ARMATURA

User Manual

AMT-FAPVR-21

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English

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ARMATURA Headquarters

Address 190 Bluegrass Valley Pkwy,
Alpharetta, GA 30005. USA

For business-related queries, please write to us at info@armatura.us.

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About the Company

ARMATURA is a leading global developer and supplier of biometric solutions which incorporate the latest advancements in biometric hardware design, algorithm research & software development. ARMATURA holds numerous patents in the field of biometric recognition technologies. Its products are primarily used in business applications which require highly secure, accurate and fast user identification.

ARMATURA biometric hardware and software are incorporated into the product designs of some of the world's leading suppliers of workforce management (WFM) terminals, Point-of-Sale (PoS) terminals, intercoms, electronic safes, metal key lockers, dangerous machinery, and many other products which heavily rely on correctly verifying & authenticating user's identity.

About the Manual

This manual introduces the operation of AMT-FAPVR-21.

All figures displayed are for illustration purposes only. Figures in this manual may not be exactly consistent with the actual products.

Document Conventions

Conventions used in this manual are listed below:

GUI Conventions

For Software	
Convention	Description
Bold font	Used to identify software interface names e.g. **OK**, **Confirm**, **Cancel.**
>	Multi-level menus are separated by these brackets. For example, File > Create > Folder.
For Device	
Convention	Description
< >	Button or key names for devices. For example, press <OK>.
[ ]	Window names, menu items, data table, and field names are inside square brackets. For example, pop up the [New User] window.
/	Multi-level menus are separated by forwarding slashes. For example, [File/Create/Folder].

Symbols

Convention	Description
	This represents a note that needs to pay more attention to.
	The general information which helps in performing the operations faster.
	The information which is significant.
	Care taken to avoid danger or mistakes.
	The statement or event that warns of something or that serves as a cautionary example.

Table of Contents

1 Product Introduction

1.1 Overview

AMT-FAPVR-21 is a dual-camera multimodal standalone module for face and palm recognition empowered by high-performance processors. The multimodal standalone module includes functions such as image collection, biometric template extraction, matching, transmission, and data management. The module has compact, light-weight size and is highly adaptable to various ambient lighting and supports touchless multi-biometric recognition.

The dual-camera module is equipped with proprietary ARMATURA facial and palm recognition algorithms and supports both facial and palm recognition in different application scenarios. The facial recognition algorithm supports face detection, liveness detection, face mask detection, facial recognition, age recognition, gender recognition, and facial expression recognition. The palm recognition algorithm supports palm detection, live palm detection, and palm recognition.

The dual-camera module integrates near-infrared light and support dual-channel image collection with visible and near-infrared light. Both lenses use low light and wide dynamic range image sensors. They are excellent in adapting to ambient light with the help of powerful image processing algorithms. A visible-light lens can capture high quality face images in low illumination (0.01 lux) and bright light (≤ 50,000 lux) as well. A near-infrared lens can capture high-resolution, high-contrast, and distortion-free palm lines and subcutaneous vein images, considerably improving the recognition accuracy.

The dual-camera module has built-in face and palm algorithms, flexible architecture, and are suitable for various scenarios. The module provides three application modes for deployment in different scenarios. They are:

1. The USB video class (UVC) functions as a collection module to stream video.
2. The module does the video streaming and face/palm biometric extraction, while the host does the biometric comparison.
3. After completion of video streaming, extraction, and biometric comparison in the module. Select a deployment mode based on application requirements and platform features to make the best use of dual-camera collection.

The software development interfaces allow quick integration of face and palm recognition functions to an application platform. The functions apply to areas such as attendance checking, entrance control, and channel access.

1.2 Features

- Dual low light and wide dynamic range image sensors, maximum 105 dB dynamic range.

- Support Face/Palm AE (smart brightness enhancement technologies for facial and palm recognition).
- Built-in near-infrared light supports smart switch control based on image detection algorithms.
- Captures face and palm images at 25 frames per second
- Maximum face and palm capacities are 100,000 and 10,000.
- Wide field-of-view allows its cameras to recognize individuals at wide varying heights.
- Include SDKs for major platforms (Windows, Android, and Linux).
- Support UVC (USB video device) streaming video protocol and Human Interface Device (HID) data protocol over USB 2.0.
- Compact, light-weight size with USB 2.0 interface makes for easy integration with a wide range of host hardware devices
- Provide a touchless, hygienic, and non-invasive biometric identification solution.
- Flexible and open software architecture deployment, adaptable to various application scenarios.
- Integrated communication and power supply USB interface.

2 Product Specifications

2.1 Technical Specifications

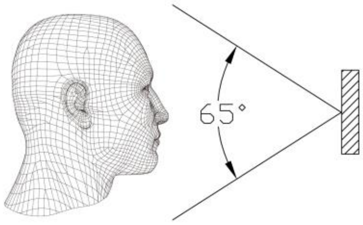
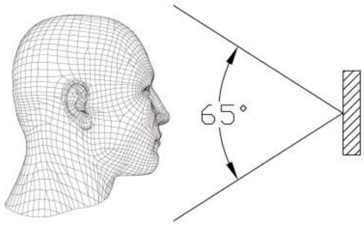
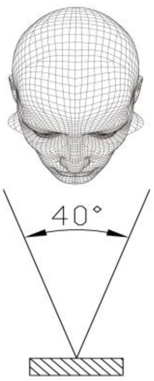
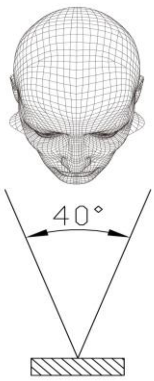
Features	Technical Specifications
Processor	Quad-core Cortex-A7@1.5 GHz, 1.2 TOPS INT8
Image Sensor	Dual 1/2.8" HDR CMOS, 2MP resolution (supports visible and near-infrared light)
Communication Interface	USB 2.0
Communications Protocol	Composite UVC device + HID protocol
Camera Type	M8, 2MP
Required Power Supply	DC 5V/1.1A
Collector Size	80 mm x 44.4 mm x 29.78 mm (Length x Width x Height)

2.2 Electrical Features

Specifications	Test Conditions	Min	Standard	Max	Unit
Operating Voltage	-	4.75	5.0	5.25	V
Operating Current	T = 25℃, VCC = 5.0 V	-	-	1.1	A
Operating Power Consumption	T = 25℃, VCC = 5.0 V	-	-	5.5	W
Standby Power	T = 25℃, VCC = 5.0 V	-	-	0.6	A
Standby Power Consumption	T = 25℃, VCC = 5.0 V	-	-	3	W
Operating Temperature	-	–10	-	50	℃
Storage Temperature	-	–40	-	85	℃

2.3 Optical and Image Specifications

Type	Visible-light Lens	Near-infrared Lens
Resolution @Frame rate	720 x 1280@25fps 480 x 640@25fps	720 x 1280@25fps 480 x 640@25fps
Default Output Format	MJPEG	NV12
Signal-to-Noise Ratio	50 dB	50 dB
Dynamic Range	105 dB	105 dB
Min Illumination	0.01 lux	0.01 lux
Max Illumination	50,000 lux	20,000 lux
Image Distortion Rate	≤ 0.5%	≤ 0.5%
Aperture	F2.0	F2.0

Vertical Viewing Angle		
Horizontal Viewing Angle		

2.4 Model Specifications

Model / Features	AMT-FAPVR-21	
Supported Algorithm Type	Facial Recognition	Palm Recognition
Effective Image Range (Algorithm Recognition Range)	50cm - 160cm	15cm - 40cm

3 Algorithm Specifications

3.1 Facial Recognition Algorithm

Based on years of in-depth technological development in the biometrics industry, ARMATURA's facial recognition algorithm supports precise recognition of multiple attributes of all age groups in complex light conditions. It can detect up to 180 facial key points within milliseconds, such as eyes, lip edges, nose tips, and contours. The facial recognition algorithm supports face detection, liveness detection, face mask detection, age recognition, gender recognition, facial expression recognition, and facial recognition.

The algorithm can detect the features on a variety of postures. As shown in Figure 3.1 below:

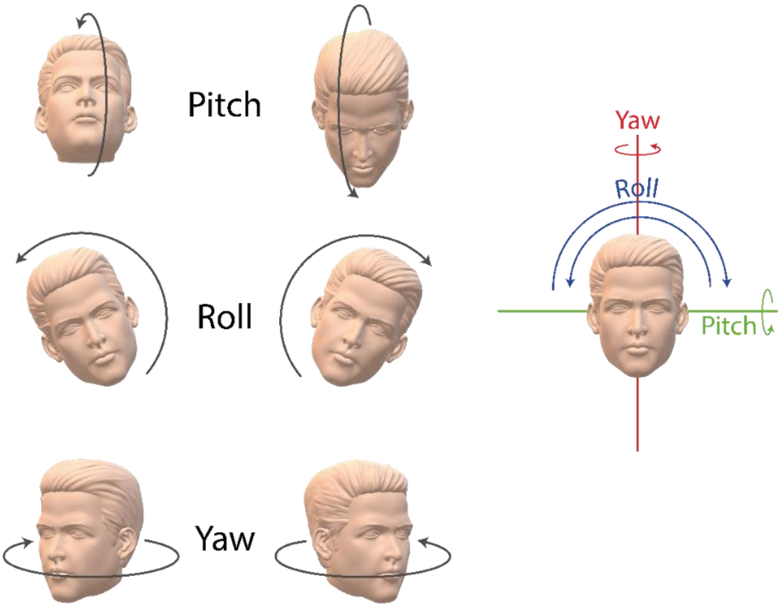


Figure 3.1 Definitions of facial postures

3.1.1 Face Detection

The algorithm can detect a human face within a range of 2m with a dynamic speed. It helps in fast and touchless verification.

Maximum Range	2 m
Detection Speed	25 ms
Min. Image Size	128 x 128 pixels
Static Recognition Ratio	No more than 60% of the whole image
Posture Adaptability	Yaw ≤ 30°, Pitch ≤ 30°, Roll ≤ 45°

3.1.2 Fake Face Detection

The algorithm can distinguish whether the detected face is a real alive face or a mask or cover concealing the real identity. It helps counter spoofing.

Features	Dual-lens liveness detection (maximum range: 1.6 m) Visible-light lens detection (maximum range: 2 m)
Detection Speed	30 ms
Min. Image Size	128 x 128 pixels
Posture Adaptability	Yaw ≤ 30°, Pitch ≤ 30°, Roll ≤ 45°
Precision	TAR=99.2% when FAR=0.001%

3.1.3 Mask Detection

The algorithm is capable of detecting if a person has worn a mask or not. It helps identify such person and take required action.

Function	Detection of masks on faces
Mask Color	Frequently seen masks in White, Black, Blue, Pink, and Gray
Detection Speed	30 ms
Min. Image Size	128 x 128 pixels
Posture Adaptability	Yaw ≤ 30°, Pitch ≤ 30°, Roll ≤ 45°
Precision	TAR=99.2% when FAR=0.001%

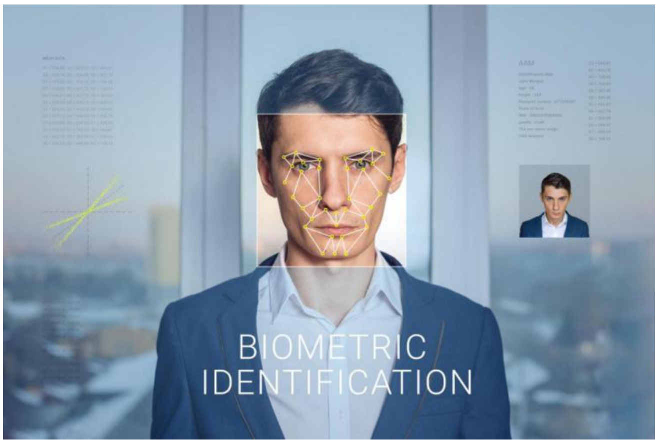
3.1.4 Facial Attribute Recognition

The algorithm is also capable of understanding facial attributes such as age, gender, and facial expression. It can display all the above-mentioned attributes when it detects a face, on the go.

Facial Attribute Recognition	Age, Gender, and Facial Expression
Facial Expression Types	Calm, Happy, Angry, Sad, Surprised, Afraid, and Disgusted
Maximum Range	2 m
Detection Speed	20 ms
Min. Image Size	128 x 128 pixels
Posture Adaptability	Yaw ≤ 30°, Pitch ≤ 30°, Roll ≤ 45°
Precision	Age recognition (±5 years) > 85%, Gender recognition > 96%, Facial expression recognition > 88%

3.1.5 Facial Recognition

The algorithm can detect a face and recognise the identity of the person within fractions of second and with high accuracy rate.



Detection Speed	70 ms
Min. Image Size	128 x 128 pixels
Features	1:1, 1:N
Face Capacity	50,000-100,000
Posture Adaptability	Yaw ≤ 30°, Pitch ≤ 30°, Roll ≤ 45°
Precision	TAR=99.2% when FAR=0.001%

3.1.6 Facial Registration Image Quality Requirements

The image saved while face registration has JPG format and the minimum resolution is 128 x 128 pixels. The individual should take care of the following things while registering their face:

- They should not wear a face mask or colored glasses.
- They should ensure that the frame of the glass does not block the eyes and that the lenses are non-reflective.
- The face angle tolerance for pitch, roll, and yaw should be between ±10 degrees.
- The whole face should be in the camera frame and the aspect ratio of the face must not be distorted.
- Face contours should be clear and the light must be even.
- The facial expression should be natural without obvious exaggeration.

Figure 3.2 Example of a facial registration image

3.2 Palm Recognition Algorithm

Palm recognition technology uses near-infrared light reflections to obtain palm line and subcutaneous vein biometrics and utilizes convergence to identify or verify individual identities. The technology boasts powerful anti-spoofing functionality, as only flowing blood can form vein images.

AMT PalmLite 12.0 is an excellent near-infrared palm recognition algorithm developed for large-capacity palm recognition with a high tolerance of palm postures in complex light conditions. The algorithm focuses on improving adaptability to an extensive variety of usage environments and user habits and ensuring high accuracy. In this manner, the robustness and pass rate are considerably improved.

The algorithm applies to various palm postures as shown in Figure 3.3:

Figure 3.3 Definitions of palm postures

3.2.1 Palm Recognition Specifications

Algorithm Version	AMT PalmLite 12.0
Palm Detection Speed	< 50 ms
Biometric Template Extraction Speed	< 220 ms
Biometric Comparison Speed	< 150 ms
Palm Capacity	6,000-10,000
Posture Adaptability	Yaw ≤ 20°, Pitch ≤ 20°, Roll ≤ 90°, Bend ≤ 15°

Precision	TAR=98.2% when FAR=0.05%

3.2.2 Palm Registration Image Quality Requirements

The image saved while palm registration has JPG or BMP format and the minimum resolution captured from the device is 480 x 640 pixels. The individual should take care of the following things while registering their palm:

- The palm and background must be separated.
- The light must be even so that the veins must be visible.
- The whole palm (including the wrist) should be in the camera frame and the aspect ratio of the palm must not be distorted.
- The palm angle tolerance for pitch, roll, yaw, and bend should be ±5 degrees.

Figure 3.4 Example of a palm registration image

4 Application Scenarios

The AMT-FAPVR-21 dual-lens camera collectors are designed with a complete metal structure shell and corresponding fixed brackets, facilitating quick installation and extension on an existing device, or integration into a device. Based on the integrated design, the dual-lens camera collector can be connected to an application platform device using its own dual-port USB-TYPE-A cable. In this way, the connection between the power supply and communications device is accomplished which simplifies the design considerably. The example of an application system is shown in Figure 4.1 below:

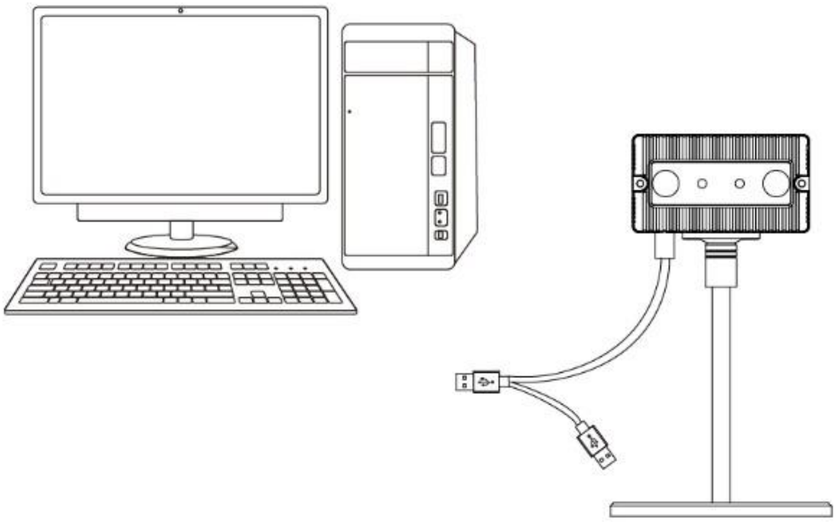


Figure 4.1 Application system of dual-lens camera collectors

To improve platform adaptability and to lower development difficulty, the dual-lens camera collectors integrate with all the functions in the biometric recognition application process, including image collection, image transmission, template extraction, template comparison, template management, and comparison result output. All the functions can be configured using the software. You can develop a required application program based on the SDK to achieve your desired functionality and complete application design.

- **Image Collection and Transmission**

  The collection and transmission of the face and palm images are made by a collector. You can specify different resolutions for image output. For a list of supported resolutions and frame rates, see section 2.3 Optical and Image Specifications. Image transmission adopts the standard UVC protocol. Visible and near-infrared light images are transmitted using separate UVC ports. You can choose the ports as per with image requirements.

- **Biometric Template Extraction**

  Biometric template extraction is the most tedious biometric recognition process. To reduce the impact of the collectors on platform performance and improve the collector's platform adaptability, the biometric template extraction is performed in the collector by default. The high-performance heterogeneous processor of the collectors helps free up the computing resources of your platform.

- **Template Comparison and Management**

  Comparison and management of biometric templates can be performed in the collectors or on a platform, according to your requirements.

  The collectors provide three application modes for use in different scenarios:

  1. The UVC functions as a collector to stream video.

  2. The video streaming and face/palm biometric extraction is achieved in the collector, while the biometric comparison is performed by a host.

  3. The video streaming, extraction, and biometric comparison are achieved in the collector.

If you use the platform for template comparison and management, the collector will push the template to the platform using the Human Interface Devices (HID) port after a biometric template is extracted. This applies to scenarios in which template storage is strictly restricted. Figure 4.2 shows some functions of a back-end comparison system.

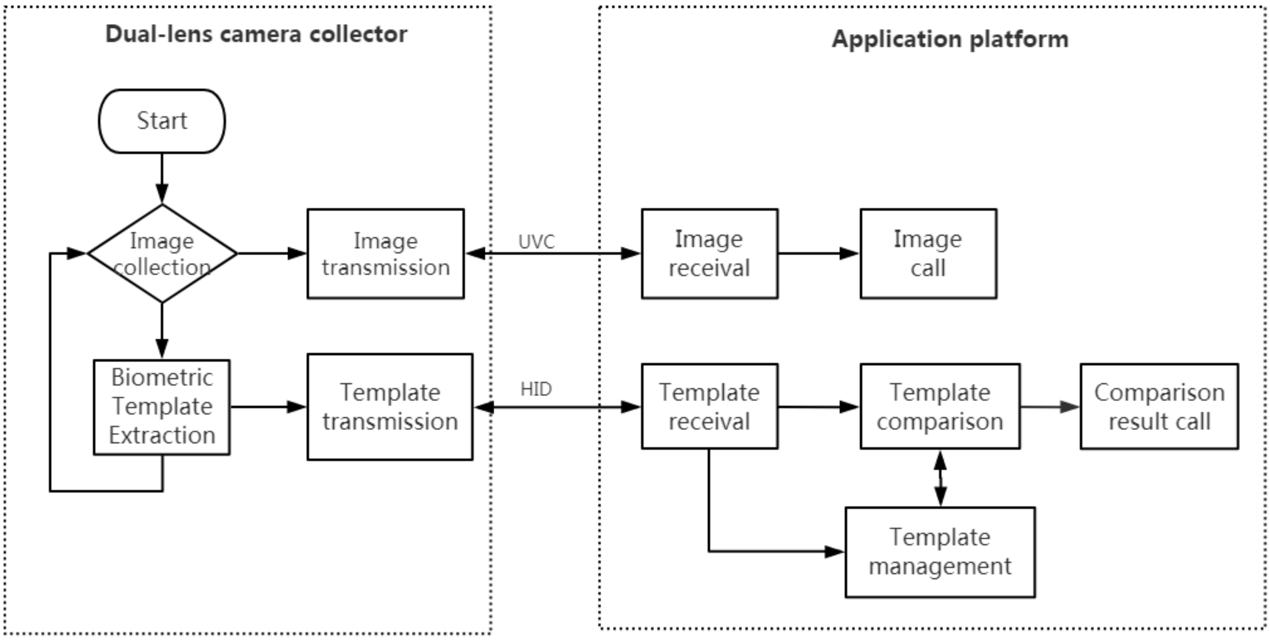


Figure 4.2 Some functions of a back-end comparison system

If you use the collector for template comparison and management, the collector will only send the output of the comparison result through the HID port for a client application to call. This can minimize the computing load of the platform processor. As such, it is particularly suitable for the integration of the face/palm recognition function in low-performance embedded platforms. Figure 4.3 shows some functions of a front-end comparison system.

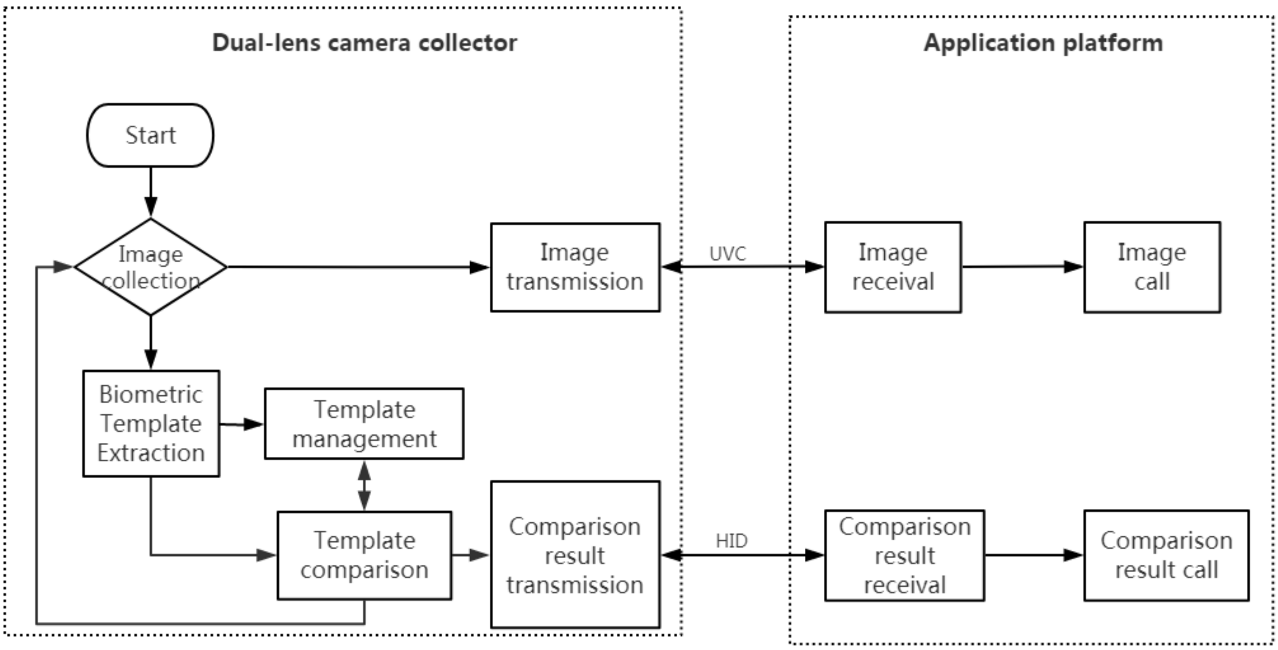


Figure 4.3 Some functions of a front-end comparison system

As the SDKs are provided, you only need to call the function interface of a configuration and write an application to integrate face/palm recognition function in your platform. It shortens the development cycle and improves product competitiveness.

5 Structural Dimensions

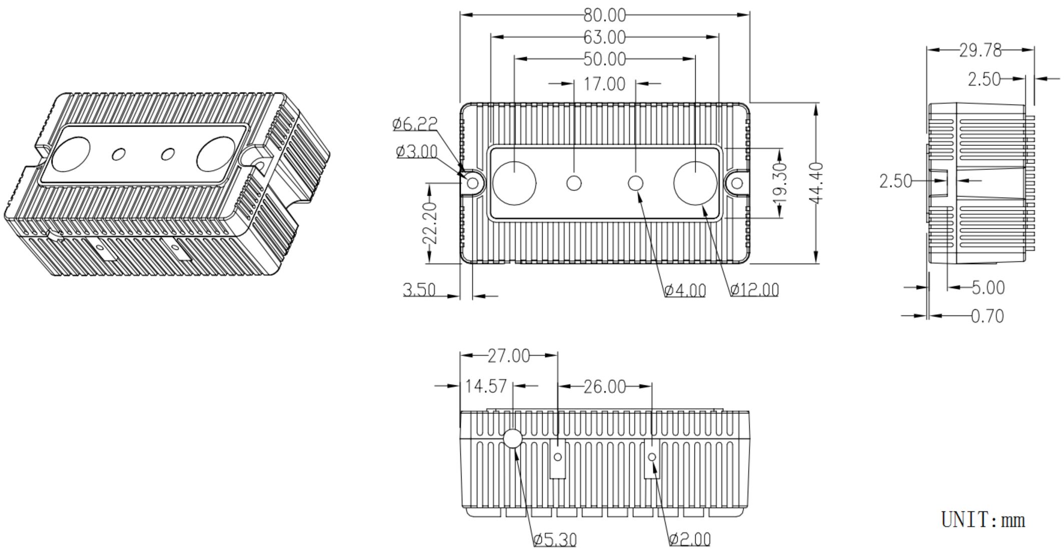


Figure 5.1 Structural dimensions of a dual-lens camera collector

6 Cable Requirements

The dual-lens camera collector is equipped with wires by default. For special needs, customers can customize according to the following requirements:

The total length of the USB cable is 1.2 meters and has a dual USB Type-A power supply interface design. A shielding layer is required, and the number of weaves should be 64, and a D+/D- twisted pair of 26 AWG cables. The wire has a magnetic ring on the collector side. Figure 6.1 shows a design example for your reference.

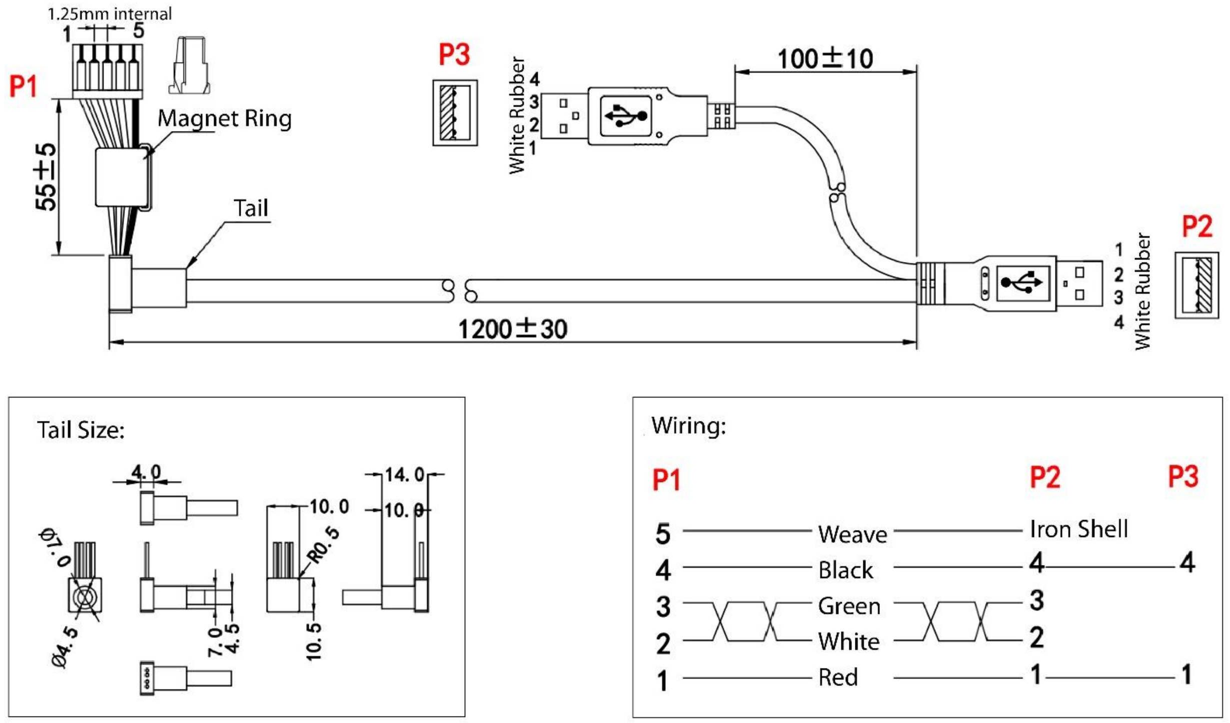


Figure 6.1 Specifications of USB Type-A cable (Unit: mm)

7 Design Guide

7.1 Optical Design

Based on integrated design considerations, the lens surface of the dual-lens camera collector has been covered with a transparent acrylic cover. If there is no special requirement, it is not recommended to add any other cover which may affect the light transmission performance.

7.2 Heat Dissipation Design

The dual-lens camera collector adopts an all-metal shell design and surface heat dissipation stripe so that it has good heat dissipation performance. It is recommended, to use it in an open and ventilated environment to improve the heat dissipation efficiency of the collector and to better exert the performance of the collector.

8 Installation Guide

8.1 Installation Modes

The dual-lens camera collector supports a variety of installation modes, including front-locking, rear-locking, down-locking, and desktop mode. Users can choose and design flexibly according to their needs. The following is a detailed description of each installation mode.

8.1.1 Front-locking and Rear-locking

The front-locking and rear-locking modes have the same fixing methods, only the installation directions are opposite to each other. The installation and fixing method are shown in Figure 8-1 using the example of rear-locking mode:

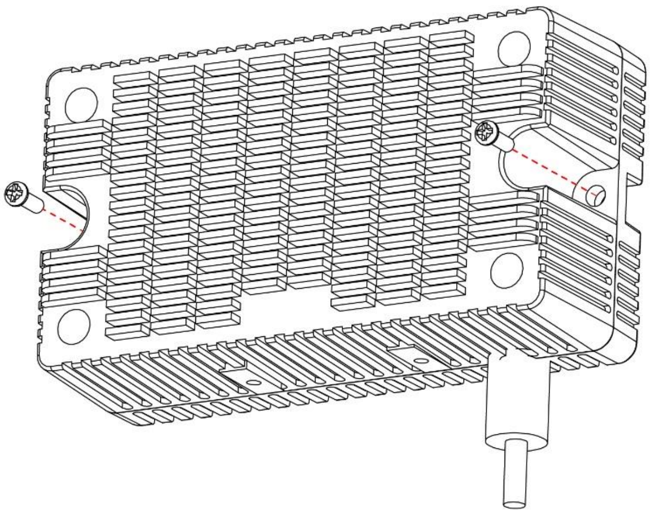


Figure 8.1 Rear-locking installation

8.1.2 Down-locking

The down-locking mode can facilitate customers to directly integrate the dual-lens camera collector on the top of the existing device. It helps in the quick integration of the collector. The specific installation method is shown in Figure 8-2.

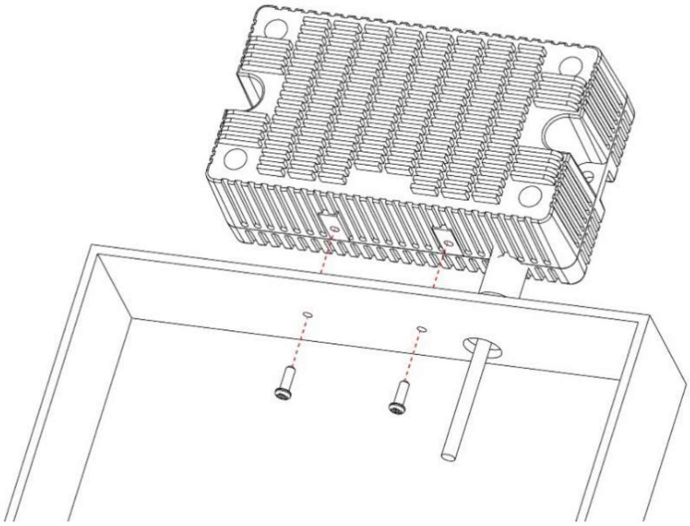


Figure 8.2 Down-locking installation

8.1.3 Desktop

The desktop installation mode is mainly to meet customer desktop-level extensions and applications. This installation mode needs to be fixed with the corresponding fixing bracket. By adding accessories at the bottom of the dual-lens camera collector, it can be adjusted to the 1/4 screw of the traditional security bracket. The installation method and the overall outcome are shown in Figure 8-3.

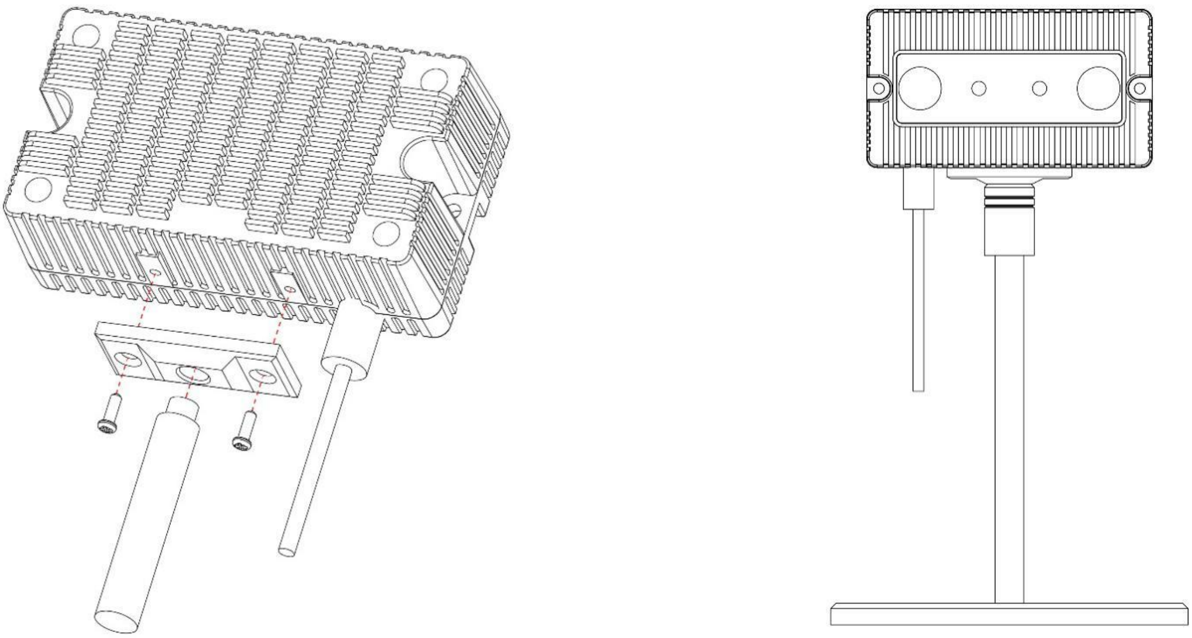


Figure 8.3 Desktop installation

8.2 Installation Height and Angle

When you install a dual-lens camera collector, you need to consider the influence of the installation angle and height on the field of view for image collection. If the mixed face/palm recognition algorithm is used, you need to consider the field of view that faces can adapt to, the range requirements of palm recognition, and the convenience and speed of man-machine interaction. Therefore, selecting a proper installation angle and height is crucial to the front-end image collection and user experience of the entire system.

Figure 8.4 describes basic concepts related to installation height and angle.

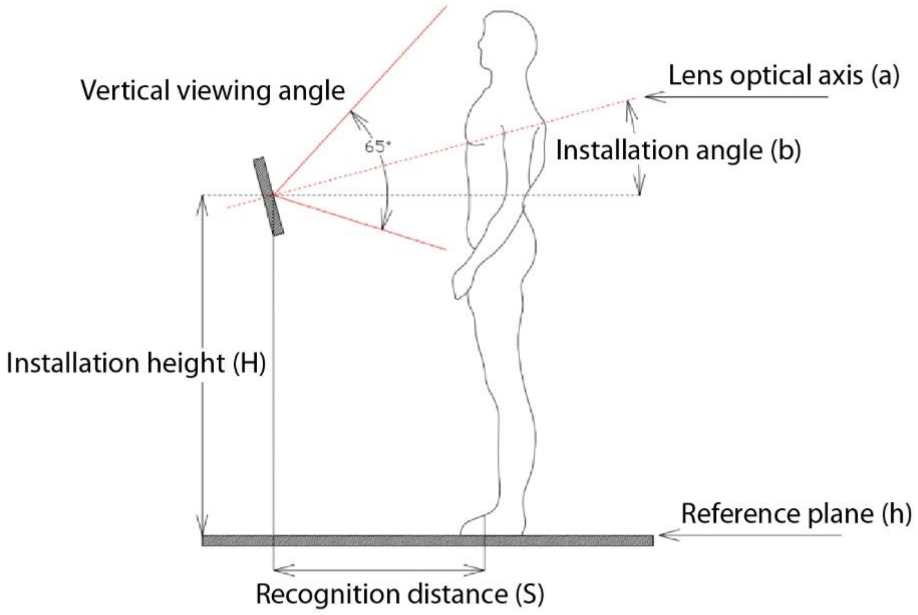


Figure 8.4 Basic installation concepts

Lens optical axis (a): a line that defines the path along which light propagates through a lens.

Reference plane (h): a plane on which a person stands when a reader is used.

Installation height (H): the height above the reference plane, at which a reader is installed.

Installation angle (b): the angle between the lens optical axis (a) and the reference plane (h), within a range of –90° to 90°.

Recognition distance (S): the distance between a face and a lens when a collector is used.

The purpose of optimizing the installation height (H) and installation angle (b) is to improve the collector's adaptability to the height of a human body and user experience within the normal range of man-machine interaction. Human body height is an important reference index because it is linearly related to the height of a person's face and the length of a person's arms. Therefore, if the installation design of a collector meets the requirements of adaptable body height, it also meets the requirements of facial and palm recognition.

To facilitate installation design, we recommend using a horizontal or slant installation mode.

8.2.1 Horizontal Installation Mode

In horizontal installation mode, the installation angle (b) is set to 0°, and the installation height (H) is set to 1.5 m. If a person can be recognized at a distance of 0.5 m to 0.8 m, the reader can adapt to individuals with a height range between 1.38 m and 2.0 m, as shown in Figure 8.5.

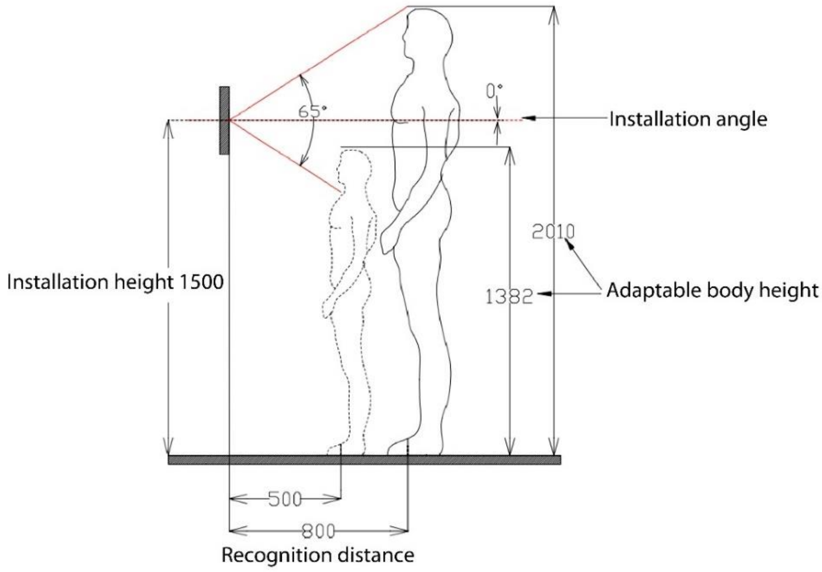


Figure 8.5 Horizontal installation

8.2.2 Slant Installation Mode

In the slant installation mode, the installation angle (b) is set to 10°, and the installation height (H) is set to 1.45 m. If a person can be recognized at a distance of 0.5 m to 0.8 m, the reader can adapt to individuals with height is between 1.45 m and 2.18 m, as shown in Figure 8.6.

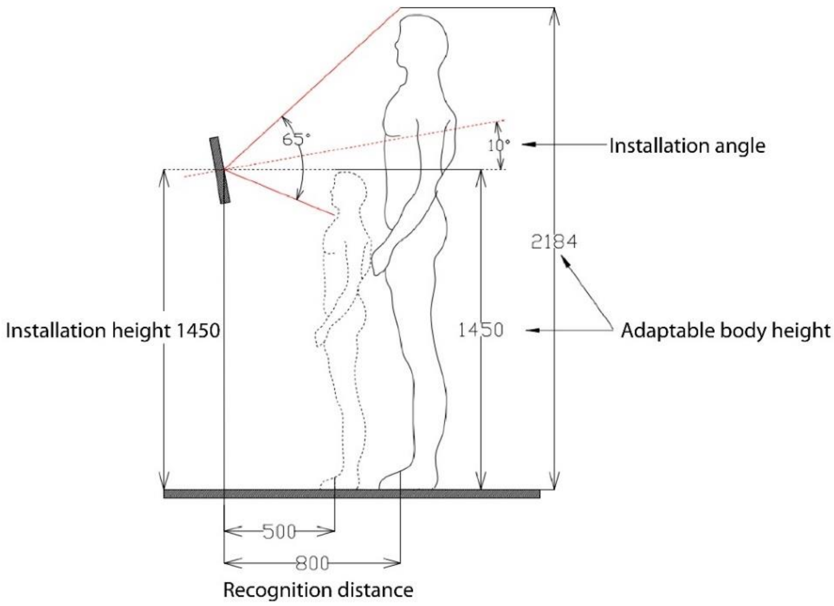


Figure 8.6 Slant installation

190 Bluegrass Valley Pkwy,

Alpharetta, GA 30005, USA

E-mail: info@armatura.us

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