MS200 dToF Lidar

USER MANUAL

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Document number：PD-P2117008 Version：A0

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Safety Guidelines

1. Do not disassemble or modify the product without authorization so as to prevent product damage or radiation exposure.
2. Do not fall or hit the product, otherwise, the internal components of the product may be damaged, resulting in abnormal work.
3. Please carefully check the power supply demand of the product, and the excess power supply may cause permanent damage to the product.
4. Do not scrape the optical cover, and keep the optical cover clean, otherwise, the product performance may be affected.
5. The product is classified as class 1 laser product (IEC / EN 60825-1:2014), which is safe under all normal use conditions, but do not look directly at the laser transmitter through the amplification equipment.
6. The product is not waterproof, do not let the product contact with any liquid or use any liquid with cleaning function to clean it.
7. It is strictly prohibited to use or store products in flammable, explosive or corrosive environments to void product damage.

CONTENT

1. Product Overview

Product Profile

MS200 is a low-cost, single-line high-precision Lidar sensor launched by Shenzhen O-radar Technology Co., LTD. The Lidar adopts precise optical scanning system, combined with high frequency laser pulse generation technology and exquisite structural design, and can achieve fast and accurate distance measurement in the range of 360°/12.0m (@90% reflectivity diffuse reflector surface). This product can be widely used in, including home sweeping robot, service robot navigation and obstacle avoidance, robot ROS teaching, research, regional security, scanning and 3D reconstruction and many other areas.

Operational Principle

The measurement principle 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 SPAD chip receives the 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. Through the built-in brushless motor, the distance is measured at different angles by rotating the ranging module, thus scanning to obtain the point cloud outline of the surrounding environment.

Product Features

Long range measurement: Integrated with a variety of telemetry optimization algorithms, 90% reflectivity range of up to 12.0m, effectively improve the efficiency of map building.

High accuracy: Compared with the triangulation principle-based Lidar, MS200 adopts dToF ranging principle to measure distance without accuracy & precision degradation with increasing distance.

Ultra-small size: 37.7*37.5*33.0mm (L*W*H), which can be built into the robot body to optimize the space utilization inside the robot.

Ultra-long service life: the power system adopts custom optimized brushless DC motor, with a service life of over 10000h.

2. Specifications

Table 2-1 MS200 Specifications

Product model	MS200	Description
Measurement range	0.03m~12m	90% reflectivity
Measurement accuracy	Typical values: ±10mm [0.03m~ 2.0m) ±20mm [2.0m~12.0m] Max value: ±20mm [0.03m~ 2.0m) ±30mm [2.0m~12.0m]	The statistical results of at least 100 data acquisitions by lidar at 90% reflectivity conditions. Accuracy is the difference between the mean and true value of the data, and precision is the sample standard deviation of the data (1σ)
Measurement precision	Typical values: ≤4mm [0.03m~2.0m) ≤15mm [2.0m~12.0m] Max value: ≤10mm [0.03m~2.0m) ≤30mm [2.0m~12.0m]	
Data contents	Distance, angle, intensity, timestamp	-
FOV (horizontal)	360°	-
Measurement frequency	4,500points/s	-
Frame rate	5~15Hz, default 10Hz	Configurable with 1Hz interval
Resolution (horizontal)	0.8°@10Hz	Angular resolution with respect to point frequency
Pitch angle of laser emission	0.5~2°	The bottom surface of the outer frame of the lidar base is the reference
Laser emission azimuth	0±2°	-
Laser wavelength	905±10nm	-
Laser Class	Class 1 Eye safe	IEC60825-1:2014
Ambient illuminance	40,000 lux	-
Working life	≥10,000hours	According to the speed 600rpm test
Voltage supply range	DC 5.0±0.5V	-
Voltage supply ripple	＜100mV	-
Start-up current	＜500mA	-
Working current	Typical 260mA	Max 300mA
Operating temperature	-10°C~50°C	Typical 25℃
Storage temperature	-30°C~70°C	Typical 25℃
Protection class	IP5X	-
Dimensions	37.7*37.5*33.0	Long*width*height(mm)
Weight	~40g	
Certification	RoHS2.0, REACH, CE, FCC	

3. Electrical Interface

Interface Definition

The MS200 uses a standard 4-pin 1.5mm pitch female chassis interface, which is equipped with system power and data communication functions.

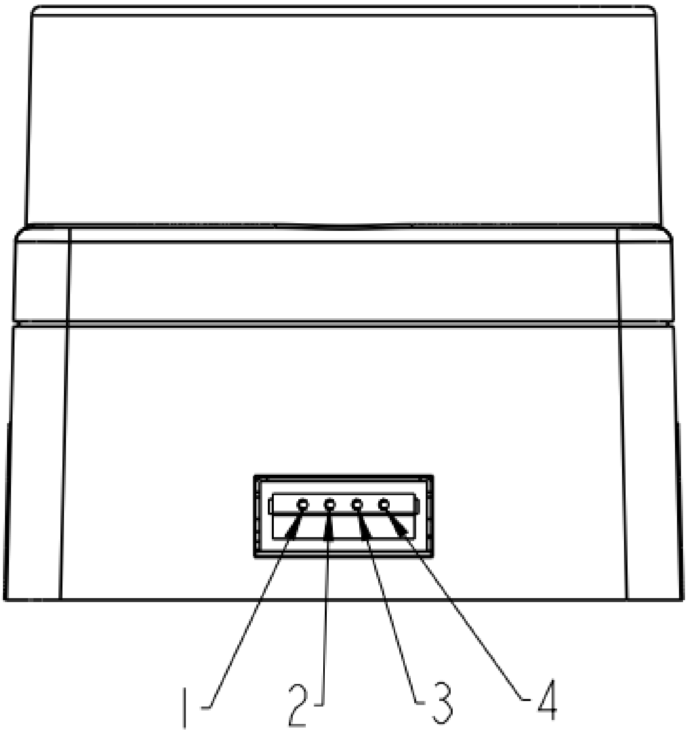

Figure 3-1 Oradar MS200 interface

Table 3-1 Interface wire sequence

Pin	Signal	Properties	Description
1	Tx	Serial data sending	Tx（Local sending，0V~3.3V)
2	Rx	Serial data receiving	Rx（Local receiving，0V~3.3V)
3	GND	Input power negative	GND（0V)
4	VCC	Input power positive	DC 5.0V（4.5V~5.5V)

Serial Port Configuration

The MS200 communicates with the outside in both directions through the UART serial port. The serial port configuration parameters are set as shown in the following table:

Table 3-2 Serial port configuration parameters

Baud rate (bps)	Data bit	Stop bit	Check bit	Flow control
230400	8	1	None	None

4. Mechnical Interface

Mechanical Dimension

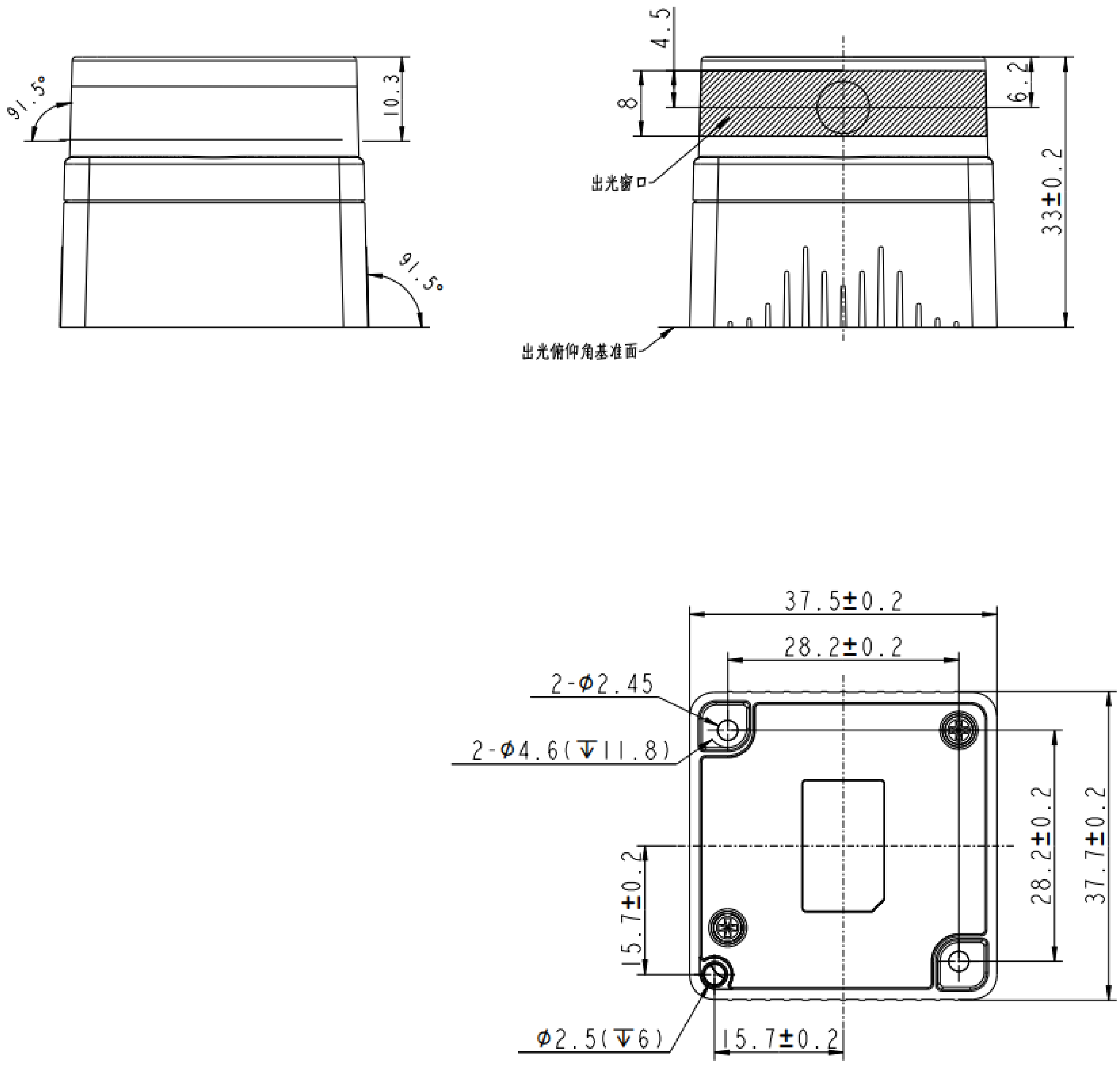

Figure 4-1 Oradar MS200 mechanical structure

Table 4-1 Oradar MS200 product size

Category	Parameter	Decription
Product size	37.7×37.5×33.0	Long*width*height(mm)
weight	About 40g	Slight variation in net weight for each product

Polar Coordinate System

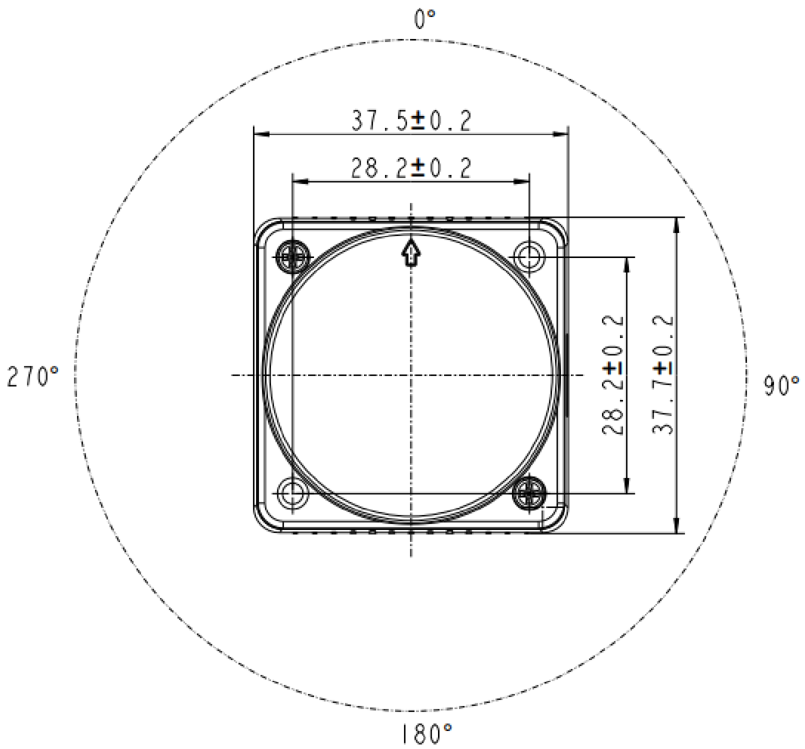

Figure 4-2 Oradar MS200 polar coordinate system

The angular information output within the MS200 product protocol is defined by the polar coordinate system within the Lidar.

As shown in the mechanical structure diagram, the top of the Lidar optical housing is marked in the zero-degree angle direction and the angle rotation direction is clockwise.

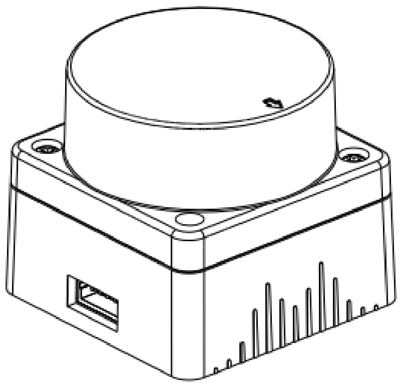

Figure 4-3 Oradar MS200zero angle identification

Due to production assembly tolerances, there is a tolerance of ±2° in the azimuth of the laser's zero-degree exit.
The laser distance sensor must not be installed in such a way as to block its light output window.

The overall orientation diagram is shown above. According to the definition of the polar coordinate system, the zero-degree angle is the marking direction of the top of the outer cover, and the Lidar external interface socket is located at 90°.

5. Working Mode

Oradar MS200 system is set up with 2 working modes: ranging mode and standby mode.

Ranging mode: The Lidar is successfully initialized and enters into normal ranging operation.

Standby mode: The Lidar is successfully initialized, but no laser beam is emitted, and the system enters a low-power state. In other words, the system stops ranging and the serial port stops data transmission.

System Workflow

Oradar MS200 outputs the lidar SN code immediately after power up. After stabilizing the rotation, the range is scanned and the point cloud measurement data is output through the serial port.

The SN Code Data Format

Oradar MS200 will output SN code once after power on; when the lidar enters the ranging state from the standby state, it will also output SN code information once, and the first packet of data is the SN code information. The data format is as follows:

Table 5-1 MS200 SN code data format

Offset (Byte)	Length (Byte)	Field	Description
0	2	Frame header identification	Takes the value 0x55AA to mark the starting position of the data frame
2	1	Flag bit	Fixed to 0x01, indicating that the current message is a SN code
3	1	Data length	Thereafter, the length of the data excluding the check and the end of the frame, N
4	N	SN code info	The SN code corresponds to an array of ASCII characters, such as: CF3P525002F
4+N	1	Check Bit	The CRC-8 checksum of all previous bytes
5+N	2	Frame tail	Takes the value 0xF231 to mark the end of the data frame

Point Cloud Data Format

The MS200 outputs point cloud data, including distance, angle, target reflection intensity, rotational speed information, and time stamp.

The point cloud data is the sum of all point clouds detected by the LIDAR detector on the surface of the measured object in the measured environment, and each point cloud includes distance and target reflection intensity information.

The MS200 outputs the point cloud information within the detection range, including the position and intensity information of each point in the point cloud. The point cloud data frames are transmitted in hexadecimal small print, and the data types are unsigned integers, and the data format is shown below:

Table 5-2 Oradar MS200 data format

Offset (Byte)	Length (Byte)	Field	Description
0	1	Frame header identification	Takes the value 0x54 to mark the starting position of the data frame
1	1	The number of the point cloud in a packet of data	Length 1 Byte, the high three bits are reserved, the low five bits indicate the number of measurement points of a packet, currently fixed at 12
2	2	Speed	Current rotation speed in °/s
4	2	Start angle	Point cloud starting angle in 0.01 °
6	3*N	Point cloud info	Point cloud information data block
6+3*N	2	End angle	Point cloud end angle in 0.01 °
8+3*N	2	Time stamp	0~29999ms, after 29999. The timestamp corresponds to the first point of each packet of data.
10+3*N	1	Check bit	The CRC-8 checksum of all previous bytes

The point cloud information contains the distance and intensity information from the first point of the starting angle measurement to the nth point of the ending angle measurement in sequence. Currently, N is fixed to 12. Each point information is represented by 3 bytes and the nth point data format is shown as follows:

Table 5-3 Point cloud data format

Offset (Byte)	Length (Byte)	Field	Description
6+3*(n-1)	2	Distance	Unit is 1mm
8+3*(n-1)	1	Intensity	Rang is 0~255

The intensity indicates the intensity of the laser pulse echo, and the larger the value, the higher the confidence of the range measurement, and the smaller the value, the lower the confidence. The intensity values 0~15 are reserved values.

Intensity value	Description
0	Error code, invalid value
2	High reflectivity environment
3	Low signal-to-noise ratio

The angle value of each point in the point cloud information can be obtained by linear interpolation of the starting and ending angles. The calculation method is:

```
step = (theta_end - theta_start) / (N - 1)
theta_n = theta_start + n * step;
```

The CRC calibration calculation example codes are 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
};

/**
 * @description: crc8 calibration
 * @param {uint8_t} *data
 * @param {uint8_t} len
 * @return {*}
 */
uint8_t get_crc8_result(uint8_t *data, uint8_t len)
{
    uint8_t crc = 0;
    if(data == NULL)
    {
        return 0;
    }

    for (uint16_t i = 0; i < len; i++)
```

```
    {
        crc = CrcTable[(crc ^ *data++) & 0xff];
    }

    return crc;
}
```

The distance and angle information of the point cloud is related to the polar coordinate system definition of the LIDAR. As shown in Figure 3-3, the direction of the ⇧ mark on the top of the radar optical enclosure is zero degree angle and the direction of angular rotation is clockwise.

6. Quick Start Guide

If you are a first-time user of the MS200 and wish to quickly evaluate the performance of the product, or wish to do secondary development based on the product, you can use the adapter board, Oradar Viewer software, SDK and ROS package provided by Oradar to quickly get started evaluating the performance of the MS200 and early development.

Device Connection

It is recommended to use the Oradar adapter board with a USB Type-C cable to connect the device to the PC.

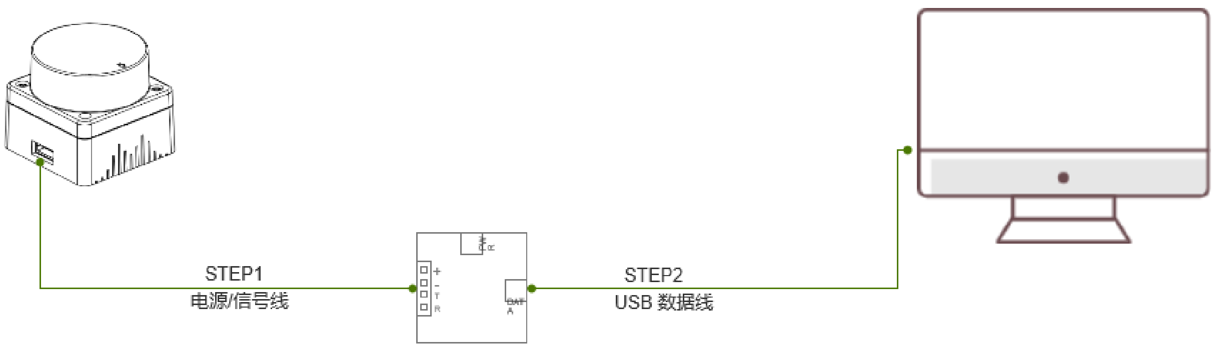

Figure 6-1 Device connection method

Connection steps:

a. Connect the Oradar MS200 to the adapter board using the 4pin power/signal cable;
b. Use a USB Type-C cable to plug into the Data port of the adapter board and connect to a personal computer;
c. Open Oradar Viewer on your personal PC to view MS200 real-time point cloud data.

Oradar adapter board provides USB to UART function, integrated UART@500000/230400/115200, USB data and USB power interface. Some development platforms or personal computers with weak drive current can use the power interface of the adapter board to access DC 5V auxiliary power supply.

图 6-2 Oradar MS200 power adapter board

Easy-to-use Oradar Viewer

Oradar Viewer is a software that can display, record and analyze point clouds in real time. It is convenient for users to evaluate the performance, and with the development kit to observe the point cloud data scanned in the environment on the PC.

Oradar Viewer currently supports Windows 10 (64-bit) operating system. Unzip the file and open the program with the file name MS200Viewer in the extracted file to use it. Connect the device as follows

Figure 6-3 Device connection method.

💡 Check the Oradar Viewer User Manual for more details on how to use it.

Software Development Kit Oradar SDK

In addition to the above-mentioned Oradar Viewer for viewing real-time point cloud data, users can also apply the LIDAR acquired point cloud data to various custom scenarios through the software development kit. The Oradar SDK supports development in Windows/Linux environments and is available as a ROS/ROS2 package.

💡 Please contact your technical support staff for Oradar SDK and related usage.

7. Change History

Version	Edited by	Approved by	Date	Description
A0	Baixiao	Ziliu	2023-05-30	First release

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