

AI Camera Development Board

Datasheet



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1 Overview

1.1 Product Description

The AI Camera Module is an integrated visual recognition development board specifically designed for multi-scenario intelligent development. Centered on the high-performance ESP32-S3R8 dual-core microprocessor, it integrates visual recognition, touch interaction, audio input/output, and wireless communication capabilities. Supporting both on-device AI recognition and cloud-based inference modes, the product features external Flash storage, an SD card slot for expansion, and a rich interface design. It meets requirements for data storage, peripheral connection, and multi-device adaptation, delivering a complete intelligent development solution from hardware to software. Balancing usability and expandability, it caters to the development needs of users with varying technical backgrounds.

Leveraging its robust functionality, the AI Camera Module finds wide application in STEAM education, robot competitions, light industrial production, garbage classification demonstrations, and interactive experiments. It assists in teaching, serves as a navigation core, improves detection efficiency, and fulfills demonstration and experimental needs—making it a comprehensive, versatile intelligent development tool.

1.2 Core Features

- **Core Processor & Communication:** Equipped with the ESP32-S3R8 dual-core Xtensa® 32-bit LX7 microprocessor, integrated with WiFi+BLE functionality. Supports on-device AI recognition and cloud-based inference, alongside 2.4GHz Wi-Fi and Bluetooth 5.0 wireless communication.
- **Storage Design:** Features an external Flash memory chip and an SD card slot for expandable local storage. Meets requirements for data logging and multimedia file storage.
- **AI Vision & Audio Capabilities:** Integrates a 2-megapixel GC2145 camera, supporting computer vision tasks such as human detection, object recognition, and motion tracking, as well as online AI recognition. Combines camera and microphone for "image + voice" hybrid interaction, enabling audio control.
- **Interaction & Display Interfaces:** Equipped with a 1.83-inch TFT touchscreen for graphical menu operation and touch control. Integrates RGB status indicators, cool-toned fill light LEDs, and microphone/speaker interfaces, supporting voice input, audio playback (including intercom functionality).
- **Expansion Capabilities:** Provides UART serial port (compatible with Arduino/Raspberry Pi and other controllers), I2C pads, and multiple GPIO interfaces for easy connection to external sensors and actuators.
- **Power Supply & Management:** Supports 3.7V lithium battery input, with charging status indication (bi-color LED) and low-voltage protection. Suitable for mobile scenarios.
- **Multi-Device Compatibility:** Features UART and BAT interfaces, compatible with multiple Single-Board Computers (SBCs) including Raspberry Pi, Arduino, micro:bit, and LattePanda.

1.3 Application Scenarios

- **STEAM education:** learning visual recognition, image processing, and AI control.
- **Industrial identification:** suitable for assembly line object recognition, label scanning, etc.
- **Interactive experiment:** programming and controlling peripherals with micro:bit and Raspberry Pi.

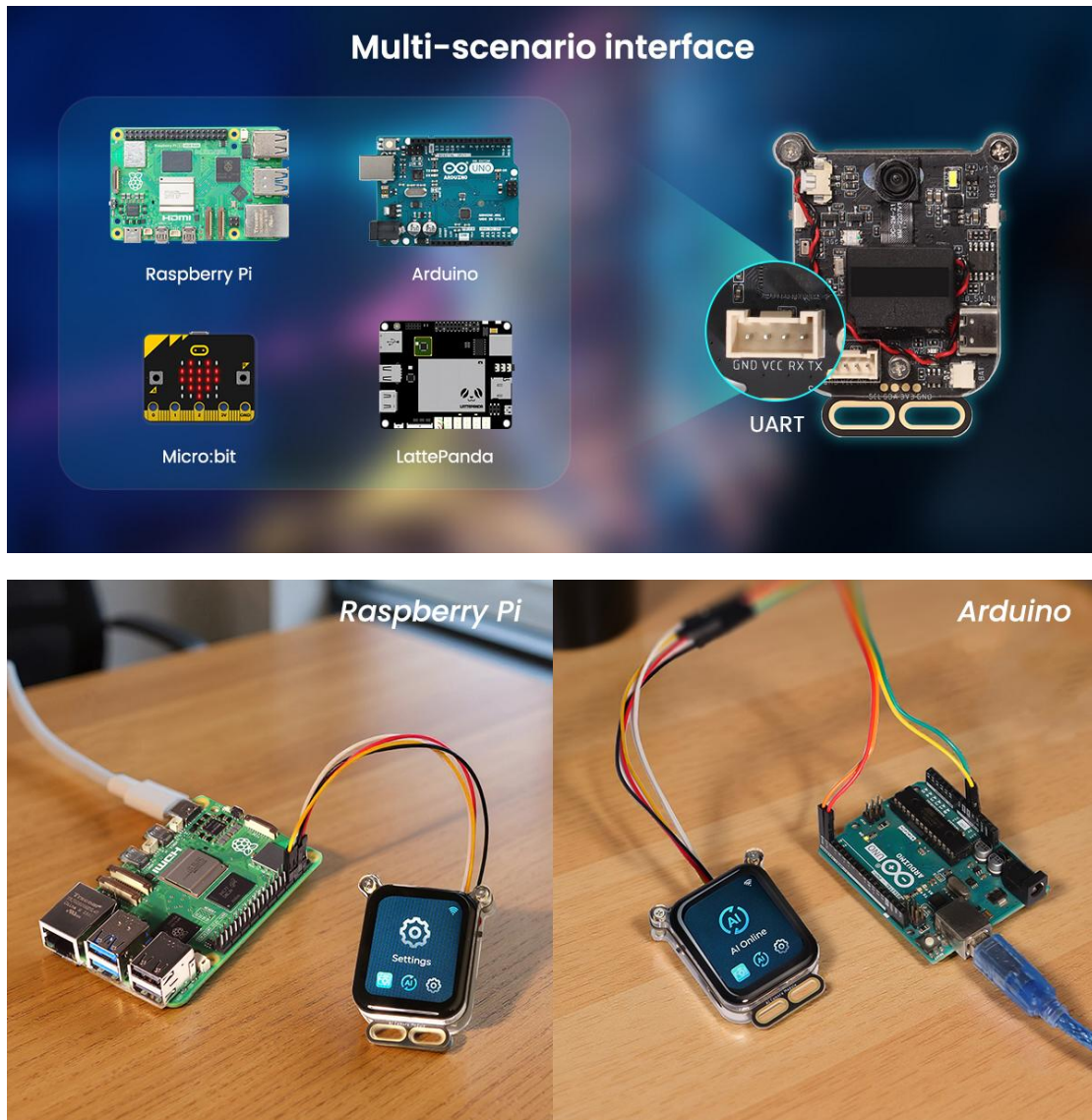


Figure 1:Application Scenarios Diagram

2 Product Appearance Diagrams



Figure 2: Front View



Figure 3: Side View

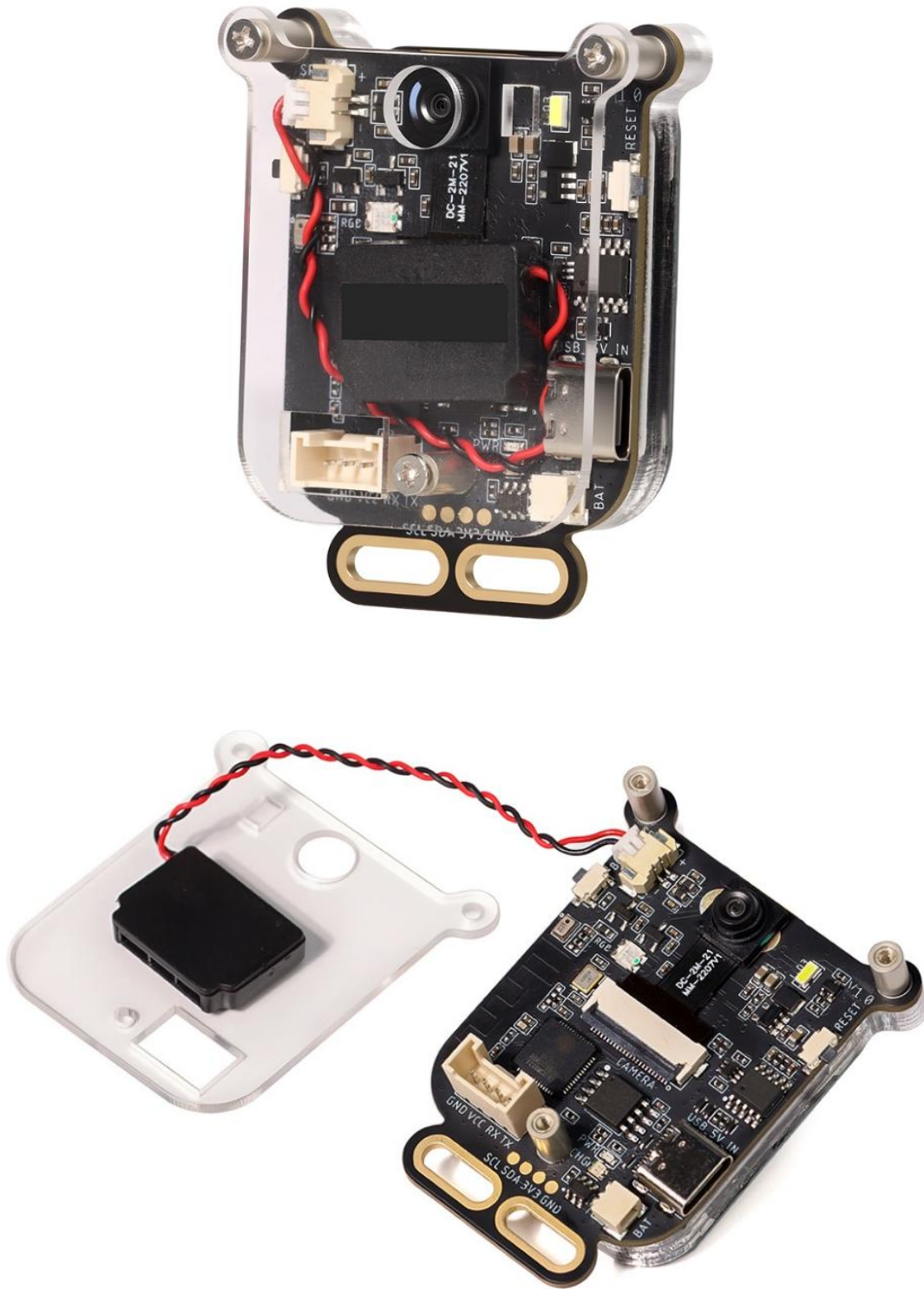


Figure 4:Back View

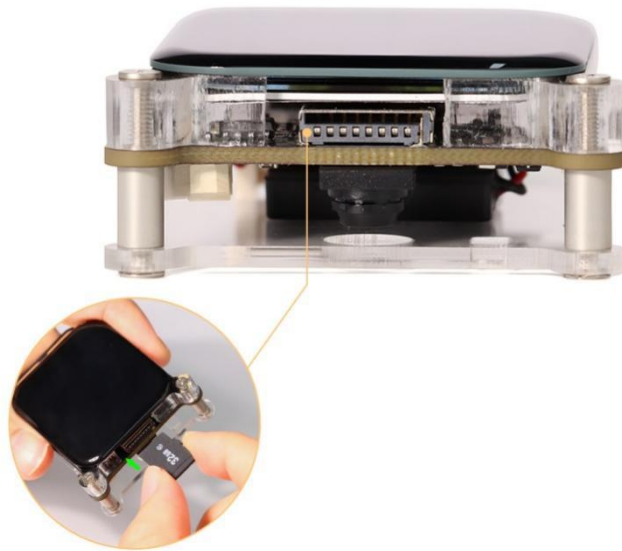


Figure 5:Top View

3 Product Dimension Drawing

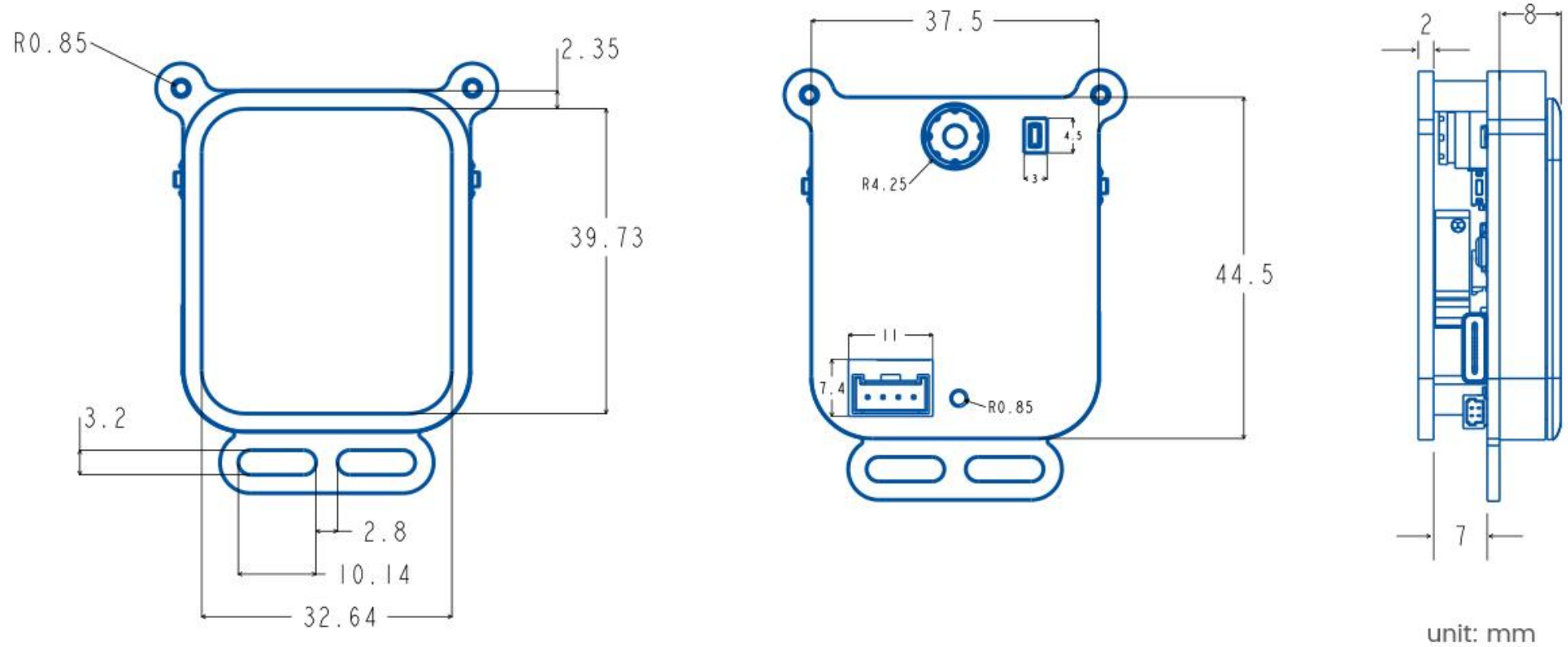
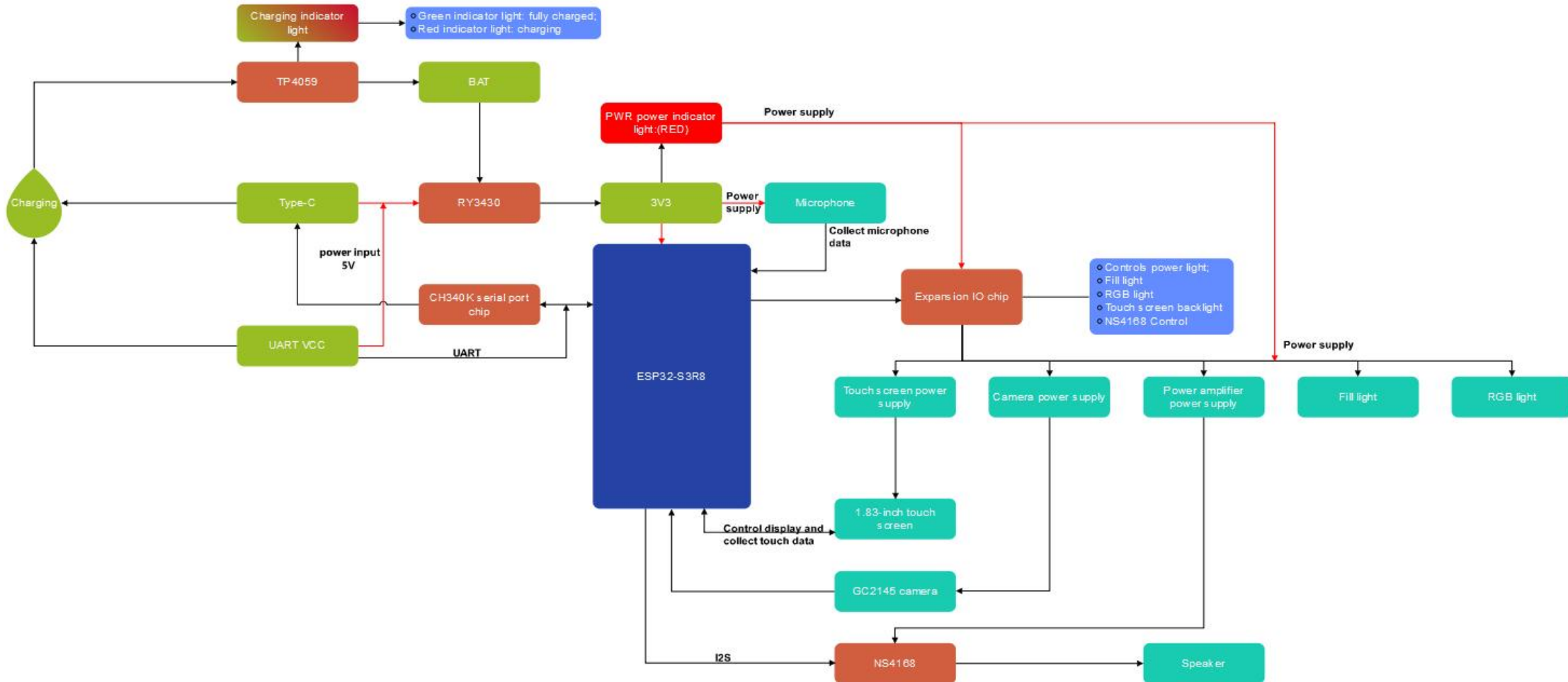


Figure 6:Dimension Drawing

4 System Block Diagram



5 Hardware Overview

The Hardware Overview covers the pin layouts and corresponding functions of each interface and button on the AI Camera mainboard.

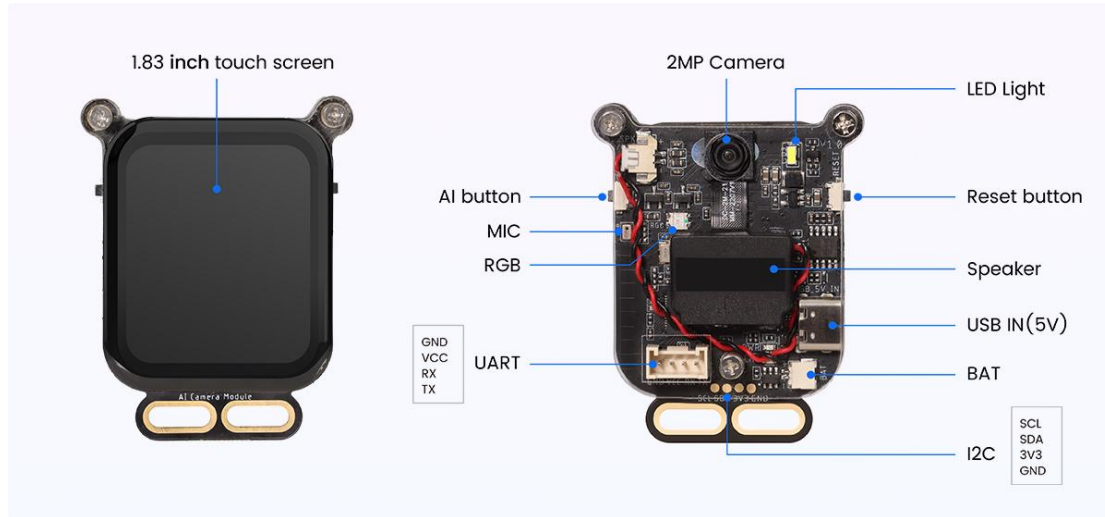


Figure 7: Mainboard Function Schematic Diagram

5.1 Buttons & Indicators

NO.	Name	Silk Screen	Pin	Connected Pin	Color & Status	Description
1	Power Indicator	PWR	EX_P1_0_PWR_EN	Extended IO: P1_0 ESP32: XTAL_32K_P XTAL_32K_N	Red	The red LED lights up immediately; if it goes out, it indicates the power supply is disconnected.
2	Charging Indicator	CHG	VBAT	/	Red/Green	Only works when the device is connected to a charging power source: 1. Battery not fully charged: Red LED stays on (charging in progress); 2. Battery fully charged: Switches to green LED (charging complete); 3. Power supply only (no battery): Both lights turn off.
3	LED Fill Light	LED3	EX_P1_1_BL	Extended IO: P1_1 ESP32: XTAL_32K_P	White	Used for ambient fill light, meeting the needs of close-range shooting.

				XTAL_32K_N		
4	RGB Tri-Color Light	RGB	EX_P0_5_RLED EX_P0_4_GLED EX_P0_6_BLED	Extended IO: P0_4 P0_5 P0_6 ESP32: XTAL_32K_P XTAL_32K_N	Lights up in sequence (Red → Green → Blue)	Reflects the device's specific process through the sequential lighting logic of "Red, Green, Blue" colors.
5	RESET Button	RESET	ESP32_EN	ESP32: CHIP_PU	Short press once	Briefly pulls down the CHIP_PU pin of ESP32, triggering the ESP32 chip to restart and initialize. Used to resolve abnormal situations such as device crashes or program freezes; a single press can reboot the device.
6	AI Button	BOOT	IO0_BOOT	ESP32: GPIO0	Short press once	In the "Artificial Intelligence Voice" mode, pressing this button can switch between "Standby" and "Listening" states.

5.2 Pin Definitions and Functions of Interfaces

NO.	Interface Name	Silk Screen	Pin	Connected Pin	Voltage	Function
1	USB IN(5V)	USB_5V_IN	USB_D+ USB_D- VBUS1	CH340K :RXD0_H TXD0_H ESP32 :U0RXD U0TXD	5V	1. Power Supply Function: Input 5V power via USB cable to provide working power for the entire device. 2. Program Download Function: Used for firmware upgrade and serial port information printing. The CH340K chip realizes "USB→Serial Port" signal conversion and automatically completes the program burning of ESP32.
2	UART Interface	GND VCC RX TX	GND VBUS2 RXD0_H TXD0_H	CH340K :RXD0_H TXD0_H ESP32 :U0RXD U0TXD	5V	1. HC-HY-4A-M, HY2.0mm-4Pin, vertical through-hole socket, which can communicate with external serial devices. It can expand various sensors and can be connected to mainstream controllers such as Arduino, Raspberry Pi, LattePanda, and micro:bit to directly output recognition results to the controller. 2. As a backup program download interface, it can also provide 5V power externally.
3	Reserved IIC Pads	SCL SDA 3V3 GND	/	/	/	For expanding IIC interface devices.
4	BAT Interface	BAT	VBAT	TP4059 :BAT	3.7V	WAFER-SH1.0-2PWB-3.7V lithium battery interface. Can be used to connect an

						external 3.7V lithium battery. Cooperates with the TP4059 chip to realize charging management, offline power supply for the device, and also has power-off protection function.
5	1.83-inch Touch Screen Interface	/	GND LEDK(EX_P1_3_LED_K) 3V3 1V8 GND GND IO9_LCD_D/C IO10_LCD_CS IO14_LCD_SCK IO13_LCD_MOSI LCD_RESET GND IO15_SCL IO16_SDA IO12_TP_TRST IO11_TP_INT 3V3 GND	/ Extended IO:P1_3 / / / / ESP32:GPIO9 GPIO10 GPIO14 GPIO13 CHIP_PU / XTAL_32K_P XTAL_32K_N GPIO12 GPIO11 / /	3.3V	Specifically designed for the 1.83-inch touch screen. It can display content, support touch interaction, and adjust the backlight brightness.
6	MIC	MIC	IO2_MIC_DATA IO1_MIC_CLK	ESP32:GPIO2 GPIO1	3.3V	Interfaces with a digital microphone to collect audio data and perform voice processing.
7	Speaker Interface	SPK	IO3_SDATA IO4_LRCLK IO5_BCLK EX_P1_4_NS_CTRL NS_3V3 VOP VON	ESP32:GPIO3 GPIO4 GPIO5 Extended IO:P1_4 XTAL_32K_P XTAL_32K_N / / /	3.3V	Connects to an 8Ω/1W power speaker. It can play various sounds and supports channel control.
8	2MP Camera Interface	CAMERA	3V3 IO41_CAM_SDA CAM_2V8 IO40_CAM_SCL ESP32_EN	ESP32: / MTDI / MTDO CHIP_PU	3.3V	Interfaces with a 2-megapixel camera module to collect images, configure parameters, and process image data.

			IO42_CAM_VS 3V3 IO45_CAM_HS CAM_1V8 CAM_1V8 IO46_CAM_D9 IO39_CAM-MCLK IO38_CAM_D8 3V3 IO47_CAM_PCLK IO21_CAM_D6 IO20_CAM_D2 IO19_CAM_D5 IO18_CAM_D3 IO17_CAM_D4	MTMS / GPIO45 / / GPIO46 MTCK GPIO38 / SPICLK_N GPIO21 GPIO20 GPIO19 GPIO18 GPIO17		
9	SD Card Slot	/	IO6_SD_MISO IO7_SD_CLK IO8_SD_MOSI	ESP32: GPIO6 GPIO7 GPIO8	3.3V	Supports inserting an SD card to provide local storage for the device. Communicates with ESP32 via SPI protocol and supports common file system operations.

6 Software Functions

6.1 Functional Module Interfaces



Figure 8:Functional Module Schematic Diagram

NO.	Functional Module	Function Item	Core Function Description	Learning/Setup Method
1	Recognition	Person Detection		Captures real-time images via the device's built-in camera to recognize human targets, accurately determining the presence of humans in the scene.
2	AI online	AI Online Recognition		After connecting to the network and binding the device, it invokes cloud-based AI recognition resources. Click "Press" to display the names of relevant objects. Supports online recognition of richer categories such as objects and scenes.
3		AI Voice Intercom		Integrates the device's microphone and speaker, enabling accurate recognition of voice commands based on the AI Xiaozhi model. Supports two-way voice intercom for interactive communication. Status Switch: Standby/Listening. Switch status by right-clicking the function key or tapping the screen.
4	Device Settings		volume	Tap to enter the volume control interface. Adjust the volume by sliding the brightness control bar. Adjustable range: 0%, 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, 100%.

5		Menu Auto Hide	Tap to enter the menu auto-hide time settings interface. Adjust the menu auto-hide time by sliding the time control bar. The time bar is divided into 6 segments (10 seconds each), with an adjustable range of 1 second to 60 seconds.
6		LED	Controls the on/off (OFF/ON) switching of the cool-toned fill light on the device.

6.2 Settings Interface



Figure 9:Functional Schematic Diagram of the Settings Interface

NO.	Functional Module	Function Item	Core Function Description
1	Settings	Configure Network	Provides network configuration instructions and network clearing function. Includes Network Configure description and a Reconfigure button.
2		Wifi Network	Displays the currently connected Wi-Fi network, showing the name of the Wi-Fi being used.
3		Screen Brightness	Supports brightness adjustment with 10 levels (10% brightness per level). The default minimum brightness is 0%, and the maximum brightness is 100%.
4		RGB Light	Open/close the RGB light.
5		SD Card	Detects whether an SD card is inserted into the device.
6		Reset to Factory Settings	Provides the option to restore the device to its factory default settings.
7		Version 1.0	Displays the device firmware version number.

7 Technical Specifications

NO.	Category	Item	Specifications
1	Main Control	CPU/Soc	ESP32-S3R8
2		MCU	Equipped with Xtensa® 32-bit LX7 microprocessor, supporting single/dual-core mode with a maximum operating frequency of 240MHz.
3		SRAM	512KB
4		ROM	384KB
5		PSRAM	Built-in 8MB PSRAM
6	Storage	External Flash Chip (W25Q128JVS1Q)	16MB
7		SD Card Slot	Reserved SD card slot. Recommended capacity is 32GB (maximum support for 128GB).
8	Communication	Wireless Communication	Supports 2.4GHz Wi-Fi and Bluetooth 5.0, operating in the 2.4GHz frequency band with a maximum transmission rate of 150Mbps. Bluetooth supports multiple data rates.
9	AI Capabilities	AI Accelerator Unit	Supports Vectored ISA, which can accelerate MFCC feature extraction and neural network inference. Compatible with TensorFlow Lite Micro, enabling edge AI applications such as image recognition and voice wake-up.
10	1.83-inch Touch Screen	Resolution	240RGB (H)×284 (V)
11		Panel	TFT-LCD Touch Screen
12		Driver Chip	ST7789P3
13		Display Area	29.52 (H)×34.93 (V) mm
14		Outline Dimension	37.34×44.43×4.1±0.2mm
15		Brightness	Above 300nit
16		Communication Interface	4-wire SPI Interface
17	GC2145 Camera Specifications	Pixels	2MP (1616*1232)
18		Lens	120° Distortion-Free
19		DVP Interface	For configuring and controlling camera module parameters

20		Image Sensor	GC2145
21		Interface Voltage	1.7~3V
22		Module Dimensions	21*21*6mm
23		Features	Enables object detection, face recognition, color recognition, and other functions.
24	Environmental Characteristics	Operating Temperature	-20℃~70℃
25		Storage Temperature	-30℃~80℃
26		Relative Humidity	10%-60%
27	Electrical Characteristics	Power Input	DC 5V/1A
28	Mechanical Characteristics	Dimensions	56*45*18.6mm
29		Net Weight	31.5g
30		Mounting Method	Secured to the PCBA/PCB with machine screws.
31	Software Features	Functional Modules	Recognition-Person Detection
32			AI online
33			Settings
34		Settings Interface	Configure Network Wifi Network Screen brightness RGB light SD Card Reset to Factory Settings Version 1.0
35		Development Language	Python/C++ SDK
36		Development Environment	Compatible with ROS, Arduino, and MicroPython
37		USB Port	For connecting to a 5V power supply.
38	Other Features	Crowtail UART Interface	Enables communication with external serial devices.
39		BAT (Battery) Connector	For connecting a 3.7V lithium battery.
40		Microphone	Sensitivity: -26dB ±1dB, Signal-to-Noise Ratio: 58dB.
41		Speaker Output	Supports connection of an 8Ω / 1W speaker.
42		SD Card Slot	For inserting an SD card to store audio and video data.
43		Buttons	AI button, RESET button.

44		LED Indicators	Power indicator Charging indicator RGB tri-color LED Cool white fill light
45		Reserved Pads	Reserved I2C pads

8 Electrical Characteristics

Power Input: DC 5V / 1A, Charging Current: 210 - 1220 mA

NO.	Item	Condition	Current	Power Consumption
1	Without Battery	Camera Off	123mA	0.6W
2		Camera On (Fill Light On)	158 mA	0.7 W
3		Camera On (Fill Light Off)	134 mA	0.6 W
4	With Battery (Charging)	Camera Off	209 mA	1 W
5		Camera On (Fill Light On)	295 mA	1.4 W
6		Camera On (Fill Light Off)	232 mA	1.1 W

9 Environmental Characteristics

9.1 Absolute Maximum Ratings

NO.	Parameter	Description	Min	Max	Unit
1	VCCmr	Supply Voltage	4.5	5.5	V
2	Tmr	Operating Temperature	-40	+85	℃

9.2 Recommended Operating Conditions

NO.	Parameter	Description	Min	Typ	Max	Unit
1	VCCop	Supply Voltage	4.5	5	5.5	V

10 Reference Documents & Resources

- [AI Camera Module Product Link](#)
- [ESP32-S3R8 Datasheet](#)

11 Revision History

Date	Version	Release Notes
2025/12/15	V1.0	Initial Release