LuminWave

DM ToF Camera

User Manual

LWP-D322-I

LWP-D322C-I

LWP-D322W-I

Contents

1 Preface

About This Manual

- The photos, graphics, charts, illustrations, etc. provided in the manual are for explanation and illustration purposes only. There may be differences with the specific products. Please refer to the actual product.
- Due to version upgrades or other needs, our company will update this manual. If you need the latest version of the manual, please log on to the company's official website (www.luminwave.com) to check it.
- It is recommended that you use this manual under the guidance of professionals.

Instructions Before use

- Before using the product, please be sure to read this manual carefully and follow the instructions in the manual to operate the product to avoid product damage, property loss, personal injury, etc.
- If this 3D camera product is used as part of your product, please make sure to provide this manual to the intended users of your product, or provide how to obtain the manual.

Heed Warning

- Warnings in the product and operating instructions to avoid accidents.

Product Maintenance and Technical Support

- Please do not attempt to open the device for repair in the absence of official guidance. If you need repair or encounter problems that cannot be solved by the instructions, please contact Luminwave Technology or Sales.

Disassembly prohibited

- It is prohibited to disassemble the product without the written consent of Luminwave.

2 Safety Notice

Power Supply

- It is recommended to use a 12V , 5A power supply to power the product.
- If you design, configure or select the power supply system (including cables) of the product by yourself , please make sure to follow the power supply and voltage mentioned in the manual, or contact Luminwave technical support. Do not use cables / adapters that do not meet power supply requirements or are damaged .

Electrical Interface

- Before powering on the product, please ensure that the electrical interface is dry and free of dirt. Do not use power in a humid environment.
- Please refer to the interface installation section of the manual and strictly follow the connector plug-in and pull-out instructions. If you have found any abnormalities in the interface (such as pin deflection, damaged cables, loose threads, etc.),
- please stop using it and contact Luminwave for technical support.
Pleasedisconnectthepowersupplybeforepluggingorunpluggingtheconnector.Hotswappingmaycausebreakdown.

Radio Frequency（RF） Interference

- Please be sure to read this manual before use. Although the product is designed, tested, and manufactured to comply with regulations regarding radio frequency energy radiation, radiation from the product may still cause other electronic equipment to malfunction.

Vibration Conditions

- If there may be strong mechanical shock or vibration in the use environment, please contact Luminwave technical support team to obtain the shock and vibration performance parameters of specific product models. Mechanical shock or vibration exceeding the allowable range may cause damage to the product.
- Products should be packaged in shockproof packaging materials to avoid damage during transportation.

Explosiveness

- Do not use the product in any area where potentially explosive atmospheres are present, such as areas where the air contains high concentrations of flammable chemicals, vapors, or particulates (such as granules, dust, or metal powders).
- Do not expose the product to high concentrations of industrial chemicals, including easily evaporated liquefied gases (such as helium), to avoid damaging or impairing product functionality.

Eye Safety

- This product is a Class 1 laser product. The laser safety level complies with the following standards. Please follow the corresponding laser safety instructions:
  IEC/EN 60825-1:2014 21 CFR 1040.10 and 1040.11 standards, except for the deviations stated in Laser Notice No. 56 issued on May 8 , 2019 (IEC 60825-1 third edition)

NOTE: For maximum self-protection, it is strongly recommended not to look directly into the transmitted laser through a magnifying device such as a microscope, head-mounted loupe, or other form of magnifying glass. During the operation of the product, the entire light window can be regarded as the laser emission range of the product, and the direct-viewing light window can be regarded as direct-viewing the laser in transmission.

Enclosure

- The product is mainly composed of metal, glass and plastic, and contains sensitive electronic components inside. Avoid improper handling such as falling and burning. Once the product is dropped or burned, please stop using it immediately and contact Luminwave for technical support.
- Avoid crushing or puncturing the product. Once the product shell is damaged, please stop using it immediately and contact Luminwave for technical support.
- Do not operate the product with the shell loose to avoid damaging personal safety.
- Before operating the product, please ensure that the product is firmly fixed to prevent external forces (such as impact, strong wind, flying rocks, etc.) from causing the product to detach from the fixed position.
- If the product shell contains tooth-like structures and grooves, please wear gloves when operating to avoid cuts, crushes and other personal injuries caused by excessive force.

Light Window

- Do not touch the light window with your hands to avoid getting fingerprints or dirt on the light window.
- Please avoid touching the light window with hard or sharp objects to avoid scratches on the light window. If scratches have occurred, please stop using the product and contact Luminwave technical support; serious scratches on the light window may
- affect the quality of the point cloud data output by the product.
  Be sure to remove the light window protective film before use.

Enclosure High Temperature

- When the product is running or for a period of time after operation, the product enclosure may be at a high temperature. In this case, please note:
  Avoid direct contact with the product enclosure to avoid discomfort or even burns;
  Avoid direct contact of flammable materials with the product enclosure to avoid fire.
- If the product needs to be embedded into other devices, effective measures should be taken to alert third parties of high temperature risks.

Peripherals

- When purchasing peripherals for installation by yourself, be sure to refer to the installation steps in the manual, or contact Luminwave for technical support. Use of non-compliant or mismatched peripherals may damage the product or compromise personal safety.

Equipment Upgrade

- Please be sure to use the upgrade package provided by Luminwave and strictly follow the instructions included in the upgrade package.

3 Disclaimer

- To the maximum extent permitted by law, the products described in this manual (including their hardware, software, firmware, etc.) are provided "as is" and may contain defects, errors or malfunctions. The company does not provide any form of express or implied warranty Warranties, including but not limited to warranties of merchantability, quality satisfaction, fitness for a particular purpose, non-infringement of third party rights, etc.; nor shall we compensate you for any special, incidental, incidental or indirect damages caused by the use of this manual or the use of our products. Including but not limited to losses arising from loss of business profits, loss of data or documents.
- If you connect the product to the Internet, you are at your own risk, including but not limited to the possibility that the product may be subject to network attacks, hacker attacks, virus infections, etc. The company is not responsible for the resulting abnormal product operation, information leakage and other problems, but the company will Provide you with product-related technical support in a timely manner.
- When using this product, please strictly follow applicable laws. The company does not assume any responsibility if this product is used to infringe the rights of third parties or for other improper purposes.
- If the contents of this manual conflict with applicable laws, the legal provisions shall prevail.

一 Product Introduction

1.1 Product Name

LuminWave DM ToF camera.

This user manual includes the following product models: LWP-D322-I、LWP-D322C-I、LWP-D322W-I、LWP-D322-IS、LWP-D322C-IS、LWP-D322W-IS.

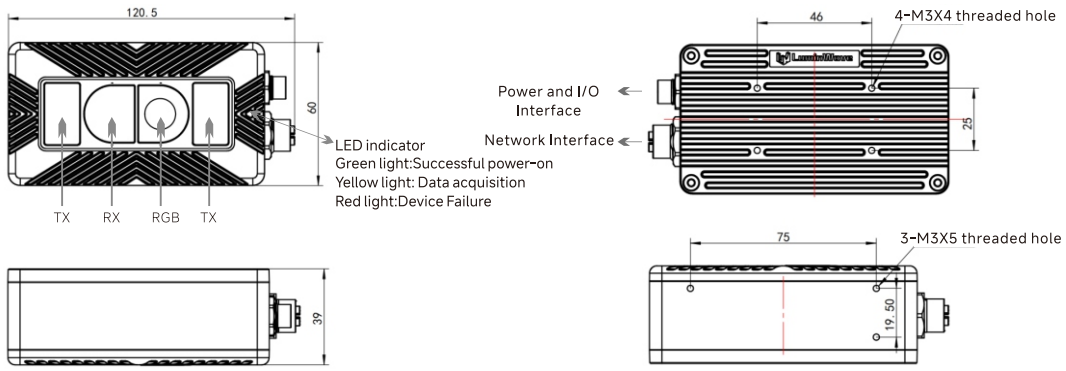
1.2 Product Overview

The DM camera is an industrial-grade RGBD smart camera. It has a high-performance iToF sensor based on SONY DepthSense™ technology platform, and powered by the RK3588 processor, which boasts a 6TOPS computing capability. It features high dynamic range and high frame rate modes. Additionally, it offers standardized tutorials for secondary development and a set of basic operator interfaces, enabling users to develop and deploy 3D vision AI application algorithms efficiently.

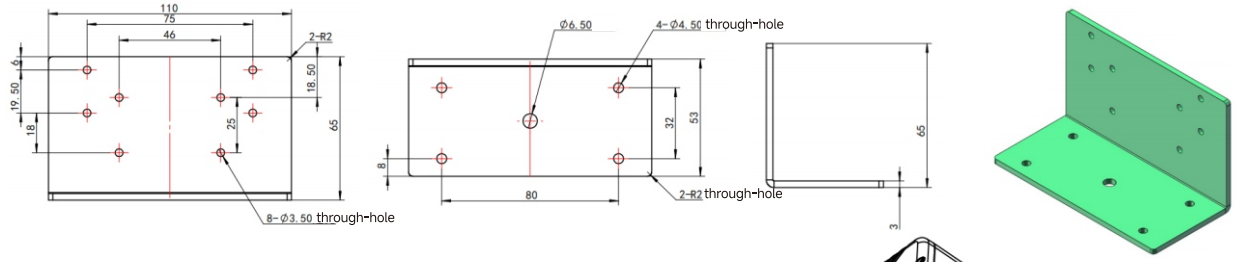
The product can be widely applied in scenarios such as Logistics Depalletizing, Collision Avoidance, Pallet Recognition, Safety Area Protection, Smart Construction Sites, Agricultural Harvesting, Smart Wheelchairs, Intelligent Security and People Flow Statistics.

1.3 Product and Accessory Dimensions

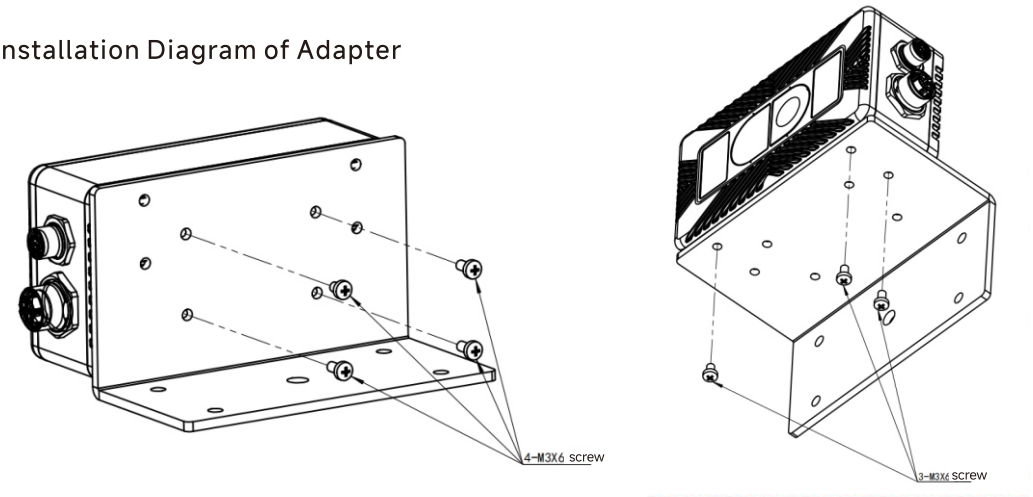
1.3.1 Product Dimensions



1.3.2 Adapter Bracket Dimensions (only available in S version)



1.3.3 Installation Diagram of Adapter



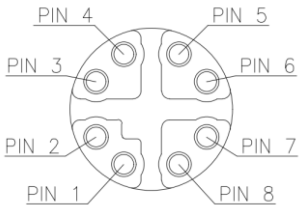
1.4 Specifications

Product munber		LWP-D322-I LWP-D322-IS (Standard FoV)	LWP-D322C-I LWP-D322C-IS (RGBD)	LWP-D322W-I LWP-D322W-IS (Wide FoV)
Operating Principle		ToF（Time-of-Flight）Depth Camera		
Sensor		Sony IMX570		
Laser		940nm VCSEL*2		
* Working Distance		0.2m~10m		
Ranging Accuracy		±3mm+0.25%*depth		
ToF Field of View（H x V）		70°x 50°		103°x 81°
ToF Resolution		640*480dpi		
RGB Resolution		—	1600*1200dpi	—
Frame Rate		Standard mode：Max 28fps High speed mode：Max 56fps		
Human Eye Safety		Class 1		
Function	HDR Function	Normal HDR, High-precision HDR		
	Exposure Time	0-4000μs exposure time adjustment		
	Filters	Support multiple filter settings including spatial, temporal, confidence, and fly point filters		
	Output Data Type	Depth、IR、PointCloud、IMU	Depth、IR、PointCloud、IMU、RGB（YUV）	Depth、IR、PointCloud、IMU
Interface	Power Supply	DC12V-24V		
	Power Consumption	<10W		
	Network Interface	M12，8-pin; X-coded; female		
	* Power and I/O Interface	M8，8-pin; A-coded; female		
Physice	* Dimensions（L*W*H）	108mm x 39mm x 60mm		
	Weight	366g		
	*Operating Temperature	-30°C ~ 65°C		
	Storage Temperature	-40°C ~ 85°C		
	Protection Class	IP67		
Supported System		Above Windows 10/ Above Ubuntu 20.04/ Ros		

*Dimensions: Dimensions of the main body.
*Operating Temperature: Extreme operating temperatures may affect product performance. If you have such requirements, please consult our technical staff first.
*Power and I/O Interface: Ensure that the device's power supply voltage is within the range of 7-24.8VDC. Voltage outside this range will affect the device's normal startup.
*Working Distance: The default range is 0.2~5m; for a 10m version, please contact our sales staff for customization.

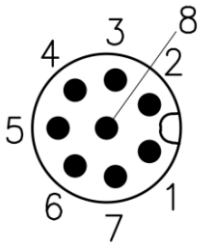
1.5 Hardware Interface

- Network Interface: M12 X-code female connector, compatible with universal M12 to RJ45 gigabit Ethernet cable.

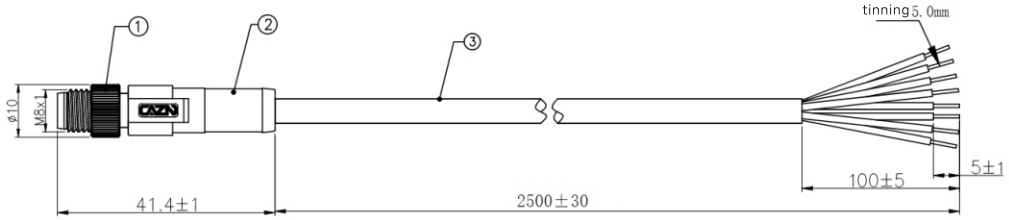


M12 X-code	Definition	Cable Color
PIN1	TD1+	White Orange
PIN2	TD1-	Orange
PIN3	TD2+	White Green
PIN4	TD2-	Green
PIN5	TD3+	White Brown
PIN6	TD3-	Brown
PIN7	TD4+	White Blue
PIN8	TD4-	Blue

- Power and IO Interface: M8 A-code female connector, we provide standard 2.5m cable.



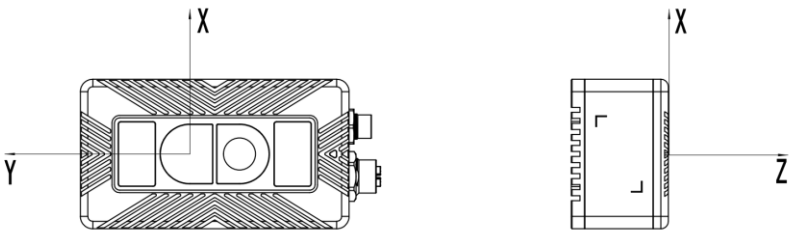
M8 A-code	Definition	Cable Color
PIN1	GND	Black
PIN2	VIN	Red
PIN3	CANL	Brown
PIN4	CANH	Green
PIN5	GPIO_OUT-	White
PIN6	GPIO_OUT+	Yellow
PIN7	GPIO_IN+	Gray
PIN8	GPIO_IN+	Blue

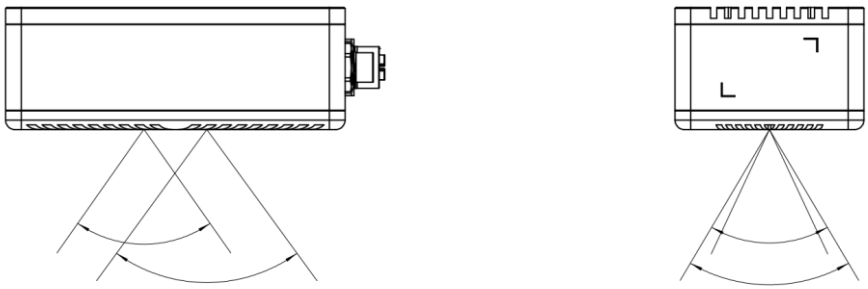


1.6 FoV and Measurement Range

Camera origin description:

- X -axis coordinate is located at the center of the camera's left light window.
- Y -axis coordinate is located at the center of the camera's left light window.
- Z-axis coordinate origin is located on the camera's left light window plane.





✦ The measurement range of standard FoV version（70°*50°）：LWP-D322-I、LWP-D322-IS、LWP-D322C-I、LWP-D322C-IS

Distance (m)	Horizontal Coverage Range (m)	Vertical Coverage Range (m)
0	0	0
1	1.23	0.88
2	2.46	1.75
3	3.69	2.36
4	4.92	3.51
5	6.15	4.39
6	7.38	5.27
7	8.61	6.15
8	9.84	7.03
9	11.07	7.91
10	12.31	8.79

✦ The measurement range of wide FoV version（103°*81°）：LWP-D322W-I、LWP-D322W-IS

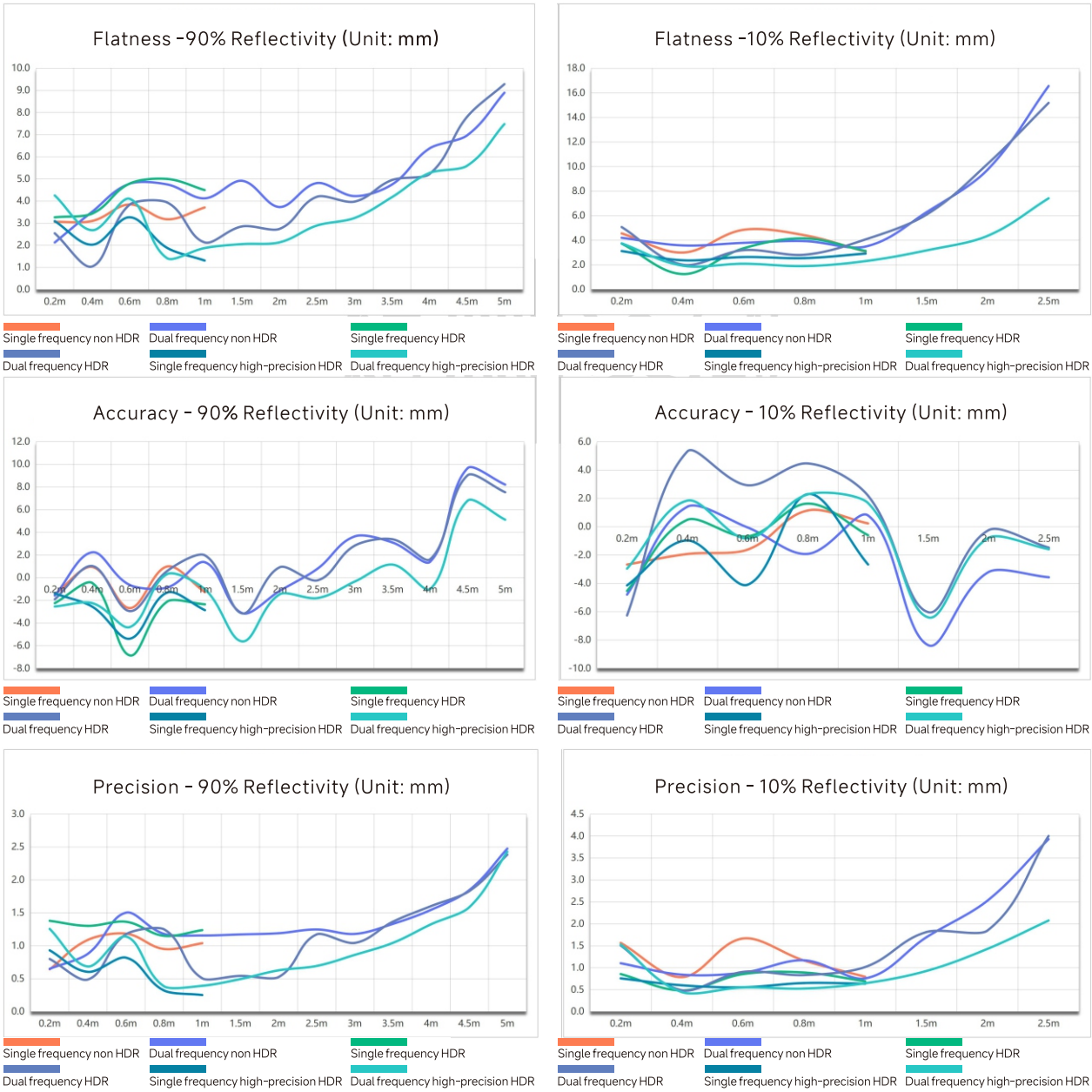
Distance (m)	Horizontal Coverage Range (m)	Vertical Coverage Range (m)
0	0	0
1	2.46	1.7
2	4.93	3.4
3	7.40	5.12
4	9.87	6.8
5	12.34	8.5

1.7 DM Camera Flatness, Precision and Accuracy Test Report

Test method: Select a DM camera randomly, and test its flatness, accuracy and precision under different reflectivity and working modes.

Reflectivity	Item	Frequency	Integral Time	Frame rate	Mode	0.2m	0.4m	0.6m	0.8m	1m	1.5m	2m	2.5m	3m	3.5m	4m	4.5m	5m
90%	Flatness (mm)	120	2000	10	Single frequency non HDR	3.1	3.1	3.8	3.2	3.7								
		120/10	2000	10	Dual frequency non HDR	2.1	3.5	4.8	4.7	4.1	4.9	3.7	4.8	4.2	4.7	6.4	7.0	8.9
		120	2000	10	Single frequency HDR	3.3	3.4	4.8	5.0	4.5								
		120/10	2000	10	Dual frequency HDR	2.5	1.0	3.8	3.9	2.1	2.8	2.7	4.2	4.0	4.9	5.2	7.8	9.3
		120	1000-150-20	5	Single frequency high-precision HDR	3.1	2.0	3.3	1.9	1.3								
		120/10	1000-150-20	5	Dual frequency high-precision HDR	4.2	2.7	4.1	1.4	1.9	2.1	2.1	2.9	3.2	4.2	5.3	5.6	7.5
	Accuracy (mm)	120	2000	10	Single frequency non HDR	-1.5	0.9	-2.7	1.0	-1.3								
		120/10	2000	10	Dual frequency non HDR	-1.6	2.2	-0.7	-0.9	1.4	-3.1	-1.2	0.8	3.6	3.1	1.4	9.6	8.2
		120	2000	10	Single frequency HDR	-2.3	-0.5	-6.9	-2.1	-2.4								
		120/10	2000	10	Dual frequency HDR	-1.9	1.0	-3.0	0.6	2.0	-3.2	0.9	-0.2	2.8	3.4	1.6	9.0	7.5
		120	1000-150-20	5	Single frequency high-precision HDR	-1.4	-2.6	-5.4	-1.3	-2.9								
		120/10	1000-150-20	5	Dual frequency high-precision HDR	-2.6	-2.3	-4.4	0.3	-1.0	-5.6	-1.5	-1.8	-0.3	1.1	-1.0	6.8	5.1
	Precision (mm)	120	2000	10	Single frequency non HDR	0.6	1.1	1.2	0.9	1.0								
		120/10	2000	10	Dual frequency non HDR	0.6	0.9	1.5	1.2	1.2	1.2	1.2	1.2	1.2	1.3	1.5	1.8	2.5
		120	2000	10	Single frequency HDR	1.4	1.3	1.4	1.1	1.2								
		120/10	2000	10	Dual frequency HDR	0.8	0.5	1.2	1.2	0.5	0.5	0.5	1.2	1.0	1.4	1.6	1.8	2.4
		120	1000-150-20	5	Single frequency high-precision HDR	0.9	0.6	0.8	0.3	0.3								
		120/10	1000-150-20	5	Dual frequency high-precision HDR	1.3	0.7	1.1	0.4	0.4	0.5	0.6	0.7	0.9	1.0	1.3	1.6	2.4
Reflectivity	Item	Frequency	Integral Time	Frame rate	Mode	0.2m	0.4m	0.6m	0.8m	1m	1.5m	2m	2.5m	3m	3.5m	4m	4.5m	5m
10%	Flatness (mm)	120	2000	10	Single frequency non HDR	4.5	3.0	4.8	4.4	3.1								
		120/10	2000	10	Dual frequency non HDR	4.2	3.6	3.8	3.9	3.5	6.3	9.7	16.6					
		120	2000	10	Single frequency HDR	3.7	1.2	3.3	4.1	3.1								
		120/10	2000	10	Dual frequency HDR	5.1	2.0	3.2	2.8	4.1	6.1	10.2	15.2					
		120	1000-150-20	5	Single frequency high-precision HDR	3.1	2.4	2.6	2.5	2.9								
		120/10	2000-200-20	3	Dual frequency high-precision HDR	3.7	1.9	2.1	1.9	2.3	3.2	4.4	7.4					
	Accuracy (mm)	120	2000	10	Single frequency non HDR	-2.7	-1.9	-1.6	1.1	0.2								
		120/10	2000	10	Dual frequency non HDR	-4.8	1.4	-0.1	-0.9	0.8	8.4	-3.2	-3.6					
		120	2000	10	Single frequency HDR	-4.5	0.5	-0.7	1.6	-0.6								
		120/10	2000	10	Dual frequency HDR	-6.3	5.3	2.9	4.5	2.2	-6.0	-0.2	-1.5					
		120	1000-150-20	5	Single frequency high-precision HDR	-4.2	-1.0	-4.1	2.3	-2.7								
		120/10	2000-200-20	3	Dual frequency high-precision HDR	-3.0	1.8	-0.8	2.3	1.7	-6.4	-0.8	1.6					
	Precision (mm)	120	2000	10	Single frequency non HDR	1.6	0.8	1.7	1.2	0.8								
		120/10	2000	10	Dual frequency non HDR	1.1	0.8	0.9	1.2	0.8	1.7	2.5	3.9					
		120	2000	10	Single frequency HDR	0.9	0.5	0.9	0.9	0.7								
		120/10	2000	10	Dual frequency HDR	1.5	0.5	0.9	0.8	1.0	1.8	1.8	4.0					
		120	1000-150-20	5	Single frequency high-precision HDR	0.8	0.6	0.6	0.6	0.6								
		120/10	2000-200-20	3	Dual frequency high-precision HDR	1.5	0.4	0.5	0.5	0.6	0.9	1.4	2.1					

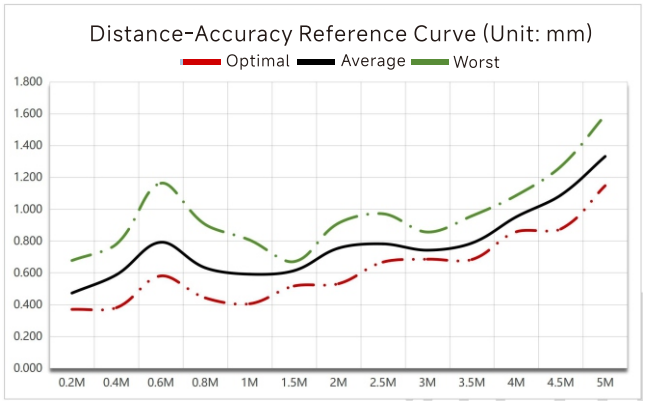
✦ The DM camera performance testing report is as follows.

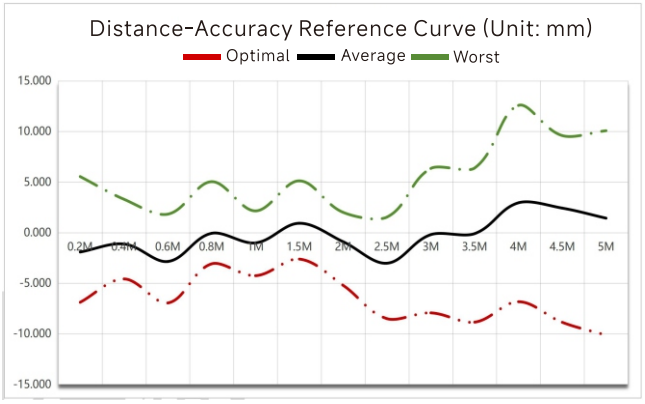


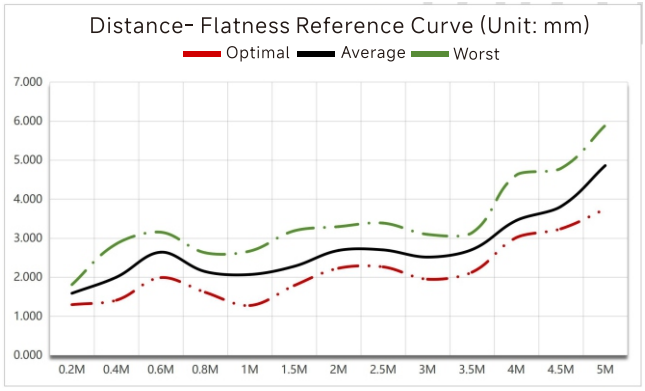
✦ Test method: Selected 20 DM cameras randomly ,tested their flatness, accuracy and precision under dual frequency mode, non HDR and 2000us integration time.

Dual frequency、non HDR、2000us		0.2m	0.4m	0.6m	0.8m	1m	1.5m	2m	2.5m	3m	3.5m	4m	4.5m	5m
Precision	Optimal	0.370	0.381	0.580	0.442	0.405	0.517	0.531	0.667	0.685	0.683	0.858	0.875	1.147
	Average	0.427	0.588	0.792	0.631	0.591	0.613	0.755	0.782	0.742	0.787	0.952	1.088	1.331
	Worst	0.677	0.780	1.163	0.904	0.806	0.670	0.912	0.912	0.856	0.952	1.086	1.268	1.591
Dual frequency、non HDR、2000us		0.2m	0.4m	0.6m	0.8m	1m	1.5m	2m	2.5m	3m	3.5m	4m	4.5m	5m
Accuracy	Optimal	-6.887	-4.579	-6.954	-3.086	-4.259	-2.616	-5.211	-8.503	-7.932	-8.850	-6.830	-8.866	-10.138
	Average	-1.918	-1.125	-2.854	-0.067	-1.015	0.925	-0.898	-3.024	-0.200	-0.100	2.948	2.423	1.427
	Worst	5.541	3.297	1.826	5.035	2.148	5.118	2.006	1.536	-6.341	6.387	12.573	9.594	10.075
Dual frequency、non HDR、2000us		0.2m	0.4m	0.6m	0.8m	1m	1.5m	2m	2.5m	3m	3.5m	4m	4.5m	5m
Flatness	Optimal	1.297	1.410	1.989	1.612	1.274	1.785	2.229	2.264	1.948	2.126	3.014	3.239	3.744
	Average	1.588	2.000	2.640	2.143	2.068	2.278	2.686	2.700	2.515	2.706	3.453	3.810	4.860
	Worst	1.810	2.854	3.153	2.626	2.668	3.187	3.296	3.386	3.097	3.137	4.167	4.785	5.888

✦ We provide the test results of flatness, accuracy and precision from 20 devices for your reference.







✦ The testing conditions are as follows:

Environment	The room temperature is set at 22°C, with no sunlight interference in the surrounding environment. Black materials are used for enclosure to minimize reflective interference.
Target	The 90% reflectance board and the 10% reflectance board are secured at the end of the track.
Camera	A DM camera is fixed to a mobile track mount, and testing begins after a 20-minute preheating period.
Collect	Data is collected in sets at intervals of 20 cm within 1 meter, and at intervals of 50 cm beyond 1 meter. The center pixel data, consisting of a 10*10 pixel area, is collected in 32 sets, and the average value is calculated from these sets.
Filtering	Flying spot: 15 Time Domain: Off Confidence Level: 15 Spatial Resolution: 3
Data	Flatness: The thickness of the planar point cloud of the target plate (1.5 meters horizontally by 2 meters vertically). Precision: The standard deviation of the time-domain data. Accuracy: The average deviation of the measured values from the true values.

二 Quick Operation

2.1 Product List

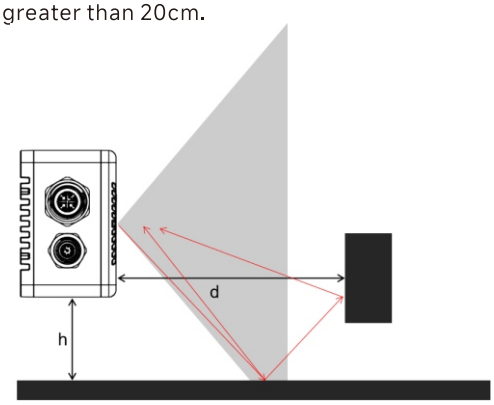
After opening the product packaging, please ensure that the DM ToF camera is intact. Check against the following list to confirm that all accessories are present. If any items are missing or damaged, please contact the sales .

DM ToF Camera x1	Parts Kit x1
2.5m Power Cable x1 (Standard)	Quick Operation Guide x1
1.5m Test Network Cable x1 (Option)	Certificate of Conformity x1
DC Power Female Connector x1 (5.5*2.1mm)	Transfer Bracket x1 (Only S version)

Note: A 2.5m power cord is default, and M12 X-code to RJ45 network cables need to be purchased (optional 1.5m, 5m, 13m), you can also purchase it from third-party sources.

2.2 Precautions Before Installation

- Please make sure to remove the light window protective film before use.
- Please check whether the equipment is completed and whether the model is correct shown in the product list in 2.1.
- Check the installation environment. Do not install in humid, high temperature, vibration environments, etc.
- To mitigate the impact of highly reflective objects in close proximity (As they may affect image quality when it positioned above, below or front of the camera at short distances), it is recommended that the distance (h) be greater than 20cm and the depth (d) be greater than 20cm.



- Fixed the 3D camera as flat as possible to avoid unevenness.
- During the object detection process, in order to ensure the accuracy of the detection results, the minimum detection distance should be no less than 20cm.
- When detecting objects, please ensure that the ToF camera is facing the object being detected, and the deflection angle should not be too large. Prevent the camera from being unable to cover the entire detection range of the target, or causing an increase in the measurement error of the target.
- The screws on the mounting base should strictly follow the ToF camera fixing hole depth, and the screw length can be selected according to the thickness of the base. The material of the mounting base is recommended to be aluminum alloy, which helps the camera dissipate heat.

2.3 Wiring Steps

1. Connect the ToF camera to the computer via a Gigabit Ethernet cable.
2. Provide the ToF camera with a 12V, 5A power supply through the power adapter.
3. The LED indicator lights up green, indicating successful power connection.

2.4 Network Configuration

- The default IP address of the ToF camera is 192.168.1.200, which can be changed to a custom IP address through the host computer.
- Before receiving data, please select Ethernet and choose Internet Protocol V4 (TCP/IPv4), and set the computer's IP address to be in the same subnet as the ToF camera's IP address.

Use of Host Computer Software

3.1 Introduction

LuminViewD is a graphical user interface tool based on the DM SDK, offering features such as color mapping display of depth images, 3D point cloud visualization, filtering parameter adjustment and device parameter settings. The following introduction covers the full range of software capabilities; however, some features may not be visible on different devices. For instance, all RGB-related displays and operations are only available when connected to devices with RGB capabilities. If you encounter any peculiar phenomena during use, you can refer to the "Notes" section for relevant explanations.

3.1.1 Supported Products

The products supported by LuminViewD include: DM ToF Cameras

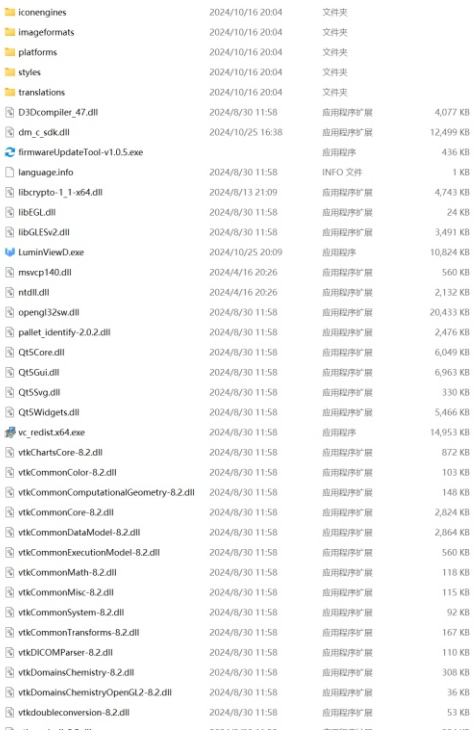
3.2 Software Installation and Device Connection

Please visit the official website of www.luminwave.com to download, or contact the technical staff to obtain it.

3.2.1 Recommended System Configuration

Configuration Item	Recommended Configuration
Operating System	Win10 64-bit Win11 64-bit
Internal Storage	Above 8g

3.2.2 Directory Structure



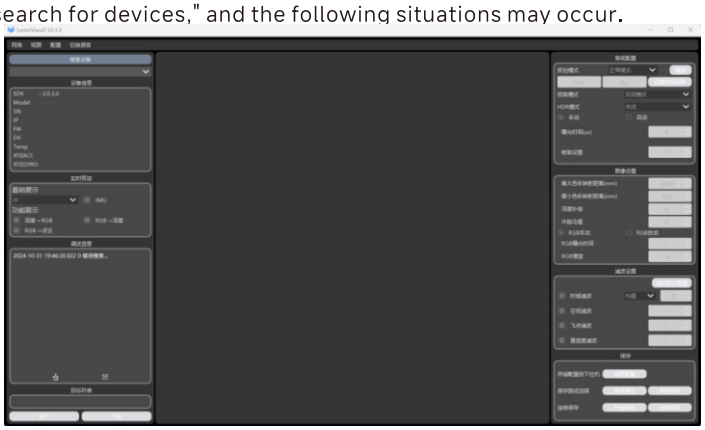
Software Directory: LuminViewD.exe is the executable for the host software, firmwareUpdateTool-v1.0.5.exe is the firmware update utility, and vc_redist.x64.exe is the installer for the VC++ runtime environment.

3.2.3 Device Connect

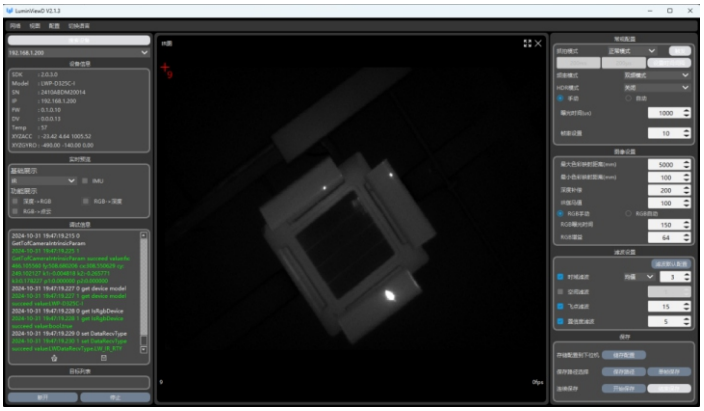
- The device supports at least a Gigabit Ethernet port and cable. The software only supports 64-bit systems.
- Fixed address connections can be made by directly connecting the device to the computer or by configuring it on a switch within the same subnet.
- Direct Connection: Connect one end to the device and the other end to the PC's Ethernet port. The device's default IP address is 192.168.1.200. On the PC, set the subnet mask of the "Local Area Connection" to 255.255.255.0 and assign an IP address within the same subnet (e.g., 192.168.1.123).

3.2.4 Data Acquisition

- After connecting the device to power, change the computer's Ethernet port to the same subnet as the device. The device's default IP is typically 192.168.1.200. Once this is done, open LuminViewD.exe and wait for the device to turn green. Then click on "search for devices," and the following situations may occur.



- Then click on “Start” to view the corresponding image. The drop-down box on the left, under Basic Display allows you to switch between different data views.



3.3 Function Introduction

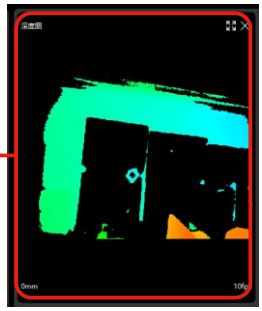
3.3.1 Device List

The device list is used for searching and connecting to devices. It supports the connection and operation of only one device at a time.

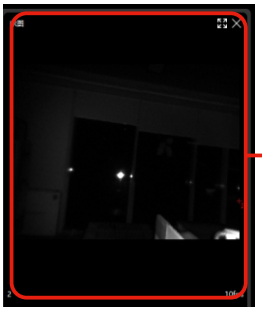
- Search for devices
- Select a device
- Click Start to open the device and retrieve data

3.3.2 Data Display Area

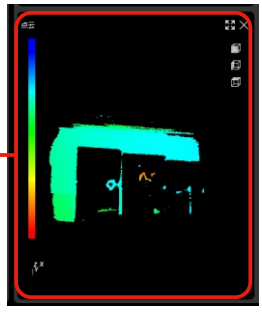
The display area is used to show images



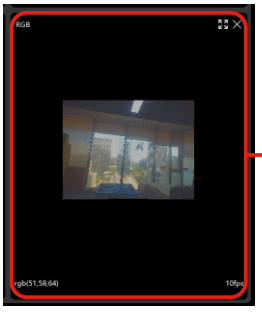
- Depth map
- The depth map provides depth information for each pixel, with the unit in millimeters.



- IR image
- The IR image provides grayscale information for each pixel.

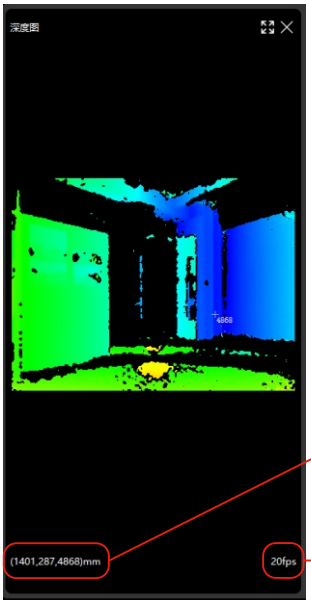


- Point cloud



- RGB image
- The RGB image provides information for the red, green, and blue color channels.

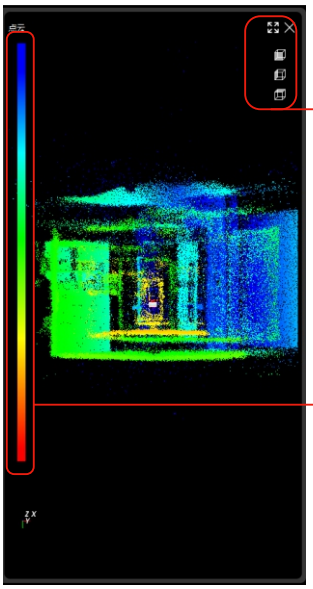
3.3.2.1 Display Area Operation Instructions



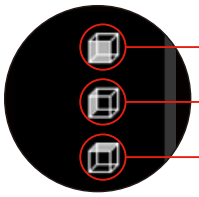
- Depth Map: You can click on a pixel with the mouse to view its depth value.
- The color and display range of the depth map are determined by the maximum and minimum color mapping distances.
- Click with the left mouse button to select a pixel, use the scroll wheel to zoom in or out.
- Drag the image with the right mouse button when the image exceeds the display area. Double-click the image to display it full screen, and double-click again to restore the original view.
- The lower left corner displays the current pixel's x y z coordinates.
- The lower right corner shows the rendering frame rate.

- IR Image: You can click on a pixel with the mouse to view its grayscale value.
- Exposure time and gamma value can both affect the brightness of the IR image
- Click with the left mouse button to select a pixel, use the scroll wheel to zoom in or out
- Drag the image with the right mouse button if the image exceeds the display area. Double-click the image to display it full screen, and double-click again to revert to the original view.
- The lower left corner displays the current pixel's grayscale value.
- The lower right corner shows the rendering frame rate.

- RGB Image: You can click on a pixel with the mouse to view its RGB values.
- Click with the left mouse button to select a pixel, use the scroll wheel to zoom in or out,
- Drag the image with the right mouse button if the image exceeds the display area. Double-click the image to display it full screen, and double-click again to revert to the original view.
- The lower left corner displays the current pixel's RGB values
- The lower right corner shows the rendering frame rate.



- Point Cloud Image: Used for rendering 3D point clouds
- Drag with the left mouse button, use the scroll wheel to zoom in and out,hold the scroll wheel while dragging to pan the entire view.



Front view

left view

Top view

Click on the icons to switch between views.

Closer areas are red and farther areas are blue.

3.3.3 Operation Area

- Menu bar

- The live preview pane

The operations panel on the right

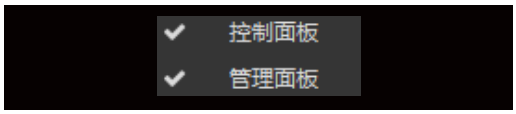
These features are mainly used for

- Updating device IP addresses
- Network protocols
- Firmware updates
- Controlling interface display settings for the device's working modes and parameters
- Configuring algorithms
- Saving related settings

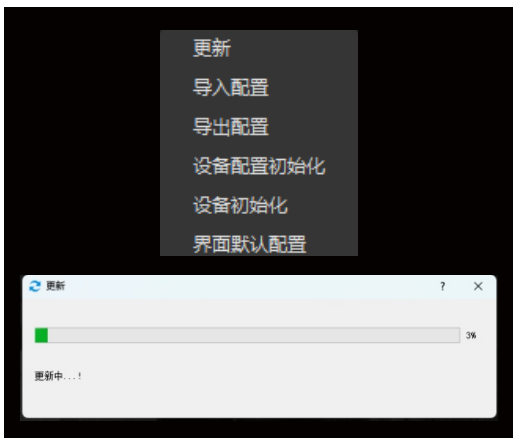
3.3.3.1 Menu Bar

- The network section only includes device network settings.

- This window is for setting the device's IP address. Before using this option, please ensure that the device's data stream output is stopped. If the device is connected to a router and is using DHCP to obtain an IP address dynamically, you can simply select the DHCP option to update it directly.

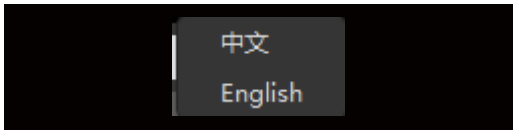


- The software features a three-panel structure, with the two options in this view used to toggle the display and hide of the left management panel and the right control panel.



- Configuration Update: This option is used to upgrade the device's firmware. After clicking, a folder window will pop up. Once the data stream output has been stopped, navigate to the firmware that needs to be updated and click to open it.
- Import Configuration: It's used to import interface configurations, with the configuration file for RGB devices named rgbconfig, and for pure ToF devices named config.
- Export Configuration: Export the current interface configuration parameters to a configuration file, with RGB devices exporting to rgbconfig and ToF devices exporting to config.
- Device Configuration Reset: Restore the device's configuration to its original settings.
- Device Initialization: Reset the device to its factory settings, including reverting the IP address and other settings to their defaults.
- Interface Default Configuration: Set the interface parameters to values that have been tested and proven to provide good performance.

- If the update fails in the window, try updating again. If it continues to fail, please contact LuminWave's technical support. If the update is successful, the following message will appear in the debug information.
- After the update is complete, you can disconnect the device, re-search, and then reconnect to verify the update.



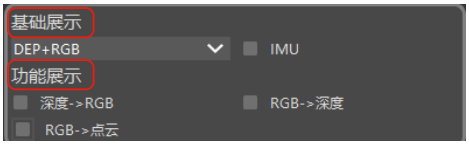
- The software supports switching languages between Chinese and English, and the selection will be automatically saved. The software will default to the last-used language when it is launched again.

3.3.3.2 Device Information

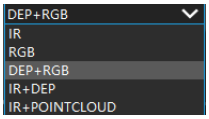
- SDK: The version of the SDK used by this software.
- Model: The model number of the device.
- SN: The serial number (SN) of the device.
- IP: The IP address of the device.
- FW: The firmware version installed on the device.
- DV: The driver version installed on the device.
- Temp: The temperature of the chip.
- XYZACC: The raw data from the IMU's three-axisaccelerometer.
- XYZGYRO: The raw data from the IMU's three-axis gyroscope.

Note: The temperature and the raw six-axis data from the IMU cannot be updated in the mode that only displays RGB data. They can be normally updated in the mode that includes ToF data.

3.3.3.3 Real-time Preview



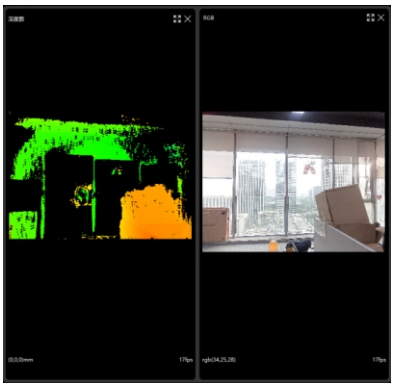
Real-time preview is divided into basic display and functional display.



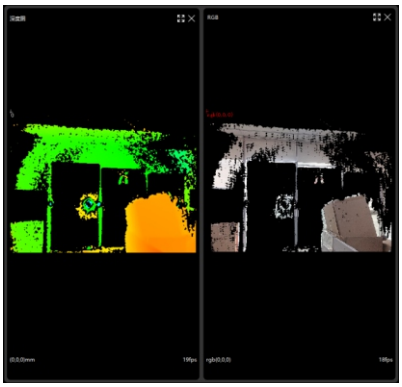
Data Mode:You can set five different data modes.

The IMU switch can be used to select different display modes for point cloud visualization and can be activated when acquiring the point cloud.

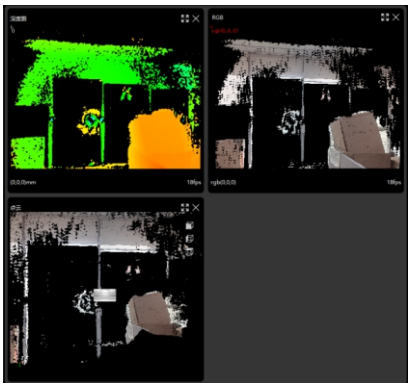
Functional Display The three features mentioned are only available in the DEP+RGB mode within the Basic Display.



Depth→RGB: Mapping depth to RGB will expand the depth resolution to match that of RGB.



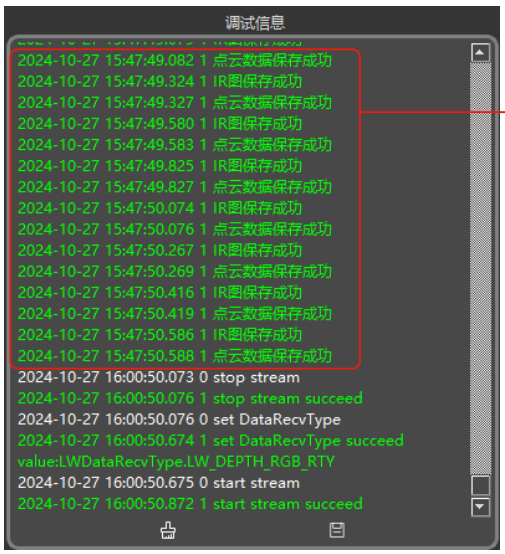
RGB → Depth: Mapping RGB to depth will reduce the RGB resolution to match that of depth.



RGB → Point cloud: This mode can only be used when one of the aforementioned two modes is enabled. Once activated, the point cloud will be colored with RGB values.

Note: The Depth→RGB mode consumes more resources and may result in a decrease in frame rate.

3.3.3.4 Debug Information



- The debug information window logs operational messages for the device.
- Messages in white font represent the operations, with green indicating success and red indicating failure. You can use the red error messages to pinpoint which operations have failed.

Clean Up: Clear the content of the window

Save: for saving the window content to a timestamped-info.log file in the current folder, respectively.

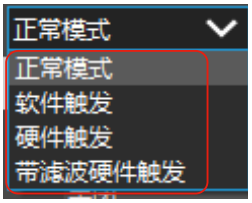
Please note that red messages here are merely feedback on specific operations and do not necessarily indicate a problem with the device. Due to large data volumes, network bandwidth saturation, network disconnections, device power loss, trigger mode switches, disconnections, or other time-consuming operations, red alert messages may appear. These messages could indicate device disconnection, network issues, or unprepared frame data. The exact situation should be analyzed based on the actual usage context and debug information.

3.3.3.5 Target List

- It's used for displaying pallet information or other application algorithm outputs

3.3.3.6 常规配置

four capture modes available



Normal Mode: Acquires real-time data information at the set frame rate.

Software Trigger: Captures the current frame data by clicking the software trigger.

Hardware Trigger: Activated by an external hardware trigger.

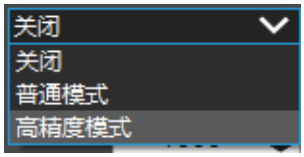
Hardware Trigger with Filtering: Allows setting a trigger interval to respond to corresponding external trigger signals.

Note: Switching between capture modes is time-consuming and requires waiting for three to five seconds after the switch is initiated before proceeding with further operations.

Frequency Mode

Dual-Frequency Mode: Designed for full-range use, operating at 20MHz + 120MHz with a maximum frame rate of 28fps.

Single-Frequency Mode: Suitable for short-range scenarios not exceeding 1.25 meters, using 120MHz with a maximum frame rate of 56fps.



HDR Mode

HDR Mode offers three settings: HDR Off, Standard Mode, and High Precision Mode.
Standard Mode: The camera captures 3 frames with high, medium, and low exposure times and fuses them to ensure good image quality in scenes with both high and low reflectivity.
High Precision Mode: Building on the standard HDR, this mode adds the fusion of 3 frames with high exposure times, ultimately outputting 1 frame from the fusion of 6 frames, which further enhances the image precision.

Manual / Automatic

It's used to control the exposure mode of the ToF camera; in automatic mode, exposure time and frame rate cannot be manually adjusted.

Exposure time and frame rate settings.

The frame rate is affected by the single/dual frequency, data type, exposure time, and HDR mode. The maximum frame rate is 56 fps (single frequency, IR data only), and the dual frequency maximum is 28 fps.
Enabling standard HDR reduces the frame rate to one-third of the current rate, while enabling high precision HDR reduces it to one-sixth of the current rate.

3.3.3.7 Image Settings

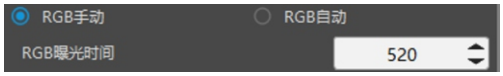
Image Settings are primarily used for controlling image display and configuring RGB image parameters.

The maximum and minimum color mapping distances are used to limit the range of depth data, and only the depth data within these values will be displayed on the depth map. The color mapping on the depth map transitions from red to blue as the distance increases from near to far.

Note: If the maximum and minimum color mapping distances are the same, the depth map will not display any data, and the point cloud will appear entirely in red.

Depth Compensation: This feature is used to add an offset value to the raw depth data, which helps to eliminate the reflections caused by the maximum distance limitation, ensuring more accurate depth measurements.

IR Gamma Value: It's used to adjust the brightness of the grayscale image.



RGB Manual and RGB Auto are used to switch between manual and automatic exposure modes for the RGB camera. In automatic mode, the RGB exposure time cannot be adjusted.

Note: After switching from automatic exposure to manual exposure, wait for 3 seconds before re-setting the exposure time and gain for the changes to take effect.

RGB Gain is used to adjust the brightness of the RGB image.

Note: After switching from auto to manual, wait for 3 seconds before setting the exposure time and gain for the changes to take effect.

3.3.3.8 Filter Settings

Filter Settings include four types of filtering: Temporal Filtering, Spatial Filtering, Outlier Filtering, and Confidence Filtering. All filters are specifically applied to ToF data. The default filter configurations are adjusted to provide a filter effect that has been tested and found to be reasonably suitable. The parameters are as follows.

Set Temporal Filtering: Temporal filtering is divided into two types, median and mean. Mean Filtering has a greater impact on the stability of the point cloud. The range for Median Filtering is 1-4, and for Mean Filtering, it is 2-28. The higher the setting, the more stable the point cloud and the higher the ranging repeatability.

Set Spatial Filtering: It's used to eliminate salt-and-pepper noise in the spatial domain. The filter can be adjusted with settings ranging from 1 to 3, with higher settings providing better smoothing effects.

Set Outlier Filtering: It's used to remove anomalous points on object edges, with adjustable threshold values. The range of settings is from 1 to 64, where a higher threshold results in greater removal of outliers.

Set Confidence Filtering: It's used to eliminate points in the image with low intensity; points with intensity below the threshold value are not included in the calculations. The threshold can be adjusted. The range of settings is from 1 to 150, where a higher threshold retains more reliable data.

3.3.3.9 Save

Save Configuration: This button is used to store the current device parameters within the device.

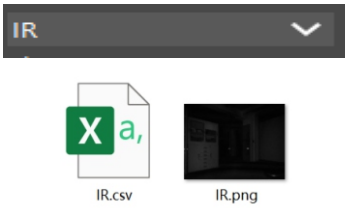
Save Path: This button is used to select the directory for saving image data. After choosing the path, the single-frame save and continuous save functions will work properly. Subsequent single-frame saves and continuous saves will be placed within folders named with timestamps in the selected directory.

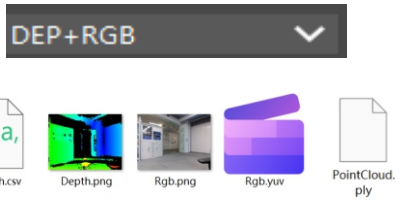
Single Frame Save: Clicking this button will save a single frame of data. Note that saving is only possible when the data stream is active and there is data refresh. The type of data saved depends on the selected basic display mode.

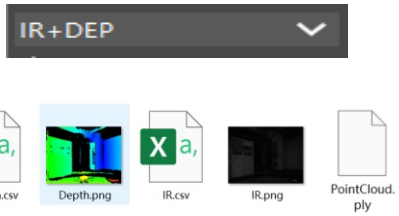
Start Saving: Clicking this button will initiate a continuous saving mode, capturing and saving data continuously. Note that the display frame rate may decrease during data saving. This function is only available when the data stream is active and data is being refreshed. The type of data saved will correspond to the selected basic display mode, saving all the data types that are included in the mode.

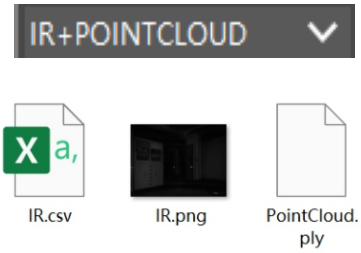
Stop Saving: Clicking this button will cease the saving process.

The data saved in different modes is as follows.









The data will be saved in various modes includes the following: CSV files contain the raw image data, PNG files store the rendered image data, YUV files hold the raw RGB data, and PLY files represent the point cloud data.

LuminWave

WhatsApp

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