

# A Smart Door Locking System Based on Image Processing

Marasani Indu<sup>1</sup>, Megha M V<sup>2</sup>, Pavithra M<sup>3</sup>, Poorva Reddy D<sup>4</sup>, Dr. Reddy Sudharshana K<sup>5</sup>

<sup>1,2,3,4</sup>student, Vemana Institute of technology

<sup>5</sup>Asso.prof., Vemana Institute of technology

**Abstract**—This paper presents an advanced smart door-locking system that integrates image processing, facial recognition, and RFID-based alternate authentication, all powered by a Raspberry Pi. A Pi Camera captures real-time images, which are processed using OpenCV to accurately recognize authorized users. An RFID reader offers an additional verification layer, ensuring secure access for trusted individuals. A servo motor functions as a simulated locking mechanism, activating to unlock the door upon successful authentication. LED and buzzer indicators provide instant visual and auditory feedback on the access decision. The Raspberry Pi serves as the central controller, coordinating data processing and hardware operations. This integrated system delivers improved security, automation, and user convenience. Its flexible, scalable architecture makes it suitable for residential, commercial, and high-security environments. Overall, the system demonstrates the potential of intelligent technologies to enhance modern access-control solutions.

**Index Terms**—Smart Door Lock, Image Processing, Facial Recognition, RFID Authentication, Raspberry Pi, OpenCV, IoT Security, Access Control System, Servo Motor Control

## I. INTRODUCTION

With rapid advancements in technology, modern security systems have evolved considerably, giving rise to smarter and more efficient solutions for residential, commercial, and high-security environments. Among these developments, door-locking mechanisms have undergone significant innovation. Traditional lock-and-key systems, while widely used, are increasingly vulnerable to duplication, tampering, and theft. As the demand for smart automation and enhanced security continues to grow, the need for reliable, adaptable, and user-friendly access-control systems has become more pronounced.

This project introduces a smart door-locking system that utilizes image processing with a Raspberry Pi as the central controller. The system integrates facial recognition with RFID (Radio Frequency Identification) as an alternate authentication method, providing a secure and convenient approach to access management. By combining these two techniques, the system ensures that only authorized individuals can gain entry, thereby reducing the likelihood of unauthorized access.

## II. LITERATURE REVIEW

A. "Smart Door Locking System with Intrusion Detection" -

Amit Vikram Seth

[1] The work titled "Smart Door Locking System with Intrusion Detection" by Amit Vikram Seth and colleagues presents an IoT-based smart security solution aimed at enhancing home safety. The system utilizes an ESP32-CAM, a solenoid lock, and a PIR motion sensor, all integrated with the Blynk app to enable remote control and real-time monitoring through a smartphone. When a visitor rings the doorbell, the camera captures their image and sends it to the user's phone, allowing them to unlock the door remotely if desired. Additionally, the PIR sensor monitors for unauthorized movement and immediately sends alerts to the user if any suspicious activity is detected. Developed using the Arduino IDE, this cost-effective and easy-to-implement system offers a practical and user-friendly approach to modern home security using IoT technology.

B. "Face Recognition Smart Home Door Lock System Using Artificial Intelligence" -

Vaijyanthimala J, Ramya A,  
Rubasri G, and Rupanjani S

[2] In "Face Recognition Smart Door Lock System Using Artificial Intelligence", Vijayanthimala J, Ramya A, Rubasri G, and Rupanjani S propose a AI-driven smart door lock system that leverages advanced face recognition technology for enhanced home security. The system employs an improved version of the Mask R-CNN model, named G-Mask, which combines face detection and recognition into a single, efficient framework. When an unrecognized individual is detected, the system captures their image and sends an SMS link to the homeowner, allowing them to review the image and approve or deny access remotely. This integration of AI and IoT not only enables real-time monitoring but also provides remote control over door access, offering both security and convenience. The proposed system achieves an accuracy of 82.71%, making it a reliable and intelligent solution for modern smart homes.

C. "Smart Door Lock System" -Suraj Pandey, Vivek Yadav, Rajkumar Yadav, Yograj, and Swatika Srivastava

[3] The paper "Smart Door Lock System" by Suraj Pandey, Vivek Yadav, Rajkumar Yadav, Yograj Swatika Srivastava, introduces a fingerprint-based smart locking system designed to enhance security in an affordable way. The system operates using an Atmega328p microcontroller, an Adafruit fingerprint sensor, and a solenoid lock to ensure that only authorized individuals can gain access. When a fingerprint is scanned, it is compared with the stored data, and if a match is found, the door unlocks. A buzzer provides

immediate feedback to indicate whether access has been granted or denied. Developed using the Arduino platform, this system is both customizable and cost-effective, making it a practical solution for securing homes and office

D. "Face Recognition Door Lock System Using Machine Learning and Image Processing"- B. Padmini, V. Narendar, S. Varanya, Y. Manish Reddy, K. Mahendar, and K. V. Sai Krishna

[4] In "Face Recognition Door Lock System Using Machine Learning and Image Processing" by B. Padmini, V. Narendar, S. Varanya, Y. Manish Reddy, K. Mahendar, and K. V. Sai Krishna presents a smart door

security system that combines facial recognition with IoT to enhance modern home safety. The system uses a standard webcam and a NodeMCU (ESP8266) module to capture and process facial images for user authentication. When a familiar face is detected, the door unlocks automatically, offering a seamless and contactless entry experience. In cases where an unrecognized face is spotted, the system captures an image and instantly notifies the homeowner. Cloud integration allows for easy storage and remote management of user data. By eliminating the need for physical keys or manual operation, this solution offers a convenient and secure alternative to traditional door locks.

E. "Door Locking System Using Face Recognition"- Mr. Rishabh Mantri, Mr. Rohit Kalveni, Mr. Mayur Vishwakarma, and Prof. Amruta B. Kale

[5] The paper "Door Locking System Using Face Recognition" by Mr. Rishabh Mantri, Mr. Rohit Kalveni, Mr. Mayur Vishwakarma, and Prof. Amruta B. Kale, presents an smart door security system that uses facial recognition with Raspberry Pi and the LBPH (Local Binary Pattern Histogram) algorithm. A Pi camera captures the image of the person at the door and compares it with images stored in a database. If there's a match, the door unlocks automatically. If not, the system sends the captured image to the homeowner through a GSM module, allowing them to approve or deny access remotely. The system is contactless and works reliably even under different lighting conditions, offering a real-time, IoT-enabled solution for enhanced home security.

F. "IoT Based Digital Door Lock" by Sanjib Kumar Dhara, Nilankar Bhanja, Thandassery Vidyalall Vikash, and Supriyo De

[5] The paper titled "IoT Based Digital Door Lock" by Sanjib Kumar Dhara, Nilankar Bhanja, Thandassery Vidyalall Vikash, and Supriyo De, published in 2021, introduces a smart door lock system that integrates IoT technology with fingerprint authentication, PIN verification, and a unique knock pattern recognition feature. Built using ESP32, Arduino Uno, and Google Firebase, the system enables users to unlock the door through a mobile app by verifying their fingerprint and entering a PIN. Additionally, it offers an alternative unlocking method via a custom knock sequence, useful

### III. DESIGN METHODOLOGY

#### A. ANALYSIS OF THE SYSTEM

The methodology of the smart door lock system involves integrates with advance technologies to create a secure and user-friendly access control solution as shown in Fig3.1. The system uses a Raspberry Pi as the controller to handle facial recognition through image processing via Open CV, while also supporting RFID authentication. A Pi Camera captures user images, which are processed and matched in real-time, and the system grants access by activating a servo motor to control the locking mechanism. LED indicators and buzzers provide immediate feedback to users, signalling successful or failed authenticatio attempts.

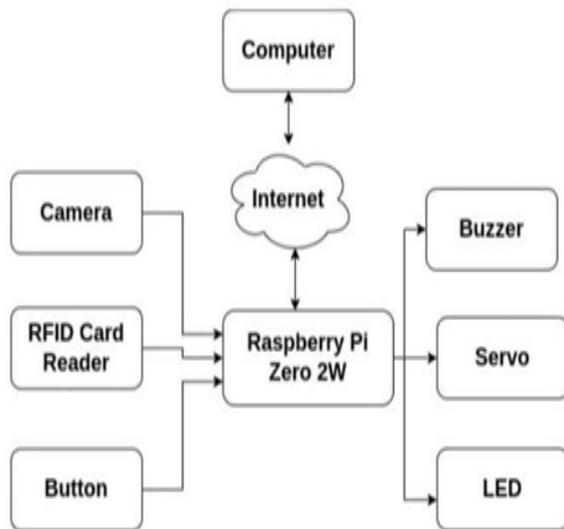


Fig.3.1: Block Diagram of smart door locking systemem

#### B.SYSTEM FLOW CHART

The system flow chart of the project begins with the user attempting authentication via facial recognition or RFID scanning. Upon capturing the face or scanning the RFID tag, the system processes the data using image processing algorithms and compares it with stored credentials. If authentication is successful, the servo motor is triggered to unlock the door, and a green LED with a buzzer indicates approval. In the case of failure, the system triggers a red LED and a buzzer to signal invalid access, while an override button allows manual control of the door in critical situation

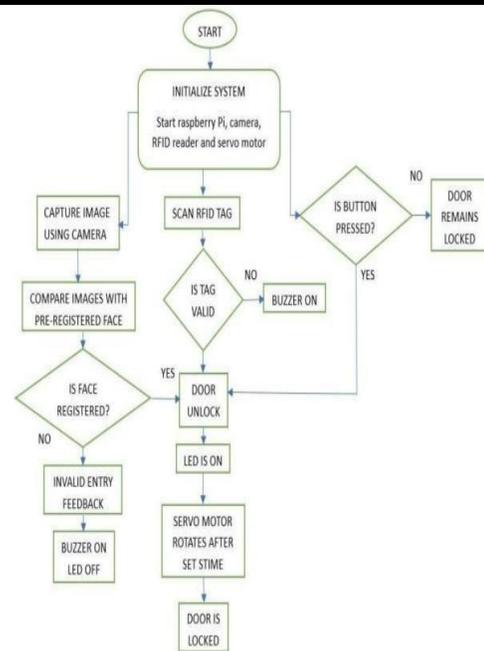


Fig 3.2 : System Flow Chart

1. Initial Setup and User Interaction : When an individual approaches the door, the system first checks if the user has an RFID tag. The RFID reader scans the tag, and if it matches a registered user, the system proceeds to unlock the door. If the RFID tag is unrecognized or invalid, the buzzer is triggered, and the system denies access.
2. Facial Recognition : If the user does not have an RFID tag or prefers facial recognition, the Pi Camera captures the user's face. The image is processed in real-time using facial recognition algorithms in Python (OpenCV). If the face does not match, the buzzer sounds, and no green LED is displayed, indicating that the authentication attempt has failed.
3. Door Locking/Unlocking : Upon successful authentication through either RFID or facial recognition, the system triggers the servo motor to unlock the door. This is achieved by sending a signal from the Raspberry Pi, which controls the servo motor physically lock or unlock the door mechanism. If the authentication fails, the door remains locked, and no LED light is displayed
4. Emergency Override Button : The system is equipped with a manual override button that allows the

user to lock or unlock the door from the inside. Pressing the button directly activates the servo motor to unlock or lock the door.

5. Feedback Mechanism : To give immediate feedback to users, the system uses LEDs and buzzers. A green LED lights up to confirm successful authentication, signalling that the door will unlock. If the authentication fails, the buzzer sounds and the LED does not light up, indicating a failed attempt.

#### IV. RESULTS

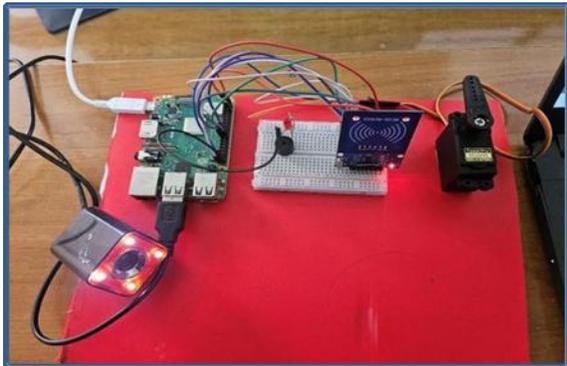


Fig. 4.1 Prototype connections



Fig.4.2 Door opening on successful image detection

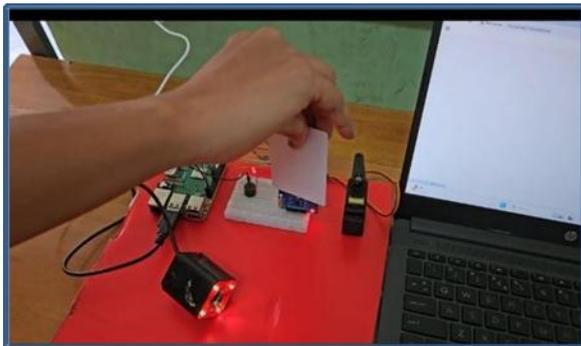


Fig. 4.3 Door opening on successful RFID detection

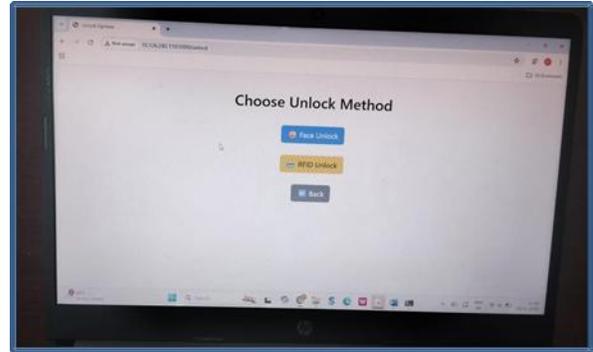


Fig. 4.4 Website view

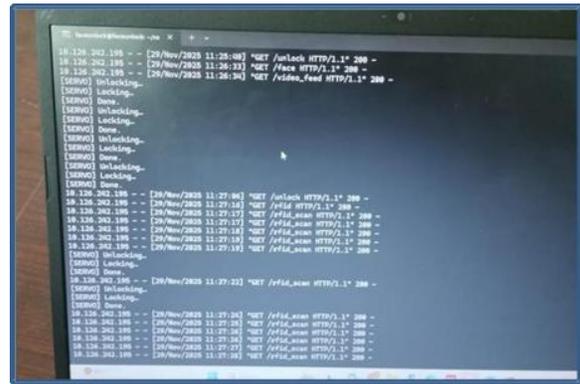


Fig.4.5 Terminal View

activating cameras when someone enters. Adding other biometric options like fingerprint or voice recognition would provide even more secure and inclusive access. Features like battery backup, offline functionality, and anti-spoofing measures would make the system more reliable and safer. Overall, this smart locking system is forward-thinking solutions with lots of exciting possibilities for the future.

#### V. CONCLUSION

The smart door locking system combines image processing and RFID authentication, to create a modern, secure, and convenient way to control access. Facial recognition acts as the main method, providing hands-free, personalized entry, while RFID cards serve as a dependable backup if the face isn't recognized. Together, these features boost both security and user flexibility, making the system perfect for homes, offices, and restricted areas. It also keeps detailed access logs from both face recognition and RFID data, helping with monitoring and audits. Looking ahead, there's plenty of room to make this

system even smarter. Using AI-powered facial recognition can improve accuracy in different lighting or weather conditions. Connecting the system to mobile apps could allow remote door control and instant alerts. Storing data in the cloud would make it easier to monitor and access records from anywhere. The system could also link up with other IoT and smart home devices, enabling automation like turning on lights or

#### REFERENCES

- [1] Mamatha K R, Thejaswini S, Rashmi N, Dr. Girish H “Secure Smart Door Lock Featuring Facial Recognition”, Machine Intelligence Research, Vol. 18 No.2,2024.
- [2] Talugula Ganesh Reddy, Sirumandla Chethan Sai, Borra Pavan Kumar, Ramineni Teja Venkatesh “Face Recognition Door Lock System Using Raspberry Pi”, Third International Conference on Secure Cyber Computing and Communication (ICSCCC),2023.
- [3] N. Jiwani, K. Gupta, and P. Whig, “Novel HealthCare Framework for Cardiac Arrest with the Application of AI Using ANN,” in 2023 5th International Conference on Information Systems and Computer Networks (ISCON), 2023.
- [4] D. Chauhan, A. Kumar, P. Bedi, V.A. Athavale, D. Veeraiah, B.R. Pratap, “An effective face recognition system based on Cloud based IoT” with a deep learning model, Microprocess. Microsyst. 81,2022.
- [5] D.S.S. Mahesh, T.M. Reddy, A.S. Yaswanth, C. Joshitha, S.S. Reddy, “Facial detection and recognition system on Raspberry Pi with enhanced security” International Conference on Emerging Trends in Information Technology and Engineering (Ic-ETITE), IEEE,2022.
- [6] Manoharan, Samuel, “Image Detection, Classification and Recognition for Leak Detection in Automobiles”, Journal of Innovative Image Processing (JIIP) 1, no.02,2019.
- [7] Hardik Asnani<sup>1</sup>, Suhaib Khan<sup>2</sup>, Suhaas Nandeesh<sup>3</sup>, Prarthana T.V, “Securing an IoT based Home using Digital Image Processing and an Android Application” International Research Journal of Engineering and Technology (IRJET),2018.
- [8] S. Pawar, V. Kithani, S. Ahuja, S. Sahu, “Smart home security using IoT and face recognition” Fourth International Conference on Computing Communication Control and Automation (ICCUBEA), IEEE,2018.
- [9] S. Kavde, R. Kavde, S. Bodare, and G. Bhagat, “Smart digital door lock system using Bluetooth technology,” in 2017 International Conference on Information Communication and Embedded Systems (ICICES), 2017.
- [10] Rishabh Kumar Gupta, S. Balamurugan, K. Aroul and R.Marimuthu, “IoT Based Door Entry System”, Indian Journal of Science and Technology, Vol 9(37),2017.