

## Face recognition system design based on ESP32

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**Abstract**—With the improvement of science and technology, people's demand for safe and high-speed encryption is more and more urgent. The traditional key unlocking method and the digital keypad password lock unlocking method are not only inconvenient to use in some occasions but also worrying about the security. This design is based on the ESP32 development board, using the way of face recognition unlocking, put forward a face recognition unlocking system design. This system takes ESP32 as the core module, uses ESP-EYE to collect and store images, and then sends them to the computer through the data bus. By comparing the collected and stored image information, the control of peripheral circuit can be realized. The experimental results show that the design cost of the system is low, the operation is convenient, the safety is strong, and has a strong practicability.

**Keywords**—Face recognition; Face ID; ESP-EYE

### I INTRODUCTION

With the increasing demand for data encryption in various industries and the urgent demand for efficient and secure automatic authentication, biometric identification technology has developed rapidly in recent decades. In the object feature recognition technology, compared with fingerprint recognition, iris recognition and other identification methods, face recognition because of its direct, friendly, convenient and other characteristics, easy to be accepted by users. With the rapid development of artificial intelligence, face detection technology is widely used in our daily lives, such as mobile payment, video conferencing and personal identification [1]. Face recognition technology is also concerned at home and abroad, many countries have launched the face recognition research. But face recognition technology in the recognition rate and security are still to be improved, the main reasons for these deficiencies are insufficient light conditions, face accessories change and slow detection speed and other

aspects. Based on this, this paper proposed a lock picking system based on Face recognition and voice wake-up, realized the basic functions of inputting Face ID and analyzing Face recognition, and studied the accuracy and efficiency of ESP-EYE Face recognition under different angles, different shades of light and multiple faces.

### II WHOLE SYSTEM DESIGN

The function of portrait collection is completed through the camera on ESP-EYE, and then connected to the upper computer through USB serial port. The upper computer can view the image content and the result of face recognition. As long as the user's face appears in the range of the camera, the system can automatically intercept the face picture, compared with the face information stored before, and then reflect the recognition results in the upper computer.

### III ESP32-EYE HARDWARE CIRCUITS

The core module of this system is ESP-EYE. ESP-EYE is a development board based on ESP32 platform. The size of ESP-EYE is 21 mm × 41 mm. P2102 USBUART Chip to achieve USB to UART conversion function; Flash 4MB Flash memory chip and PSRAM 8MB memory chip are used to store programs and cache. The top is the 3D PIFA antenna; Below is the external crystal clock source of the ESP32, the side function button, and the LDO power chip, which provides the required voltage for each component. At the bottom is the USB power supply interface, connected to external power supply, power supply for the entire system. Two LED indicator lights on the right, one in red and one in white, are used for waking up, networking, face recognition and other aspects of the display of different states; One button on the left and one on the right, RST reset button and BOOT download button. The top part is the camera, which is connected with the video transmission module for the

external display screen. At the bottom is the microphone, which can detect and control the voice. The SPI Port is the reserved data Port, and its hardware structure is shown in Figure 1.

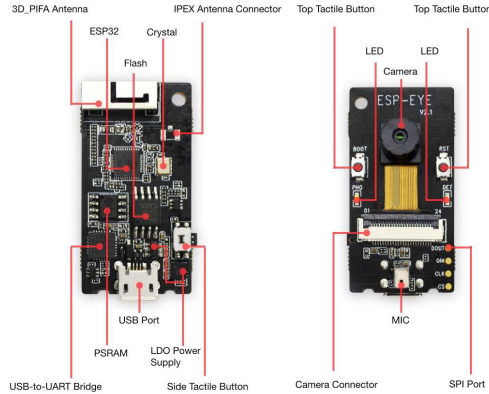


Figure 1. ESP-EYE hardware constructs.

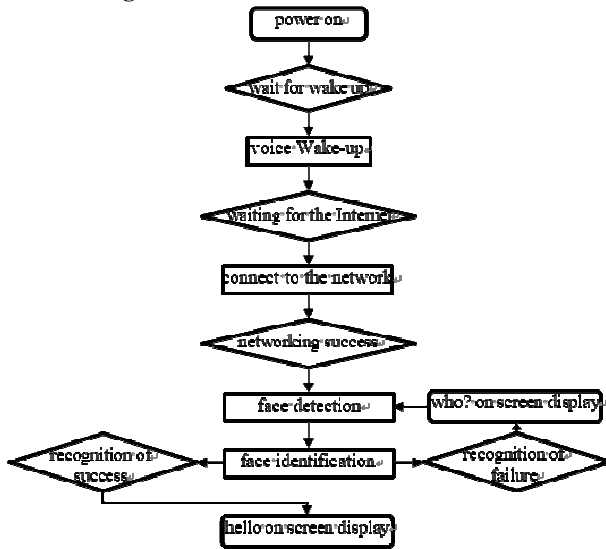


Figure 2. Face recognition flow chart.

#### IV ESP-EYE FACE RECOGNITION PROCESS

Face recognition is mainly divided into two parts: face information acquisition and face information comparison. After ESP-EYE is turned on and successfully connected to the upper computer, the camera is already in the working state. After detecting the user's face, the system will collect the face information and compare it with the previously stored face information, and the comparison results will be directly displayed on the interface of the upper computer. Face recognition flow chart is shown in Figure 2.

The specific operation steps are as follows:

(1) After the development board is powered on, it will enter the state of "waiting to wake up" (the red light is always on and the white light is often off). When the user says the wake-up word "Hi Lexin", the development board

wakes up and enters the state of "waiting for networking" (red light flashing, white light often off).

(2) Users can connect to the Wi-Fi hotspots created by ESP-EYE through PC, mobile phone and other devices. The default user name for this hotspot: esp-eye-xxxx, no password by default.

(3) Once connected, ESP-EYE automatically performs "face detection". Users can go to 192.168.4.1/FACE\_STREAM to view real-time image information. At this point, the red light of the development board is extinguished and the white light is often on.

(4) When the user clicks the side button, he/she can enter "Enter Face ID" (the red light is always on), and the webpage displays: Start ENROLLING. The user faces the camera and starts taking portraits. For each successful collection, The red light of THE development board will flash, and The webpage can display The corresponding collection times, such as The 1st Sample, etc. By default, users need to capture three portraits for each Face ID they enter. After portrait collection is completed, the red light of the development board is often off, indicating that the Face ID has been input. At this point, the page displays: Uniting Face ID XXX; After successful entry of Face ID, the system will return to "Face detection".

(5) When the development board detects a face, if there is already a Face ID input, the development board will carry out "Face recognition" : if the "Face recognition" match is successful, the development board red light flashes once, the webpage displays Hello ID XXX; if the "Face recognition" match fails, the development board has no response, the webpage displays "WHO?". Otherwise, the development board only performs "face detection".

#### V ESP32-EYE FACIAL RECOGNITION EFFECT

First, power on the ESP-EYE development board and wake it up by voice. When the red light flashes, it means that the development board has successfully awakened by voice and is waiting for networking. Use a computer to access the WiFi created by the development board, as shown in Figure 3. After successful connection, the white light of the development board is always on. Users can access the webpage 192.168.4.1/FACE\_STREAM through the computer to view real-time image information. The results of face detection and face recognition will also be displayed in this interface.

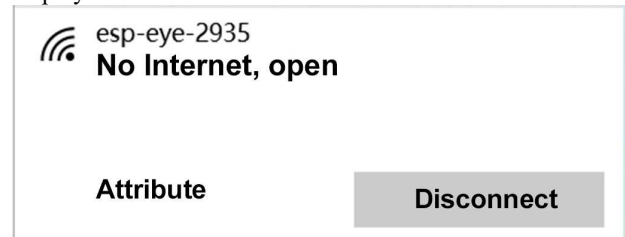


Figure 3. Connect to the Internet.

Face the camera and start taking portraits. For each successful collection, the red light of the development board will flash, and the webpage will display the corresponding collection times. After the portrait collection is completed,

the red light of the development board will often turn off, indicating that the Face ID has been input. After entering the Face ID, the link of Face recognition begins. When the Face recognition match is successful, the red light of the development board flashes once, and the webpage displays Hello ID, as shown in Figure 4.



**Figure 4.** Recognition of success.



**Figure 5.** Recognition of failure.

When the development board does not detect a face, it will stop at the link of face detection. When face recognition fails to match, the development board does not respond, and the webpage displays WHO? , as shown in Fig 5.

It can be found that ESP-eye recognition results are still good in the case of partial occlusion. However, in the case of improper light and Angle, the detection results are not satisfactory, especially in the weak light conditions, can not identify the face, even if the recognition will appear the recognition error, the lighting conditions are higher.

## VICONCLUSION

The test results show that the ESP-EYE development board can quickly wake up through voice, and can also well realize the addition, deletion, detection and recognition of face information. However, in the process of specific operation, it is found that the camera has high requirements for the environment, and the number of faces, the Angle of faces and the light and other factors have great interference to face recognition. The whole system has high integration, strong portability and easy operation. It can realize some basic control functions only by adding simple peripheral circuit, so it has high practical value.

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