IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 6, Issue 1, May 2026
Impact Factor: 8.2

IoT Based Smart Door Lock System

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Abstract: *The IoT-based Smart Door Lock System with Home Automation using fingerprint authentication offers a secure and automated access control solution. It uses a biometric fingerprint sensor to verify user identity before unlocking the door. Authorized fingerprints are stored in a database, and each access attempt involves matching the scanned print with stored templates. If a match is found, the microcontroller activates the door lock, granting entry automatically. Unauthorized attempts trigger an alert notification immediately. The system integrates biometric security with IoT features for real-time monitoring and remote control. It enhances safety by preventing unauthorized access and enables smart home functionality. The design ensures reliability, user convenience, and automation in access management. It can be linked with mobile or cloud platforms for status tracking. The IoT connectivity allows users to monitor door status remotely. Energy efficiency and scalability are also supported in the architecture. Suitable for homes, offices, labs, and restricted areas, the system provides a modern, intelligent security solution.*

Keywords: *IoT Smart Door Lock, Fingerprint Authentication, Biometric Security, Home Automation, Access Control, Real-time Monitoring, Remote Control, Microcontroller, Unauthorized Alerts, Cloud Integration, Energy Efficiency, Scalability*

I. INTRODUCTION

In recent years, the rapid advancement of the Internet of Things (IoT) has significantly transformed security systems, replacing traditional lock-and-key mechanisms with smart, automated solutions that offer superior protection, convenience, and remote monitoring. Smart door lock systems stand out as a key application of IoT in home automation and security, integrating advanced sensors, microcontrollers, and internet connectivity for intelligent access control. The IoT-based Smart Door Lock System using Fingerprint Authentication is an innovative solution that enhances security by permitting only authorized users entry while delivering real-time alerts for unauthorized attempts. The primary objective is to create a secure door locking system employing a fingerprint sensor for biometric authentication, where authorized fingerprints are stored in the module's database. Upon access attempt, the system scans the fingerprint, compares it against stored data, and if matched, activates the locking mechanism to unlock the door automatically. This eliminates vulnerabilities of traditional keys or passwords, which can be lost, duplicated, or stolen, ensuring only verified individuals gain access to secured areas like homes, offices, labs, and restricted zones. Conventional locks suffer from key loss, unauthorized copying, and no monitoring, lacking notifications for tampering. The proposed system overcomes these by combining biometric technology—leveraging unique, irreplicable fingerprints—with IoT for reliable, intelligent security. A standout feature is the real-time alert mechanism: when an unregistered fingerprint is detected, the system instantly identifies the mismatch and sends an alert via the IoT platform to the owner, enabling immediate response and action. This bolsters security layers, making it ideal for modern smart homes and offices, providing comprehensive monitoring and peace of mind .

II. SYSTEM ARCHITECTURE

The IoT-based smart door lock system follows a layered architecture that combines sensing, processing, actuation, and cloud communication into a cohesive unit. At the core is the ESP32, which functions as both the control unit and the

DOI: 10.48175/IJARSCT-34740

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communication gateway. The sensing layer consists of a fingerprint module that captures and processes biometric data from users. This data is transmitted to the ESP32, where it is matched against stored templates using embedded logic. Because this verification happens locally on the device (edge computing), the system ensures quick response times and continues to operate even if internet connectivity is temporarily unavailable.

The processing layer within the ESP32 handles decision-making and system control. Based on the authentication result, it activates the actuation layer, which includes the door lock mechanism (typically a solenoid controlled via a relay) and a buzzer for feedback. If access is granted, the relay is triggered to unlock the door; if access is denied, the buzzer sounds to indicate an unauthorized attempt. This immediate feedback improves both usability and security.

The communication layer enables the system to connect to the internet via Wi-Fi and interact with the ESP RainMaker. Through this platform, the ESP32 sends real-time data such as access logs, system status, and alert notifications to the cloud. The cloud layer then synchronizes this information with the user interface layer, which is typically a mobile

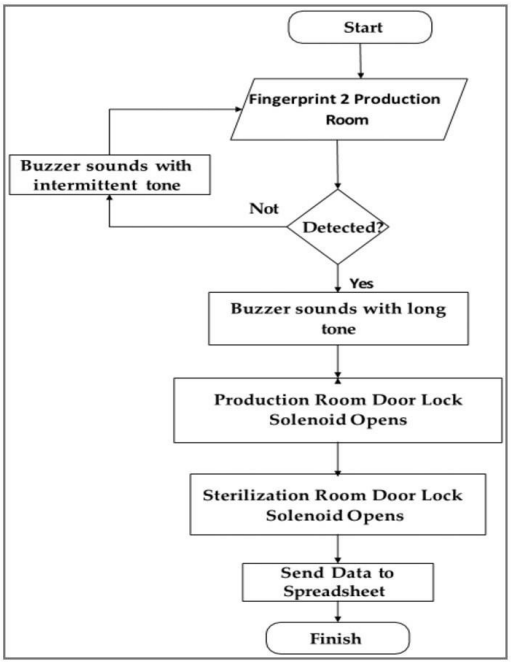

Fig. 1 WORKFLOW MODEL

application on the owner's smartphone. This allows the user to remotely monitor door activity, receive alerts for failed authentication attempts, and potentially control the lock from anywhere.

Overall, the architecture is designed to balance reliability, security, and scalability. Local processing ensures fast and dependable operation, while cloud integration adds remote accessibility and data tracking. The modular nature of the system also allows for future enhancements, such as adding face recognition, PIN-based entry, or integration with broader smart home ecosystems.

III. METHODOLOGY

Methodology for an IoT-based smart door lock system is: select a Wi-Fi microcontroller (like ESP8266/ESP32), connect it to a lock actuator and an authentication module (keypad, RFID, or fingerprint), write firmware to handle access control and send commands over Wi-Fi to a cloud or app platform, then test hardware and remote locking/unlocking with security and reliability checks.

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3.1 Working Principle

The working principle of an IoT-based smart door lock system is that a microcontroller (such as ESP8266/ESP32 or Arduino with Wi-Fi) is connected to a lock actuator (solenoid or servo) and one or more authentication sensors (like keypad, RFID, fingerprint, or camera). When a user enters credentials locally or sends a lock/unlock command from a mobile app via the internet, the microcontroller receives the command over Wi-Fi, authenticates it, and then sends a control signal to the relay or motor that operates the lock to either engage (lock) or disengage (unlock) the door. The system also sends back real-time status updates and alerts (such as "door locked" or "unauthorized access") to the user's app or cloud server, enabling both remote monitoring and remote control of the door.

3.2 Circuit Diagram

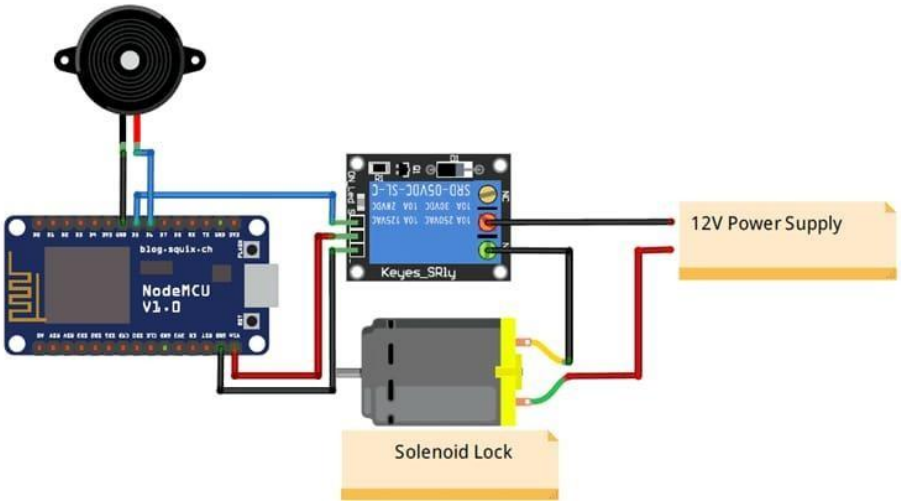

Fig. 2. CIRCUIT DIAGRAM

IV. IMPLEMENTATION

An IoT-based smart door lock system can be implemented using an ESP32 or Node-MCU as the main controller, connected to a Wi-Fi network and a mobile app such as Blynk. The ESP32 is wired to a relay module (or a transistor–MOSFET circuit) that controls a 12 V solenoid lock, with a flyback diode across the solenoid to protect the switching components from back-EMF. Power is supplied through a 12 V source for the solenoid, while a 5 V regulator provides stable voltage for the ESP32 and relay logic. The Blynk app on a smartphone sends lock/unlock commands to a virtual pin on the ESP32, which then toggles the relay to energize or de-energize the solenoid and mechanically open or close the door latch. Optionally, a 4×4 keypad, RFID module, or fingerprint sensor can be interfaced with the ESP32 so that the lock only opens after correct authentication before the IoT command is executed, making the system both remote-controllable and locally secure.

4.1 Firmware Development

Firmware development for the IoT-based smart door lock is done in the Arduino IDE using the ESP32's Wi-Fi and Blynk libraries, where the ESP32 continuously listens for lock/unlock commands from the Blynk app over the internet and toggles a relay that controls the solenoid lock; the code also manages the system state (locked/unlocked) and can optionally read from a keypad, RFID, or fingerprint module before accepting the unlock command. The firmware initializes the Wi-Fi connection on startup, then runs Blynk.run() in the main loop so that when the user taps the lock/unlock button in the app, the corresponding virtual pin is written and the ESP32 switches the relay GPIO, giving short-term control of the solenoid while logging status messages to the serial monitor for debugging.

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4.2 User Interface

The user interface is built inside the Blynk app on the smartphone, where a simple project is created for the ESP32 device and a button or switch widget is mapped to a virtual pin (for example V1) that represents the lock state: ON (unlock) and OFF (lock), optionally accompanied by a text label or LED widget that shows whether the door is currently locked or unlocked. Advanced versions may add a numeric keypad or RFID login screen in the app, or use a more complex UI (like a dashboard with camera feed from an ESP32-CAM) so the user can view a live image of the door and then press an unlock button only after confirming the person at the door, making the interface both intuitive and secure.

V. RESULTS AND DISCUSSION

The IoT-based smart door lock system built around the ESP32 was successfully implemented and tested for secure access control. The system responded effectively to fingerprint inputs and processed authentication in real time.

During testing, the fingerprint sensor showed high accuracy in recognizing enrolled users. Authorized fingerprints resulted in quick door unlocking, demonstrating efficient system performance and minimal delay.For unauthorized attempts, the system reliably denied access and activated the buzzer alert. This immediate response enhances security by providing both audible warning and system awarenes .

For unauthorized attempts, the system reliably denied access and activated the buzzer alert. This immediate response enhances security by providing both audible warning and system awareness.The integration with ESP RainMaker enabled seamless communication between the device and the user's smartphone. Alert messages for failed attempts were delivered promptly, supporting remote monitoring.

The system maintained stable operation under normal conditions, with consistent relay switching and proper door lock control. It also showed good reliability in continuous operation scenarios.

Overall, the system improves security and convenience compared to traditional locks. However, performance depends on proper fingerprint enrollment and stable internet connectivity for cloud-based features.

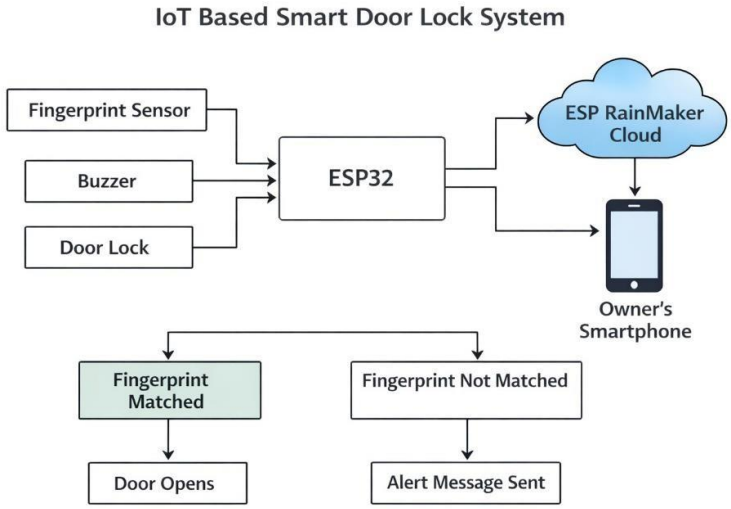

Fig 5.1: Implementation Diagram

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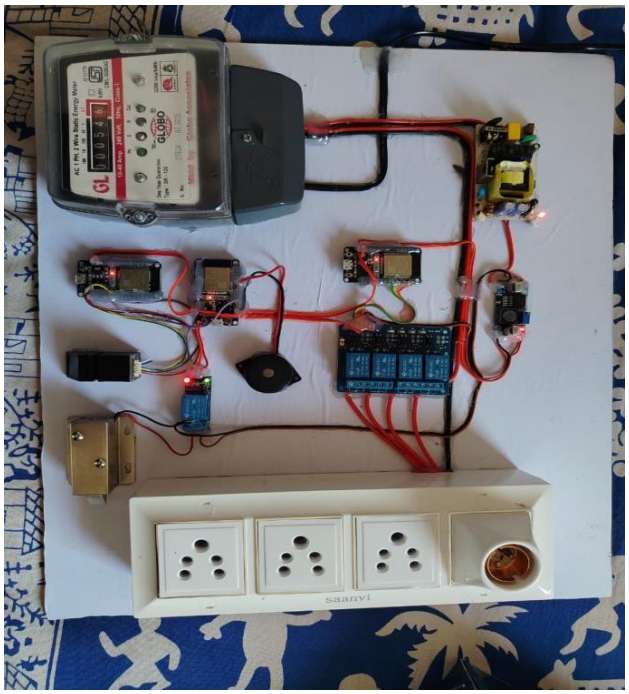

Fig5.2:Result

VI. CONCLUSION

In conclusion, an IoT-based smart door lock system offers a convenient, secure, and remotely controllable solution for modern access control by integrating an ESP32 or similar microcontroller with Wi-Fi connectivity, a Blynk-based mobile app, and a relay-driven solenoid or motorized lock. The firmware enables real-time communication between the user's smartphone and the door lock, allowing lock/unlock commands to be sent over the internet while local authentication components such as keypad, RFID, or fingerprint sensors can be added to enhance security and prevent unauthorized access. The simple yet flexible user interface in the Blynk app provides intuitive control through buttons and status indicators, making the system suitable for homes, offices, or small-scale commercial applications where both remote access and user-friendly operation are essential.

VII. ACKNOWLEDGMENT

We acknowledge the support of the Department of Electronics and Telecommunication Engineering, Mauli Group of Institutions, College of Engineering & Technology, Shegaon for providing the necessary facilities to carry out this project work. We express our sincere gratitude to our project guide for valuable guidance and technical support throughout the development of the system. The contributions of all team members in the implementation of this project are duly recognized. We also thank all those who provided indirect support during the completion of this work.

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