CS40-Product Manual

Revision of previous versions			
Data	Version	Description	Author
2024.07.02	V1.0	Release	Daisy

Contents

1. Description and characteristics

1.1 Product Description:

CS40 is equipped with a PToF image sensor with a resolution of 640*480, which uses PToF technology to obtain three-dimensional information of objects and spaces, and has excellent performance such as large field of view and Ethernet transmission, providing users with convenient and efficient 3D perception capabilities. The product adopts a high-performance hardware processing platform, which allows users to integrate a variety of application algorithms and reduce dependence on back-end application platforms. It supports TCP/IP network communication protocol to achieve long-distance data transmission.

Features:

- Ethernet transmission, low data latency

- High dynamic measuring range

- Can be used outdoors

Applicable scenarios

- Outdoor obstacle avoidance

- Pallet identification

- Visual Orientation &

The product is mainly powered by a 6-core aviation head interface for power supply and Ethernet data transmission, and the specific interface and use are detailed in Section 3.3.

Figure 1-1. Description of the appearance of the CS40 solid-state LiDAR

1.2 Terms of Use

Product Warranty Service Notice

To ensure that you are fully covered by the product warranty, please follow these recommendations during the application process:

1. The product warranty is 1 year and is 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 shell, so as not to cause damage to the product and affect your warranty rights.

4. Make sure that there are no foreign objects inside the product to avoid affecting the internal circuit.

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

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

7. When cleaning the product shell or glass cover, please use a dry dust-free cloth, which can be slightly dipped in a small amount of water or alcohol to remove the stain to ensure that the shell is dry and free of residue.

2. Introduction

2.1 Purpose of this document

This document details the specifications, interface details, and installation and usage guidelines of the CS40 solid-state lidar, providing users with the reference information they need to understand and use the CS40.

2.2 System Block Diagram

The CS40 hardware system consists of 3 main components, the processor motherboard, the RX module, and the TX module. The ARM processor is located on the motherboard, and the RX module and TX module are snapped onto the motherboard through connectors.
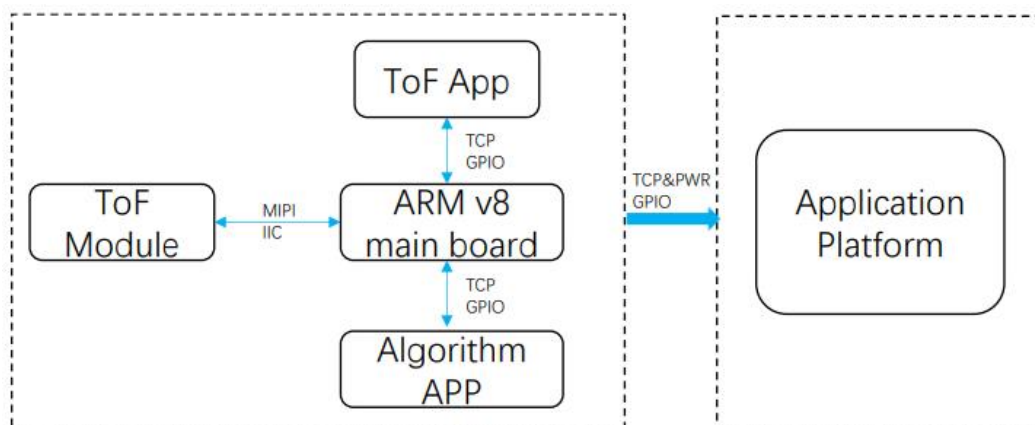
Figure 2-1. Block diagram of the CS40 solid-state LiDAR system

2.3 Technical Parameters

Technical parameters		
Depth image	resolution	640*480/15fps
	FOV	H90° x V70°
Basic parameters	Working distance	0.3~5m Indoor；0.3~4m，Outdoor
	VCSEL wavelength	940nm
	precision	0.3~0.5m:±2.0cm@90%reflectivity 0.5~4m:±2% @90%reflectivity
	Product dimensions	103.6mm * 70mm*43.7mm
	Data transmission	TCP/IP protocol
	Power supply mode	DC 12~24V/2A
	power consumption	Average 5.88W@IntegCount 1510
	operating system	Windows，Linux，Arm Linux
	Operating temperature	-20~60℃
	security	Class1
	Ingress protection	IP67

Table 2-1. CS40 solid-state LiDAR technical data sheet

3. Component Specifications

3.1 ToF Module

Compose	Description
ToF imager	Time of light image sensor
ToF emitter	Class1
Other Components	Laser Driver,EEPROM,Voltage Regulators,FPC,Commector etc.

Table 3-1. ToF module components

3.1.1 ToF module image sensor

Compose	Description
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	2.16mm
Focus	Fixed
Horizontal Field of View	87.2
Vertical Field of View	67.7
Diagonal Field of View	104
TV Distortion	-6.1%

Table 3-2. ToF image sensor parameters

3.1.2 ToF module laser emitter

The ToF laser emitter emits uniform near-infrared (940nm) light to the object, and the laser emitter meets the safety requirements of laser class 1 under normal operation.

Items	Test Condition	Min	Typical	Max	Unit
Optical Output power	Pulse=4.0A	4.5	6.1	7.7	W
Operating Current		-	4	-	A
Operating voltage	Pulse=4.0A	-2.7	4.1	5.5	V
Slope efficient	Pulse=4.0A	-	1	-	mW/mA
Power conversion efficiency	Pulse=4.0A	-	45	-	%
angle	Pulse=4.0A	-	90	-	°
	Pulse=4.0A	-	70	-	
Wavelength	If=4.0A	929	941	953	nm
Wavelength coefficient	Pulse=4.0A	-	0.07	-	nm/℃

Table 3-3. Laser emitter parameters

*Viset=5V、Pulse width=100us Duty Cycle 2%、Ta=25℃

3.2 Processor Motherboard

Compose	Description
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	(24+24)pin receptacle for connection to Depth Module
Ethernet	100Mbps 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 Motherboard Parameter Table

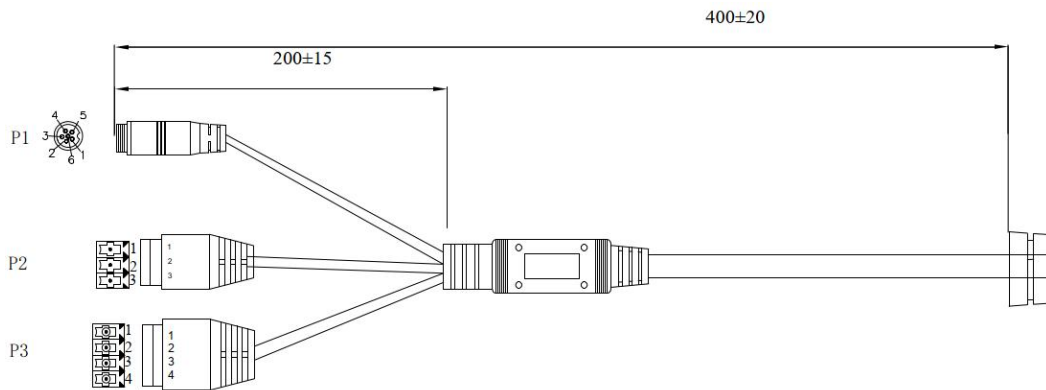## 3.3 Tail cable and adapter cable description

3.3.1 Tail line description

Figure 3-1. Schematic diagram of the CS40 tail line

P1: M12 Aircraft Head Male _6PIN		P2:DGK5.08_3PIN		P3:DGK5.08_4PIN	
Pin Number	Signal Name	Pin Number	Signal Name	Pin Number	Signal Name
1	100BASE-T:TX-	1	GND	1	GND
2	100BASE-T:TX+	2	VCSEL_IN	2	RS485_A(P)
3	V+(12~24V/2A)	3	V+(12~24V/2A)	3	RS485_B(N)
4	100BASE-T:RX-	Note: P2 Pin1 & Pin3 are power interfaces, which can be used to supply power to other bypass devices. Pin2 is an external trigger signal that is used to control the laser operating state		4	GND
5	100BASE-T:RX+				
6	EGND				

Table 3-5. CS40 tail wire description sheet

3.3.2 Adapter Cable Description
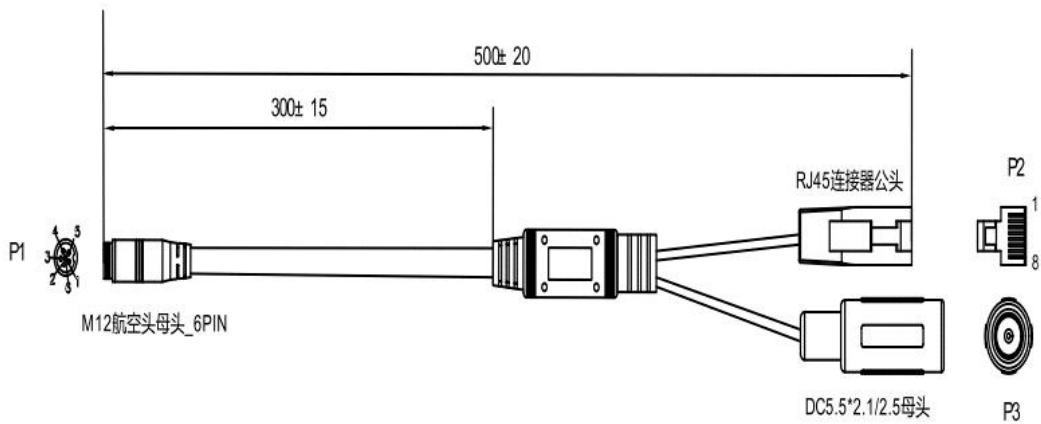
Figure 3-2. Schematic diagram of CS40 adapter cable

P1: M12 aircraft head female head _6PIN		P2:RJ45 公头		P3:DC5.5*2.5 公头	
Pin Number	Signal Name	Pin Number	Signal Name	Pin Number	Signal Name
1	100BASE-T:TX-	1	100M_TX+	Note: DC5.5*2.5 is required.The power supply range is 12~24V/2A adapter is used.Suggested purchase links: https://item.jd.com/100029626633.html	
2	100BASE-T:TX+	2	100M_TX-		
3	V+(12~24V/2A)	3	100M_RX+		
4	100BASE-T:RX-	6	100M_RX-		
5	100BASE-T:RX+				
6	EGND				

Table 3-6. CS40 Adapter Cable Instruction Sheet

3.4 Electrical Characteristics

3.4.1 Suggested Conditions of Use

Parameter	Symbol	Min	Typ	Max	Units
Supply voltage	DC	11	12	24	V
Operating ambient temperature	Ta	-20	25	60	℃
Humidity of the working environment		20		80	%
Store humidity		20		80	%
Storage temperature		-20	25	65	℃

Table 3-7. CS40 recommends the use of a condition description table

3.4.2 Power consumption

Parameter	Conditions	Average	Max	Units
Work	1510 points times		490	mA
Standby	-	86		mA

Table 3-8. CS40 Power Consumption Description Table

Note: 12V input voltage

3.4.3 Absolute Conditions of Use

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

Parameter	Symbol	Min	Typ	Max	Units

Supply voltage	DC	12	12	24	V
Operating ambient temperature	Ta	-20		60	℃

Table 3-9. CS40 Absolute Conditions of Use Description Table

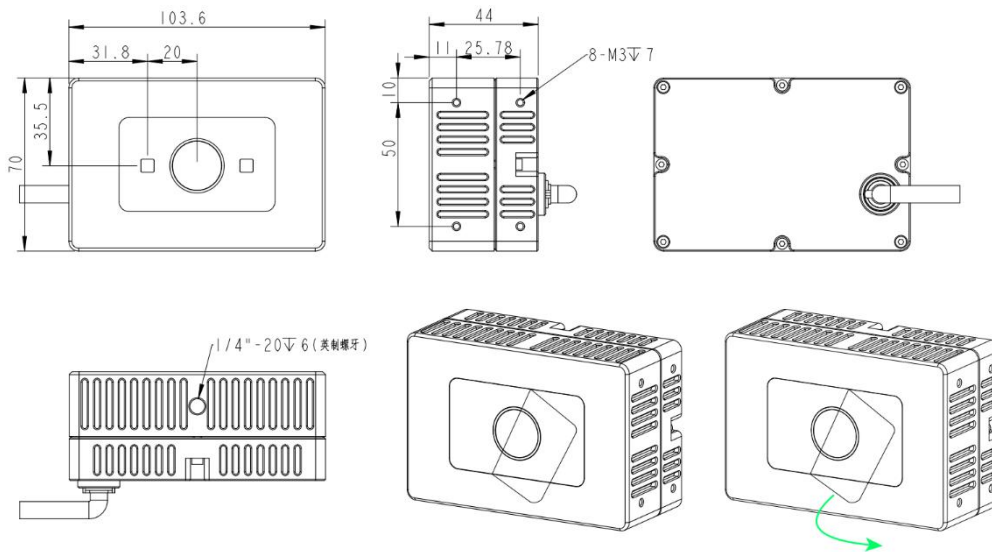## 3.5 CS40 mechanical structure dimensions

Figure 3-3. Schematic diagram of the mechanical structure of CS40

3.6 Optical Specifications
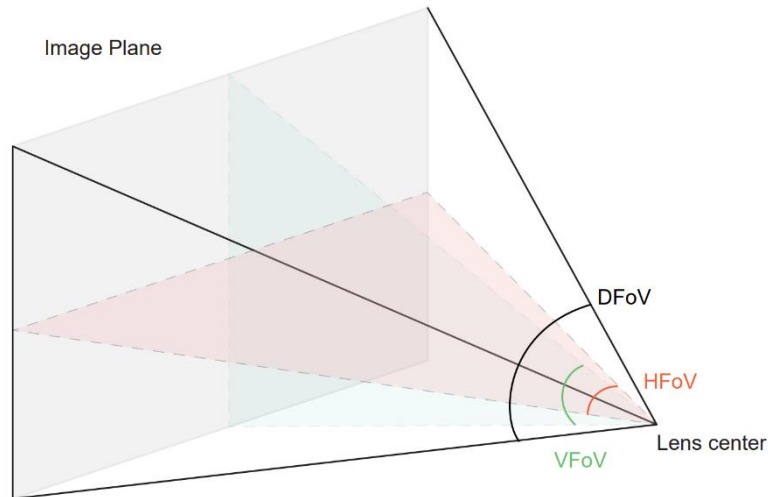
3.6.1 Field of view

Figure 3-4. Schematic diagram of the field of view

Field of View (FOV) refers to the range of angles at which a ToF sensor is able to capture a scene. ToF sensors have an aspect ratio of 4:3, and the angle of view in the horizontal direction is usually greater than the angle of view in the vertical direction. HFOV (Horizontal Field of View) and VFOV (Vertical Field of View) represent the horizontal and vertical field of view, respectively. DFOV (Diagonal Field of View) refers to the angle between the diagonal of the sensor and the center of the lens. The CS40 has a typical FOV of 90 degrees horizontally (H90°) and 70 degrees vertically (V70°).

3.6 Working conditions and needs

3.6.1 Hardware Requirements

Ethernet cable, aircraft carrier adapter cable, 12~24V/2A power supply;

3.6.2 Software Requirements

Operating system:

64bit Window 10/11；Linux(x86，x64);

Supported Software Environments:

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

3.6.3 Temperature and humidity

Temperature during operation:	-20~60 ℃
Humidity during operation:	20~80 %，relative humidity
Storage Temperature:	-20~65 ℃
Storage Humidity:	20~80 %，relative humidity

3.6.4 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 a 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 a three-dimensional coordinate system used to represent point

cloud data. You can convert the camera coordinate system to the world coordinate system through the camera's internal parameters, and you can refer to the sample code in the SDK for details.
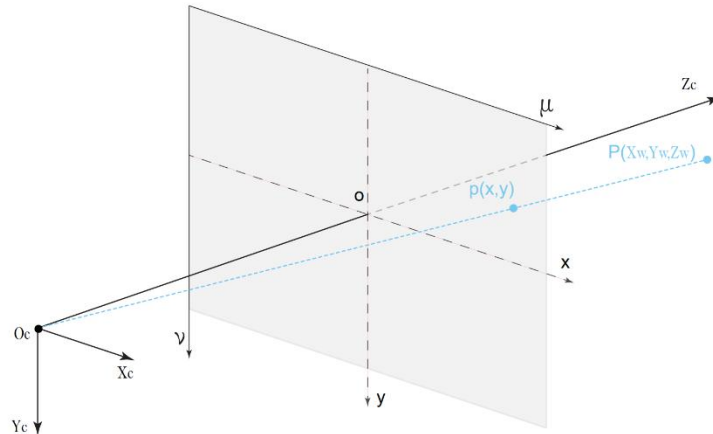

Figure 3-5. Schematic diagram of the optical coordinate system

The origin of the CS40 is illustrated by the following diagram:

1. The coordinate origin of the X-axis is located 35.5mm away from the upper edge of the product;

2. The coordinate origin of the Y axis is located 51.8mm away from the right edge of the product;

3. The coordinate origin of the Z-axis is located on the front surface of the lens.
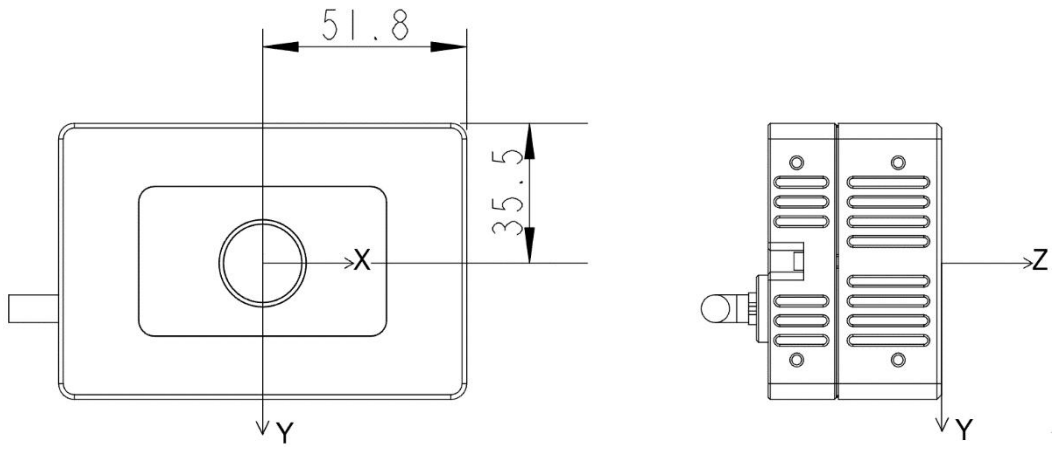
Figure 3-6. Schematic diagram of the CS40 coordinate system

4. Install and use

4.1 Precautions

4.1.1 Laser Safety

	Risk of electric shock
⚠️	The use of non-standard or inappropriate power supplies that do not meet the specifications may result in fire and electric shock risks. Therefore, you must ensure that the power supply you choose meets the specified voltage and current requirements.

	Laser safe
⚠️	When using this product, care should be taken to prevent damage to the eyes as it emits invisible laser light. The laser emitted by this product belongs to the Class 1 safety level, and according to the EN60825-1 standard, it will not cause any impact on human health under standard use. Make sure to use this product in the correct way.

4.1.2 Proper power supply

The CS40 is powered by a DC power supply, and it is recommended to use an output 12V power supply to power the CS40. Please note that damage to the product may occur if the supply voltage exceeds 24V or falls below 11V.

Adapter Power Supply Configuration Standards:

Input: 200-240-50Hz 0.8A MAX

Output: 12V⎓2A AC --> DC

4.1.3 Proper Operation

1. Do not attempt to disassemble the product case. All products are rigorously calibrated before leaving the factory. Any disassembly or contact with internal components may cause damage to the product, affect its accuracy, and may even result in the product not working properly.

2. Please connect and disconnect the power cord of the product properly. Improper handling may cause damage to the product. In order to avoid power fluctuations affecting the product, make sure that the product and power cord are properly connected before turning on the power supply. When it is time to remove the power cord, make sure that the power supply on the power supply side has been turned off.

3. Please do not adjust the position of the lens. Improper handling may result in damage to the product.

4. When the product is not in use, please put it back in the original box 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 indicated in the product specification sheet,

please refer to Section 2.3 for specific details.

2. We recommend that you install the product on a part with good

thermal conductivity, such as metal brackets, etc. This can effectively

help the product to dissipate heat, so as to ensure its stable and long-

lasting performance.

4.2 Hardware Installation

Please ensure that you have read and understood the warnings listed in

Chapter 4.1 "Precautions". To ensure the accuracy of your distance

measurements, follow these recommendations:

Try to avoid using the CS40 in strong sunlight. If you must use it in bright

light, make sure the ambient light level is less than 120,000 lux (120kLux).

In the shooting scene, do not place any unexpected objects, especially

mirrors or other objects with reflective surfaces, so as not to affect the

measurement results.

During use, keep the temperature of the device shell stable to avoid

temperature fluctuations affecting the measurement accuracy.

Make sure the CS40 is securely mounted to reduce measurement errors

due to shaking.

Make sure all accessories are ready before use.

4.2.1 Installation Steps

 The CS40 transmits data via an Ethernet cable and requires a power adapter to power it. Here's how to do it:

1. Install the CS40 in a suitable fixture, such as a camera mount.

It is recommended that the product can be searched, and the FOV area should be kept at a certain distance from the wall, and should not coincide with the wall to prevent abnormal images;
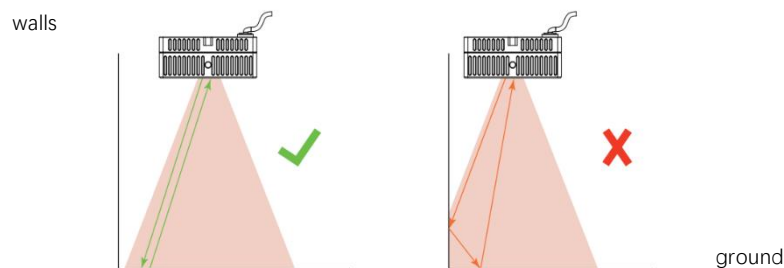

Figure 4-1. Schematic diagram of the CS40 installation FOV area

2. Connect the CS40 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 side of the camera.

4. Connect the adapter to a power source.

5. When setting up the network connection, please set the IP address of the camera and the host computer in the same line segment (see 4.3: IP Address Configuration).

6. The default IP address of CS40 is 192.168.1.150, if you need multiple devices to connect to the same PC and enable the runtime at the same time, the IP address of the other CS40 needs to be changed to 192.168.1.xxx.

4.3 IP address configuration

After connecting to CS40 on the PC, you need to configure the network IP address of the CS40 port when you enable the use of CS40, and perform the following steps:

1. Select the current CS40 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 by CS40).

3. If the current computer needs to connect two CS40s at the same time, you need to select the second CS40 to perform the above steps "1" &"2" again after connecting the second device, for example: the IP address of "Device 1" is 192.168.1.150, the IP address of "Device 2" is 192.168.1.151, and the IP address input in "2" can be set to 192.168.1.11 and 192.168.1.22 respectively (where 11 or 22 can be changed to other). Note: Multi machine connections require the use of routers or switches.

Figure 4-2.CS40 Configuring IP Steps 1, 2, and 3

4.4 Synexens SDK

Customers can use the Libsynexens SDK for secondary development, which supports Windows/Linux platforms and x86_64 and ARMv7/ARMv8 architectures, and has specific performance optimizations for embedded architectures. For details, see the accompanying documentation in the SDK.

https://support.tofsensors.com

4.5 GUI Software Graphical Tools

Credimension Viewer is a Windows presentation GUI tool for the Synexens family of products. This tool is mainly used to obtain, display, and save Depth, IR, and Point cloud information, and supports functions such as viewing basic device information, setting resolution, number of integrations, filtering, and firmware upgrade. Before you get started, we recommend that you choose the most suitable GUI version for your

specific needs and read the content of the corresponding version of the
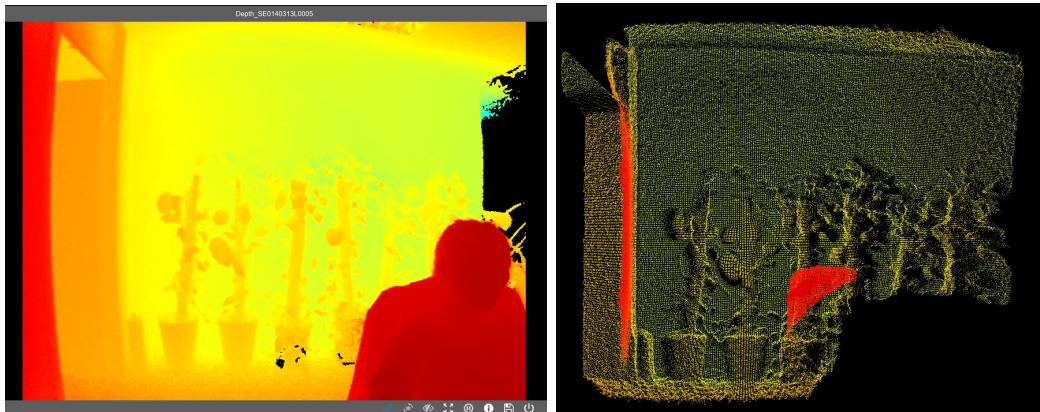
user manual.

https://support.tofsensors.com/home/resources/index?pid=2/#fat

Figure 4-5. CS40 depth (left) + point cloud (right).

5. Product accessories and packaging

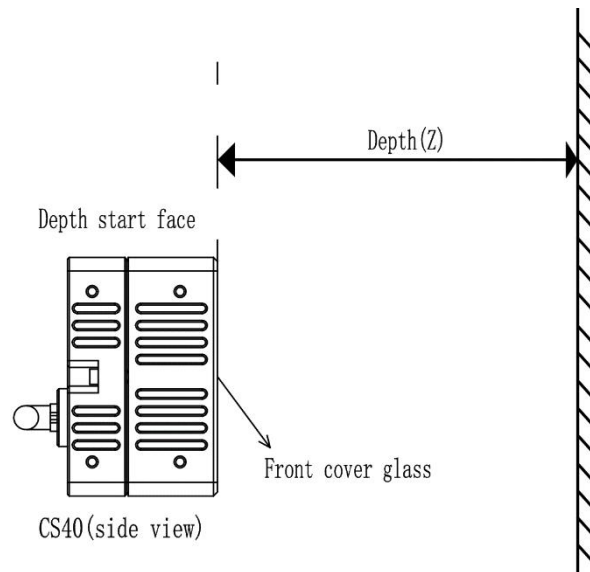| Name description	Photo
CS40	
For the description of the adapter cable, see Chapter 3.3.2 Adapter Cable Description	
12V DC power cord	

Table 6-1. CS40 Product Parts Table

6. Performance Measurement

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

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

2) Inter-frame noise: used to evaluate the stability of depth data between multiple frames, the formula of 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 picture of the white wall and test the

point cloud thickness of the white wall at different distances.

7. Cleaning precautions

If you need to clean the CS40 product enclosure or glass cover, please note the following precautions:

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

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

3. After cleaning, please make sure that there are no water droplets, dust and other residual substances attached to the surface of the glass cover, so as not to affect the function of the product.

8. Compliance with Regulations

Class1

Disclaimer

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