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Original Article

Integrated Access Control System of Face Recognition and Non-Contact Temperature Measurement Based on Arduino

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Abstract *- In this paper, the Arduino development board is used as the main controller to recognize the characteristics of passers-by through the camera installed on the upper computer, which runs the face recognition program based on Python and OpenCV. Then, read the body temperature through the body temperature sensor. If the body temperature sensor detects that the body temperature exceeds 37.3 ℃, the buzzer will sound and give an audible, visual alarm. After the debugging of simple simulation equipment, the expected functions can be realized and applied to the actual scene.*

Keywords *- Face recognition, Machine learning, OpenCV, Image classification.*

1. Introduction

Face recognition temperature detection intelligent access control system combines face detection technology and human body temperature detection technology through the recognition of face and human body temperature detection to meet the set requirements to open the door [1-3]. At present, there are a large number of embedded face recognition equipment; its main principle is through the convolutional neural network algorithm [4-6], OpenCV vision algorithm, and so on, through a large number of image training to extract photo features, and compared with the camera input image, to identify the person in the picture. At the same time, the remote infrared temperature measurement system has also been popular present, which can measure the temperature of the human body through the remote infrared sensor. It can monitor the temperature of people entering and leaving in real-time on the big screen [7-8]. But smart devices that combine the two are still rare on the market.

Therefore, starting from the need for routine epidemic prevention, this paper develops an intelligent device that can identify the identity of personnel and detect the body temperature to realize fast and intelligent epidemic prevention detection after connecting the intelligent module of health assistance outside the ordinary door. Face recognition technology can quickly realize contactless door opening and clocking operation, greatly reducing the risk of virus transmission through clocking contact. Besides, the integrated design realizes one machine with multiple functions, reduces the loss of human resources, and improves the passing efficiency.

2. Ideas Proposed

This paper combines face recognition technology with Arduino hardware control technology, expected to achieve the following functions: a) recognizes the face image of the personnel, intercept the personnel not recorded in the system; b) the temperature of the personnel shall be detected. When the temperature exceeds 37.3℃, the alarm shall be reported. the temperature shall be refused; c) Record the time and body temperature of personnel passing through the gate to ensure traceability [9-10]. Because of the above research contents, the research schemes of different modules are formulated as follows [11].

2.1. Mechanical Structure Design

The 3D model of the access control system is shown in Fig.1, which mainly includes: the handwashing disinfection module, temperature detection module, face recognition module, and laser distance sensing module. the opening and closing module used a parallelogram mechanism, which changes the rotating pair into the moving pair through the motor and drives the opening and closing of the switch valve. the disinfection module realizes the function module from the silent state to the working state through the screw mechanism, which is embodied in the fact that the disinfectant device rises to the arm height of the person facing different heights [12-14].

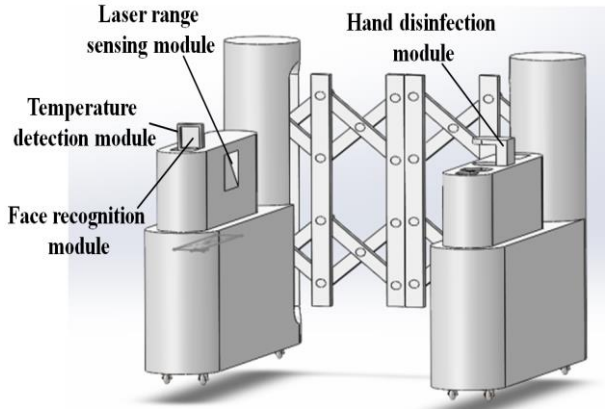

Fig. 1 3D model of access control system

2.2. Electric Control Part

The temperature detection module adopts infrared temperature measurement mode, which has the advantages of no contact, wide coverage of accurate measurement, faster temperature measurement, high accuracy, application safety, and long service life [15-16]. the carry-on code identification module adopts a two-dimensional code identification mode, which can be applied well to self-service device interfaces of various functions. It has the characteristics of high integration and low power consumption. the Mask recognition module adopts OpenCV embedded image processing, fast processing speed, and high accuracy [17].

According to the specific situation of later research and development, other external modules are considered to realize the integration and linkage of multiple plug-ins to meet the possible needs of communication with mobile apps [18]. the overall wiring mode of the electronic control part is shown in Fig.2 and Fig.3.

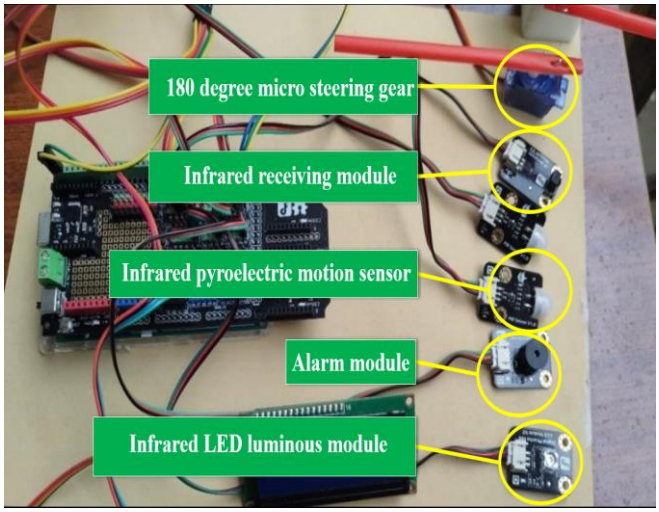

Fig. 2 Overall wiring diagram

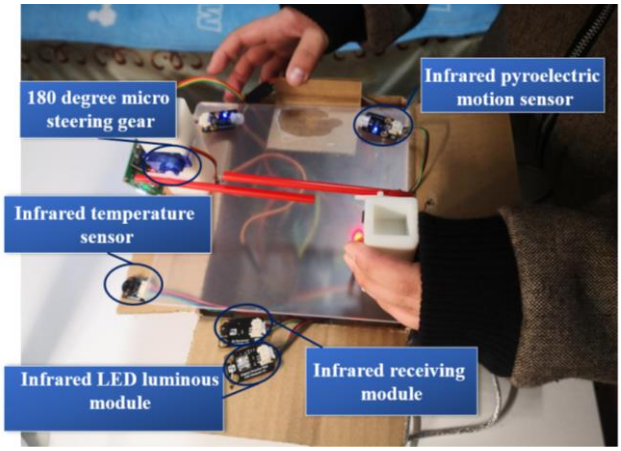

Fig. 3 Overall effect drawing

2.3. Program Run

Firstly, read the Arduino serial port and the prepared database file, and then the pictures read by the camera are converted into grayscale images, denoted as 'a'. the classifier 'HaarCascade_frontalface_ALT2' compares the grayscale images with the data 'b' in the database to obtain similar threshold values of face images [19-20]. Determine whether to open the door through the level of matching, the overall idea as shown in Fig.4.

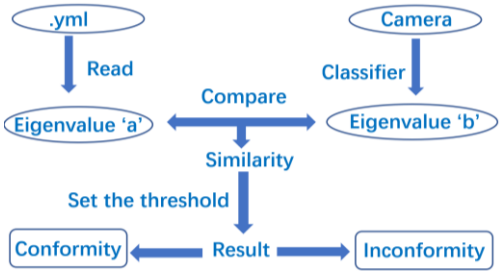

Fig. 4 Face recognition program overall framework.

3. System and Function Debugging

Perform functional debugging, static debugging, and dynamic debugging on the integrated access control system to ensure the normal operation of each part of the function.

3.1. Function Debugging

3.1.1. Face recognition function:

After debugging the program, if the camera detects a fac e, we box the face, as shown in Fig.5, and judge whether the person is recorded into the system;

3.1.2. Record strangers:

Registration of personnel not entered into the system;

3.1.3. Temperature test:

When the temperature of the tester exceeds 37.3°C, it ca n send an alarm and refuse to pass;

3.1.4. Information traceback:

Record the time and temperature of personnel passing th rough the gate.

Fig. 5 Box selection after face recognition

3.2. Static Debugging

Static debugging includes software static debugging and hardware static debugging. Software static debugging runs the program step by step to check whether the program logic is correct [21]. For example, test face image imaging, image acquisition, image comparison function whether the function is running normally, whether the sequence logic is correct, the program logic static test is shown in Fig.6. Hardware static debugging is mainly to check whether each sensor and other hardware work normally, such as whether the range of the temperature sensor is within the normal range [22-24].

face_detection_3.py — Line: 34, Col: 14

```
8   # hundreds of checks a piece. Haar Cascades run fa
9   # only evaluated if previous stages pass. Additiona
10  # a data structure called the integral image to qu
11  # contrast check in constant time (the reason for
12  # grayscale only is because of the space requirment
13
14  import sensor, time, image
15
16  # Reset sensor
17  sensor.reset()
18
19  # Sensor settings
20  sensor.set_contrast(3)
21  sensor.set_gainceiling(16)
22  # HQVGA and GRAYSCALE are the best for face trackin
23  sensor.set_framesize(sensor.HQVGA)
24  sensor.set_pixformat(sensor.GRAYSCALE)
25
26  # Load Haar Cascade
27  # By default this will use all stages, lower satges
28  face_cascade = image.HaarCascade("frontalface", sta
29  print(face_cascade)
30
31  # FPS clock
32  clock = time.clock()
33
34  while (True):
35      clock.tick()
```

Fig. 6 Static test of program logic

3.3. Dynamic Debugging

Dynamic debugging is to run the program completely and check whether the hardware can complete the related functions such as taking photos, measuring, and releasing. This part includes whether the software works following the designed process of the system and whether the hardware system acts following the normal scheme [25]. For example, whether the temperature is displayed after the temperature is measured and whether the access control is opened in time within the normal temperature range.

4. Experimental Scheme and Result Analysis

4.1. Experimental Scheme

Temperature measurement is the most important part of epidemic prevention. to ensure safety, people with fever should not be tested during the experiment. Therefore, two high-temperature objects with a temperature of more than 38℃ were used for the test. to verify the alarm function of the system, three strangers (non-students, non-teachers, and non-parents) were tested, and system matching was performed. We developed the following experimental scheme to verify the accuracy of the identification function, temperature measurement function, and door opening function in the integrated access control system. Firstly, the facial photos of 16 subjects (including 7 students, 4 teachers, and 5 parents) were collected, and these photos were stored in the system for comparison when allowed.

4.2. Experimental Process

Subjects were randomly assigned to collect photos through the camera during the experiment. After the photos were successfully matched with the system and compared with the temperature sensor test results, the gate would be opened if the temperature was within the allowed normal range and the mask was correctly worn. Otherwise, the gate stays closed, and alarms will be sent in real-time. the results are shown in Table 1.

Table 1. Recording table of experimental results

No.	Tested person	Recognition results	Wear a mask	TEMP / ℃	Storage
1	Student 1	Normal	Yes	35.6	Yes
2	Student 2	Normal	Yes	36.1	Yes
3	Teacher 1	Normal	Yes	36	Yes
4	Teacher 2	Normal	Yes	35.8	Yes
5	Student 3	Normal	Yes	35.4	Yes
6	Student 4	Normal	No	36	Yes
7	Stranger 1	Larm	Yes	36.1	Yes
8	Parents 1	Normal	Yes	36.2	Yes
9	Parents 2	Normal	No	36.3	Yes
10	Parents 3	Normal	Yes	36	Yes
11	Parents 4	Normal	Yes	35.6	Yes
12	Stranger 2	Larm	No	35.8	Yes
13	Stranger 3	Larm	Yes	35.4	Yes
14	Student 5	Normal	Yes	35.2	Yes
15	Student 6	Normal	Yes	35.2	Yes
16	Student 7	Normal	Yes	35.2	Yes
17	High-temperature object 1	Larm	Yes	38.2	Yes
18	Teacher 3	Normal	Yes	36.1	Yes
19	Teacher 4	Normal	Yes	35.8	Yes
20	Parents 5	Normal	Yes	35.6	Yes
21	High-Temperature object 2	Larm	No	39	Yes

Table 1 Experimental results show that all students, teachers, and parents stored in the system are matched successfully. Under normal temperature and correct wearing of masks, the integrated access control system can normally open the gate and release it. the off-campus personnel who are not stored in the system in advance will be identified, the gate will be kept closed, and the real-time alarm will be given. When the temperature exceeds 38℃, the gate can also remain closed and alarm in real-time.

5. Conclusion

- Designed an integrated access control system, including a face camera, image matching, mask-wearing detection, temperature detection, real-time alarm, and other functions;
- The program designed by the system can run according to the set logic;
- All the designed functions of the system can normally work in the actual verification process, indicating that the hardware scheme and control scheme proposed in this paper is feasible.

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