M4 Product User Manual

1. Product Overview

This document introduces the M4 products independently developed by Zhejiang MRDVS Technology Co., Ltd., including product specifications, functions, and operating instructions.

The M4 product is independently developed by MRDVS. Currently, the product models included are M4 Lite, M4 camera, ToF products with gigabit network communication interface, and 24VDC power supply.

Figure 1.1 Renderings of M4 camera

1.1 Product Features

- Built-in 1Tops computing power, can run without external CPU
- RGB-D function
- It can independently complete obstacle avoidance, docking, positioning, soft package grasping, storage location detection, and volume monitoring functions
- Gigabit Ethernet port

1.2 Notes on use

Please pay attention to the following points during use:

- Do not tear off the label on the product
- Do not attempt to disassemble the product, otherwise the product may be damaged
- Avoid using the product in strong magnetic environments
- Avoid using products in environments with strong sunlight (greater than

100KLUX) interference

- If you need to clean the product shell, use a soft dust-free cloth moistened with a small amount of purified water or alcohol to wipe it
- Please keep the original packaging of the product and use the original packaging as much as possible during transportation

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2. Product specifications

2.1 Ranging principle

The M4 camera uses the Time of Flight (ToF) method to measure the distance from an object to the camera by measuring the time it takes for light to pass through the object and reflect back to the camera.

The M4 camera uses the most direct measurement method for depth imaging, obtaining better depth information with minimal computing resources and constructing deep scenes with higher frame rates. According to its basic principles, ToF cameras, like lidar, can also be divided into pulsed ToF (P_ToF) and continuous wave modulation ToF (CW_ToF). P_ToF emits light pulses (usually invisible light) onto the observed object, and then receives the light pulses reflected from the object. The distance between the measured object and the camera is calculated by detecting the flight (round-trip) time of the light pulses; CW_ToF emits a modulated continuous light and measures the flight time of the light by measuring the phase difference between the return and transmission of the light.

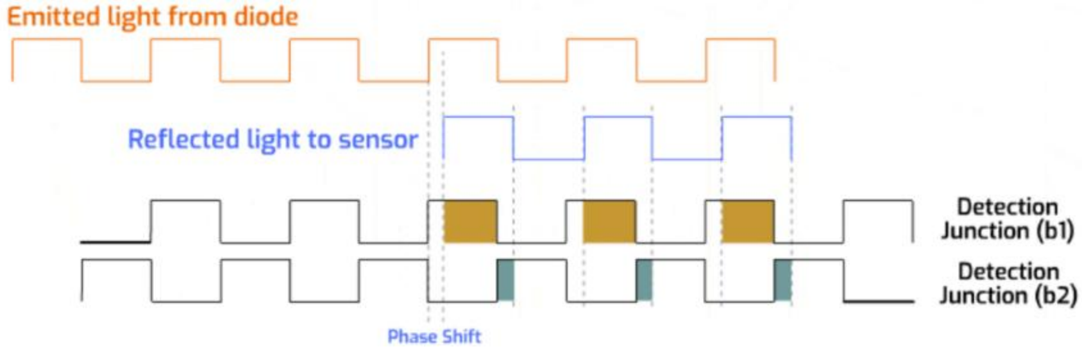

Figure 2.1 Detection schematic

2.2 Specification sheet

Table 2-1 Product Specification Sheet

Camera	Model number	M4
Performance	Chip	Sony chips

	Ranging mode	Optical time-of-flight method
	Operating wavelength	940nm
	TOF resolution and frame rate	640 × 480 (typical value 12fps)
	TOF field of view angle	81°×61°
	RGB resolution and frame rate	1920 × 1080 (typical value 12fps)
	RGB viewing angle	88°×56°
	Measuring distance	0.3~ 5M (90% reflectivity) 0.3~ 2.5m (10% reflectivity)
	Measurement accuracy	±4mm+0.25%×depth
	Pixel format	TOF：RAW12　RGB：Mono8
Electrical	Communication interface	Ethernet / CAN
	Power interface	Industrial grade aviation plug 5Pin
	Power supply	24V DC / 2A
	Average power consumption	6.2w
Structure	External dimensions	88mm×47mm×47mm
	Weight	333g
	IP protection level	IP42
	Temperature	Working temperature -20 ℃~ 60 ℃, storage temperature -25 ℃~ 85 ℃
	Humidity	10%~ 90% RH non-condensing

Other	Anti-light interference	Can adapt to up to 100Klux sunlight
	Anti-shadow-light	100Klux Shadow-Light Intersection Change Less Than 1cm
	Software environment	C / C++ / ROS SDK
	Operating system support	Windows7/8/10/11, Linux, Arm Linux/ROS
	Heat dissipation method	Passive cooling

Note: The product size is subject to the 3D model

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3. Product features

3.1 Electrical characteristics

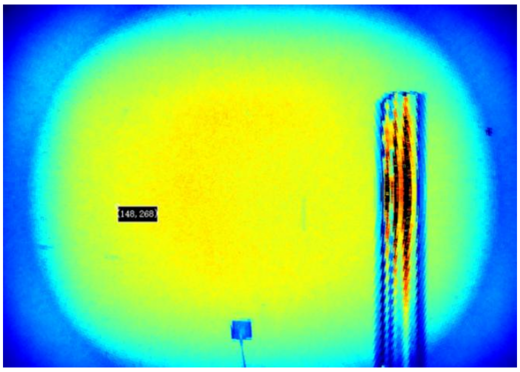
Table 3-1 Product Electrical Characteristics

Parameter	Indicator	Status	Minimum	Typical	Maximum	Unit
Supply voltage	VDD		22	24	26	V
CAN				TBD		V
Working environment temperature			-20		60	℃
Working environment humidity			10		90	%
Storage			10		90	%

humidity						
Storage temperature			-25		85	℃

3.2 Output characteristics

Under preset conditions, the M4 camera outputs a depth map (Figure 3.1) and corresponding signal strength data for each pixel (Figure 3.2), as well as a point cloud map drawn based on the depth data (Figure 3.3). The object in the figure is an aluminum profile.



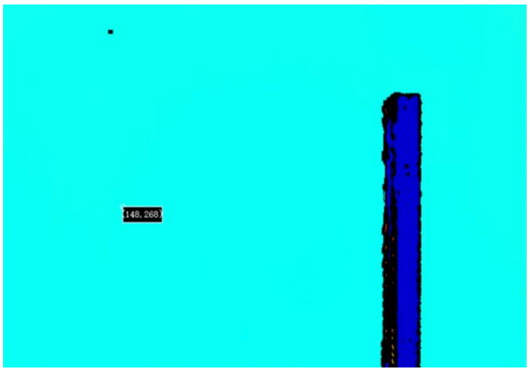


Figure 3.1 Depth map Figure 3.2 Intensity map

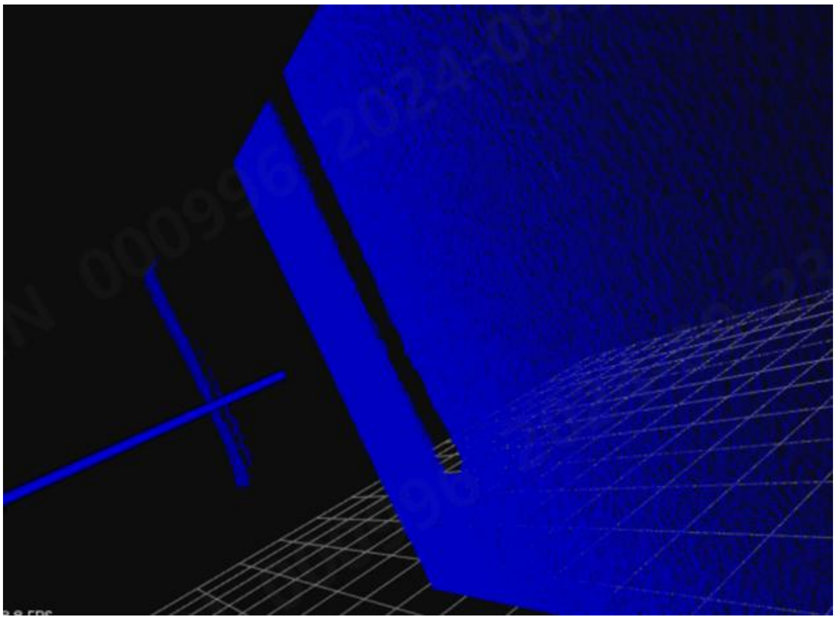


Figure 3.3 point cloud diagram

Depth map detection uses the high dynamic range (HDR) method to expand the measurement range. In this method, two depth maps with different integration times are output on the detection chip, and different measurement ranges are obtained through different calibration parameters. The upper computer takes the larger intensity value of the two images for each pixel and fuses it into the final output, so as to obtain more accurate depth values within each measurement range.

3.3 Detection range

Figure 3.1 is a schematic diagram of the detection area of the M4 camera. The horizontal detection angle of the camera is 81 °, and the vertical detection angle is 61 °. The detection distance is related to the optical power. When the optical power is higher and the reflectivity of the target object is higher, the blind spot near the camera is larger (i.e. the closest distance value of the detection range is larger), and the blind spot far away is smaller (i.e. the farthest distance value of the detection range is larger). Conversely, when the optical power is smaller and the reflectivity of the target object is lower, the blind spot near the camera is smaller (i.e. the closest distance value of the detection range is smaller), and the blind spot far away is larger (i.e. the farthest distance value of the detection range is smaller). For objects with a reflectivity of 10% to 90%, the range of the M4 camera is 0.3 to 5 meters, and the measurement deviation is large at locations larger than 5 meters due to low reflection signals and interference from ambient light.

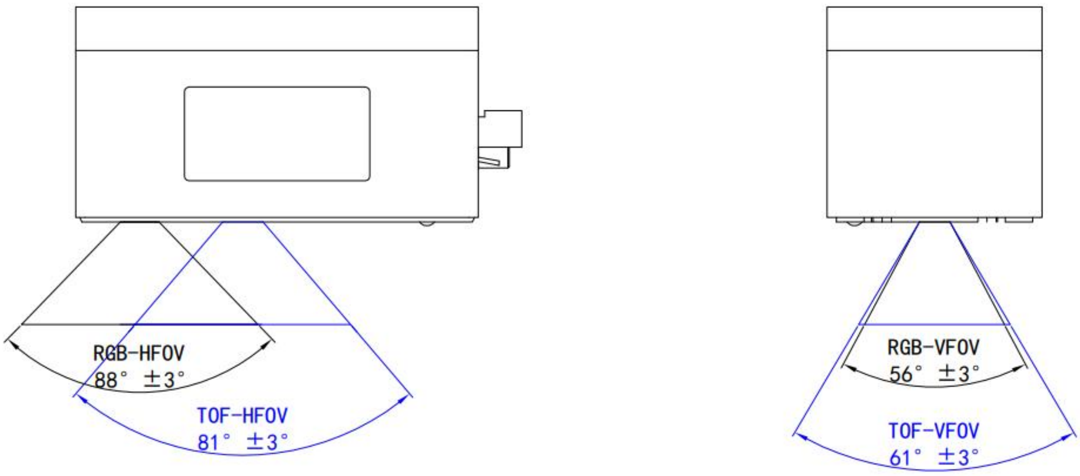


Figure 3.4 Field of view range

3.4 Reflectance comparison table

The reflectance mentioned in this specification is measured concerning the Kodak whiteboard, and the specific reflectance of other objects is shown in the table below.

Table 3-2 Comparison table of reflectance of various material objects

Serial number	Material	Reflectivity
1	Black rubber	22%
2	Black ceramic cup	34%

3	Black plastic wrap	42%
4	Newspaper	45%
5	Black cloth	78%
6	Opaque plastic bottle	85%
7	Smooth wooden board	90%
8	White paper	90%
9	Kodak standard whiteboard	100%
10	Transparent glass	140%
11	Glossy light metallic surface	150%

3.5 Structural dimensions

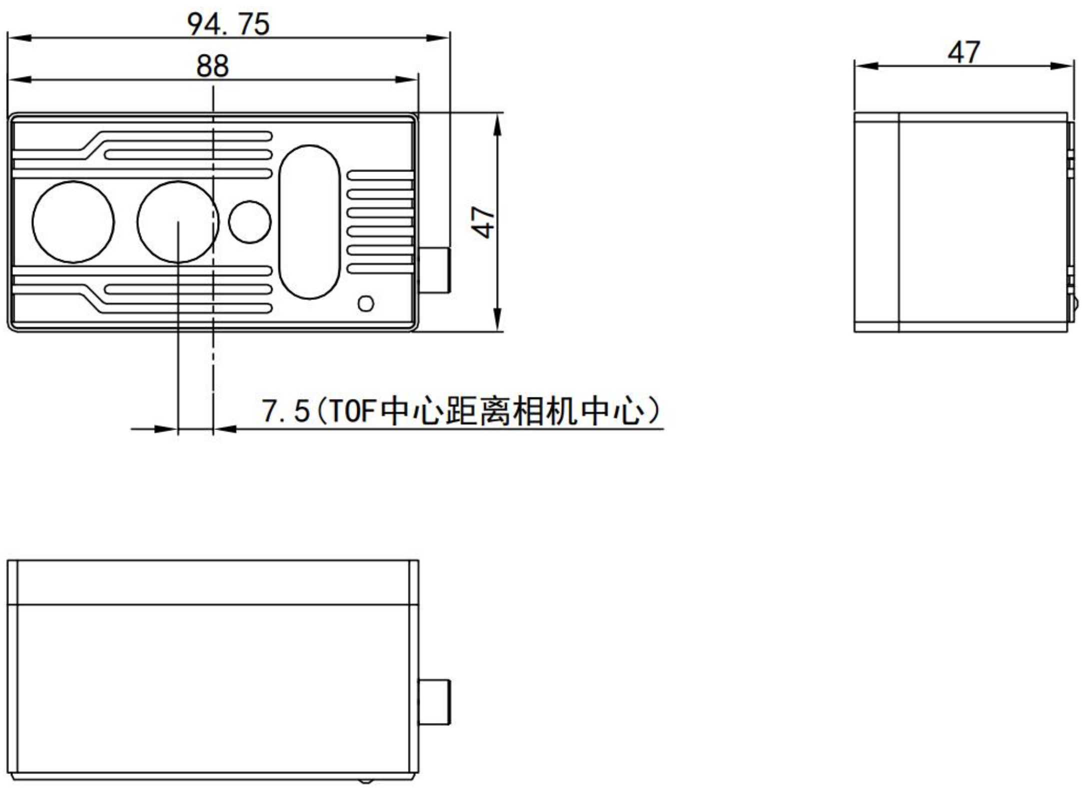


Figure 3.5 M4 camera size chart

3.6 Optical coordinate system and origin

Optical coordinate system:

- The optical coordinate system is divided into the camera coordinate system (CCS) and the world coordinate system (WCS).
- Camera coordinate system: refers to the two-dimensional coordinate system of the depth map, and the coordinate origin of the camera refers to the optical center point.
- World coordinate system: refers to the three-dimensional coordinate system of point cloud map.
- Depth map coordinate system can be converted to point cloud map 3D coordinate system through camera internal parameters. Please refer to the case in the SDK.

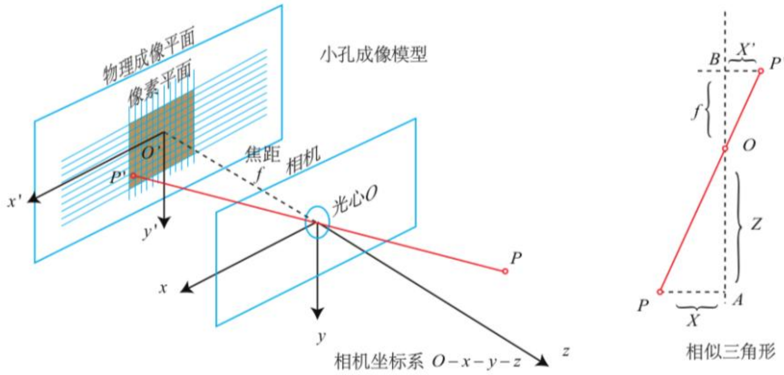


Figure 3.6 Optical coordinate system

The origin description of the camera is shown in the following figure.

1. The X coordinate origin is aligned with the X axis of the product.
2. The Y-coordinate origin is aligned with the Y-axis of the product.
3. The Z-coordinate origin is located on the front surface of the camera.

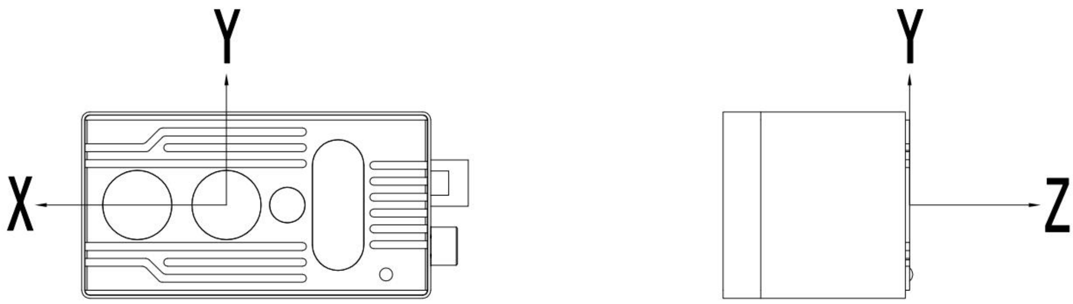


Figure 3.7 Schematic diagram of camera origin

3.7 Product Interface

The 5PIN port of M4 camera is defined as follows (**Note: Reserve 35mm installation position/bending radius at the outlet end**):

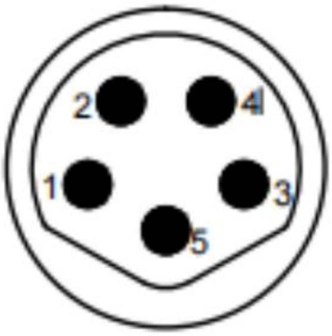


Table 3-3 Pin Description

Port	Pin	Signal	Explanation	Remarks
Socket definition	1	VIN+	24V power input positive terminal	Brown
	2	CAN_L	CAN_L	White
	3	GND	Signal ground	Blue
	4	VIN-	24V power input negative terminal	Black
	5	CAN_H	CAN_H	Gray

3.8 Recommended installation method

The following three installation methods are recommended for actual camera use.

Installation Method 1: Can't see the right wall and can't see the ground. The camera is placed in the corner of the wall, only the front wall exists in the field of view, and the right wall is not seen. The camera's distance measurement is good. As shown in the figure below.

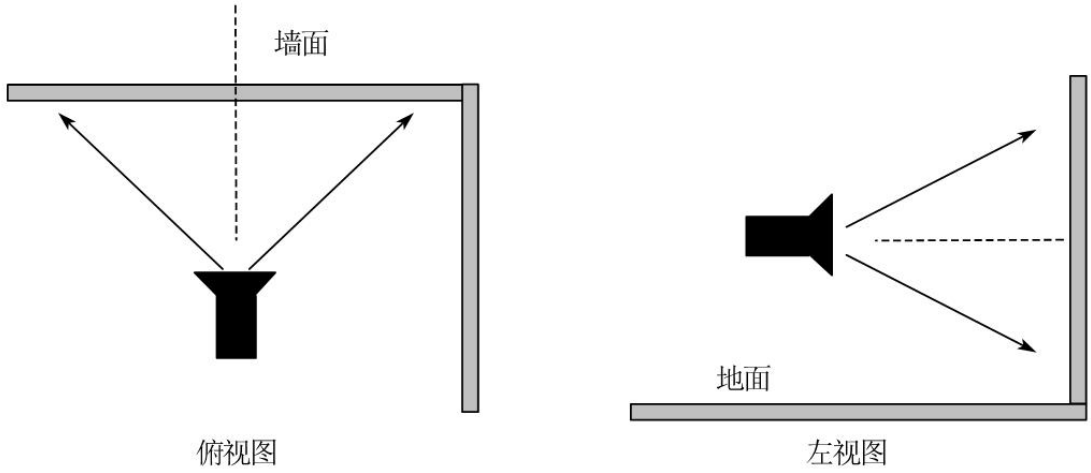


Figure 3.8 Installation Method 1

Installation Method 2: See the right wall but not the ground. The camera is placed in the corner of the wall, and the right wall can be seen in the field of view, and the camera is 20cm away from the right wall "d". The distance measurement can meet ± 15mm. As shown in the figure below.

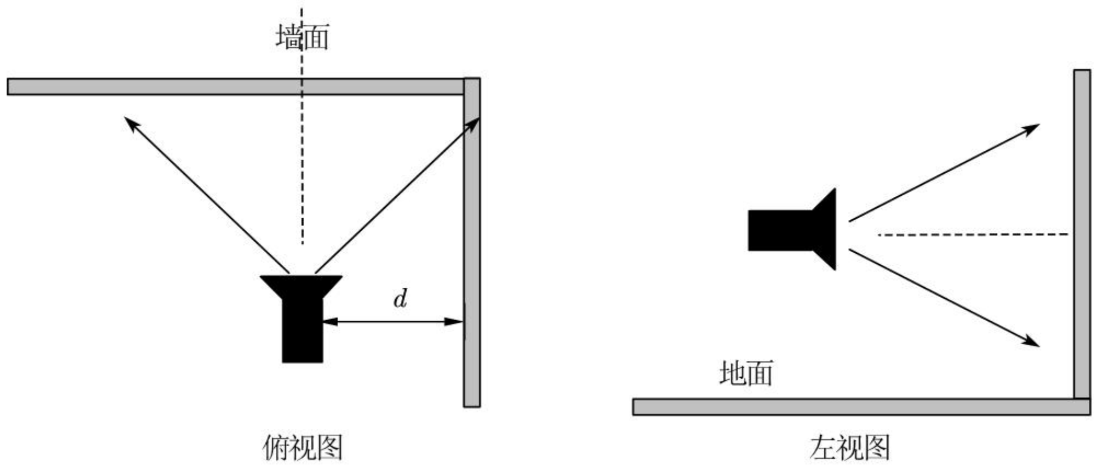


Figure 3.9 Installation Method 2

Installation Method 3: See the ground but not the right wall. The height h of the camera from the ground is recommended to be installed at 10cm~ 30cm. As shown in the figure below.

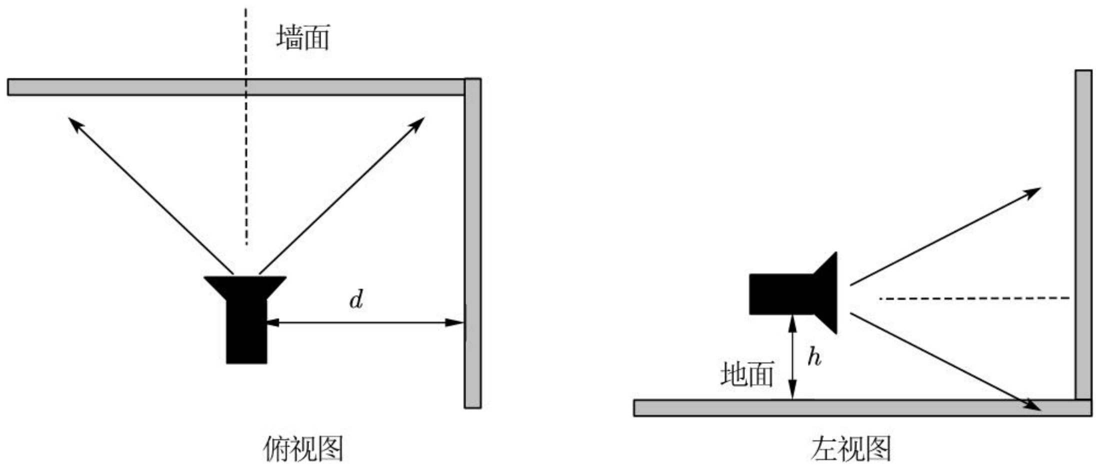


Figure 3.10 Installation Method 3

When the camera is near the ground, the ground near the camera is overexposed, which will affect other areas, and there will be stray light and multipath effects near the ground. As shown in Figure 3.11 below.

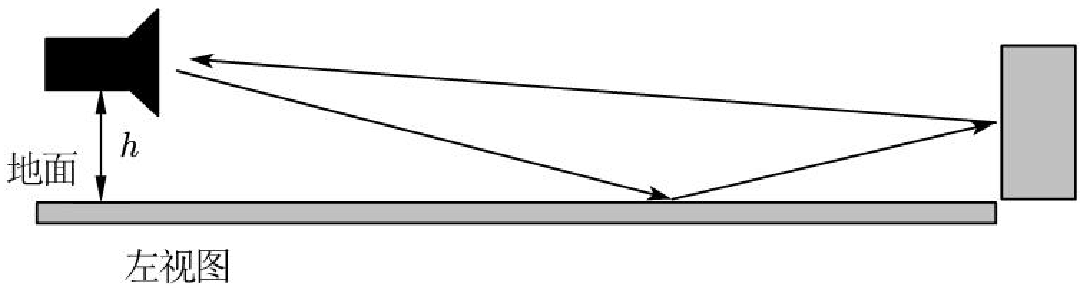


Figure 3.11 Multipath effect near Earth

Stray light mainly manifests as ghosts and flares in imaging optics. As shown in Figure 3.12 below: ghost and flare.

Figure 3.12 Stray light affects ghost and flare

Therefore, for the installation method that will see the right wall and the ground as shown in the figure below, **it is not recommended to use this product.** Affected by the stray light on the ground and the multipath of the wall, the distance measurement is more complex.

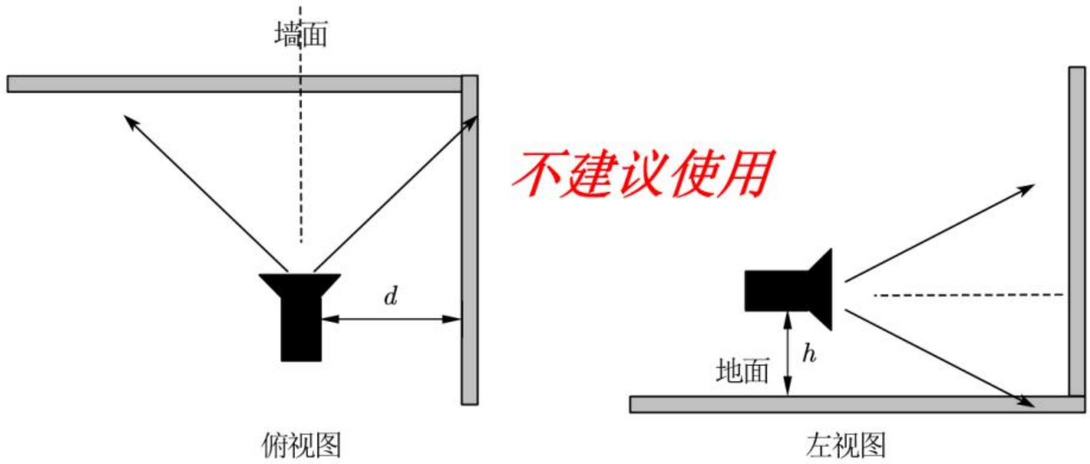


Figure 3.13 Unrecommended Installation Methods

4. Accuracy & Precision description

4.1 Accuracy description

To eliminate the fixed deviation between the sensor measurement value and the actual value, calibration is usually used to establish a mapping relationship between the measurement value and the actual value. For the M4 camera, the camera can be fixed on the guide rail, and measured against a white wall, and the measurement value of each pixel point and the distance between the white wall imaging area and the camera can be established. Then, based on this correspondence relationship, the measurement value can be corrected to obtain a more accurate distance value, as shown in Figure 4.1.

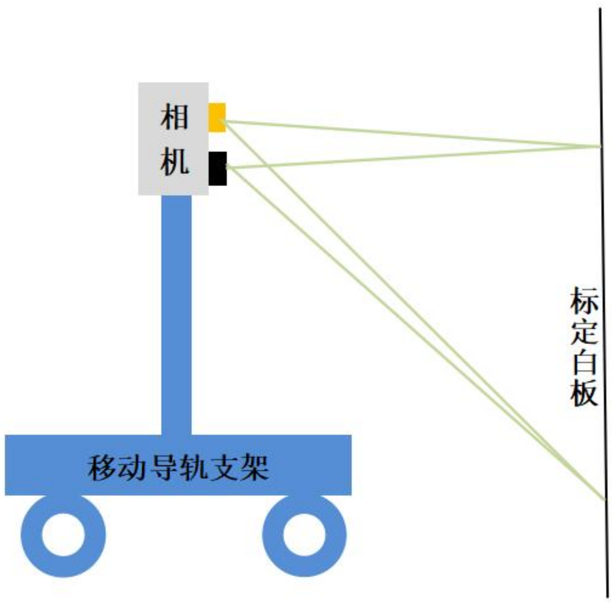


Figure 4.1 Calibration diagram

The M4 camera is an active-ranging method, and the accuracy of the measurement is affected by many factors. Improper installation may introduce problems such as multipath, resulting in distorted ranging accuracy.

Especially when the camera is installed next to a high-reflectivity object, the performance of measuring low-reflectivity target objects is particularly outstanding. The ideal situation is to measure the distance according to the blue path, but the light reflected by the wall will also propagate to the target object and then reflect back to the camera (green light path), and even the camera's illumination light will illuminate the high reflectivity object next to it directly into the camera (red path). Due to the imperfection of the optical system, glare is formed, which interferes with the distance measurement, as shown in Figure 4.2.

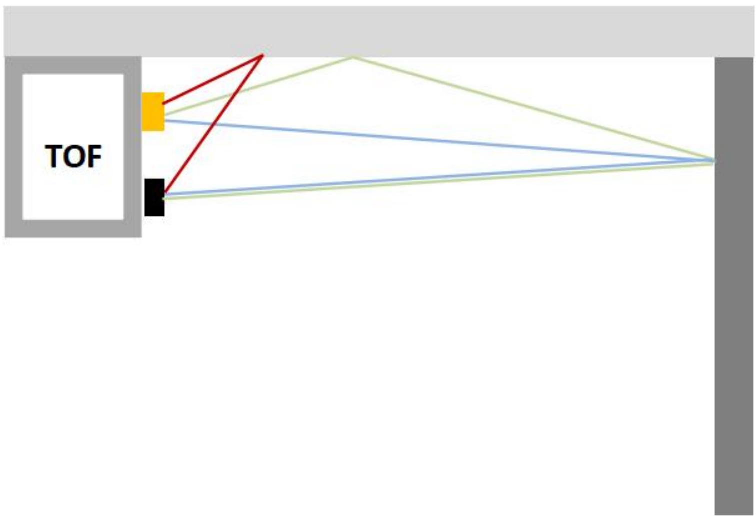


Figure 4.2 Camera installation diagram

4.2 Precision description

When we talk about accuracy, we usually refer to single-point fluctuations (1-sigma). As an optoelectronic measurement tool, the accuracy of the M4 camera is inevitably affected by AD conversion, signal-to-noise ratio, system noise, etc. Figure 4.3 describes the relationship between measurement accuracy and signal strength.

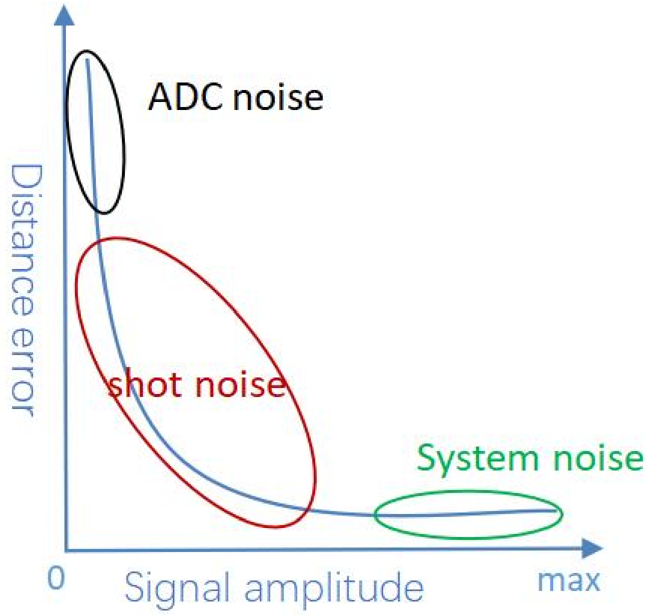


Figure 4.3 Relationship between measurement accuracy and signal strength

M4 camera ranging is the process of converting optoelectronic analog signals into Digital Signal Processing. During the ADC process, the analog signal is equivalent to rounding on the minimum resolution filter, which inevitably introduces some noise. A 1.1V analog signal may only be recognized as a 1V signal with an error of 10%, an analog signal of 10.1V may only be recognized as a 10V signal after AD, with an error of 1%, and a 100.1V signal is recognized as a 100V signal with an error of 1%. Therefore, the AD conversion process will especially introduce noise and errors when the signal strength is relatively low. In addition, the signal-to-noise ratio SNR of TOF cameras is usually SNR ± 1/√ t about the integration time t, so we increase the integration time to improve the signal strength.

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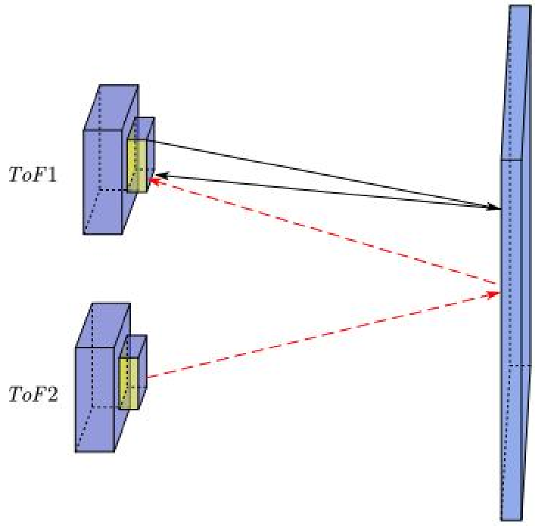
5. Multi-machine interference description

5.1 Parallel interference

In actual environments, there may be two cameras installed in parallel, and the light source signals received by the cameras not only include the light source returned by their cameras but also other light sources returned by the same cameras, causing depth data interference. Parallel interference refers to the phenomenon where the interference between two M4 cameras placed in parallel to detect the same direction increases the detection error.



To avoid parallel interference, it is recommended to have a certain angle between the camera installation and the horizontal direction. If it is necessary to have a 0 ° angle between the installation and the horizontal plane, you can contact the personnel of MRDVS for customization.

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6. Software introduction

6.1 SDK Introduction

The SDK can be used to initialize and start the camera, obtain data, and turn off the camera. Camera application development on system platforms other than Linux or Windows can refer to the source code in the SDK for corresponding porting development.

Table 6-1 SDK Description

Operating system	Linux&Windows
Programming languages	C/C++
Data format	16-bit unsigned short integer
How to use	Shared library files (.so), dynamic link libraries (.dll), or integrated SDK source code

6.2 SDK output order

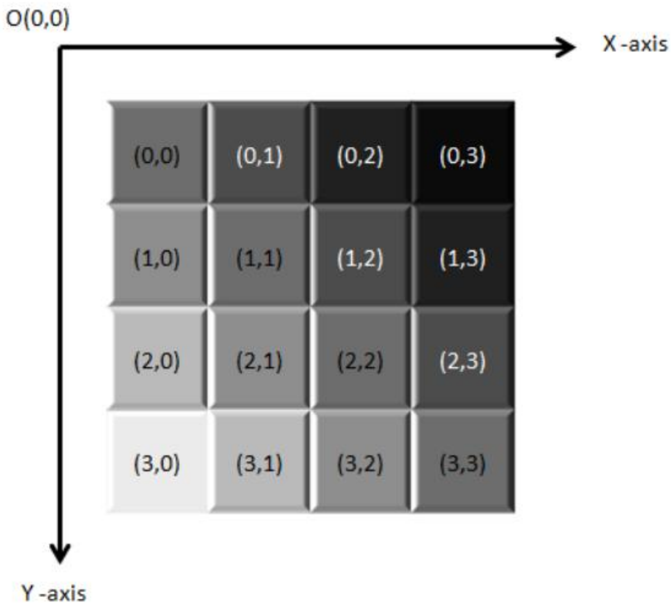


Figure 6.1 SDK output sequence

The SDK outputs depth map data and intensity map data with resolution settings in frames, arranged in a one-dimensional array with the upper left corner pixel of the image as the origin, and outputs them in order from left to right and from top to bottom. As shown in Figure 6.1, the output order is formed by first outputting along the x-axis and then along the y-axis.

(x,y):(0,0)(0,1)(0,2)(0,…)(1,0)(1,1)(1,2)(1,…)(2,…)(3,…)(…,…)。

Each pixel of the depth map represents the distance from the measured object to the plane where the camera is located as a 16-bit unsigned short integer.

The intensity map represents the intensity returned by the measured object as a 16-bit unsigned short integer for each pixel.

6.3 IP Address

The default product IP address of the M4 camera is 192.168.100.82. If you want to change the IP or DHCP mode, please modify it through the demonstration tool provided by Mayer Weishi.

6.4 Presentation software

6.4.1 IP configuration

Before configuration, connect the power cord and connect the camera and computer with a network cable. The default factory IP of the camera is 192.168.100.82, so you need to configure the IP. Change the IP of the current computer to 192.168.100.x network segment (not 100.82), and change the subnet mask to 255.255.255.0. The specific operation is to open Settings - Ethernet (select Change Adapter option) - Right-click Ethernet - Internet Protocol Version 4 (TCP/IPv4), for example, change the IP Address to 192.168.100.20 and the subnet mask to 255.255.255.0.

6.4.2 Open the software

Download and install the software, double-click the LxCameraViwer demo program icon, and the host computer will open it. It will automatically search for cameras, open cameras, and automatically start collecting (when a single camera is connected).

Note: When running the software for the first time, some systems require permission to pass through the firewall.

The software includes basic functions, image selection, camera configuration, and camera information. Camera information includes key camera IP, ID, MAC, serial number information, software, and algorithm version information. Check the depth map, intensity map, RGB, and point cloud, and the corresponding image will be displayed in the middle border.

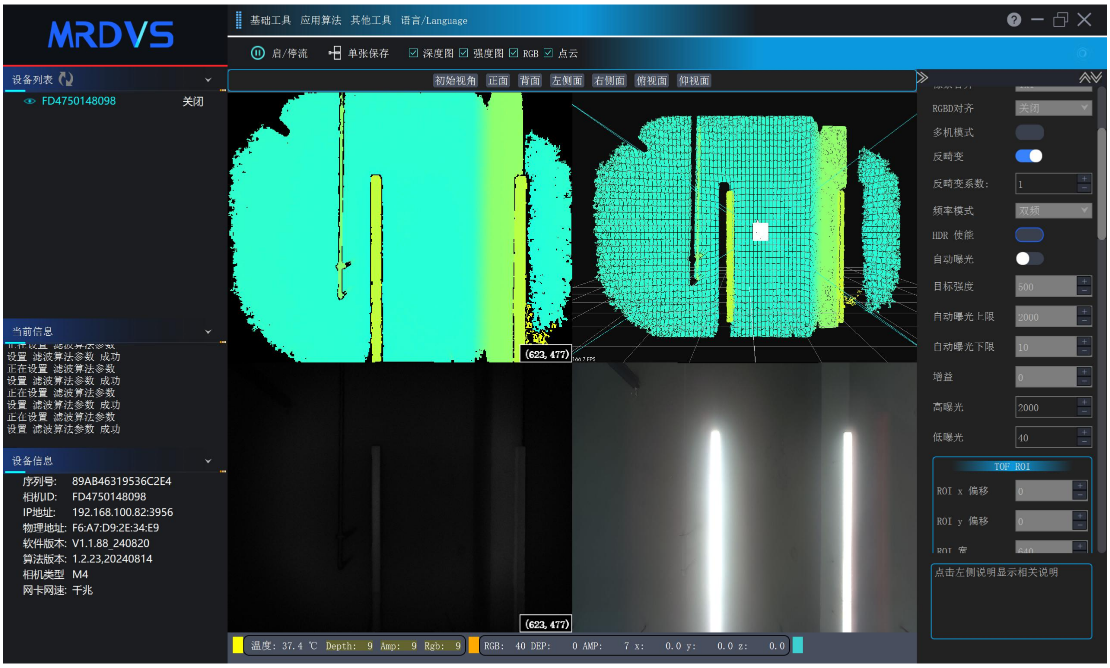


Figure 6.2 Image Display

6.4.3 Image Saving

Click Save to save the selected image, which is saved by default in the software installation directory./data folder. At the same time, the endpoint will also print the image saving path, for example: save path =./data/camera ID.

After saving, it is shown in the following figure, where "_a" is the intensity map, "_d" is the depth map, "_r" is the RGB (MONO) map, and .pcd represents the point cloud. The format of the depth map and intensity map is PGM, RGB is PNG format, and point cloud is PCD format.

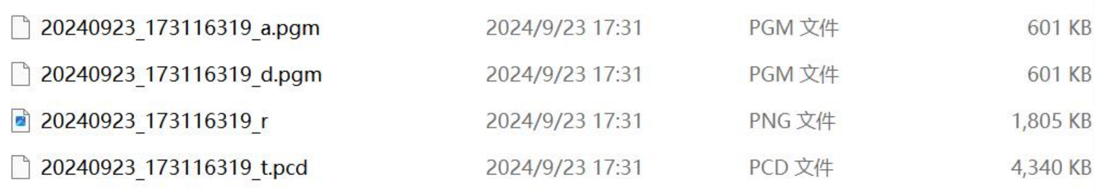
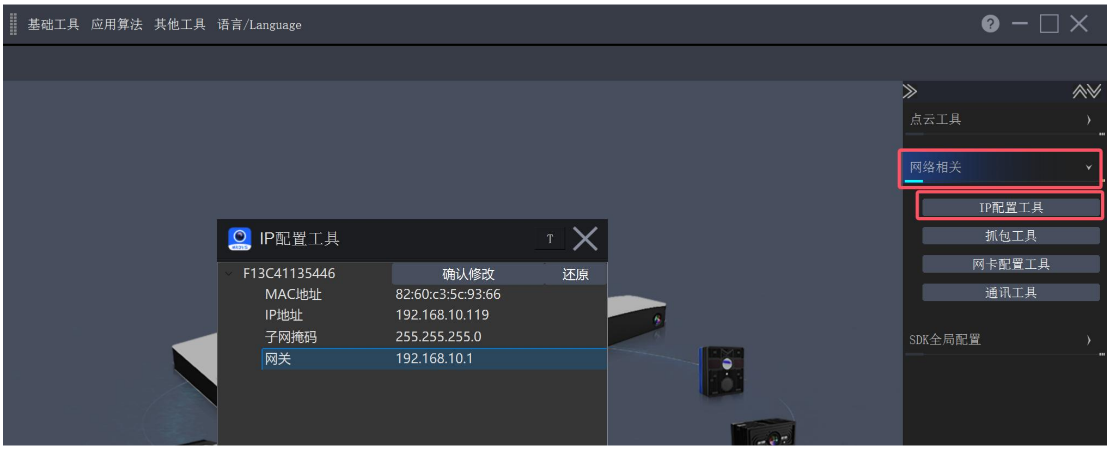


Figure 6.3 Image Saving

6.4.4 change IP

Enter the required IP, such as 192.168.10.199. Then enter the subnet mask 255.255.255.0, enter the gateway: 192.168.10.1 (the gateway and the required IP in the same network segment, the gateway only needs to change the last bit to 1); click confirm modification, power off the camera and restart to complete the IP modification.



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7. Main functions

7.1 Distance Range

The measurement distance of the M4 camera is 0.3~5m. If you need a special distance range, you can contact MRDVS personnel for customization.

7.2 Filter processing

The SDK provided by MRDVS mainly includes the following filtering processing methods:

- Median filtering
- Mode filtering
- Flying spot removal

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8. Notes

8.1 Laser safety level

	**Laser safety**
	This product emits invisible lasers during operation and should be used to avoid damaging human eyes. **The laser emitted by this product meets the Class 1 safety level and will not cause harm to the human body during normal use according to the requirements of EN60825.**

8.2 Correct operation

The M4 series camera uses a 24V DC power supply. Please connect the power cord before connecting the power supply. Do not reverse the positive and negative poles, as reverse connections may damage the product.

8.3 working temperature

During use, please note that the working environment temperature should not exceed the temperature range specified in the product specification table (Table 2-1). Please try to install the product on metal brackets and other parts with good heat conduction to accelerate product heat dissipation and achieve optimal performance.

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9. Frequently Asked Questions QA

Table 9-1 FAQ Explanation

Serial number	Question	Explanation
1	Click to open the camera and there is no response.	Please check if the firewall is turned off. You need to turn off the firewall.
2	The upper computer obtained multiple IPs.	The same IP address in the local area network has been obtained by the camera. You need to select the desired IP address to open it.
3	Open camera data	It is recommended to use a gigabit Ethernet cable

	unstable	for the camera. The data will be unstable at the beginning when using a 100Mbps Ethernet cable.
4	Software installation location	If you install the default C drive, you may have permission settings.

Attached: Packaging Accessories

Serial number	Description	Picture
1	M4 depth camera	
2	5PIN air plug power cord	
3	One certificate of conformity	

MRDVS YouTube Channel:

https://www.youtube.com/@MRDVS-2024

MRDVS LinkedIn:

https://www.linkedin.com/company/mrdvs

MRDVS official website:

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