

Smart Fingerprint Attendance System Using Raspberry Pi

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Abstract

This paper presents the design and implementation of a smart fingerprint-based attendance system tailored for classroom environments. The system uses Raspberry Pi 3 A+, a fingerprint sensor, and Google Sheets for automatic, real-time logging of student attendance. The system offers an efficient, secure, and user-friendly solution to track student attendance while minimizing errors associated with traditional manual methods. It eliminates the need for paper-based attendance management and integrates seamlessly with cloud-based storage, providing access to attendance data from any device with internet access.

Keywords: Fingerprint authentication, Raspberry Pi 3 A+, classroom attendance, google sheets, automation, cloud storage

INTRODUCTION

Traditional methods of taking attendance in classrooms, such as roll call or manual registers, are often time-consuming, error-prone, and susceptible to manipulation. Additionally, these methods lack an efficient way to track attendance data over time and often require manual updates and handling. Biometric systems, such as fingerprint recognition, offer a secure, fast, and automated solution to track attendance in an accurate and tamper-proof manner [1, 2].

This project proposes a “Smart Fingerprint Attendance System” using a Raspberry Pi 3 A+, which interfaces with a fingerprint sensor for student identification. The attendance data are then automatically recorded in Google Sheets, which serve as a cloud-based database. This system reduces not only the administrative workload but also provides real-time updates and remote access to attendance records [3, 4].

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RELATED WORK

Several studies have explored attendance management using biometric systems and cloud-integrated databases. However, limited research has focused on the integration of low-cost embedded systems with cloud-based spreadsheet solutions like Google Sheets for real-time attendance tracking.

SYSTEM DESIGN AND METHODOLOGY

The Smart Fingerprint Attendance System is designed to automate student attendance using a biometric fingerprint scanner. The system uses Raspberry Pi 3A+ as the main processing unit and stores attendance data in Google Sheets via the internet [5, 6].

HARDWARE COMPONENTS

Raspberry Pi 3A+

The Raspberry Pi 3A+ is the core processing unit in the Smart Fingerprint Attendance System. It is responsible for identities and Fingerprint data, verifying student identities and updating attendance records in Google Sheets via the internet.

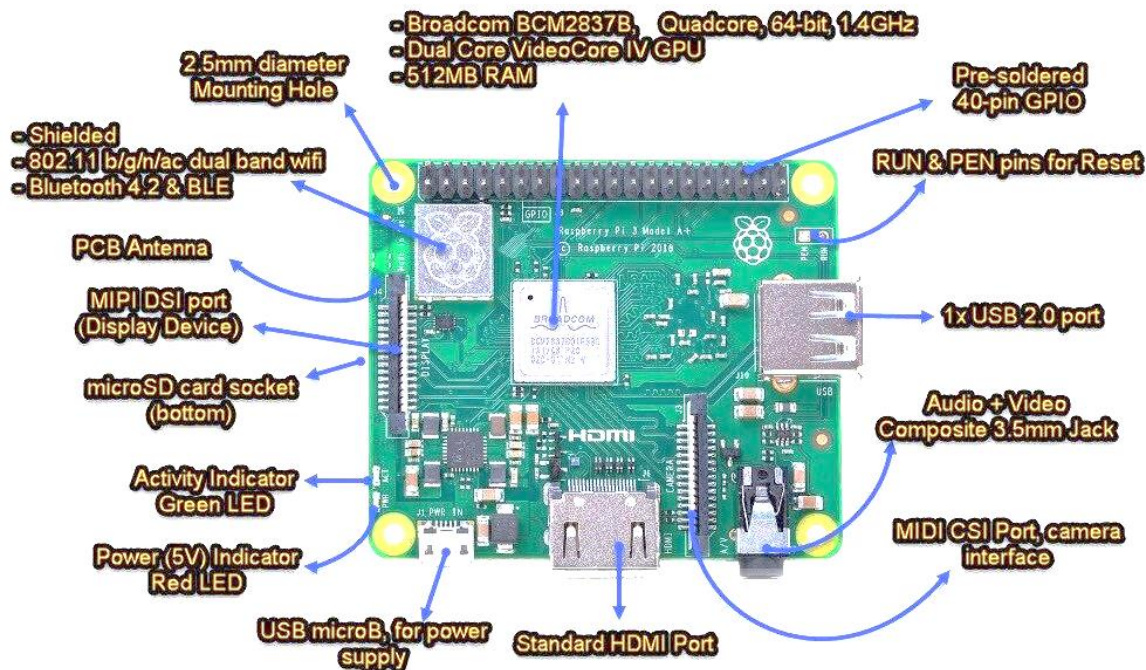


Figure 1. Raspberry-Pi 3A+.

Processor is equipped with a Broad-com BCM2837B0, Quad-core Cortex-A53 (64-bit) @ 1.4GHz, making it powerful enough for biometric authentication and data processing. Memory 512MB LPDDR2 SDRAM is suitable for running Python scripts, Google API, and database handling. Wi-Fi (802.11 b/g/n/ac) and Bluetooth 4.2 are used for wireless connectivity. It is Used to send attendance data to Google Sheets via the internet (Figure 1). USB Port is a single USB 2.0 port that is available for connecting the fingerprint sensor (if using a USB-based model). GPIO Pins (40-Pin Header) is used to interface with external components like Fingerprint Sensor (UART), LCD Display (I2C/SPI), and Buzzer (GPIO control). We use Power Supply to Operates on 5V/2.5A making it power efficient. It can be powered using an adapter or a portable power bank. The Raspberry Pi 3A+ is an ideal choice due to its compact size, built-in Wi-Fi, and low power consumption, making the Smart Fingerprint Attendance System efficient and cost-effective [7, 8].

R307 Fingerprint Sensor

The fingerprint sensor captures and processes students' fingerprints, comparing them with a pre-registered database to authenticate their identity. The R307 Fingerprint Sensor is an optical biometric sensor used for fingerprint recognition and authentication. It is widely used in security systems, attendance systems, and access control applications. The R307 works on the optical fingerprint recognition principle.

- *It is working as:* The user places a finger on the optical scanning surface. The built-in LED light illuminates the fingerprint area. The CMOS sensor captures a high-resolution image of the fingerprint. The captured image is processed to enhance contrast and remove noise. The minutiae (ridges and valleys) of the fingerprint are extracted and converted into a binary pattern.
- *Feature Extraction & Template Generation:* The fingerprint pattern is analyzed to generate a

unique template. This template is stored in the sensor's memory (EEPROM) for future matching. When a user places their finger on the sensor, a new fingerprint scan is taken.

The scanned fingerprint is compared with stored templates in the memory. If a match is found, authentication is successful. If no match is found, access is denied. If authentication is successful, the module sends a HIGH signal (success) via the UART interface. If authentication fails, a LOW signal (failure) is sent.

- *Advantages:* High Accuracy, Fast Processing, Compact & Lightweight, Easy Interfacing, Good Storage Capacity, Durability, Security.

The CMOS sensor captures a high-resolution image of the fingerprint. The captured image is processed to enhance contrast and remove noise [8, 9].

Google Sheets

Google Sheets acts as the cloud-based storage for attendance records. It is accessible from any device with an internet connection and is used to log attendance automatically once the fingerprint is authenticated [10].

Google Sheets API is used to send the attendance data (student ID, date, and time) to the cloud-based Google Sheets document. This allows real-time tracking of attendance and provides access to records from anywhere.

- *Power Supply:* A 5V power supply powers the Raspberry Pi and the fingerprint sensor.
- *LCD Display:* An LCD screen is used to display messages, such as "Scan your fingerprint" or "Attendance recorded," to improve users' interaction and Feedback.

SOFTWARE COMPONENTS

- *Raspbian OS:* The Raspberry Pi runs on the Raspbian operating system, a Debian-based OS optimized for Raspberry Pi devices (Figure 2).
- *Python:* Python is the primary programming language used for interacting with hardware components and Google Sheets API. Libraries, such as RPi.GPIO, PyFingerprint, and gspread, are utilized for GPIO control, fingerprint sensor interaction, and Google Sheets communication, respectively.
- *Google Sheets API:* The Google Sheets API allows the Raspberry Pi to send data to a Google Sheet in real time, logging the attendance automatically when a student's fingerprint is authenticated.

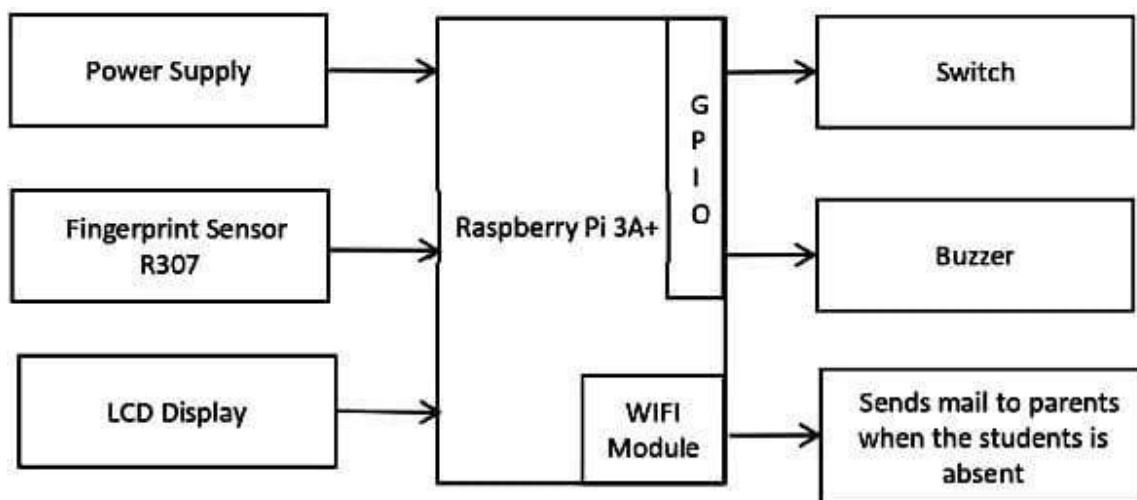


Figure 2. Block diagram proposed methodology.

- *Raspberry Pi 3A+*: The core processing unit that manages fingerprint authentication and communicates with Google Sheets.
- *Fingerprint Sensor (R307)*: Captures and verifies student fingerprints.
- *LCD Display (16 x 2 or LED Display)*: Displays attendance status, such as “Attendance Marked” or “Access Denied”.
- *Wi-Fi Module (Built-in on Raspberry Pi 3A+)*: Enables internet connectivity to send data to Google Sheets.
- *Google Sheets*: Stores attendance records in an organized format.
- *Push Button*: Can be used to switch modes or reset the system.
- *Buzzer*: Provides sound alerts for successful or failed authentication.
- *Power Supply*: A 5V power supply powers the Raspberry Pi and the fingerprint sensor.

Project Working

Instructors or administrators enroll students’ fingerprints into the system by scanning each student’s fingerprint multiple times. The fingerprints are then stored in the Raspberry Pi’s local database. On the day of class, students place their fingers on the fingerprint sensor one by one. The Raspberry Pi captures the fingerprint data and matches it with the pre-enrolled fingerprints.

If a match is found, the student’s attendance is logged into Google Sheets with the current date and time. A confirmation message, such as “Attendance recorded successfully,” is displayed on the connected LCD screen.

The Google Sheets API is used to send the attendance data (student ID, date, and time) to the cloud-based Google Sheets document. This allows real-time tracking of attendance and provides access to records from anywhere. An optional LCD/LED screen displays the status to the user, such as instructions for scanning the fingerprint or confirming that the attendance has been recorded.

The system logs attendance in real-time, allowing teachers to remotely monitor and track student attendance via Google Sheets from any device with internet access (Figure 3).

FLOWCHART AND ALGORITHM

The step-by-step algorithm for the system is as follows:

Enrollment Algorithm

Initialize Raspberry Pi and Fingerprint Module.

- Prompt the student to place their finger on the scanner.
- Capture the fingerprint image.
- Process and convert it into a digital template.
- Store the fingerprint template in the database with a unique student ID.
- Display “Fingerprint Registered Successfully”.

Attendance Marking Algorithm

- Initialize Raspberry Pi and load stored fingerprint templates.
- Prompt the student to place their finger on the scanner.
- Capture and process fingerprints.

Compare the scanned fingerprint with stored templates

- If **match found** → Mark attendance, display success message, and store timestamp.
- If **no match** → Display error and prompt retry.
 - Store the attendance data in a local/online database.
 - Display “Attendance Marked” confirmation.

RESULTS AND DISCUSSION

Performance Testing

The performance of the system is assessed based on:

- *Accuracy*: The fingerprint sensor's ability to correctly identify students. The system achieved a high accuracy rate (over 95%) in matching enrolled fingerprints.
- *Speed*: The system successfully logs attendance within 2–3 seconds per student, ensuring that the class can begin promptly without significant delays.
- *Reliability*: The system was tested for continuous use over several class sessions without any hardware or software malfunctions.
- *Usability*: Students found the system easy to use, with clear instructions displayed on the LCD screen for fingerprint scanning.

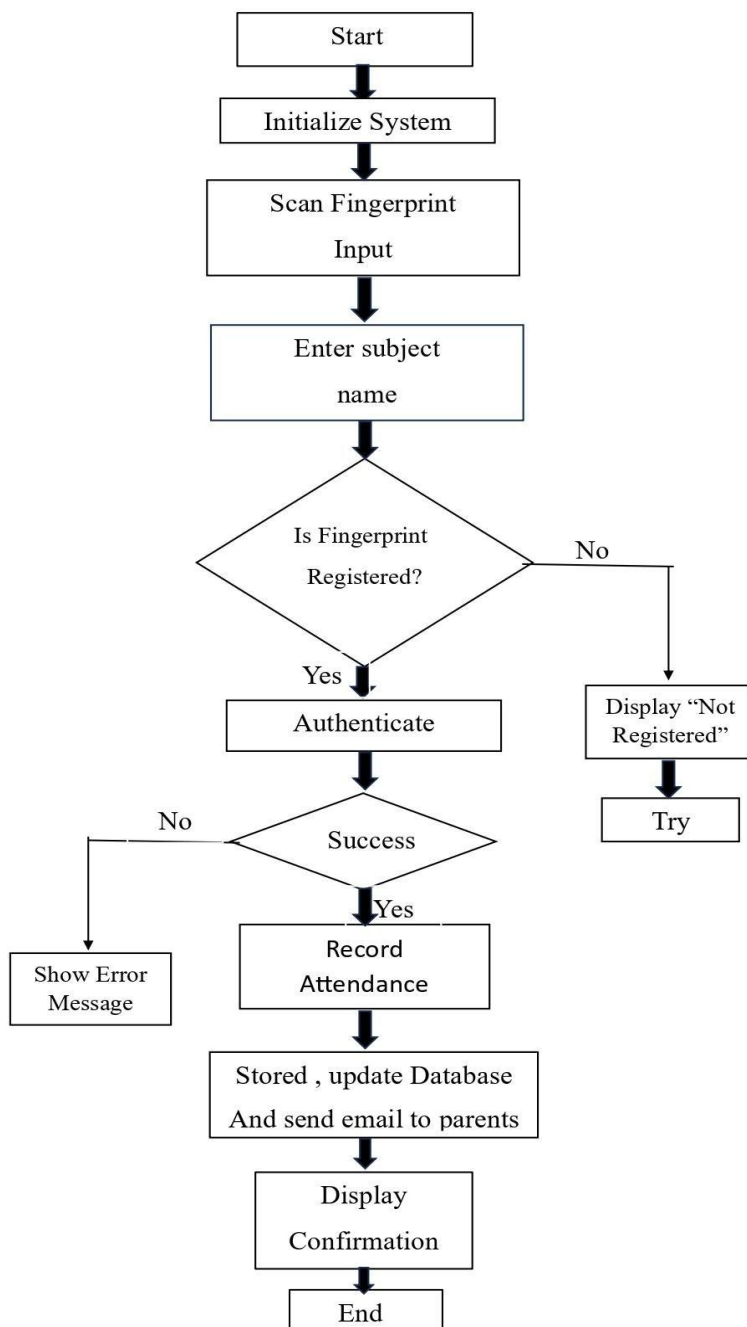


Figure 3. Flow chart of proposed methodology.

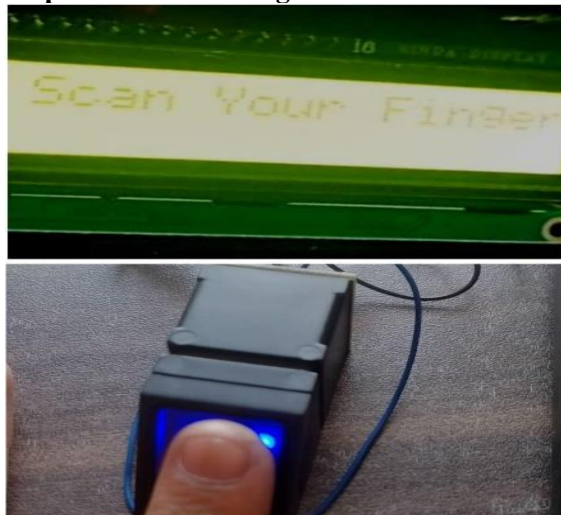
Step 1: System Attendance System



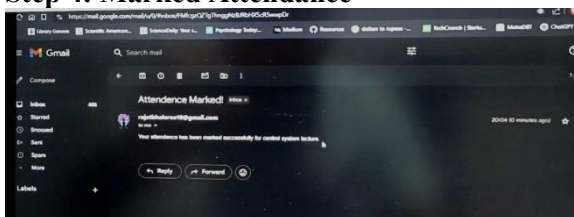
Step 2: Entry Details



Step 3: Scan Your Finger



Step 4: Marked Attendance



Security

The fingerprint-based authentication ensures that the attendance system is tamper-proof, as fingerprints are unique to everyone. Additionally, access to the Google sheets document is secured using Google account authentication, ensuring that only authorized personnel can view or modify the attendance data.

LIMITATIONS

- *Fingerprint recognition accuracy:* Fingerprint recognition technology may not always be accurate, leading to false positives or negatives.
- *Internet connectivity:* The system requires internet connectivity to update attendance records in Google Sheets, which may be unreliable or unavailable in some areas.

- *Biometric data security*: The system stores sensitive biometric data, which must be protected from unauthorized access or breaches.
- *Cost*: The system may be too expensive for some educational institutions, particularly those with limited budgets.
- *Temperature and humidity*: The Raspberry Pi device may be sensitive to extreme temperatures or humidity, potentially leading to malfunctions or data loss.

FUTURE SCOPES

Future improvements to the system can include:

- *Facial Recognition*: Integrating facial recognition to create a multi-modal biometric authentication system.
- *Web Interface*: Developing a web-based dashboard for teachers to monitor and manage attendance records.
- *Integration with Learning Management Systems (LMS)*: Linking the attendance data with existing LMS platforms to provide a seamless user experience.
- *Machine learning*: Implement machine learning algorithms to predict student attendance patterns and identify potential issues
- *Mobile app integration*: Develop a mobile app for students to access their attendance records and receive notifications. Teachers & students can check attendance via an app.
- *Integration with existing systems*: Integrate the attendance system with existing educational software and systems.
- *Multi-Language Voice Assistance & AI Chat-bot*: Implementing voice commands for marking attendance. AI chat-bot to answer students' attendance-related queries. Support for regional languages to enhance usability.
- *AI-Powered Attendance Analytics*: Implementing Artificial Intelligence (AI) and Machine Learning (ML) to analyze attendance trends. AI can predict student absenteeism based on past records. ML models can detect irregular patterns and notify administrators of attendance concerns.
- *RFID/NFC (Near Field Communication) technology*: Adding to allow students to mark attendance using smart ID cards. Students who face difficulties with fingerprint recognition (injuries, poor prints) can use RFID cards as an alternative Dual authentication (Fingerprint + RFID) for improved security.
- *Cloud-Based Attendance Storage & Remote Access*: Expanding beyond Google Sheets to use Firebase, AWS, or Google Cloud for centralized data storage. Allow teachers and administrators to view reports and attendance logs remotely. Data security and backup features to prevent loss of records.
- *IoT-Based Classroom Automation*: Linking attendance with IoT-enabled devices like smart doors and classroom lights. Automated classroom entry – Doors unlock only for authenticated students. Classroom resources (projectors, Wi-Fi) activate based on attendance verification.

CONCLUSIONS

The Smart Fingerprint Attendance System using Raspberry Pi 3 A+ and Google Sheets provides an efficient, accurate, and secure method of managing classroom attendance.

- *Security and Data Integrity*: By utilizing unique biometric identifiers, the system enhances security and ensures the integrity of attendance data, reducing the likelihood of fraudulent entries. By automating the attendance process, the system reduces administrative overhead and minimizes errors associated with traditional attendance methods. Real-time data logging to Google Sheets provides easy access to records, allowing teachers and administrators to monitor attendance efficiently. This system can be expanded to large classrooms and integrated with other educational systems to further enhance the management of classroom resources. Future work can explore additional biometric methods, such as facial recognition, or expanding the system's capabilities, to include reporting and analytics features.

- *Scalability and Integration:* The modular nature of the system allows for easy scalability and potential integration with existing organizational infrastructures, enhancing its applicability across various settings. Overall, the Smart Fingerprint Attendance System is a promising step toward more modern, secure, and efficient attendance management in various sectors, including educational institutions, corporate offices, and event management.

REFERENCES

1. Patel S, Agarwal S, Mistry P. Fingerprint-based authentication system for attendance management. *J Inf Secur.* 2022 Mar;3(2):35–42.
2. Gupta RK. Raspberry Pi for IoT and cloud-based applications. *Int J Comput Appl.* 2023 Oct;122(7):28–32.
3. Kumar M, Agarwal A, Pradhan SR. Fingerprint-based biometric authentication for educational attendance systems. *Int J Comput Sci Technol.* 2024 Jan;9(1):14–20.
4. Gupta RD. Raspberry Pi for IoT-based educational systems. *Int J Educ Technol.* 2022 Mar;12(3):56–60.
5. Google Developers. Google Sheets API [Internet]. Available from: <https://developers.google.com/sheets/api>. [Accessed 2025 Mar 7].
6. Camposano R, Wilberg J. Embedded system design. *Design Automation for Embedded Systems.* 1996 Jan;1(1):5-0.
7. Domahidi A, Chu E, Boyd S. ECOS: An SOCP solver for embedded systems. In 2013 European control conference (ECC) 2013 Jul 17 (pp. 3071-3076). IEEE.
8. Wolf W, Madsen J. Embedded systems education for the future. *Proceedings of the IEEE.* 2002 Aug 6;88(1):23-30.
9. Pimentel AD, Hertzbetger LO, Lieverse P, Van Der Wolf P, Deprettere EE. Exploring embedded-systems architectures with Artemis. *Computer.* 2001 Nov 30;34(11):57-63.
10. Papp D, Ma Z, Buttyan L. Embedded systems security: Threats, vulnerabilities, and attack taxonomy. In 2015 13th Annual Conference on Privacy, Security and Trust (PST) 2015 Jul 21 (pp. 145-152). IEEE.