International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 09 Issue: 06 | June - 2025 SJIF Rating: 8.586 ISSN: 2582-3930

Door Lock System Using Raspberrypi

M. Ruchitha
UG Student
ruchithamaddur@gmail.com

V. Jayasri
UG Student
jaysrivallapu@gmail.com

G. Ravali
UG Student
Ravalidk2003@gmail.com

Dr. Vijaykumar R.Urkude
Professor
viju1721@gmail.com

Department Of Electronics and Communication Engineering
Vignan's Institute of Management and Technology for Women,
Kondapur(V), Ghatkesar (M), Medchal Dist -501301 Telangana State.

ABSTRACT

In the modern age of digital security, conventional door lock systems are creasingly susceptible to breaches. This paper proposes a robust, multi-factor door lock system that integrates fingerprint recognition, facial detection, and a PIN-based unlocking mechanism using a Raspberry Pi microcontroller. It enhances security by requiring three authentication methods before granting access. The system incorporates a fingerprint sensor via UART, a USB-connected webcam for facial recognition, and a keypad for PIN entry. A servo motor acts as the locking mechanism, controlled through GPIO pins of the Raspberry Pi. By combining biometric, visual, and numeric credentials, this system mitigates the weaknesses of single-layer authentication methods. Python scripts and OpenCV libraries are employed for facial recognition, while fingerprint templates are stored in a secure database. The system is energy-efficient, cost-effective, and can be integrated into existing home automation setups. The solution addresses key concerns office security, offering both reliability and scalability. This project thus presents a feasible alternative to expensive commercial smart lock systems, offering a customizable and user-friendly experience.

Keywords: Raspberry Pi, Fingerprint Sensor, Webcam, Keyboard

I. INTRODUCTION:

Security is a fundamental requirement in both residential and commercial spaces. Traditional locking systems, while long-standing, are vulnerable to key duplication, unauthorized access, and mechanical failures. With advancements in the Internet of Things (IoT) and embedded systems, electronic access control systems are now increasingly being deployed to address these limitations. These systems leverage biometric authentication, facial recognition, and personal identification numbers (PINs) to strengthen security protocols.

This paper introduces a multi-authentication door lock system that utilizes three verification modes: fingerprint recognition, facial detection, and PIN input, each with its own layer of security. At its core, the system is powered by a Raspberry Pi, a compact yet powerful computer capable of interfacing with various peripherals. A fingerprint module is connected via UART, a webcam via USB for facial recognition, and a keypad for PIN entry.

Only upon successful verification of three credentials is access granted through the activation of a servo motor controlling the lock mechanism.

The webcam captures the user's image and uses OpenCV and machine learning models to match it with pre-stored facial data. Simultaneously, the fingerprint sensor reads and verifies fingerprints against stored templates. For added security, a PIN must be entered on a keypad to confirm the identity. Any failed attempt results in the activation of a buzzer and sends an alert email to the owner's device, making it a real-time intrusion detection system as well.

The project leverages open-source libraries for facial recognition and uses Python's serial communication libraries to interface with the fingerprint module.

II. OBJECTIVES

1. **Enhance Physical Security**: By implementing multiple authentication factors—fingerprint, facial recognition, and a PIN code—the system prevents unauthorized access more effectively than traditional locks.
2. **Achieve Real-Time Monitoring**: Through email notifications, the system alerts the homeowner or authorized personnel of every access attempt, whether successful or failed.
3. **Develop a Cost-Effective Solution**: Using Raspberry Pi and open-source libraries minimizes hardware and software costs without compromising functionality.
4. **Provide Scalability and Integration**: The system is designed to be modular, allowing future upgrades such as cloud storage, integration with voice assistants, or mobile app access.

III. PROBLEM STATEMENT

Conventional door locks, whether mechanical or electronic, are vulnerable to various types of attacks such as key duplication, lock picking, and brute-force attempts. Biometric systems such as fingerprint recognition alone can also be bypassed with lifted prints, and facial recognition systems may be fooled by images or poorly lit environments. A single-layer authentication system thus poses considerable security risks, particularly in sensitive or high-value areas.Moreover, existing commercial smart lock solutions are often expensive, difficult to customize, and offer limited transparency into access logs or intrusions. Most systems also lack integration with notification mechanisms to alert the owner in real time during unauthorized access attempts. Users need a more flexible, affordable, and multi-layered security system that ensures reliable access control and monitoring. This paper addresses the challenge by designing a door lock system that uses multiple verification techniques-fingerprint, facial recognition, and PIN input to enhance access control. In the event of an unauthorized attempt, the system sends real-time alerts via email and triggers an alarm. The Raspberry Pi's ability to interface with sensors, actuators, and the internet makes it a perfect fit for such a system.

IV. LITERATURE REVIEW

Recent advancements in biometric and embedded systems have led to the development of more secure and intelligent door lock systems. Researchers have explored the use of fingerprint, facial recognition, and PIN-based authentication, often leveraging the Raspberry Pi due to its low cost, GPIO support, and flexibility. Fingerprint-based systems, such as those using the R305 sensor, have shown reliable performance and are widely adopted for their uniqueness and ease of use. However, their effectiveness can be compromised by environmental factors like dust and moisture. Facial recognition systems using libraries like OpenCV and Dlib on Raspberry Pi have provided a contactless method of authentication, although they are sensitive to lighting and processing constraints. PIN-based systems remain a popular method due to their simplicity but are vulnerable to guessing and shoulder surfing. To overcome the limitations of individual methods, several studies have proposed multi-modal systems that combine fingerprint, facial, and PIN authentication to enhance security and reliability. These hybrid systems offer better resistance against spoofing and unauthorized access but require optimization to handle processing loads efficiently on Raspberry Pi. Overall, integrating multiple authentication techniques on a single platform holds great promise for developing secure, user-friendly door lock systems.

V. System Architecture and Components Block Diagram:

The below block diagram represents the physical components of Finger print,facial and Pin detection door lock system.

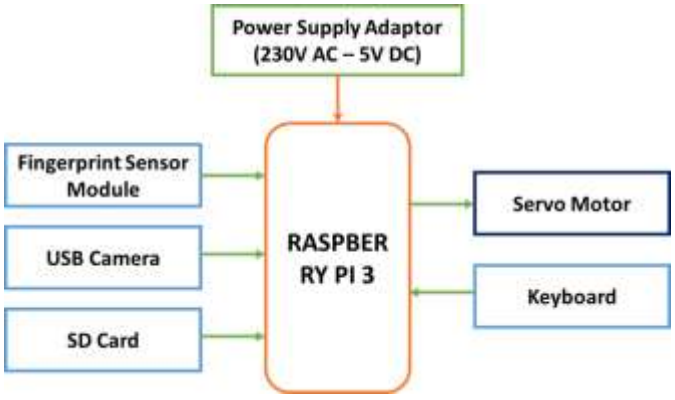

Figure 1 : Block Diagram

Hardware Components:

1. **RaspberrPi :** Raspberry Pi is a small single board computer. By connecting peripherals like Keyboard, mouse, display to the Raspberry Pi, it will act as a mini personal computer. Raspberry Pi is popularly used for real time Image/Video Processing; IoT based applications and Robotics applications. It is slower than laptop or desktop but is still a computer which can provide all the expected features or abilities, at low power consumption. Raspberry Pi Foundation officially provides Debian based Raspbian OS. Also, they provide NOOBS OS for Raspberry Pi. We can install several Third-Party versions of OS like Ubuntu, Archlinux, RISC OS, Windows 10 IOT Core, etc.

Figure 2 : Raspberry Pi

2. Webcam : A webcam is a digital camera connected to a computer that captures and transmits video and audio data in real-time over the internet. It's used for various purposes, including video conferencing, live streaming, and recording videos. Webcams can be built into devices like laptops or be external, often with integrated microphones.

Figure 3 : Web Camera

3. Fingerprint Sensor: Biometric identification from a print made by an impression of the ridges in the skin of a finger is often used as evidence in criminal investigations. Yes, now we can use the same biometric identification technique to build our own hobby projects like a biometric authenticator/access control system with the help of readily-available Fingerprint Identification Modules.

Figure 4 : Fingerprint Sensor

4. Servo Motor : A servo motor is an electrical device which can push or rotate an object with great precision. If you want to rotate and object at some specific angles or distance, then you use servo motor. It is just made up of simple motor which run through servo mechanism. If motor is used is DC powered then it is called DC servo motor, and if it is AC powered motor then it is called AC servo motor. We can get a very high torque servo motor in a small and light weight packages.

Figure 5 : ServoMotor

Software Programming :

1. **System Idle:** Wait for any input (finger, face, or PIN).
2. **Fingerprint Auth:**
   - Scan fingerprint

- Match with stored templates

3. **Facial Detection/Recognition:**

- Use OpenCV to detect face
- Use face_recognition to verify against known faces

4. **PIN Entry:**

- User enters 4-6 digit PIN on keypad
- Match with stored PIN

5. **Access Granted:**

- If any method is successful → activate relay to unlock door.

6. **Feedback:**

- Use LED/LCD to show "Access Granted" or "Denied"

VI. WORKING PRINCIPLE:

The fingerprint, facial detection, and PIN- based door lock system using Raspberry Pi works by integrating three authentication methods to control access. When a user approaches, the system waits for input from either the fingerprint sensor, camera, or keypad. If the fingerprint is scanned, the Raspberry Pi compares it with stored templates to verify identity. For facial detection, the camera captures the user's face, detects features using OpenCV, and matches them against a pre-registered dataset using face recognition algorithms. If the user chooses to enter a PIN, the keypad input is compared to a stored secure PIN code. If any of the authentication methods are successful, the Raspberry Pi triggers arelay module that unlocks the door. The system ensures flexibility and improved security by allowing one or more methods to validate access, and can be further enhanced by combining methods for multi- factor authentication

VII. RESULTS:

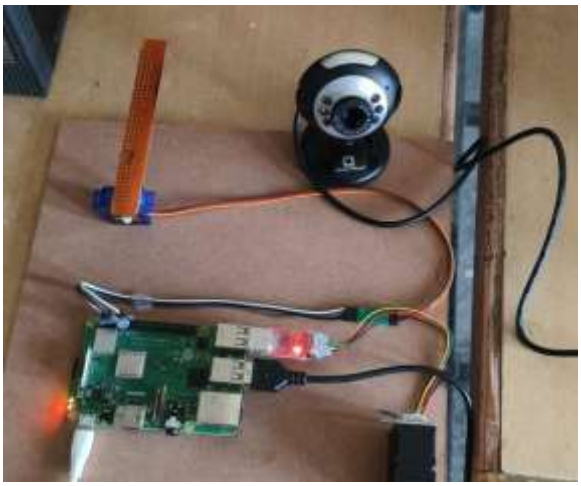

Figure 6 : Hardware kit

Figure 7 : Start Video Streaming

Figure 8 :Face Matched

Figure 9: Finger Matched

Figure 10 : OTP Generated

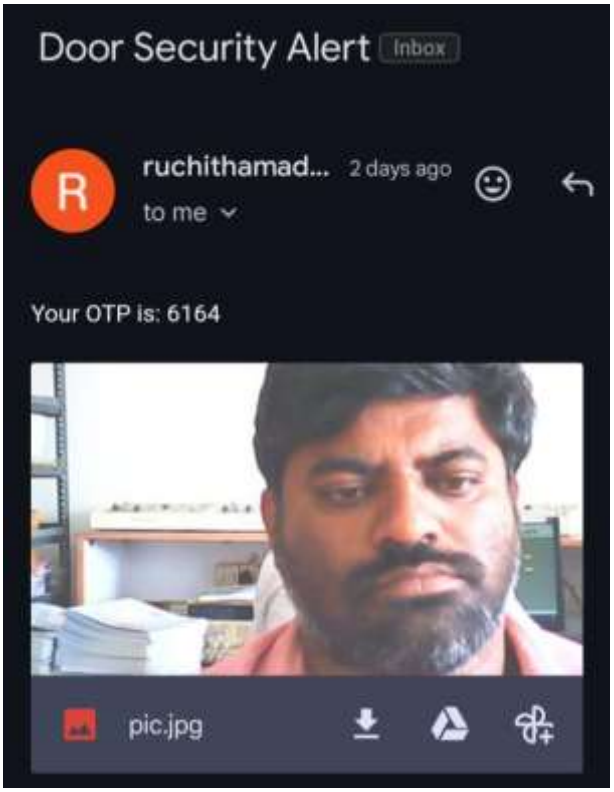

Figure 11 : Received Email Alert

Figure 12: Unlocking Door

Figure 13 : Physical representation of Unlocking door

Figure 14 : Locking Door

Figure 15 : Not Matched Finger/Face/OTP

VII. CONCLUSION:

In this paper it contains the integration of fingerprint, facial recognition, and PIN-based authentication into a door lock system using Raspberry Pi offers a robust, secure, and cost- effective solution for modern access control. By combining biometric and numeric authentication methods, the system enhances security while maintaining user convenience. The use of Raspberry Pi enables flexibility, scalability, and ease of implementation, making it suitable for both residential and commercial applications. This multi-factor approach significantly reduces the risk of unauthorized access, demonstrating the effectiveness of Raspberry Pi-based systems in real-world security applications.

REFERENCES:

[1]. R. Singh et al., "Biometric Access Control Using Fingerprint Recognition," IJCA, 2018.

[2]. M. A. Turk and A. P. Pentland, "Eigenfaces for Recognition," Journal of Cognitive Neuroscience, 1991.

[3]. P. Viola and M. Jones, "Rapid Object Detection using a Boosted Cascade of Simple Features," CVPR, 2001.

[4]. S. Agrawal et al., "Smart Door Locking System using IoT and Face Recognition," IEEE ICSP, 2020.

[5]. A. Jain et al., "Multimodal Biometric Authentication Systems," Elsevier, 2019

[6]. D. Kumar et al., "Home Automation and Security Using Raspberry Pi," IJETT, 2017.

[7]. L. Zhang et al., "A Robust Face Recognition System Based on LBP," IEEE Sensors Journal, 2015.

[8]. V. Patel et al., "Real Time Face Recognition and Door Unlocking Using Raspberry Pi," IJEAT, 2021.

[9]. J. Smith, "PIN-based Access Control for Embedded Systems," Embedded Tech Journal, 2016.

[10]. H. Lee and S. Park, "Low-Cost Smart Security Lock System Using Raspberry Pi," IEEE Access, 2020.