CS40Pro-Product Manual

Revision History			
Date	Version Number	Describe	Author
July 12th, 2024	V1.0	Release	Daisy
Nov 19th, 2024	V1.1	Change the structure, M12 head definition, power consumption, etc	Daisy

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1. Description and characteristics

1.1 Product Description

CS40Pro equipped with a PToF image sensor and RGB image sensor with a resolution of 640*480, it uses PToF technology to obtain three-dimensional information of objects and space, and has excellent performance such as high frame rate and Gigabit Ethernet transmission, providing users with convenient and efficient 3D perception capabilities. This product adopts a high-performance (quad-core 64 -bit Cortex-A55) hardware processing platform. and is equipped with a 1TOPS NPU. Users can integrate a variety of application algorithms to reduce dependence on the back-end application platform. It supports CAN, TCP/IP, and RS485 protocols to achieve long-distance data transmission.

Features	Applicable scenarios
• Gigabit Ethernet transmission, high frame rate, low latency	• Avoid obstacles and collisions
• High dynamic measurement range (0.5~10m@Ref 90%)	• Security protection
• Outdoor & Indoor	• Industrial visual positioning and guidance
	• Route guidance, edge detection

This product is mainly powered by aviation connector and uses Ethernet data transmission. For details on the specific interface and usage, see the chapter 3. 3.

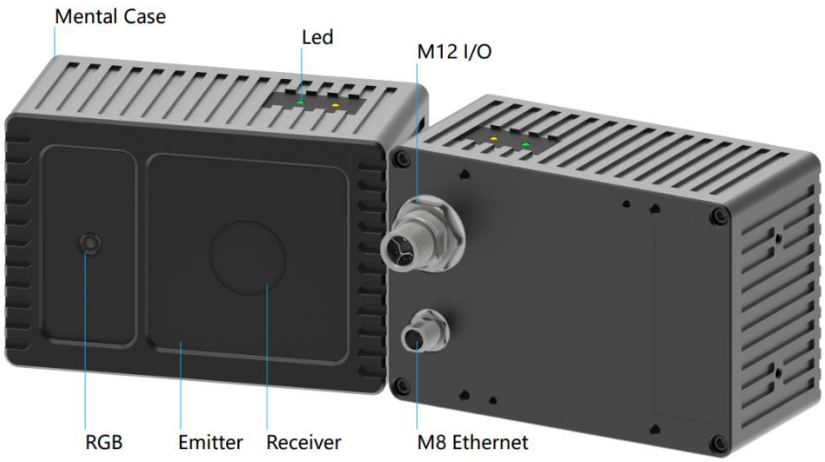


Figure 1-1. CS40Pro solid-state laser lidar appearance description

Product advantage

- No cycle rollover issues
- No motion blur
- With AI recognition function

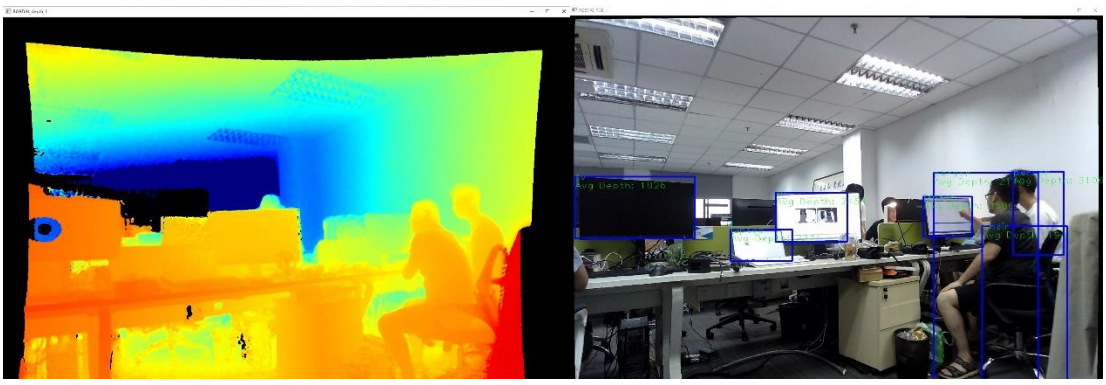


Figure 1- 2. CS40Pro AI recognition function

1.2 Terms of Use

Product Warranty Service Notice

To ensure that you can fully enjoy the product warranty service, please follow the following suggestions during application:

1. The product warranty period is 1 year, effective from the date of purchase.

2. Please keep the product labels intact and do not damage or remove them. These labels contain important product information.

3. Do not disassemble the product casing to avoid damaging the product and affecting your warranty rights.

4. Make sure no foreign matter enters the product to avoid affecting the internal circuit.

5. Avoid using the product in a strong magnetic environment, as it may interfere with normal operation or cause data loss.

6. When the product is not in use, please store it in the original packaging for best protection.

7. Ensure that the surface of the glass cover is clean and dust-free. (For cleaning, see Chapter 7)

2. Introduction

2.1 Purpose of this document

This document describes the solid-state laser lidar CS40Pro in detail

Specifications, interface details, and installation and usage guides provide users with a comprehensive understanding and use of the CS40Pro required reference information.

2.2 System Block Diagram

The CS40Pro hardware system consists of three main components: the processor mainboard, RX module and TX module. The ARM processor is located on the mainboard, and the RX module and TX module are connected to the mainboard through connectors.

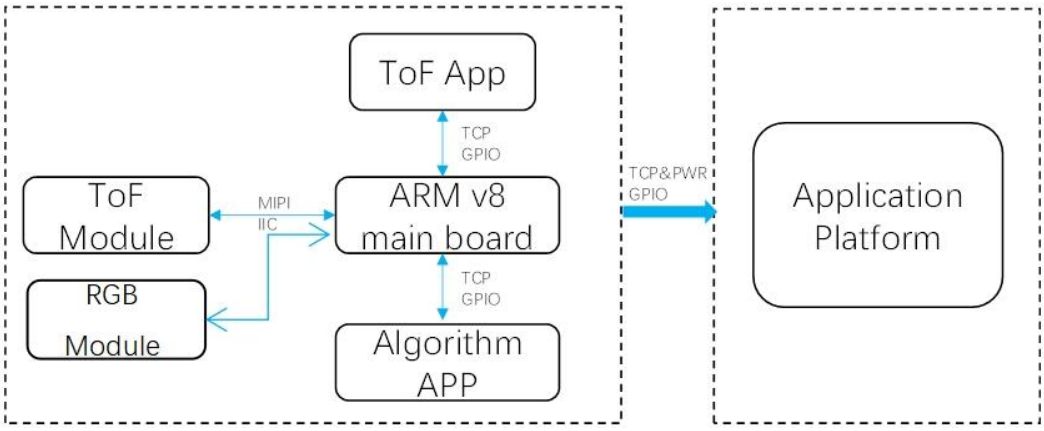


Figure 2-1. CS40Pro solid-state lidar system block diagram

2.3 Technical parameters

Technical Parameters		
Depth Image	Resolution/Frame Rate	640*480&320*240/30fps
	FOV	H71° x V53°
Color images	Resolution/Frame Rate	1600*1200/30fps
	FOV	H84° x V66°
Basic parameters	Working distance	0.5~10m, Indoor & Outdoor @ref 90%
	VCSEL wavelength	940nm
	Accuracy	±2% @ref 90%
	Product size	108mm * 74mm * 50mm
	Data Transfer	1000M Ethernet&RS485
	Power supply	DC 12V/3A&24V/&POE
	Power consumption	Average 7.2W@IntegCount 700us
	operating system	Windows, Linux, Arm Linux
	Operating temperature	-20~60℃
	Security	Class1
	Protection level	IP67

Table 2-1. CS40Pro solid-state laser lidar technical parameters

3. Component specifications

3.1 ToF Module

composition	describe
ToF imager	Time of Flight image sensor
ToF emitter	Class1
Other Components	Laser Driver, EEPROM, Voltage Regulators, FPC, Commentor etc.

Table 3-1. ToF module components

3.1.1 ToF Module Image Sensor

composition	describe
Active Pixels	640*480
Sensor Aspect Ration	4:3
Format	10-bit RAW
Shutter Type	Global shutter
Signal Interface	MIPI CSI-2, 2X Lanes
F Number	F1.2
Focal Length	2.86mm
Focus	Fixed
Horizontal Field of View	71°
Vertical Field of View	53°
Diagonal Field of View	88.6°
TV Distortion	-6.2%

Table 3-2. ToF Image Sensor Parameters

3.1.2 ToF module laser emitter

ToF laser emits uniform near-infrared (940nm) light toward an object. The laser meets Class 1 laser safety requirements under normal operation.

Items	Test Condition	Min	Typical	Max	Unit
Optical Output power	I_F=3.5A,DC=10%,Tp=1ms	7.9	8.4	8.7	W
Operating Current	Pulsed, DC=10%,Tp=1ms		5.5	-	A
Threshold Current		0.5	0.7	1.2	A
Forward voltage	I_F=3.5A,DC=10%,Tp=1ms		4.9	5.2	V
Slope efficient		-	2.9	-	W/A
Power conversion efficiency	I_F=3.5A,DC=10%,Tp=1ms	-	48	-	%
angle	I_F=3.5A,DC=10%,Tp=1ms	-	72	-	Deg
	I_F=3.5A,DC=10%,Tp=1ms	-	55	-	Deg
Wavelength	I_F=3.5A,DC=10%,Tp=1m	930	940	950	nm

Table 3-3. Laser parameters

3.2 Processor Mainboard

composition	describe
Vision Processor	Depth Processing ASIC
32Gb EMMC	Vision Processor firmware storage and ToF firmware storage
24 MHz Crystal	Clock source for Vision Processor
Depth Module Receptacle	24P in receptacle for connection to Depth Module
RGB Module Receptacle	24P in receptacle for connection to RGB Module
Ethernet	10 0 0Mbps Ethernet port connects to a host or network server through an RJ45 port
Voltage Regulators	DC to DC and LDO converters powering Vision Processor Board and depth module
Mounting holes	Vision Processor Board secure mounting

Table 3- 4. ToF processor mainboard parameter table

3.3 Adapter Cable Description

3.3.1 M8 adapter cable description

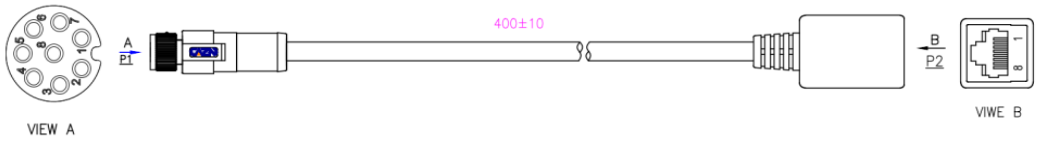


Figure 3 - 1. CS40Pro M8 adapter cable diagram

P1:M8 aviation connector female_8PIN		P2: RJ45 female	
Pin Number	Signal Name	Pin Number	Signal Name
1	BI_DA+	1	BI_DA+
2	BI_DA-	2	BI_DA-
3	BI_DB+	3	BI_DB+
8	BI_DB-	4	BI_DB-
7	BI_DC+	5	BI_DC+
4	BI_DC-	6	BI_DC-
5	BI_DD+	7	BI_DD+
6	BI_DD-	8	BI_DD-

Table 3-5. CS40ProM8 adapter cable description

3.3.2 M12 adapter cable description

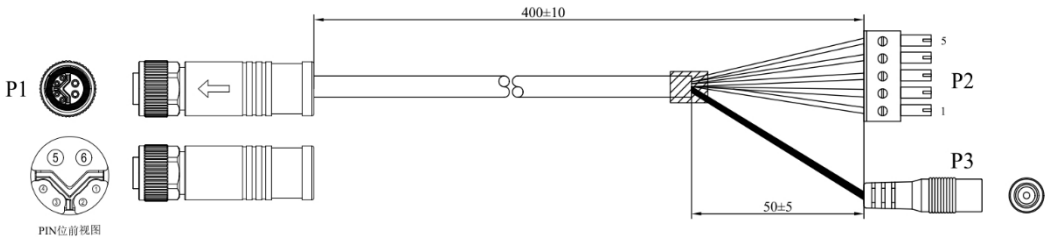


Figure 3 - 2. CS40Pro M12 adapter cable diagram

P1: M12 aviation connector female_8PIN		P2: DGK5.08_5PIN		P3: DC5521 5525 series male connector	
Pin Number	Signal Name	Pin Number	Signal Name	Pin Number	Signal Name
1	485_P	1	CAN_N-(L)		
2	485_N	2	CAN_P+(H)		
3	CAN_P	4	485_P		
4	CAN_N	5	485_N		
5	PWR12~24V	3	GND	1	PWR12~24V
6	GND			2	GND

Table 3-6. CS40ProM12 adapter cable description

3.4 Electrical characteristics

3.4.1 Recommended conditions of use

Parameter	Symbol	Min	Type	Max	Units
Supply voltage	DC	11	12	24	V
Operating temperature	Ta	-20	25	60	℃
Working environment humidity		20		80	%
Storage humidity		20		80	%
Storage temperature		-20	25	65	℃

Table 3-7. CS40Pro recommended usage conditions

3.4.2 Power consumption

Parameter	Conditions	Average	Max	Units
Work	700us		600	mA
Standby	-	165		mA

Table 3-8. CS40Pro power consumption table

Note: 12V input voltage

3.4.3 Absolute conditions of use

The following are the absolute operating conditions required for the normal operation of the product. If the use environment exceeds this range, it may cause product damage. Long-term use in an environment beyond the absolute operating conditions may also shorten the expected service life of the product.

Parameter	Symbol	Min	Type	Max	Units
Supply voltage	DC	12	12	24	V
Operating temperature	Ta	-20		60	℃

Table 3-9. CS40Pro Absolute Usage Conditions

3.5 CS40Pro Mechanical Dimensions

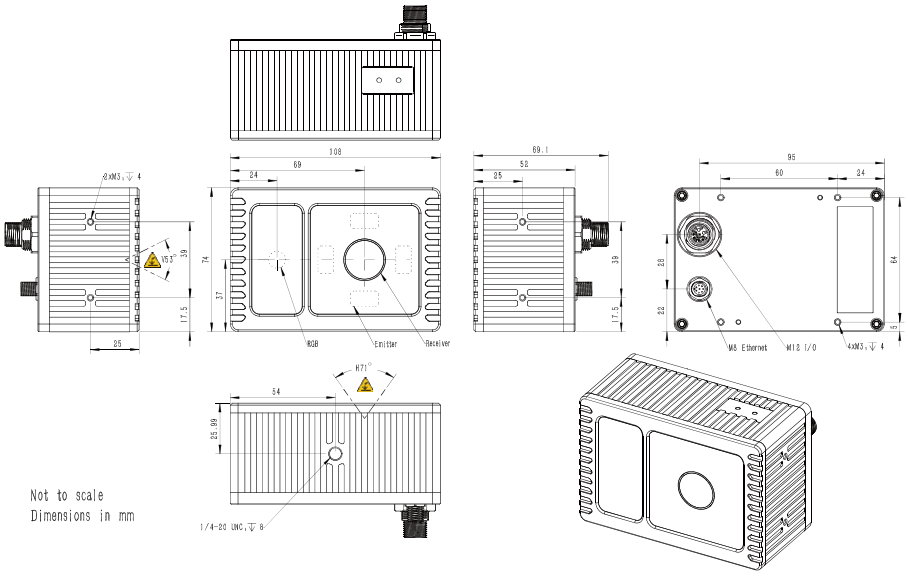


Figure 3-3. CS40Pro mechanical structure diagram

3.6 Optical specifications

3.6.1 Field of view

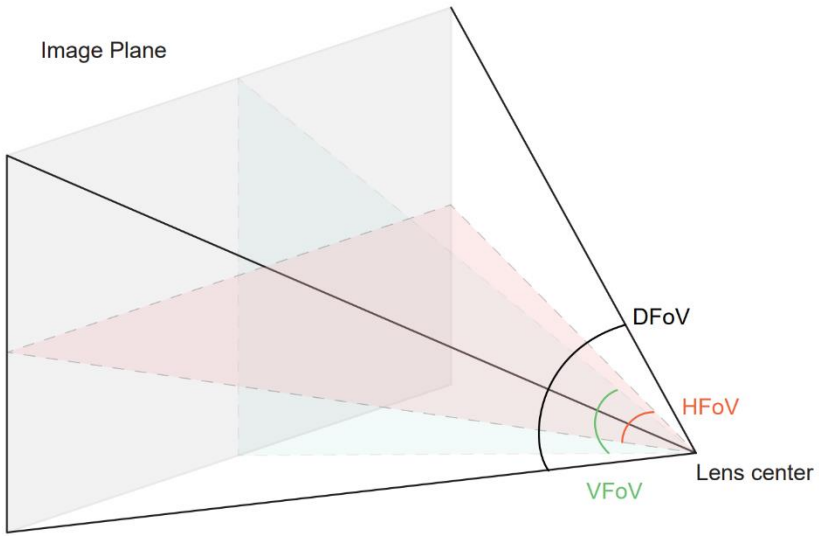


Figure 3 - 4. Schematic diagram of field of view

Field of View (FOV) refers to the angular range of a scene that a ToF sensor can capture. The aspect ratio of a ToF sensor is 4:3, and the horizontal viewing angle is usually larger than the vertical viewing angle.

HFOV (Horizontal Field of View) and VFOV (Vertical Field of View) represent the horizontal field of view and the vertical field of view, respectively. DFOV (Diagonal Field of View) refers to the angle between the diagonal of the CS40Pro sensor and the center of the lens. The typical field of view of the CS40Pro is 71 degrees horizontally (H71°) and 53 degrees vertically (V53°).

3.7 Working conditions and requirements

3.7.1 Hardware Requirements

Ethernet cable, Aircraft female head adapter, 12V power supply/POE power supply;

3.7.2 Software Requirements

Operating system:

64bit Window 10/11, Linux (x86, x64);

Supported software environment:

C/C++/Python/C#/ROS1/ROS2;

3.8 Optical coordinate system and origin

The optical coordinate system is divided into the camera coordinate system (CCS) and the world coordinate system (WCS). The camera coordinate system (CCS) is a two-dimensional coordinate system based on the depth map, and its coordinate origin is the optical center of the

camera, that is, the center of the lens. The world coordinate system (WCS) is used to represent the three-dimensional coordinate system of point cloud data. You can convert the camera coordinate system to the world coordinate system through the camera's intrinsic parameters. For specific implementation, please refer to the sample code in the SDK.

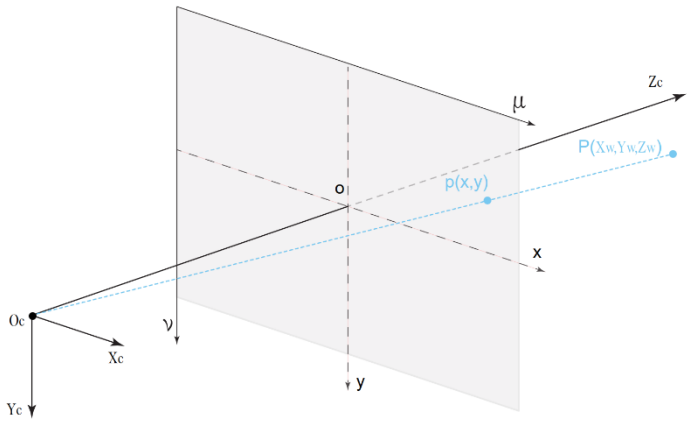


Figure 3 - 5. Schematic diagram of the optical coordinate system

The origin of CS40Pro is illustrated by the following diagram:

1. The origin of the X-axis coordinate is located 37mm from the upper edge of the product;

2. The origin of the Y-axis is located 69mm from the left edge of the product;

3. The origin of the Z-axis coordinate is located on the front surface of the lens.

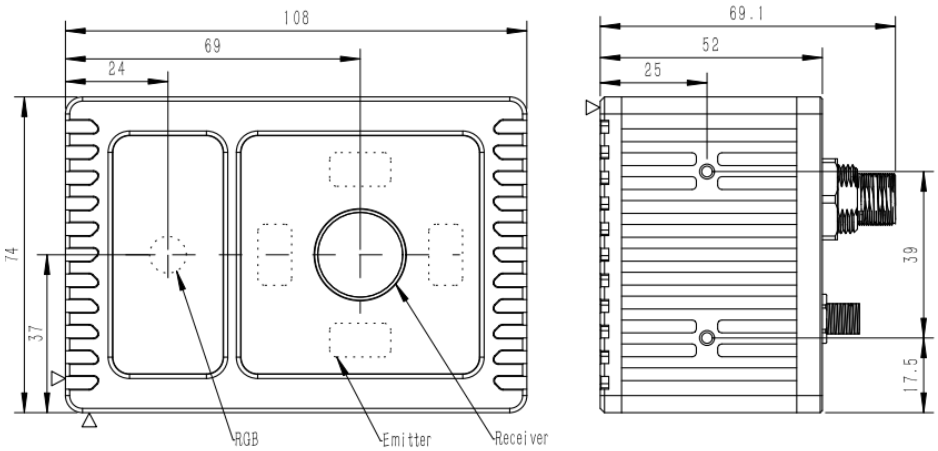


Figure 3 - 6. CS40Pro coordinate system diagram

4. Installation and use

4.1 Notes

4.1.1 Laser Safety

	Risk of electric shock
	Using a non-standard or inappropriate power supply that does not meet the specifications may result in a risk of fire and electric shock. Therefore, you must ensure that the power supply you select meets the specified voltage and current requirements.

	Laser Safety
	When using this product, you should be careful to avoid eye damage because it emits invisible lasers. The laser emitted by this product belongs to the Class 1 safety level. According to the EN60825-1 standard, it will not affect human health under standard use. Please make sure to use this product in the correct way.

4.1.2 Correct power supply

CS40Pro is powered by DC power or POE. It is recommended to use an output 12V power supply to power CS40Pro. Please note that if the power supply voltage exceeds 24V or is lower than 11V, it may cause damage to the product.

Adapter power configuration standard:

Input: 200-240-50Hz 0.8A MAX

Output: 12V ⎓ 2A AC --> DC

4.1.3 Correct operation

1. Do not attempt to disassemble the product housing. All products are strictly calibrated before leaving the factory. Any disassembly or contact with internal components may damage the product, affect its accuracy, and may even cause the product to malfunction.

2. Please connect and disconnect the power cord of the product correctly. Improper operation may cause damage to the product. To avoid the impact of power fluctuations on the product, please make sure that the product and the power cord are properly connected before connecting the power. When you need to remove the power cord, please make sure that the power at the power end has been turned off.

3. Please do not adjust the position of the lens. Improper operation may cause damage to the product.

4. When the product is not in use, please put it back into the original packaging to ensure that the product is not accidentally damaged.

4.1.4 Operating temperature

1. Please pay attention to the working environment temperature when you use the product. It is recommended that you do not exceed the temperature range marked in the product specification sheet. For details, please refer to Section 2.3 .

2. We recommend that you install the product on a component with good thermal conductivity, such as a metal bracket, etc. This can effectively help the product dissipate heat, thereby ensuring its stable and long-lasting performance.

4.2 Hardware Installation

Please make sure you have read and understood the warnings listed in Chapter 4.1 "Precautions". To ensure accurate distance measurements, please follow the suggestions below:

- If you must use it in a strong light environment, make sure the ambient light is less than 100KLux.

• Do not place any unexpected objects in the shooting scene, especially mirrors or other objects with reflective surfaces, which may affect the measurement results.

• During use, keep the temperature of the device casing stable to avoid the impact of temperature fluctuations on measurement accuracy.

• Make sure the CS40Pro is firmly installed to reduce measurement errors caused by shaking.

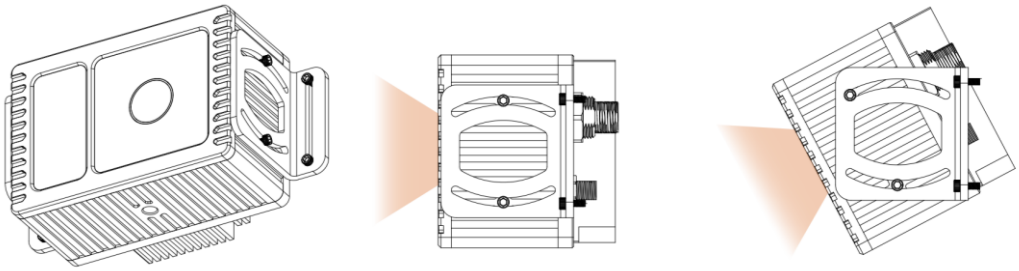
• Before use, make sure all accessories are ready.

4.2.1 Installation steps

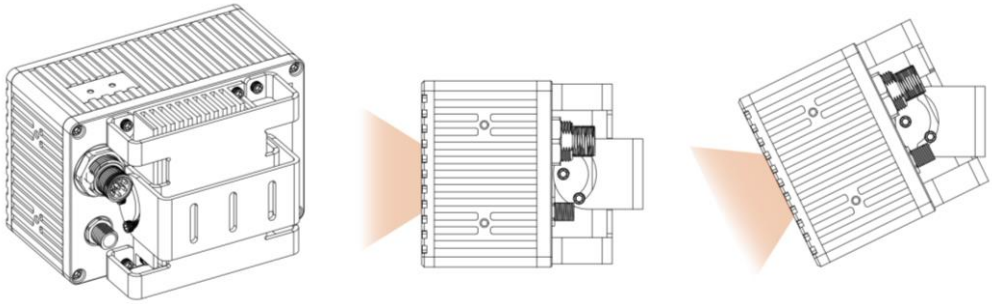
CS40Pro transmits data via Ethernet cable and needs to be powered by a power adapter. The following are the specific steps:

1. Install the product in a suitable environment, such as a mount; Two mounting brackets are also available:

   a) Fix the two L-shaped brackets to the left and right sides of the CS40Pro with two M3 screws to realize the fixing in the installation scene; At the same time, the L-shaped bracket provides a certain degree of rotation freedom, and the user can adjust the appropriate Angle of illumination according to the installation and use scenario;



b) Fix the two U-shaped brackets on the rear side of the CS40Pro with four M3 screws to realize the fixing of the installation scene; At the same time, the U-shaped bracket provides a certain degree of rotation freedom, and the user can adjust the appropriate Angle of illumination according to the installation and use scenario;



c) It is recommended that the product's searchable FOV area be kept at a certain distance from the wall and not overlap with the wall to prevent image abnormalities;

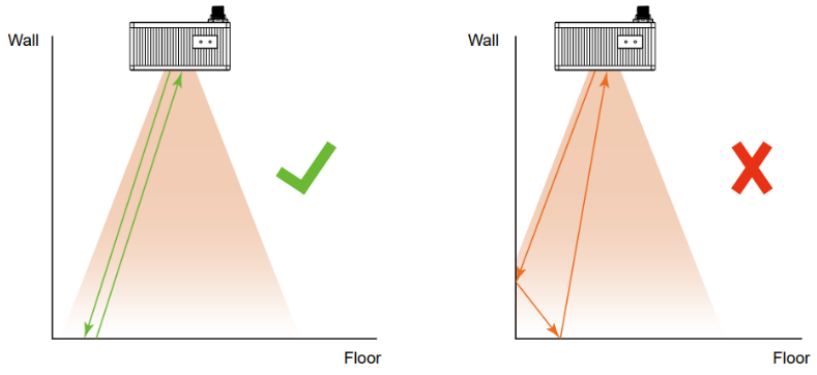


Figure 4-1. CS40Pro installation FOV area

2. Connect the CS40Pro product to the host computer via an Ethernet cable.

3. Plug the DC connector of the power adapter into the multi-function connector on the back of the CS40Pro. (Use POE, no need)

4.When setting up the network connection, please set the IP addresses of CS40Pro and the host computer in the same line segment (see 4.3 : IP address configuration for details).

5. The default IP address of CS40Pro is 192.168.1.150. If you need to connect multiple devices to the same PC and start running at the same time, the IP address of another CS40Pro needs to be changed to 192.168.1.xxx.

4.3 IP address configuration

After the PC is connected to CS40Pro, you need to configure the network IP of the network port when you start using CS40Pro. The steps are as follows:

1. Select the currently connected CS40Pro network, right-click Properties, select TCP/IPv4 and click Properties
2. Enter the IP address: 192.168.1.xxx (xxx cannot be the same as 150 set in CS40Pro).

3. If the current computer needs to connect to two CS40Pros at the same time, after connecting the second device, you need to select the second CS40Pro and perform the above steps "1" & "2" again. For example, the IP address of "Device 1" is 192.168.1.150; the IP address of "Device 2" is 192.168.1.151; the IP address entered in "2" can be set to 192.168.1.11, 192.168.1.22 respectively (where: 11 or 22 can be changed to other)

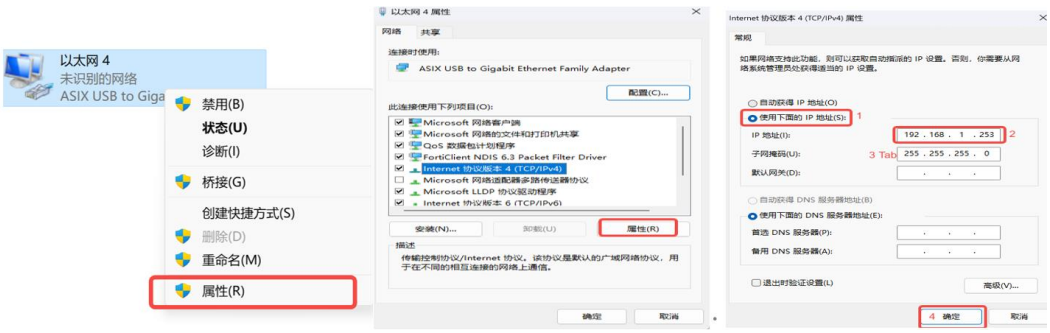


Figure 4-2. CS40Pro IP configuration steps 1, 2, and 3

4.4 Synexens SDK

Customers can use Synexens SDK for secondary development. The SDK supports Windows/Linux platforms and x86_64 and ARMv7/ARMv8 architectures. For detailed usage, please refer to the supporting documentation in the SDK document.

https://support.tofsensors.com/resource/sdk/sdk.html

4.5 GUI Software Graphical Tools

Credimension Viewer is a windows demonstration GUI tool for Synexens series products. This tool is mainly used to obtain, display and save Depth, IR, Point cloud information. It also supports viewing basic device information, setting resolution, integration times, filtering, firmware upgrade and other functions. Before starting to use, we recommend that you choose the GUI version tool that best suits your specific needs and read the corresponding version of the user guide.

https://support.tofsensors.com/resource/gui.html

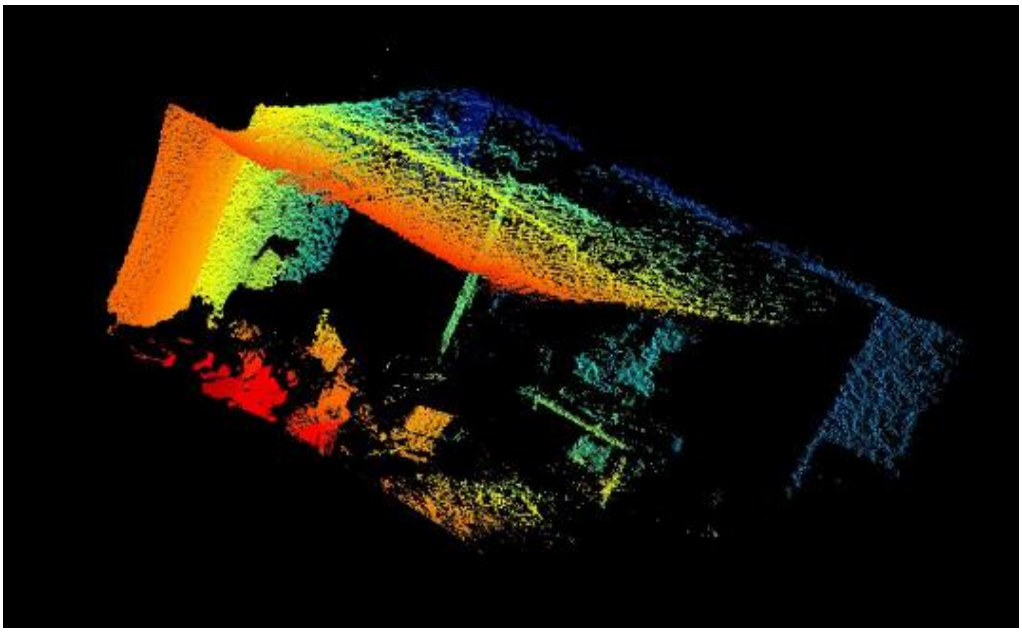


Figure 4-5. CS40Pro point cloud

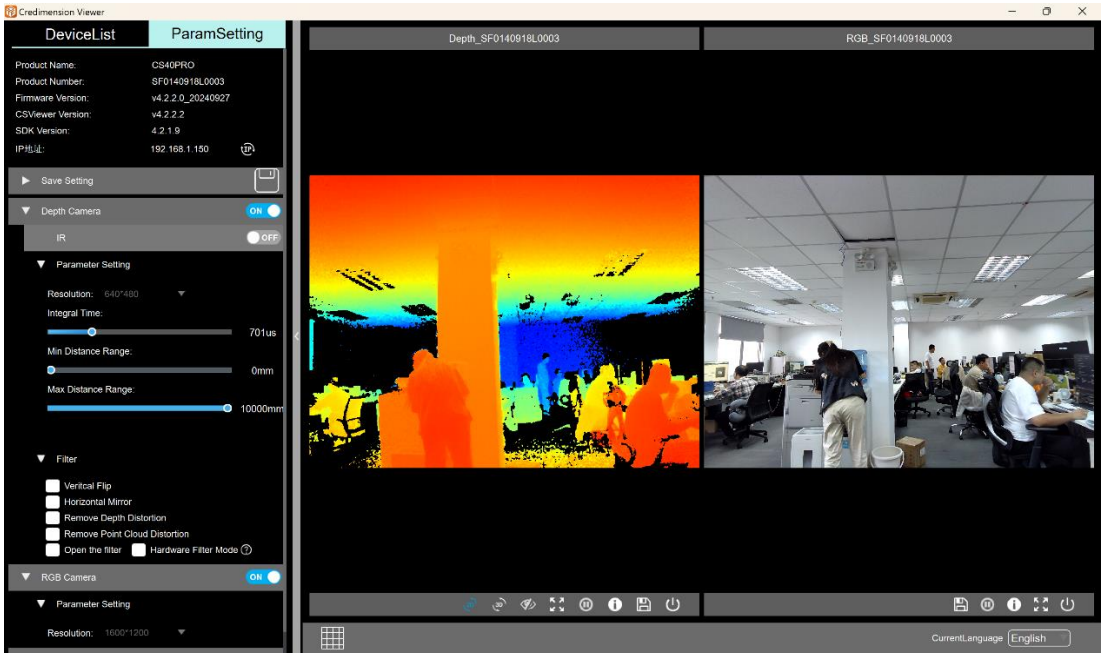


Figure 4-6. CS40Pro depth+RGB

5. Product accessories and packaging

Name Description	Picture
CS40Pro	
For the description of M8 adapter cable, see Chapter 3.3.1	
For the description of M12 adapter cable, please refer to Chapter 3.3.2	
12V DC power cable	

Table 6-1. CS40Pro Accessories List

6. Performance evaluation

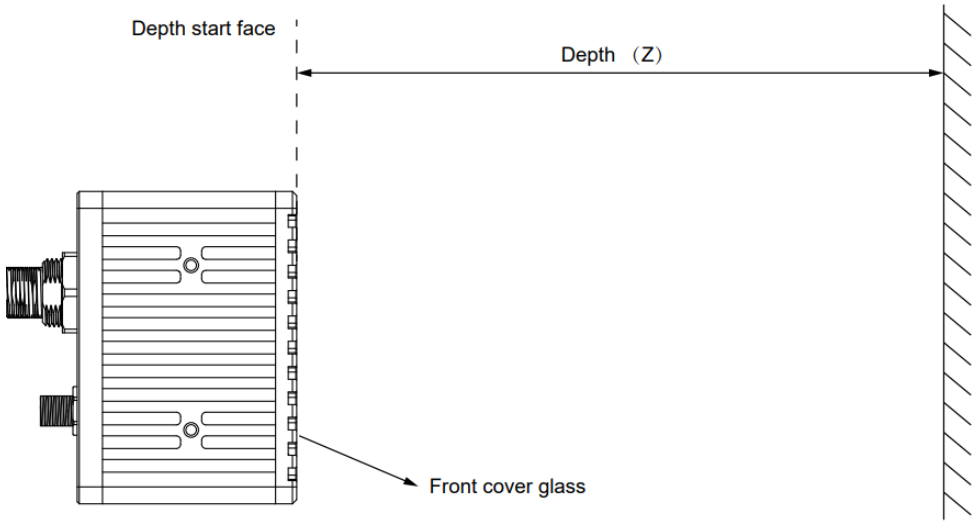


Figure 7-1 CS40Pro evaluation starting point

1) Absolute accuracy: refers to the difference between the measurement result and the true value, which is used to characterize the closeness between the measurement result and the true value. The formula is defined as follows:

$$Accuracy = \left| \frac{\sum_i depth_i}{N} - D \right|$$

2) Inter-frame noise: It is used to evaluate the stability of depth data between multiple frames. The formula for inter-frame noise is defined as follows:

$$Temporal\ noise = \frac{1}{N} \sum_i \sqrt{\frac{\sum_j \left(depth_j - \frac{\sum_j depth_j}{M} \right)^2}{M}}$$

3) Point cloud thickness: Take a photo of a white wall and test the point cloud thickness of the white wall at different distances.

7. Cleaning precautions

If you need to clean the CS40Pro product housing or glass cover, please pay attention to the following precautions:

1. For light dust, please use a soft, dry dust-free cloth to gently wipe it to reduce the potential impact of static electricity on the product;

2. If you need to remove stubborn stains or large dust particles, please use a soft dust-free cloth dipped in a small amount of pure water or alcohol to gently wipe to avoid scratching the glass cover; then wipe the product dry with a dry dust-free cloth;

3. After cleaning, please ensure that there are no water droplets, dust or other residual substances attached to the surface of the glass cover to avoid affecting the function of the product.

8. Compliance regulations

Class1

Disclaimer

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