Smart Track: A Wireless IoT Attendance System with Google API Integration using ESP32

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***Abstract*—The Smart Attendance System using ESP32 is an IoT-based solution designed to automate attendance tracking by integrating an RFID module with Google Sheets API. This system eliminates manual logging errors by using RFID tags assigned to individuals, which are scanned to record attendance in real time. The ESP32 processes RFID data and updates an online spreadsheet, allowing for remote monitoring and data management. Additionally, two servo motors control access for entry and exit, while an LED indicator system provides immediate visual feedback—green for authorized access and red for unauthorized attempts. A buzzer is also integrated to provide an auditory alert for each scan, further enhancing the system's feedback mechanism. The implementation of this system enhances accuracy, security, and efficiency in attendance tracking, making it a reliable alternative to traditional methods.**

I. Introduction

Attendance monitoring plays a crucial role in various organizations, including schools, offices, and events. Traditional methods, such as manual logbooks or biometric systems, often suffer from inefficiencies, inaccuracies, and security risks. To address these limitations, we developed a Smart Attendance System using ESP32, which integrates an RFID module for identification and Google Sheets API for real-time data logging. The system not only automates attendance tracking but also provides a secure and structured access mechanism through servo-controlled entry and exit points. Additionally, LED indicators and a buzzer offer instant feedback on authentication status, improving user experience and security. By leveraging cloud storage, it ensures accessibility and data integrity while reducing human intervention.

II. Methodology

A. Hardware Implementation

- **ESP32 Microcontroller:** Acts as the core processing unit, handling communication between the RFID module, servo motors, LEDs, buzzer, and Google Sheets API.
- **RFID Module (RC522):** Reads unique card IDs and sends the data to the ESP32 for authentication.
- **Servo Motors:** Control entry and exit gates based on RFID authentication.
- **LED Indicators:**
  - Green LED: Turns on for authorized card scans, signaling successful authentication.
  - Red LED: Activates for unrecognized or unauthorized card scans, denying access.
- **Buzzer:**
  - Emits a short beep for successful authentication.
  - Emits a longer beep for unauthorized access attempts.
- **Power Supply**
  Circuit Connections: Ensured stable voltage levels and reliable wiring to prevent malfunctions.

B. Software Development

- **ESP32 Programming:**
  - Developed using Arduino IDE with necessary libraries for RFID, Wi-Fi connectivity, and HTTP requests.
  - Implemented authentication logic to compare scanned RFID tags against a predefined database.
- **Google Sheets API Integration:**
  - Configured Google Sheets API for cloud-based data storage.
  - Established HTTP communication between ESP32 and Google Sheets using a webhook mechanism.
  - Recorded timestamps, names, and status (entry/exit) in real time.
- **Servo Motor, LED, and Buzzer Control:**
  - Implemented movement logic based on successful RFID scans.
  - Defined conditions for unauthorized access attempts, triggering the red LED and buzzer alert.
  - Activated the green LED and short buzzer beep for valid scans before opening the respective servo motor.

C. System Workflow

1) A user taps an RFID card on the scanner.
2) The ESP32 processes the card ID and checks for a match in the database.
3) If the card is registered:
   - The system logs the attendance with a timestamp on Google Sheets.
   - The green LED lights up momentarily.
   - The buzzer emits a short beep.

- The respective servo motor (entry/exit) opens for a few seconds.

4) If the card is unregistered:
   - The red LED turns on, indicating access denial.
   - The buzzer emits a long beep.
   - The system does not log any attendance data.
5) The system repeats this process for each RFID scan.

III. Results and Discussion

The system was tested under various conditions to evaluate its performance, accuracy, and reliability. During testing, the ESP32 successfully read RFID cards and updated attendance records in Google Sheets with minimal latency. The servo motors operated as expected, granting access to authorized users while restricting unauthorized entries. The LED indicators and buzzer functioned correctly, providing real-time feedback to users.

One challenge faced was ensuring a stable Wi-Fi connection for uninterrupted API communication. In cases of poor network conditions, data synchronization delays occurred. This issue could be mitigated by implementing an offline storage mechanism to buffer data before uploading it once the connection is restored. Additionally, response times varied slightly depending on the network speed, but overall, the system performed efficiently. The LED and buzzer feedback system proved to be a valuable addition, as it allowed users to immediately understand whether their access was granted or denied.

IV. Conclusion

The Smart Attendance System using ESP32, RFID, Google Sheets API, LED indicators, and a buzzer effectively automates attendance tracking and access control. The integration of real-time data logging enhances accuracy and reduces the need for manual record-keeping. The addition of LED indicators and a buzzer improves user interaction by providing immediate authentication feedback. While the system is functional, improvements such as local storage backup and additional authentication layers (e.g., biometrics or PIN entry) could further enhance its reliability. Future developments could also explore the use of IoT dashboards for better data visualization and monitoring.

References

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