CS20-P-Product specifications

Revise the historical version			
Date	Version	Description	Author
2023/06/12	V1.0	First draft	Terry
2023/07/24	V1.1	1. Modify the adapter description; 2. Added adapter DC adapter referral link.	Terry

目录

1.Description and characteristics

Product description

CS20-P is an Ethernet depth camera, the camera is equipped with a ToF image sensor with a resolution of 320*240, using ToF technology to obtain three-dimensional information of objects and space, with excellent performance such as long distance and low power consumption, providing users with convenient and efficient 3D perception capabilities.

The product is mainly transmitted through the 6-core aviation head interface for power supply and Ethernet data transmission, the specific interface and use are detailed in Chapter 3.2.

Product features

- Centimeter-level Measurement Accuracy
- Measuring range: 0.1-5 m@90% Ref
- Aviation head power supply and Ethernet data transmission

Applicable scenarios

- Smart buildings
- Anti-tailgating
- People counting

Figure 1-1. Exterior view of the CS20-P depth camera

2.Introduce

2.1 The purpose of this document

This document details the specifications of the Ethernet depth camera CS20-P, providing users with the relevant information they need to understand and use the CS20-P Ethernet depth camera.

2.2 Overview of ToF (Time-of-Flight) Technology

ToF technology calculates the distance of an object from the camera through the flight time of light. First, the ToF sensor gives the light source to drive the chip modulation signal, and then the modulation signal emits high-frequency modulated near-infrared light through the control laser, and when the light encounters the measured object, it is diffusely reflected back to the sensor receiving end, and the depth information is calculated by the time difference between transmitting and receiving light.

The CS20-P Ethernet depth camera uses continuous wave modulation (CW-iToF) in i-ToF (indirect ToF). Through the proportional relationship of the energy value collected by the sensor in different time windows, the signal phase is parsed, and the time difference between the transmitted signal and the received signal is indirectly measured, and then the depth is obtained.

Continuous wave modulation (CW-iToF)

Usually using a sine wave modulation method, the phase offset of the sine wave at the receiving and transmitting ends is proportional to the distance of the object from the camera, and the distance is measured by the phase offset

$$\varphi_{TOF} = \operatorname{atan}\left(\frac{C_1 - C_3}{C_2 - C_4}\right)$$
$$D = \frac{c}{2} * \frac{\varphi_{TOF}}{2\pi * f_m} + D_{offset}$$

Formula 2-1. Distance calculation

The phase offset (ϕ) and depth (D) are obtained by the analysis of the integrated energy values from the above equations C1, C2, C3, and

C4, which are the energy collected by the receiving windows of four different phase delays, corresponding to sampling at the phase sampling point 0°, 90°, 180°, and 270°, namely:

$$C_1 = Asin(\varphi)$$

$$C_2 = Asin(\varphi + 90°) = Acos(\varphi)$$

$$C_3 = Asin(\varphi + 180°) = -Asin(\varphi)$$

$$C_4 = Asin(\varphi + 270°) = -Acos(\varphi)$$

Formula 2-2. Energy value vs. Phase

where A is the amplitude of the received sinusoidal signal.

In terms of accuracy, CW-iToF accuracy is mainly limited by random noise, which is inversely proportional to the Signal to Noise Ratio (SNR) of the received optical signal, and quantization noise, which is inversely proportional to the sine wave modulation frequency. Therefore, in order to improve accuracy, CW-iToF generally adopts high-power short integration time sampling to improve the SNR of the received optical signal; At the same time, the modulation frequency is increased to suppress quantization noise.

In terms of range, the phase range that CW-iToF can resolve is [0~2π], so its maximum range is Dmax=c/(2fm). That is, the higher the frequency, the higher the accuracy and the smaller the range. Beyond the depth of the range, periodic phase wrap will occur, and the measured value will fall incorrectly within [0~Dmax].

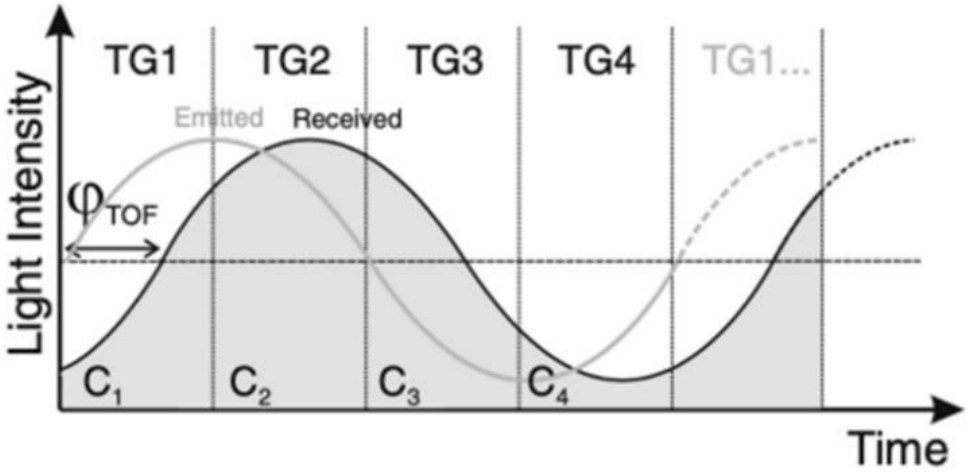

Figure 2-1. Light flight time and light intensity

2.3 Block diagram of the camera system

CS20-P Ethernet depth camera hardware system includes 2 main components, processor motherboard, ToF module. The ARM processor is located on the motherboard, and the ToF module is buckled on the motherboard through connectors.

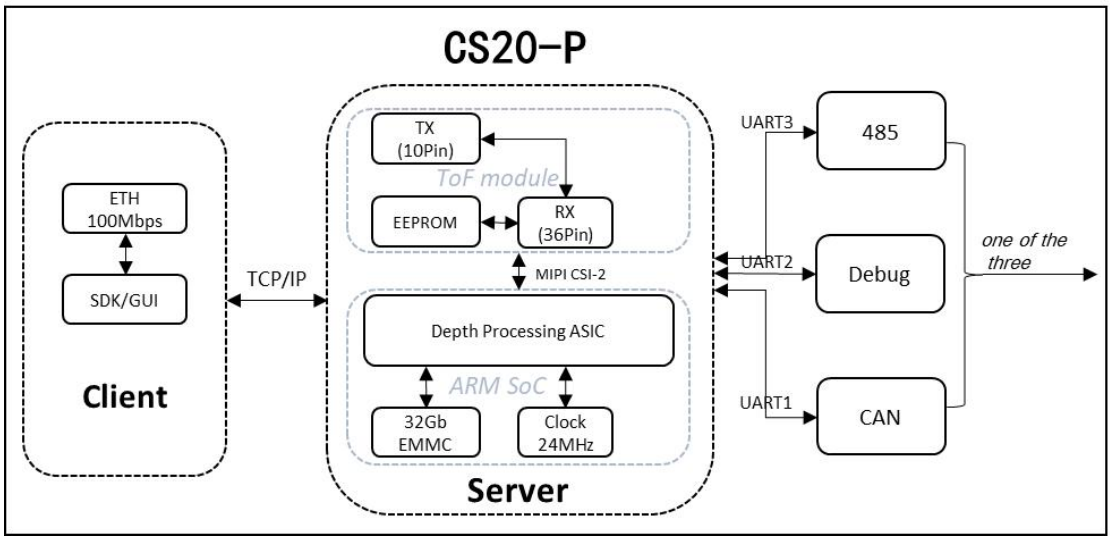

Figure 2-2. Block diagram of the CS20-P Ethernet depth camera system

2.4 Technical Parameters

技术参数		
Depth image	resolution	320*240
	FOV	H100°xV75°
Basic parameters	Working distance	0.1-5m, indoor
	VCSEL wavelength	940nm
	precision	0.1~0.5m: ±3cm; 0.5~5m: ±2% @ 90% reflectivity
	Product size	90mm x 25mm x 25mm
	Data transmission	TCP/IP Interface
	Power supply mode	12-24V/2A
	power consumption	average 3.0W
	operating system	Win 10，
	Operating temperature	-10 ~ 50℃
	security	LASER CLASS1

3. Component specifications

3.1 ToF module

compose	description
ToF imager	Time of light image sensor
ToF emitter	Class 1 laser compliant (optional)
Other Components	Laser Driver, EEPROM, Voltage Regulators, FPC, Connector etc.

Table 3-1. ToF module components

3.1.1 ToF module image sensor

compose	description
Active Pixels	320*240
Sensor Aspect Ration	4：3
Format	10-bit RAW
Shutter Type	Global shutter
Signal Interface	MIPI CSI-2, 2X Lanes
F Number	1.2
Focal Length	2.534mm
Focus	Fixed
Horizontal Field of View	100.2
Vertical Field of View	75.1
Diagonal Field of View	125.5
TV Distortion	<11.8%

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 laser safety requirements of Class 1 under normal operating conditions.

Items	Test Condition	Min	Typical	Max	Unit
Optical Output power	Pulse=5.0A，50℃	-	4.3	-	W
Threshold current	Pulse 50℃	-	-	1	A
Operating Current	Pulse 50℃	-	5	-	A
Operating voltage	Pulse=5.0A，50℃	-	2.0	-	V
Slope efficient	Pulse=5.0A，50℃	-	1	-	mW/mA
Power conversion efficiency	Pulse=5.0A，50℃	-	43	-	%
Angle	Pulse=5.0A，50℃	-	110.25	-	°
	Pulse=5.0A，50℃	-	90.22	-	
Wavelength	If=5.0A，50℃	938	940	942	nm
Wavelength coefficient	Pulse=5.0A	-	0.07	-	nm/℃

Table 3-3. ToF module laser emitter parameters

3.2 Processor motherboard

Components	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	(36+10)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 3-5. Processor Board Components

3.3 CS20-P interface description

3.2.1 CS20-P Tail Description

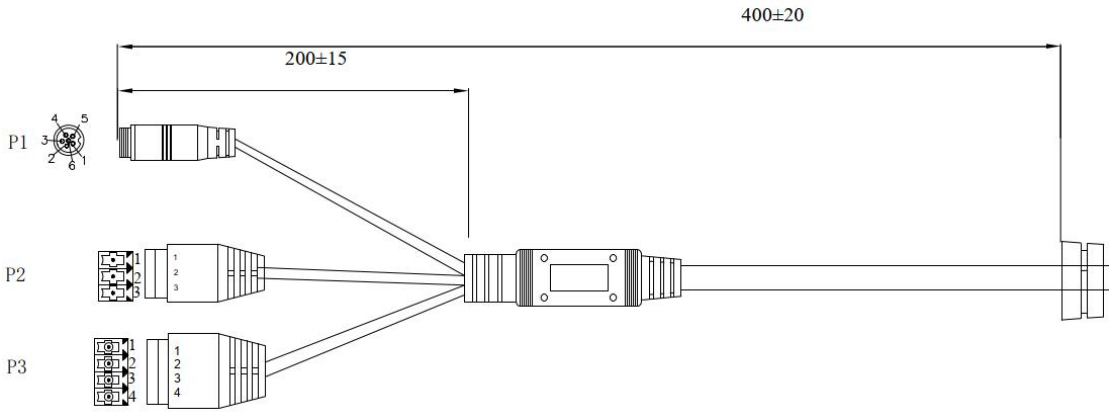

Figure 3-1. Schematic diagram of the CS20-P tail

P1: M12 Aviation Head _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 is a power interface that can be used to power other bypass equipment; Pin2 is an external trigger signal that controls the operating state of the laser		4	GND
5	100BASE-T：RX+			Note: 485/Uart/CAN interface communication, can be configured through software, default 485 interface	
6	EGND				

Figure 3-2. Buttcock line Receptacle Pin Map

3.3.2 CS20-P Adapter Description 3.3.2 CS20-P Adapter Description

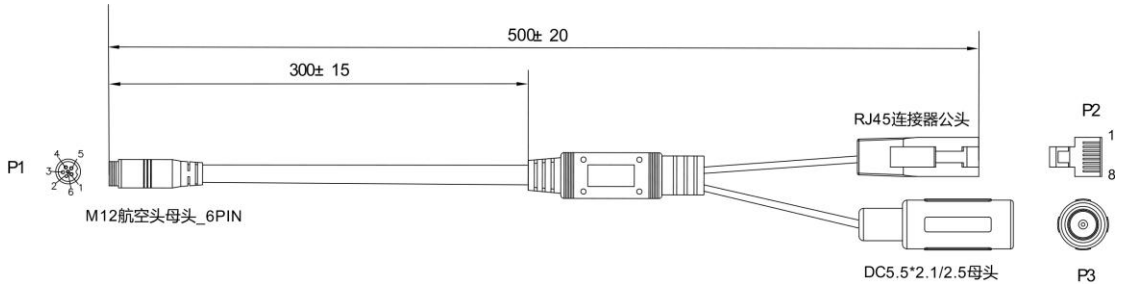

Figure 3-2. Schematic diagram of the CS20-P adapter cable

P1: M12 aircraft head female _6PIN		P2: RJ45 male		P3: DC5.5*2.5 male	
Pin Number	Signal Name	Pin Number	Signal Name	Pin Number	Signal Name
1	100BASE-T：TX-	1	100M_TX+	Note: It needs to be used with DC5.5*2.5 adapter with a power supply range of 12-24V/2A. Suggested purchase link: 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				

3.2.2 CS20-P adapter instructions

3.4 Power consumption

state	Imin（mA）	Iavg（mA）	Ipp（mA）
Standby (complete machine)	54	55	56
Motherboard + ToF Module	197	220	527
Supply voltage: V+=12V, measured data based on exposure time=3000us.			

Table 3-7. CS20-P Ethernet depth camera power consumption specification

4. Performance evaluation

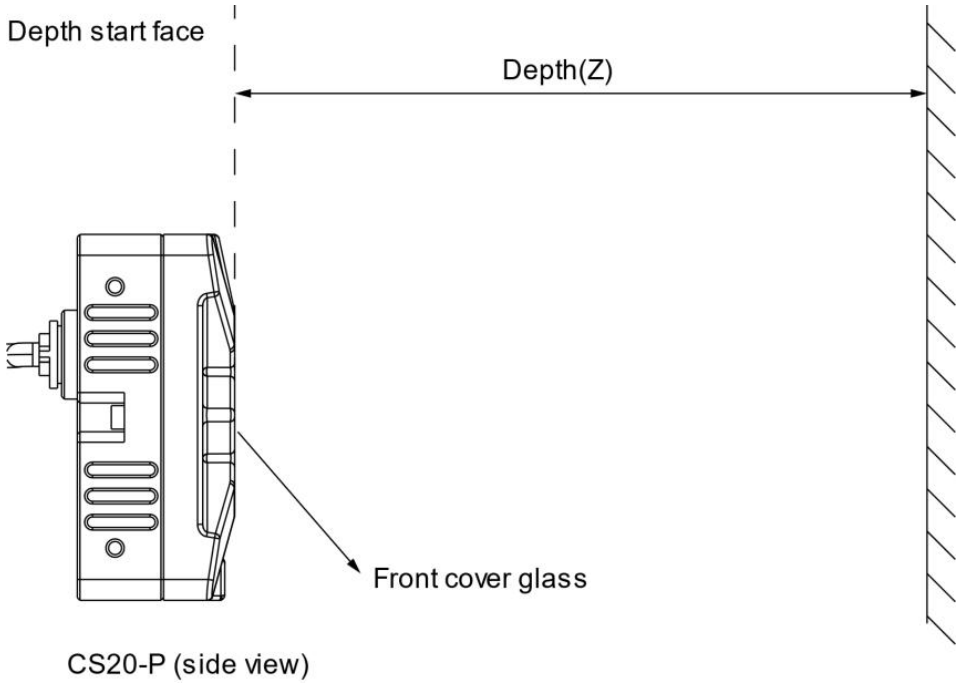

Figure 4-1 CS20-P evaluation starting point

1.Absolute accuracy: refers to the difference between the measurement result and the true value, used to characterize the closeness 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 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: shoot the white wall and test the point cloud thickness of the white wall at different distances

5.Mechanical structure

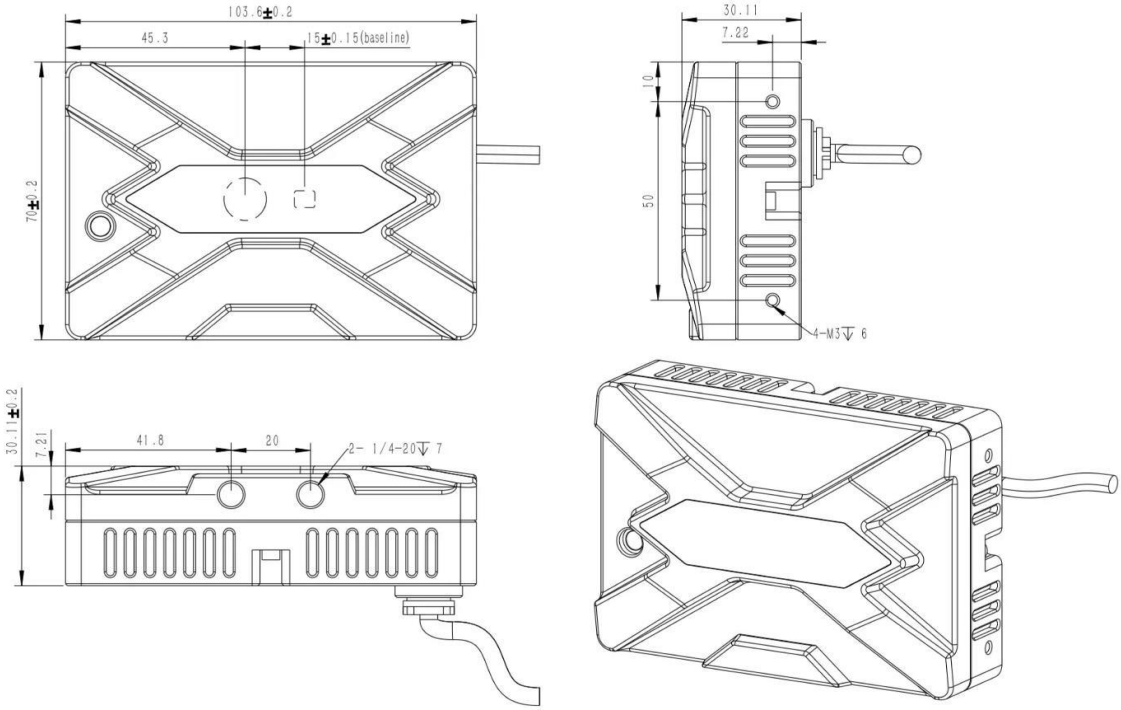

Figure 5-1 CS20-P Ethernet depth camera structure diagram

Dimension	Min	Nominal	Max	Unit
Width	103.40	103.60	103.80	mm
Height	69.80	70.00	70.20	mm
Depth	29.91	30.11	30.31	mm
Weight	298.00	300.00	302.00	g

Table 5-1. Structural dimensions

6.Storage conditions

Condition	Description	Min	Max	Unit
Storage Temperature		-15	60	° C
	Humidity	Temperature/RH: 40° C/90%		
Work Temperature		-10	50	° C

7.Camera cleaning steps

1. Do not use any chemicals or water on the camera lens.

2. Use the lens purge brush to remove dust and dirt from the lens as much as possible.

3. Wipe with a dry, clean microfiber cloth.

8. Software

- Windows client --- Credimension Viewer

Credimension Viewer is a Windows presentation GUI tool for the Synexens family of products. The tool is mainly used to obtain, display, save Depth, IR, Point cloud information, and support viewing device basic information, setting resolution, integration time and other functions.

- SDK---CSAPI

Customers can use the Libsynexens SDK for secondary development, which supports the Windows/Linux platform and x86_64 and ARMv7/ARMv8 architectures, with specific performance optimizations for embedded architectures. For details about how to use it, see the supporting documentation in the SDK.

9. Compliance with Regulations

“ ROHS、CLASS 1 ”

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