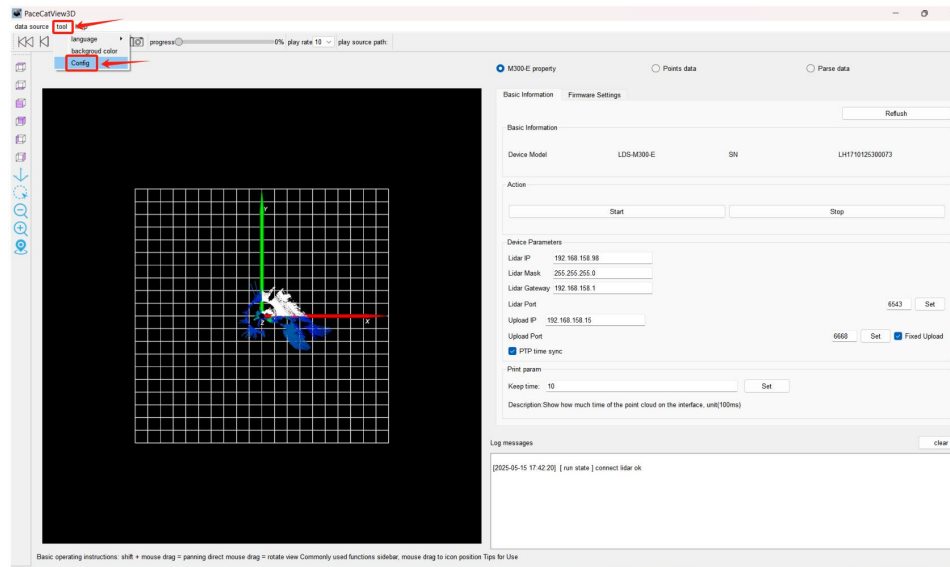
Open PaceCatView3D.exe; to connect the LiDAR, select Connect → the corresponding LiDAR model (here, select M300-E)





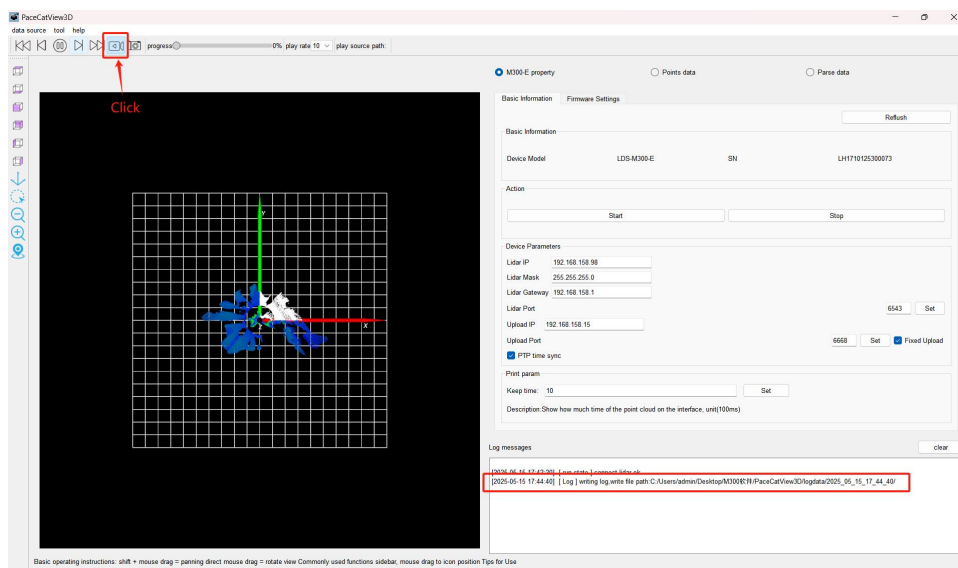
A device list window will pop up. Select the LiDAR to be connected and click Connect



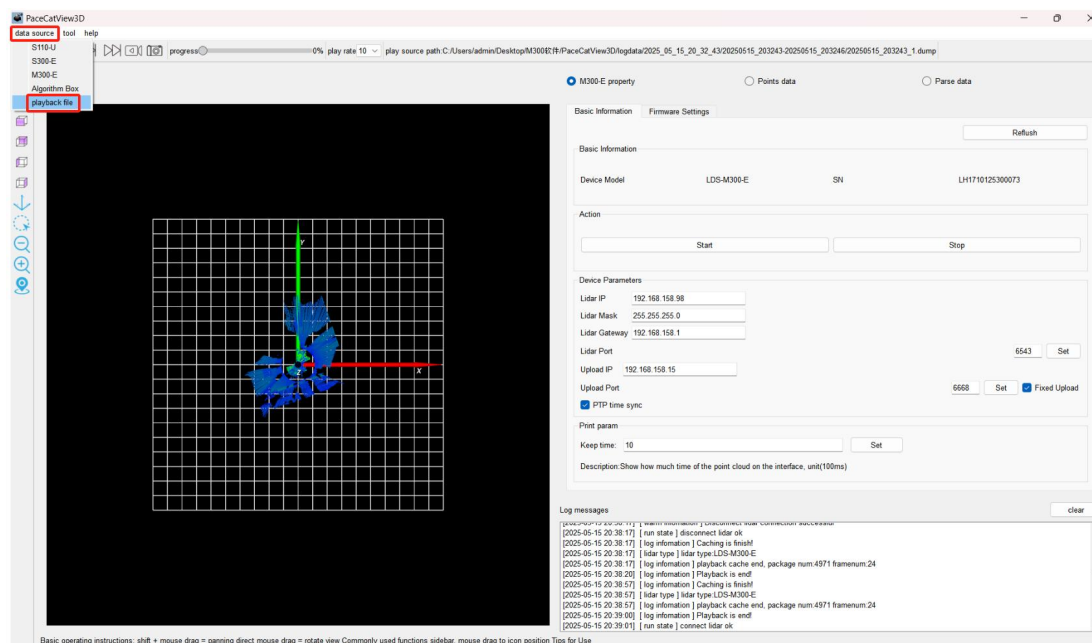
Once the host computer successfully connects to the LiDAR, it will automatically jump to the point cloud interface, where users can view the LiDAR point cloud. To save the LiDAR point cloud data, select tool → Config → Set. Users can choose a suitable save path.



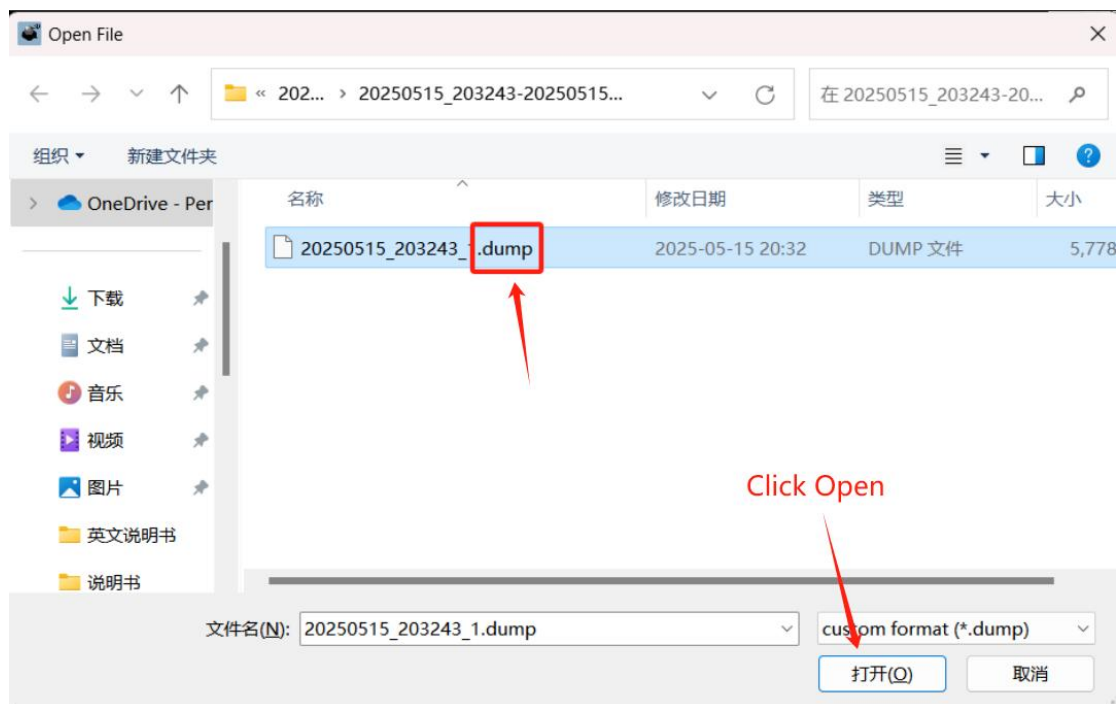
Click the  on the left to start recording point cloud data; click the  again to stop recording, and the data will be saved in the “logdata” folder.



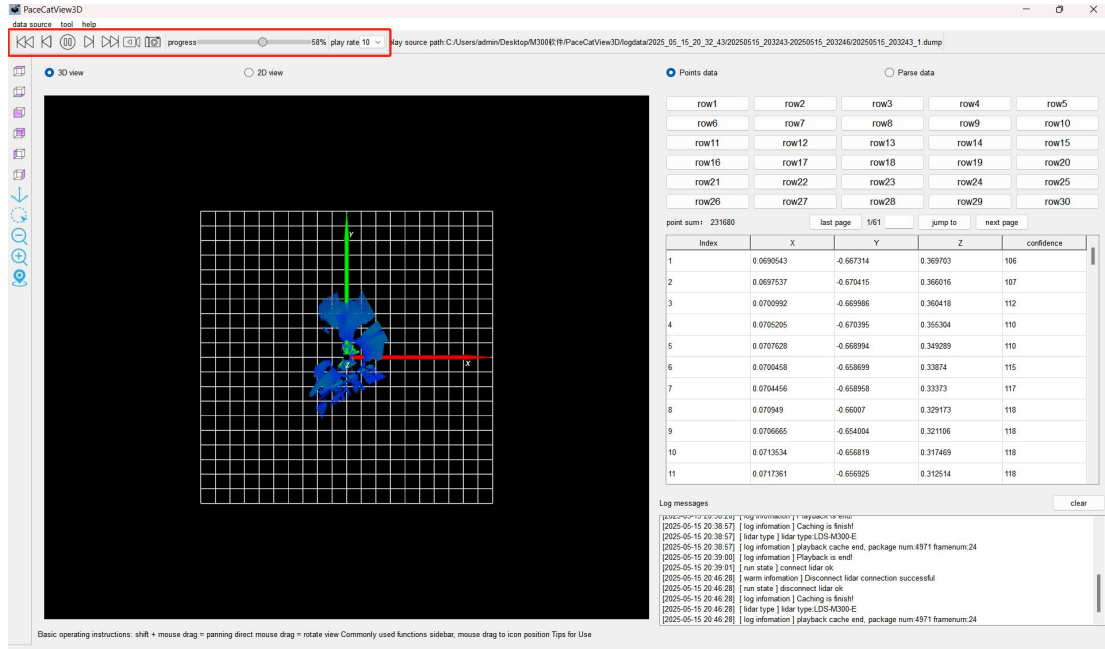
Click "data source" and then select "playback file".



Find the "dump" file in the "logdata" folder.

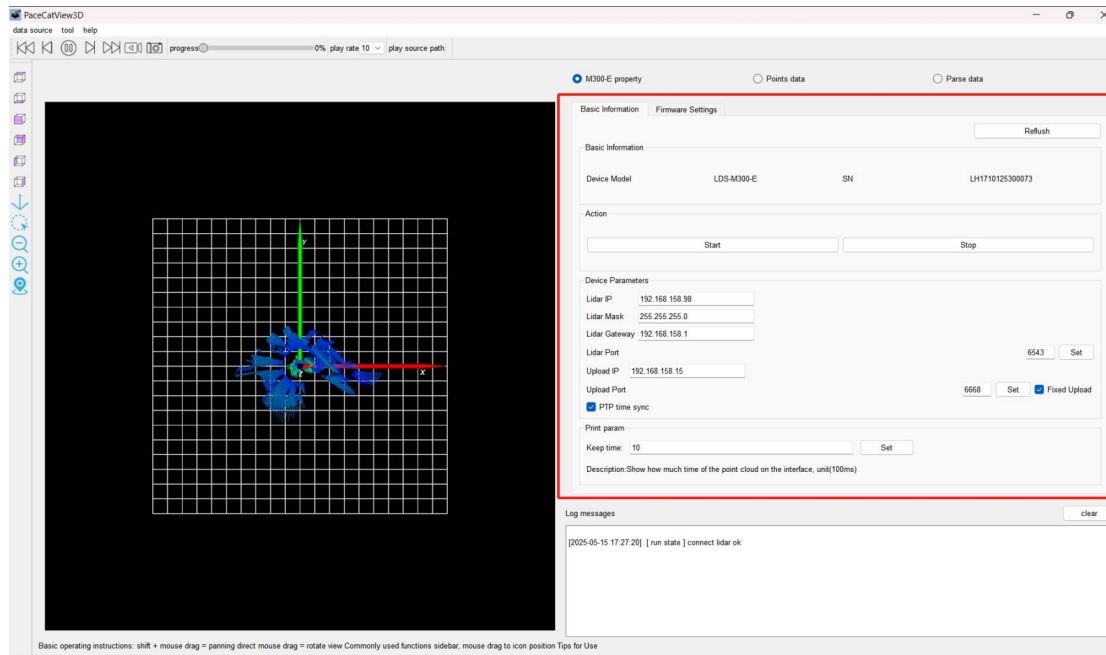



During playback, you can choose the playback frame rate. To replay repeatedly, manually drag the progress bar to the starting position and play again. The host computer will default to disconnecting the LiDAR during data playback.

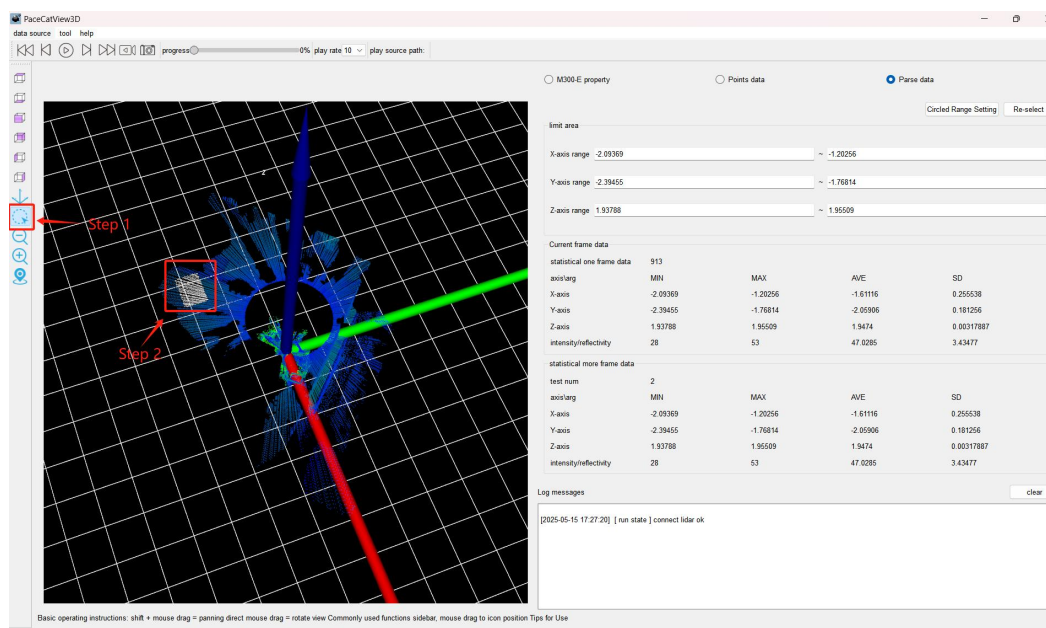



6.1.3 PaceCatView3D Description of basic functions

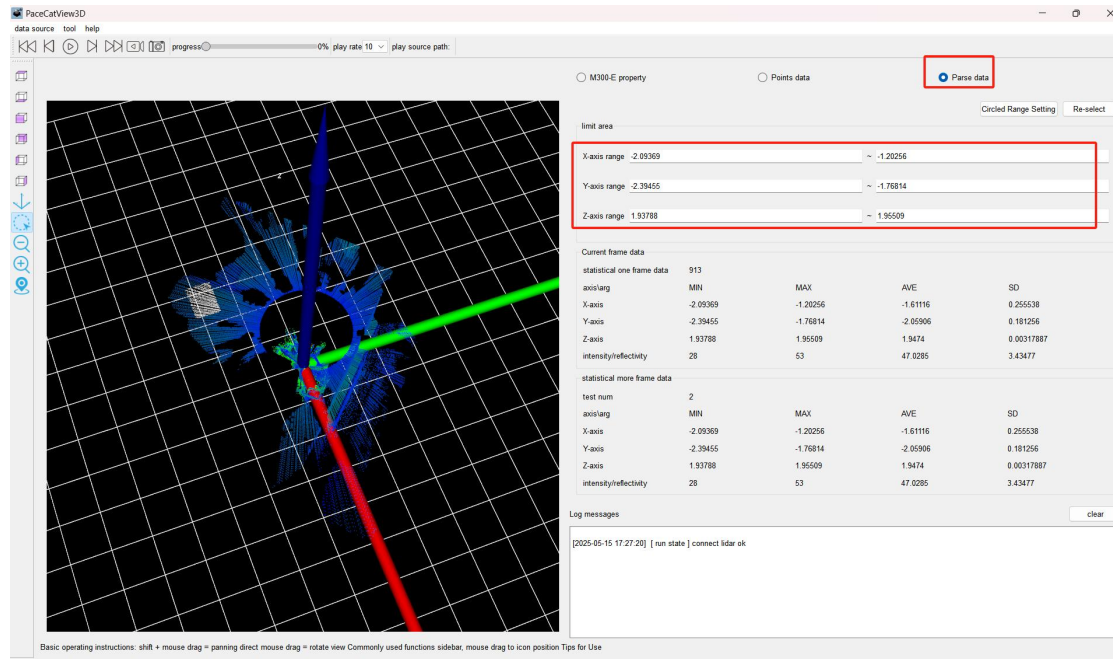
The device parameter section of LiDAR basic information supports modifications, as shown in the right part of the figure below. Users can set parameters independently. Note for IP modification: The LiDAR's upload IP must match the computer's IP, and only fixed upload mode is currently supported.



On the point cloud interface, click the  on the left, left-click one vertex, and right-click another vertex to select an area for region filtering.



Click “Parse Data” on the right to view the coordinates of the filtered region. You can also modify the coordinates here to filter a new region. Click the  again or click Set Selection Range to cancel the region filtering function.



VII. Data Communication Protocol

The LDS-M300-E outputs data in three main types: point cloud data, IMU data, and network heartbeat data.

7.1 The point-cloud data protocol

Single dot data

```
typedef struct {
    uint32_t depth: 24;           // Depth
    uint32_t theta_hi: 8;         // Vertical angle (high bits)
    uint32_t theta_lo: 12;        // Vertical angle (low bits)
    uint32_t phi: 20;             // Horizontal angle
    The uint 8 _ t reflectivity;   // Reflectivity intensity
    char rsvd;                    // Reserved byte
} PacecatSpherPoint;
```

Real-time Rotation Speed Information

```
typedef struct {
    uint16_t mirror_rpm;          // Mirror rotation speed of the LiDAR head
    uint16_t motor_rpm_x10;       // Baseplate rotation speed (×10)
    uint8_t tags;                 // Error code
} RuntimeInfoV1;
```

Point cloud data

```
typedef struct {
    uint8_t version;              // Version number
    uint16_t length;              // Data length
    uint16_t time_interval;       // Packet time (0.1us per unit, time from first to last point)
    uint16_t dot_num;             // Number of points
    uint16_t udp_cnt;             // Packet counter (auto-increments, cycles after
reaching maximum)
    uint8_t frame_cnt;            // Frame counter (not enabled)
    uint8_t data_type;            // Data type (fixed value currently)
    uint8_t time_type;            // Time type (not enabled)
    union {
        RuntimeInfoV1 rt_v1;      // Real-time rotation speed information
        uint8_t rsvd[12];         // Reserved field
    };
    uint32_t crc32;               // CRC32 checksum (not enabled)
    uint64_t timestamp;           // Complete timestamp (nanoseconds)
    PacecatSpherPoint points[dot_num]; // Point data array
} PointCloudData;
```

7.2 IMU Data Protocol

Raw IMU Data Structure

```
#define TRANS_BLOCK 0x200
typedef struct {
    uint16_t code;           // fa88
    uint16_t len;            // Data length
    uint16_t idx;            // Sequence number for packet loss detection
    (increments by 1)
    char rsvd[2];            // Reserved bytes
    uint8_t data[TRANS_BLOCK]; // Data payload
} TransBuf;
```

The IMU post-transformed data

```
typedef struct
{
    uint8_t Header;
    int16_t Accel_X;        // linear velocity x-axis
    int16_t Accel_Y;        // linear velocity y-axis
    int16_t Accel_Z;        // linear velocity z-axis
    int16_t Gyro_X;         // Acceleration x-axis
    int16_t Gyro_Y;         // Acceleration y-axis
    int16_t Gyro_Z;         // Acceleration z-axis
    char rsvd[3];           // Keep the bytes
    uint64_t timestamp;     // full time-stamp nanoseconds
}IIM42652_FIFO_PACKET_16_ST;
```

7.3 Network heartbeat protocol

```
struct {  
    char    sign[4];                // must be "LiDA"  
    uint32_t proto_version;         // Protocol version number  
    uint32_t timestamp[2];          // Timestamp (high and low 32 bits)  
    char    dev_sn[20];             // LiDAR serial number  
    char    dev_type[16];           // LiDAR model  
    uint32_t version;               // Firmware version  
    uint32_t dev_id;                // LiDAR ID  
    uint8_t ip[4];                  // LiDAR IP address  
    uint8_t mask[4];                // Subnet mask  
    uint8_t gateway[4];             // Gateway address  
    uint8_t remote_ip[4];           // Upload destination IP address  
    uint16_t remote_udp;             // Upload destination UDP port  
    uint16_t port;                  // Service port  
    uint16_t status;                // LiDAR operational status  
    uint16_t rpm;                   // Baseplate rotation speed  
    uint16_t mirror_rpm;            // Mirror rotation speed  
    uint8_t ranger_version[2];       // Ranging module version  
    uint16_t CpuTemp;               // CPU temperature (scaled value)  
    uint16_t InputVolt;             // Input voltage (scaled value)  
    uint8_t alarm[16];              // Alarm status flags  
    uint32_t crc;                   // CRC32 checksum  
};
```

7.4 Network Heartbeat Protocol Parsing Example

```

ff ff 19 91 1a 85 00 78 14 9f 4c 69 44 41 01 01
00 00 c6 7e 89 36 66 04 00 00 4c 48 31 37 31 30
30 32 34 41 30 30 30 33 37 00 00 00 00 00 00 4c 44
53 2d 4d 33 30 30 2d 45 00 00 00 00 00 00 00 d2 ad
13 19 01 00 00 00 c0 a8 01 25 ff ff ff 00 c0 a8
01 01 c0 a8 01 0c 0c 1a 8f 19 01 00 ad 29 3d 18
20 c5 4e 02 2a 2d 00 00 00 00 00 00 00 01 01 00
00 00 00 00 00 00 23 3a 49 dc
  
```

data	explain
4c 69 44 41	Frame header / LiDA
01 01 00 00	Protocol Version / 0x00000101
c6 7e 89 36 66 04 00 00	Timestamp / 0x0000046636897ec6; unit of ns
4c 48 31 37 31 30 30 32 34 41 30 30 30 33 37 00 00 00 00 00	Serial Number / LH1710024A00037
4c 44 53 2d 4d 33 30 30 2d 45 00 00 00 00 00 00 00	Model / LDS-M300-E
d2 ad 13 19	Firmware Version / 0x1913add2
01 00 00 00	Device ID / 0x00000001
c0 a8 01 25	LiDAR IP / 192.168.1.37
ff ff ff 00	Subnet Mask / 255.255.255.0
c0 a8 01 01	Gateway / 192.168.1.1
c0 a8 01 0c	Upload IP / 192.168.1.12
0c 1a	Upload port / 0x1a0c / 6668
8f 19	LiDAR port / 0x198f / 6543
01 00	LiDAR status / 0x0001
ad 29	Baseplate RPM / 0x29ad/1066.9rpm; unit 0.1
3d 18	Mirror RPM / 0x183d / 6205rpm; unit 1
20 c5	Ranging Module Version / 0xc520
4e 02	CPU Temperature / 0x024e / 59.0 degrees; unit 0.1
2a 2d	Input Voltage / 0x2d2a/11.562V; unit 0.001
00 00 00 00 00 00 00 00 01 01 00 00 00 00 00 00 00	Alarm Info
23 3a 49 dc	Checksum

VIII. Development Tools & Supports

To facilitate users in quickly developing products with the LDS-M300-E LiDAR, PACECAT provides the following development tools:

For downloading SDK development kits, sample programs, and ROS drivers for Windows, Linux and other platforms, please visit:

<https://github.com/BlueSeaLiDAR/m300>

For any inquiries, please contact BlueSea's after-sales hotline: 400-822-0027.