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Automatic Security System Architecture for Smart Greenhouse Using Face Recognition Approach

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Automatic Security System Architecture for Smart Greenhouse Using Face Recognition Approach

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Abstract. Automation has taken over nearly all domains of operation due to the rapid progress of technology. Over the years, the evolution of human-computer interaction has sped up. With regards to technology improvements, Smart Greenhouse has come a long way. As such, it is critical to have a dependable security system in place to safeguard Greenhouse assets and employee privacy. To access Greenhouse using the conventional security system, an individual must utilize a key. However, the current security mechanism contains numerous flaws regardless of how it is cast or taken. By using face recognition, this study seeks to assist users in enhancing the door security of the Smart Greenhouse. The suggested system comprises several subsystems, including picture capture, face recognition, and automatic door access management. Face Recognition is supported by OpenCV because it uses Eigenfaces and scales down face photos without sacrificing essential features. The Doorlock Selenoid will function as the key. One relay will serve as both an active and passive solenoid. Thus, the images captured from the webcam will be compared to the stored features, and if a match is found, access will be provided to the authorized person. Otherwise, the door is not accessible.

1. Introduction

Crime rates are rising in the modern day. Numerous events, such as theft, burglary, and unwelcome invasions, occur unexpectedly. It necessitates the installation of a security system capable of preventing illegal entrance to the Greenhouse. Entryways are a critical component of the Greenhouse's security system. To open the door, we must have the appropriate key. As a result, employees often encounter problems when misplacing the key or using a programmed entrance lock framework. Employees occasionally forget the key in the house, necessitating the need to break the lock.

The stages are taken to avoid such issues by providing automatic identification that leads to biometrics. Biometric data is collected using hardware devices such as fingerprint [1], RFID [2], and OTP [3]. The disadvantage of this method is that the object must contact the hardware to collect biometric data and perform Recognition. The proposed system recognizes faces automatically through facial recognition algorithms, and the facial recognition process occurs without the user coming into direct contact with any hardware.

The initial phase in the face recognition system is face detection. The dependability of face detection affects the performance of the overall face recognition system. It can identify only the facial portion of a picture independent of the image's backdrop by utilizing face detection. The approach in this paper was mostly built on OpenCV and utilized Haar classifiers for face recognition. The Raspberry pi serves

as the primary processing element. The image is captured via the webcam and compared to the stored features, and access is granted to the authorized user if a match is found. Without this, the door is inaccessible.

2. Proposed architecture for the system

The main objective of the proposed system is to design a security system that can provide great flexibility and lower cost-effectiveness by connecting all modules of the smart greenhouse automation system.

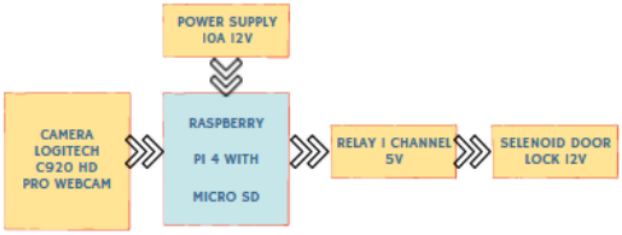


Figure 1. Block diagram of the architecture of an automated security system.

The block diagram in Figure 1 shows the Raspberry Pi 4, the Logitech camera, the relay, and the solenoid door lock. The Raspberry Pi microcontroller board acts as the master and the project's body, while the remaining hardware components function as supporting components. The system operates following the written software and automatically conducts all the above security measures and other automated activities. All physical components are required for the system to function correctly, and all of these tools operate collaboratively under a single controller.

The webcam's face recognition is handled using the haar cascade approach. The initial step, this process involves training the image to determine whether it is positive or negative. If the captured face is clear, the image is considered positive; if there is no face, the image is considered negative [4]. The Haar cascade classifier algorithm features by default are shown in Figure 2. This applies to all scales in the boosted classifier and may be quickly computed using an integral representation of the picture to be identified in [5]. The Raspberry Pi then compares the captured face to a build-in database. A signal is provided to the door lock relay when a matching face is identified, activating the solenoid.

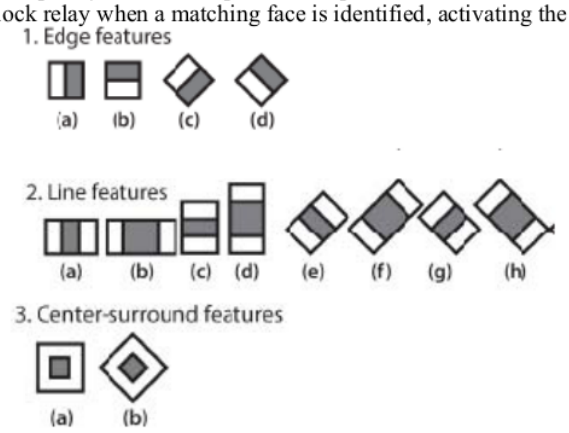


Figure 2. Haar Cascade classifier algorithm features from the OpenCV source.

The suggested system's fundamental components are as follows:

2.1. Raspberry pi 4

Raspberry Pi is a credit-card-sized single-board computer that weighs only 50g [6]. The Raspberry Pi 4 Model B is embedded with a quad-core 1.5 GHz 64-bit ARM Cortex-A72 processor, 2-8 GB RAM, 802.11ac Wi-Fi, full gigabit Ethernet (unlimited throughput), Bluetooth 5, two USB 2.0 ports, two USB 3.0 ports, and dual-monitor support via a pair of micro HDMI (HDMI Type D) ports supporting up to 4K resolution. The MicroSD card slot on the Rasberry Pi 4 can be used to expand storage space, and the HDMI port can be used to connect to the display. The Raspberry Pi 4 was created to promote the use of computer science, particularly in education. Due to the original model's primary market, robotics is substantially more popular than the projected variant. Because raspberry pi's programming language is based on Linux, it is vital to use the same environment to achieve the most performance from the raspberry pi. RASPBIAN is the optimal operating system for the raspberry pi, and it currently includes over 35,000 pre-compiled application packages that can be installed quickly and easily.

2.2. Webcam Logitech

A webcam is a video camera that streams video or images in real-time via a USB cable or a computer network via a LAN cable/ Wi-Fi connection. The resulting video resolution is pretty impressive, despite the inexpensive cost and high flexibility. Webcams are typically used to establish video connections, which enable computers to serve as video or video conferencing nodes [7]. The webcam we are using here is the Logitech C920 HD Webcam, which delivers prominent and detailed Full HD video (1080p at 30fps) with Full HD glass lens, 78° field of view, HD auto light correction, and dual microphones for stereo sound clarity.

2.3. Relay Single Channel

In our approach, we use a single channel relay to control devices from the raspberry pi. Relays are electrically regulated switches that regulate appropriate pull and work only with a holding current. It is designed to operate between 5 and 12 volts. When logic 1 is transmitted on the port pin, a relay is activated, sending a logic 0 on the port pin to turn it off. The advantages of adopting single-channel relays include their low cost, extendibility, and noiseless operation.

2.4. Door Lock

We propose to deploy a solenoid door lock with 12v power in the system. This solenoid lock is a rotary or linear actuator that controls the actuator's angle, speed, and acceleration. It utilizes a closed-loop control system attached to a relay, which automatically moves the door after the facial recognition process has been matched.

3. The proposed method for face detection

The suggested system is constructed around a Raspberry Pi with a high-performance processor, which runs a Debian-based Linux distribution commonly referred to as RASPBIAN. The proposed method's flow chart is visualized in Figure 3. When a human face is detected, the webcam captures the image. By implementing OpenCV on Raspbian, we can do face recognition using the Haar cascade Algorithm. If the face is identified using the image saved in the database system, it indicates that an authorized individual is trying to access the smart greenhouse door, at which point the door lock opens. The door does not open if the face is not recognized.

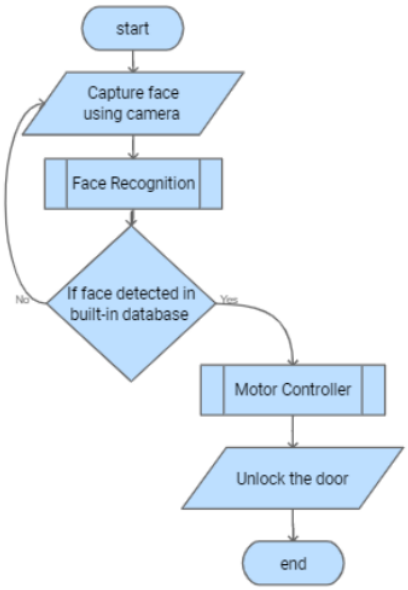


Figure 3. Flowchart for the automatic door system.

4. Experiment and Result

Our work is carried out in real-time, and our security system has demonstrated competitive outcomes compared to other door locking security systems. The GPIO pins enable the Raspberry Pi to control and monitor the outside world by connecting the Raspberry Pi to electronic circuits. The Raspberry Pi and other hardware tools have a complementary functional connection shown in figure 4. When no face is detected in front of the webcam, no signal is sent to the Raspberry Pi. Since the GPIO has not received any instructions from the Raspberry Pi, the door remains closed. The Haar cascade classifier detects the face within 2-3 seconds. The name of the recognized person is shown in the left corner of the detecting box on the Screen. Training from face recognition, we have used 50 images per face shown in figure 5. Once the face is recognized, the door is opened automatically and locked again within 10 seconds, as shown in figure 6.

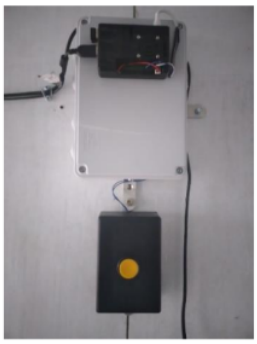


Figure 4. Hardware implementation.

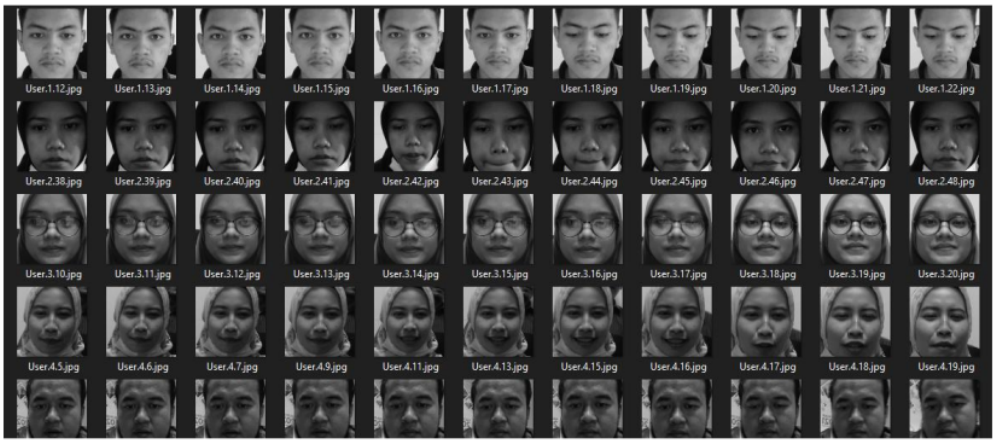


Figure 5. Face Recognition Dataset.

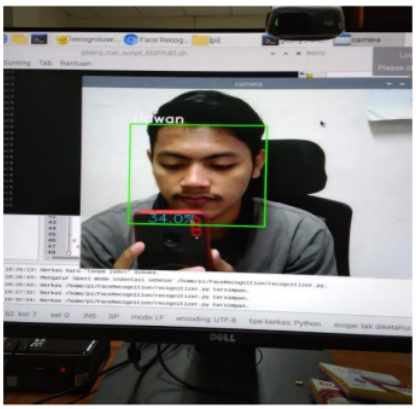
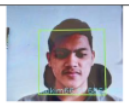
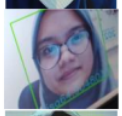
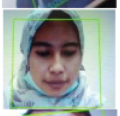


Figure 6. Face is detected.

The test results in Table 1 indicate that each face has a confidence rating of more than 50, meaning that the face is still recognized by the system but requires additional security. Face recognition is constrained by head orientation and lighting. The more light recorded and the proper head position used for face recognition, the higher the confidence value

Table 1. Face recognition results.

User	Face	*Confident Value (%)*
Hakim		66.67

Arvita		55.67
Nisa		64.30
Yunita		63.19
Afredo		53.60

5. Conclusion

This paper presents the implementation of a face recognition system for the Smart Greenhouse system's door lock security. The door lock solenoid is used to control the greenhouse door's opening and closing system in response to commands from the raspberry pi's GPIO pin. The door is immediately unlocked after confirming the individual's face using the Haar cascade classifier method for face recognition in an image. This approach is still limited in terms of head orientation due to the fact that the existing technology only records images of faces from the front. The system's accuracy decreases as the number of distinct faces increases. It can be avoided by training the system with other faces. For optimal performance, the system above requires adequate illumination. For the following research, the raspberry pi will send notifications to security via email or mobile phone informing them of intruders.

6. Acknowledgment

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