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IoT-Based Classroom Door Lock System

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Team Members

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1 Project Overview

1.1 Problem Statement

Classroom security is a critical concern in educational institutions in today's digital developing world. Traditional manual door locks are volatile to human negligence and more of manual work, as they may sometimes be left open, leading to unauthorized access and potential security breaches that is not feasible in today's digital world. As, the world is growing digitally at a higher pace, we came to a solution for classroom door lock system based on Iot integration. A smart locking system can significantly enhance security by integrating authentication mechanisms and real-time monitoring. Thus, this project aims to enhance the smart door lock system that integrates authentication mechanisms, real-time monitoring, and SMS alerts for enhanced security that will be discussed further.

1.2 Objectives

The whole aim of creating the smart door locking system lies in the field of Iot integration and security based approach to remove vulnerabilities and other breaches. Also, here we tried to :-

1. Develop an IoT-based system that allows remote locking and unlocking of classroom doors using mobile device with the administrator permission.
2. Integrate IoT features using ESP32, Blynk, and ThingSpeak.
3. Implement an SMS alert system using the Twilio API for instant security notifications.
4. Automate door locking based on predefined conditions (e.g. after or during class hours).
5. Implement an LCD-based status feedback mechanism for local monitoring.
6. Ensure cost-effective and efficient implementation using open-source platforms and low-cost microcontrollers.
7. Store door access data along with timestamps in a cloud database for future analysis and performance reports.

1.3 Solution Explanation

This project uses an ESP32 microcontroller connected to a servo motor for controlling the classroom door lock. The system allows teachers/administrators to lock/unlock doors remotely using the Blynk mobile application, SMS alert is sent to the administrator using the Twilio API. The lock status is stored and monitored using ThingSpeak, providing real-time updates on door security. The system logs access attempts and incorrect password entries on ThingSpeak for analysis. If unlock attempts are detected at odd hours (e.g., night-time), the system flags it as a potential security anomaly. An open-source simulator, Wokwi, is used for testing and validation. Additionally, an LCD display is integrated to provide real-time local feedback on door status.

2 Design & Implementation

2.1 System Architecture

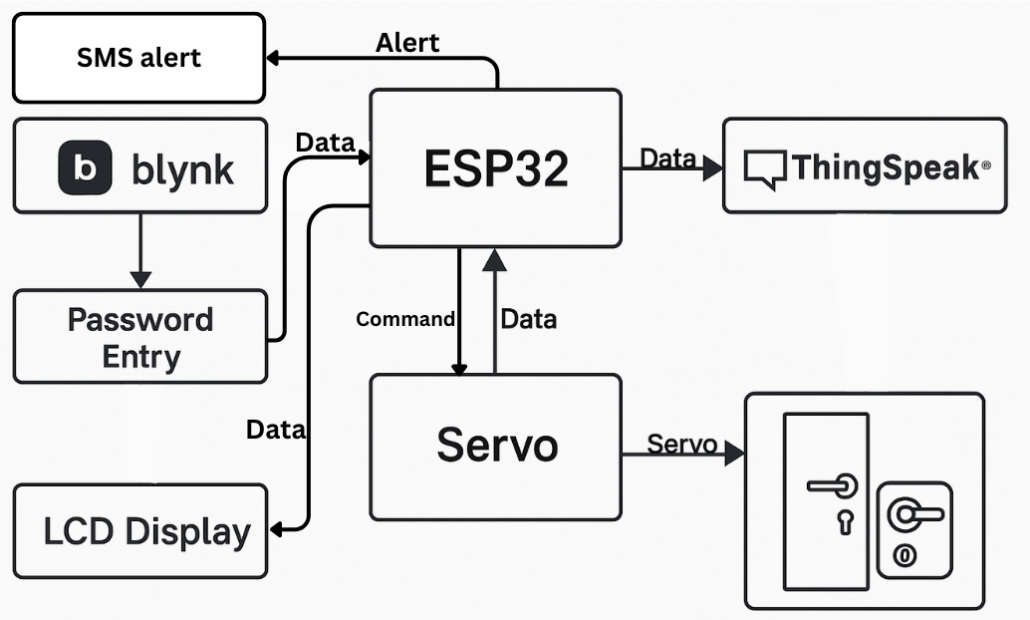


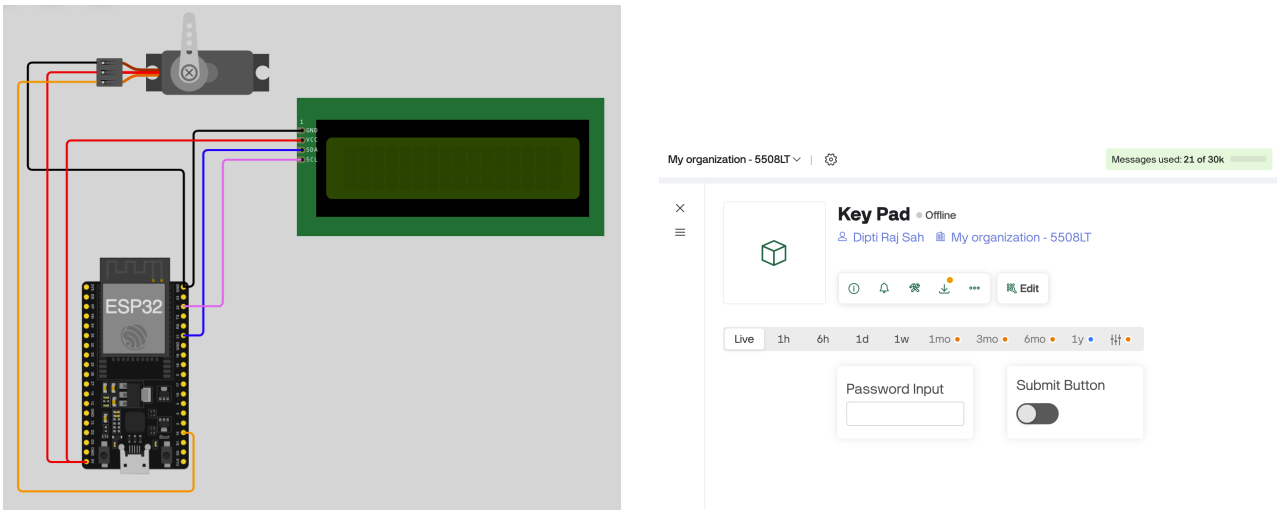
Figure 1: System Architecture

2.2 Components & Connection

1. ESP32 as the primary microcontroller for wireless connectivity and control.
2. Servo Motor for operating the door locking mechanism.
3. LiquidCrystal I2C LCD to display real-time status messages (e.g. "Door Locked", "Door Unlocked").
4. Blynk App as the user interface for remote control and also password based authentication.
5. ThingSpeak API for data logging and remote monitoring.
6. The Twilio API is used to send an SMS notification to the administrator's registered phone number.
7. WiFi Connectivity: Enables remote communication
8. Power Source: Battery-powered operation with monitoring

2.3 Circuit Design

The microcontroller interfaces with the servo motor to control the locking mechanism. When a command is received from the Blynk app, the ESP32 processes the signal and actuates the servo accordingly. An LCD display shows the lock status in real-time. All lock/unlock events, along with timestamps, are logged in ThingSpeak for tracking and analysis.



(a) Circuit Diagram

(b) Blynk App Interface

Figure 2: Circuit Design

2.4 Programming Logic

1. WiFi Connection: ESP32 connects to a secured WiFi network.
2. Blynk Authentication: Users input a password in the Blynk app.
3. Password Verification:
   - If the password matches, the servo motor LOCK/UNLOCKs the door, and the LCD displays "Door Unlocked".
   - If incorrect, it increments the incorrect attempt counter and the LCD displays an error message.
4. Data Logging:
   - Each lock/unlock event, along with the timestamp, is recorded in ThingSpeak, that is further used for result analysis and performance report.
   - Various dataset such as
     - Time Duration of Door Being Open
     - Number of Unlock Attempts (Per Day)
     - Peak Usage Hour
     - Anomaly Detection at night time after 8pm(Customised as per code)
     - Battery status

     is sent to ThingSpeak for data logging.
   - Unauthorized access attempts are also logged.
5. SMS Alert Feature:
   - An SMS is sent to the administrator using the Twilio API.
   - The SMS contains details such as the time of the attempt and the status of the door.
6. LCD Feedback: The LCD continuously displays the current status of the door.

3 Results & Testing

3.1 Link to Demo

Click on this link to view the demo: Demo Link

3.2 System Performance

The system was tested in a simulated environment using Wokwi. The key performance indicators include:

- Lock Response Time: The system responds to lock/unlock commands within 2 seconds.
- Remote Control Reliability: The Blynk app successfully sends commands over WiFi.
- Data Logging Accuracy: Lock/unlock events were recorded correctly in ThingSpeak with timestamps.
- SMS Alert Functionality: Access attempts triggered instant SMS alerts.
- LCD Feedback Accuracy: The LCD correctly displays the lock/unlock status in real-time

3.3 Collected Data Graphs

Data on lock/unlock operations was collected in ThingSpeak. The recorded data includes Door Status, Timestamp, Incorrect Attempts, Door Open Duration, Battery Voltage, Peak Hour Usage, Anomaly Detection and Daily Unlock Attempts. Graphs illustrate the frequency of door access and unauthorized access attempts over time.

Figure 3: Graphical Analysis of System Performance

3.4 Testing Approach

Test Case	Results
Correct Password Entry	Door unlocks, LCD displays "Door Unlocked"
Wrong Password Entry	"Wrong Password", "Try Again" message displayed, log entry in ThingSpeak
WiFi Disconnected	No remote control, local LCD status unchanged
Multiple Wrong Attempts	Incorrect Attempts Counter increases, log entry in ThingSpeak
Peak Hour Tracking	Unlock attempts are recorded per hour in ThingSpeak
Battery Voltage Logging	Battery level updates correctly on ThingSpeak
Anomaly Detection	Unlock attempts after 8 PM trigger anomaly alert
LCD Display Updates	LCD properly displays real-time lock/unlock status

Table 1: Testing Approach and Results

4 Conclusion

The IoT-based classroom door lock system effectively enhances security by integrating authentication, remote monitoring and with an SMS alert feature for enhanced security. The Blynk app provides a simple and intuitive interface for controlling access, while ThingSpeak enables real-time data tracking and logging. The system ensures that classrooms remain secure, even in cases of human oversight. Thus, we can conclude that the system is in a working state of monitoring the smart classroom door lock based on Iot device and the prototype for the work is attached with the report.

5 Future Improvements

1. Multi-Factor Authentication (MFA): Implement biometric authentication (fingerprint, RFID, voice control or facial recognition) for enhanced security.
2. Real-Time Alerts: Enable SMS/email notifications to alert administrators of unauthorized access attempts.
3. Battery Backup: Integrate an emergency power supply to ensure functionality during power failures.
4. Integration with University Network: Connect the system with the university's centralized security infrastructure for broader control and monitoring.

6 Why This Technology/Platform Was Chosen?

We chose ESP32, Wokwi, ThingSpeak, and Blynk because they offer better connectivity, scalability, and ease of use compared to alternatives like Arduino Uno and other IoT platforms.

- ESP32 vs. Arduino Uno → ESP32 has built-in Wi-Fi Bluetooth, higher processing power, and more GPIOs, making it ideal for IoT applications.

- Wokwi vs. Real Hardware → Wokwi allows free cloud-based simulation, easy debugging, and remote collaboration without needing physical hardware.
- ThingSpeak vs. Other IoT Platforms → ThingSpeak provides real-time data logging, cloud storage, and built-in analytics, making monitoring more efficient.
- Blynk vs. Other IoT Apps → Blynk offers an easy-to-use mobile interface, secure cloud control, and multi-platform support for remote door management.

7 Contributions

Dipti: Designed circuit, Twilio SMS alert and configured Blynk app for remote access.
Anubhav: Integrated ThingSpeak for real-time monitoring and data logging, prepared report documentation.
Arjun: Implemented system control logic, Created PowerPoint presentation.

8 Peer Review

We have put in immense effort to bring this project to life, ensuring a seamless and efficient IoT-based classroom door lock system. Dipti designed the circuit, implemented the Twilio SMS alert system, and configured the Blynk app for remote access, making the system highly responsive and secure. Anubhav worked on integrating ThingSpeak for real-time monitoring and data logging, along with preparing the report documentation to present our work effectively. Arjun took charge of implementing the system control logic and designed a well-structured PowerPoint presentation to showcase our project. Through collaborative effort and dedication, we successfully developed a robust and intelligent door lock system, combining security, automation, and real-time monitoring.

9 GitHub Repository

The source code for this project is available on GitHub: **GitHub Repository - IoT Door Lock System**