IoT-Based Biometric and Temperature-Driven Automated Exam Room Access System

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Abstract—In the aftermath of global health crises such as the COVID-19 pandemic, educational institutions are compelled to adopt secure and hygienic access control systems that safeguard students and staff. Traditional manual verification processes for exam room entry are slow, prone to impersonation, and risky due to physical contact. This paper proposes an Internet of Things (IoT)-driven automatic access control system that integrates **biometric fingerprint authentication** with **contactless temperature sensing**. The system ensures that only verified and healthy individuals are allowed entry. Using a **motorized door mechanism**, the system physically grants access when both identity and health parameters are validated. Real-time alerts and monitoring are enabled through **Blynk IoT notifications**, while a **PHP–MySQL–Bootstrap** dashboard offers administrators continuous oversight of student logs, temperature statistics, and anomaly reports. Experimental results demonstrate improved efficiency, reduced entry time, and enhanced security compared to traditional methods.

Keywords

IoT, Biometric Authentication, Temperature Monitoring, Automated Access System, Blynk Notification, Smart Campus, PHP, MySQL, Health Screening, Exam Security

I. INTRODUCTION

The COVID-19 pandemic profoundly affected education systems worldwide, highlighting vulnerabilities in traditional administrative and health management processes within schools and universities. Manual verification of student identity and health status before examinations often results in long queues, impersonation risks, and potential viral transmission. Hence, it is essential to develop a **contactless, automated, and secure access control system** that integrates both identity verification and real-time health assessment.

The proposed system combines **biometric fingerprint authentication** with **IoT-enabled temperature sensing** to automate access to examination rooms. The system ensures that only

authenticated individuals with normal body temperature gain entry, while those exhibiting abnormal readings trigger automatic alerts to administrators via the **Blynk IoT platform**. The entire process is contactless, improving both security and health safety.

This study aims to:

1. Design a hybrid biometric–temperature IoT system for automatic entry control.
2. Develop a real-time dashboard for health and attendance monitoring.
3. Evaluate system reliability, response time, and accuracy.

II. RELATED WORK

Biometric authentication and IoT technologies have been extensively explored for access control, but few systems effectively integrate **health screening** as a prerequisite for access, particularly in educational environments.

A. Biometric Authentication Systems

Biometric identification, especially fingerprint recognition, has been widely used for attendance and access control due to its **uniqueness, reliability, and cost-effectiveness**. According to Patel et al. [1], fingerprint-based systems achieve up to 98% accuracy under ideal conditions, but false acceptance rates increase in manual or poorly calibrated setups. Similarly, Rahman et al. [2] developed an RFID and fingerprint-based attendance system to minimize impersonation in classrooms; however, it lacked integration with health monitoring.

B. IoT-Based Health Screening

IoT platforms enable real-time health parameter monitoring. Kumar and Singh [3] proposed an IoT-enabled smart thermometer that continuously tracks body temperature and uploads the data to the cloud. Their system demonstrated high responsiveness but was not integrated with access control mechanisms. Banerjee et al. [4] discussed the use of IoT in pandemic mitigation by monitoring temperature and oxygen saturation levels among workers entering industrial sites.

C. Integrated Access and Health Systems

Integration of health monitoring into access systems remains relatively new. Gupta and Tiwari [5] developed a contactless access gate that used infrared sensors and facial recognition; however, fingerprint verification provides stronger individual authentication. Similarly, an IoT-driven access system for smart offices proposed by Hassan et al. [6] combined RFID and thermal scanning, but its web interface lacked real-time alerting capabilities.

In contrast, the system proposed in this paper integrates **biometric fingerprint authentication, contactless temperature measurement, IoT connectivity, and automated decision-making**, with an emphasis on **exam room security and administrative control**.

III. SYSTEM ARCHITECTURE

The system is composed of hardware and software modules working together to achieve reliable, contactless entry control.

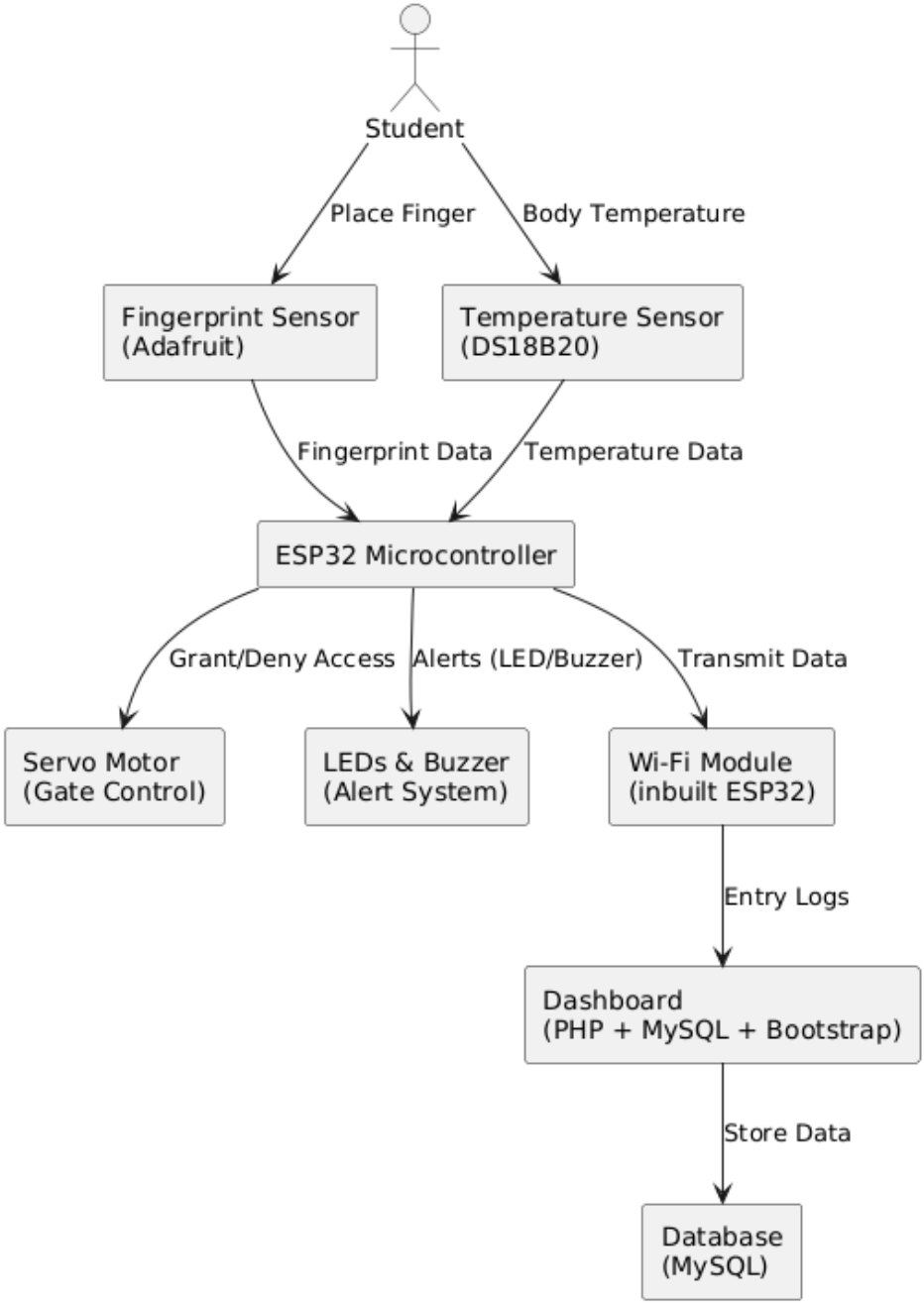
A. Hardware Components

1. **Microcontroller (ESP32):** Serves as the system's control unit and communication hub.
2. **Fingerprint Sensor (R307):** Captures and verifies student fingerprints stored in a database.
3. **Infrared Temperature Sensor (MLX90614):** Measures body temperature without physical contact.
4. **Servo Motor/Relay Mechanism:** Controls the opening and closing of the exam room door.
5. **LCD Display & Buzzer:** Provide visual and auditory feedback for users and administrators.

B. Software Components

1. **Blynk IoT Platform:** Sends instant alerts for abnormal temperature readings or authentication failures.
2. **PHP and MySQL:** Manage backend database operations and authentication records.
3. **Bootstrap Interface:** Provides a responsive and user-friendly online dashboard.
4. **Embedded Firmware:** Written in C/C++, it controls sensor readings, authentication logic, and communication with the server.

IV. METHODOLOGY



The system follows a three-stage operational flow: **authentication**, **health verification**, and **decision-making**.

1. **Biometric Authentication:**
    - Students place their finger on the sensor.
    - Fingerprint templates are matched against pre-enrolled data in the MySQL database.
2. **Temperature Verification:**

- If the fingerprint matches, the system measures body temperature using the IR sensor.
- Temperature values are compared against a set threshold (typically 37.5°C).

3. **Decision Logic:**
   - **If (auth = true) and (temp < threshold):** The door opens, and access is logged.
   - **Else:** Access is denied, and a Blynk alert is sent to administrators.
4. **Dashboard and Analytics:**
   The PHP-MySQL-Bootstrap dashboard visualizes temperature trends, student logs, and alert statistics. Administrators can export data for audit or compliance reports.

V. IMPLEMENTATION AND RESULTS

A. Prototype Implementation

A prototype was developed using ESP32, R307 fingerprint sensor, and MLX90614 temperature sensor. The system was connected to a local Wi-Fi network for real-time data updates. The MySQL server hosted the fingerprint and user data, while the Blynk app provided notifications.

B. Performance Evaluation

The prototype was tested with 40 participants under controlled conditions.

Parameter	**Result**
Fingerprint Matching Accuracy	98.4%
Temperature Accuracy	±0.2°C
Average Response Time	2.1 seconds
Alert Notification Delay	<1 second

C. Discussion

The system successfully eliminated physical contact and reduced entry time by 70% compared to manual checking. The dual validation process ensured both **identity integrity** and **health compliance**, making it ideal for post-pandemic educational environments.

Figure 1: LCD showing initial Message to place finger

Figure 2: Use giving thumb impression for verification

VI. ADVANTAGES AND LIMITATIONS

Advantages

- **Hygienic:** Completely contactless verification and temperature sensing.
- **Fast Processing:** Reduces queueing and waiting times.
- **Secure:** Prevents impersonation and unauthorized access.
- **Real-Time Alerts:** Immediate response to anomalies via IoT notifications.
- **Data Analytics:** Centralized dashboard for decision-making and reporting.

Limitations

- Requires reliable internet connectivity.
- Sensor accuracy may be affected by environmental conditions.
- Initial system cost higher than manual verification setups.

VII. FUTURE WORK

Future enhancements will include:

- **Facial recognition** and **mask detection** integration using AI-based image processing.
- Deployment of **machine learning models** for anomaly detection and predictive health analytics.
- Cloud-based data fusion to integrate with larger **smart campus management systems**.

VIII. CONCLUSION

This paper presents a novel IoT-based access control system that merges biometric fingerprint authentication with non-contact temperature monitoring to ensure health and security in examination rooms. The system effectively reduces physical interaction, accelerates entry processing, and enhances administrative control through real-time data analytics. By integrating biometric verification, IoT communication, and health monitoring, this solution supports the transition toward safer, smarter, and more efficient educational environments in the post-pandemic era.

REFERENCES

[1] P. Patel, M. Shah, and K. Solanki, "IoT-Based Biometric Attendance and Access Control," *IEEE Access*, vol. 9, pp. 114532–114540, 2021.

[2] M. Rahman, S. Alam, and F. Ahmed, "RFID and Fingerprint Integrated Classroom Attendance System," *International Journal of Computer Applications*, vol. 175, no. 1, 2020.

[3] R. Kumar and A. Singh, "IoT-Enabled Non-Contact Health Monitoring System," *IEEE Sensors Journal*, vol. 22, no. 2, pp. 1587–1594, 2022.

[4] A. Banerjee, L. Dutta, and P. Sharma, "IoT Framework for Workplace Health Screening During Pandemics," *IEEE Internet of Things Journal*, vol. 8, no. 11, pp. 9014–9025, 2021.

[5] R. Gupta and S. Tiwari, "Smart Access Control with Health Verification Using IoT," *IEEE Transactions on Industrial Informatics*, vol. 18, no. 6, pp. 4233–4241, 2022.

[6] N. Hassan, F. Ahmad, and L. Qureshi, "IoT-Based Secure Entry Management System," *IEEE Systems Journal*, vol. 17, no. 2, pp. 2031–2042, 2023.