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PresenceNet: An IoT-Based Smart Attendance System using RFID & NodeMCU

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Abstract: *The PresenceNet system is an IoT-based smart attendance solution designed to automate and streamline the attendance process in educational institutions and organizations. This system leverages RFID technology, a NodeMCU (ESP8266) microcontroller, and wireless communication to detect and record user presence with minimal human intervention. Each individual is assigned a unique RFID card, which, when scanned by the RC522 RFID reader, transmits the user's identity to the NodeMCU. The data is then time-stamped and transmitted via Wi-Fi to a connected server or logged into an Excelcompatible sheet using serial communication. The system also provides real-time feedback through an OLED display for user verification. Compared to traditional attendance methods, PresenceNet offers greater accuracy, efficiency, and security. It minimizes the risk of proxy attendance, reduces administrative workload, and enables centralized, scalable data management. The system is lightweight, cost-effective, and adaptable to various environments including classrooms, offices, and event venues.*

Keywords: RFID Attendance System, NodeMCU ESP8266, IoT Attendance Tracker, OLED Display, Real-Time Logging, Automated Attendance, Smart Presence Recording.

I. INTRODUCTION

Attendance tracking is a critical but time-consuming task in educational and professional settings. Traditional methods are prone to errors, inefficiencies, and proxy issues. To address these challenges, this project introduces PresenceNet, an IoTbased smart attendance system using RFID technology and the NodeMCU ESP8266 microcontroller. When users scan their RFID cards, the system records their identity and timestamp, displays confirmation on an OLED screen, and logs the data wirelessly into an Excel-compatible format. This modern solution is faster, more secure, and scalable, offering a practical upgrade over manual or semi-digital attendance systems.

II. LITERATURE SURVEY

Recent advancements in RFID and IoT technologies have inspired a range of automated attendance systems, each addressing different aspects of accuracy, efficiency, and scalability.

Rjeib et al. (2018) proposed an RFID-based web application for managing student information and attendance records through a centralized system. While effective in reducing manual workload, the absence of IoT integration limited its realtime capabilities and scalability across institutions [1].

Kariapper and Razeeth (2019) conducted a comprehensive survey highlighting the superiority of RFID over traditional systems in terms of speed, accuracy, and automation. However, they emphasized that

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combining RFID with IoT features could further enhance performance and system intelligence [2].
Ula et al. (2019) introduced a secure RFID-based attendance model that eliminates data loss by storing records in a database. Their study showed promising results in educational institutions but identified high setup costs and limited wireless flexibility as key drawbacks [3].
Al Hajri et al. (2019) developed a fully automated classroom attendance system that minimizes teacher intervention and eliminates recording errors. The system, while robust, lacked biometric integration and relied on short-range RFID readers, limiting its practical deployment range [4].
Nivetha et al. (2020) demonstrated a simple and effective RFID-based attendance system that significantly reduced administrative effort. However, the study acknowledged the need for cloud-based storage and parent notification features to enhance communication and data accessibility [5].
These studies reveal that while RFID systems are well-suited for attendance tracking, many lack real-time communication, mobility, and user feedback. The proposed system—PresenceNet—builds on these gaps by integrating RFID with NodeMCU (ESP8266), OLED display feedback, and IoT-based data logging to Excel, offering a scalable and cost-effective attendance solution.

III. SYSTEM OPERATION

The PresenceNet system begins with a battery-powered supply, which provides electrical energy to the entire setup. This power is regulated by a buck converter (LM2596), which steps down the voltage to a safe level suitable for powering the microcontroller, RFID reader, and other peripherals. Once the system is powered, it becomes ready to scan RFID cards assigned to individuals. Each user is issued a unique RFID card that stores a specific identification number.

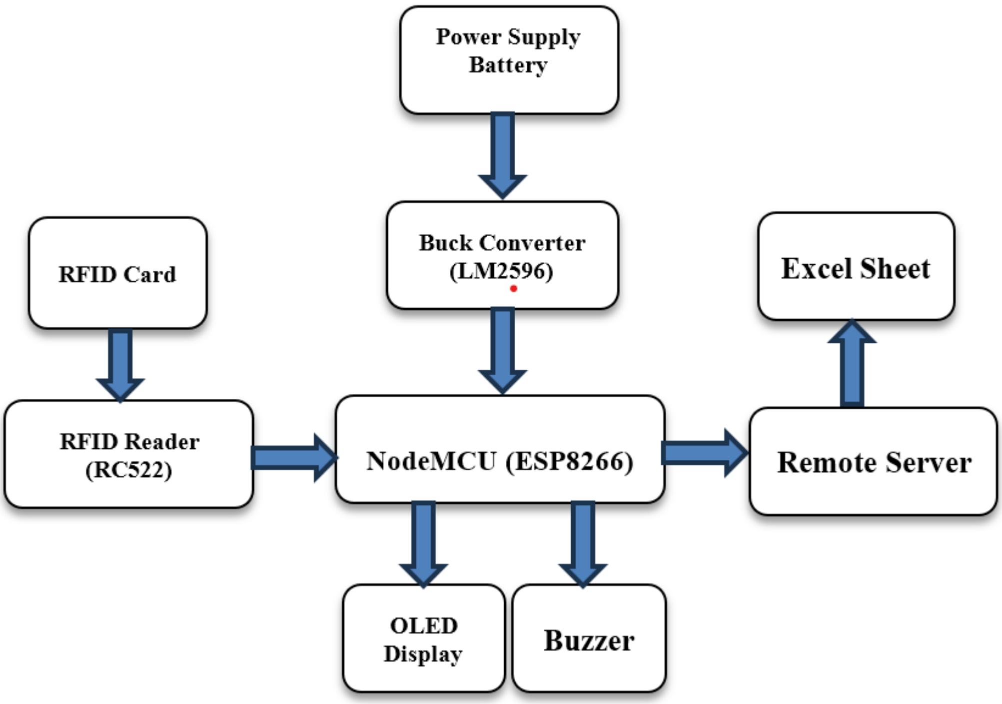

Figure 1: System Operation

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When a user places their RFID card near the RC522 RFID reader, the reader detects the card and transmits its unique ID to the NodeMCU (ESP8266) microcontroller using SPI communication. The NodeMCU then verifies the received ID against a list of registered IDs stored in its memory. If the ID matches a registered user, the system proceeds to mark their attendance. This attendance data is timestamped and displayed on the OLED screen, which provides real-time visual confirmation, such as the user's name and the message "Attendance Marked."

At the same time, a buzzer provides an audible signal, usually a short beep, to confirm a successful scan. If the card is not recognized or is unauthorized, the OLED displays an error message like "Card Not Recognized," and the buzzer may emit a different tone to alert the user.

Once the ID is validated, the NodeMCU uses its built-in Wi-Fi capability to send the attendance data including user ID, date, and time to a remote server. This data is then logged in real time into an Excel-compatible format, which can be hosted on platforms like Google Sheets or a custom server. This allows administrators to access, monitor, and analyze attendance records from any location, improving overall efficiency.

Through this streamlined process, the PresenceNet system offers a contactless, accurate, and real-time attendance recording solution. It eliminates the need for manual attendance marking, reduces the risk of proxy attendance, and ensures efficient data management with centralized, easily accessible records.

IV. HARDWARE COMPONENTS AND RATINGS

1. **NodeMCU (ESP8266):**

   Function: Acts as the main controller, processes RFID data, communicates with the server, and controls display/ buzzer.

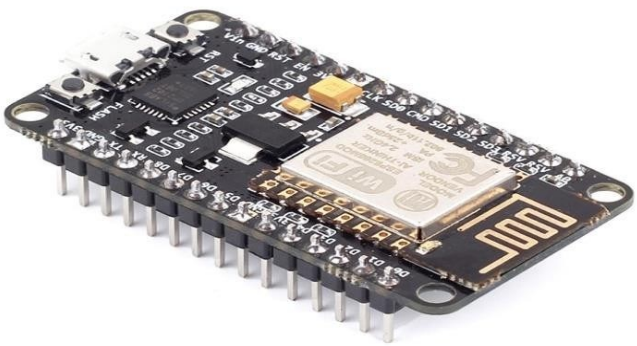

Figure 2: NodeMCU (ESP8266)

Specifications:

- Microcontroller: ESP8266
- Clock Speed: 80/160 MHz
- Operating Voltage: 3.3V
- Digital I/O Pins: 11
- Communication: UART, I2C, SPI, Wi-Fi (802.11 b/g/n)
- USB micro-B for programming

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2. RC522 RFID Reader Module:

Function: Reads RFID cards/tags and sends their unique IDs to NodeMCU.

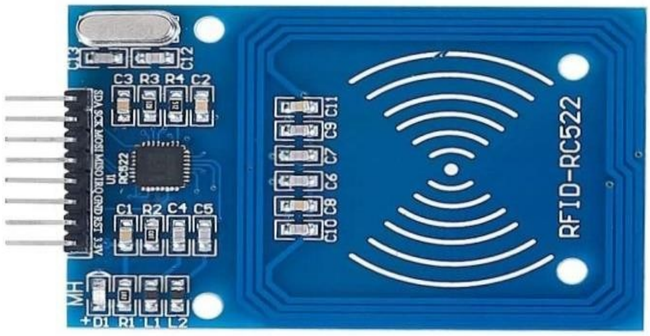

Figure 3: RC522 RFID Reader Module

Specifications:

- Operating Voltage: 3.3V
- Frequency: 13.56 MHz
- Communication: SPI (default), I2C, UART
- Read Range: 2–5 cm

3. RFID Cards:

Function: Carried by each user to identify themselves uniquely.

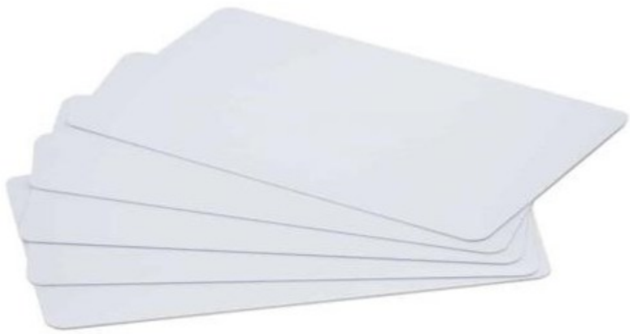

Figure 4: RFID Cards

Specifications:

- Type: MIFARE Classic 1K (or equivalent)
- Frequency: 13.56 MHz
- Memory: 1 KB EEPROM
- Unique ID (UID): 4 or 7 bytes
- Read Range: 2–5 cm (depends on reader)

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4. **OLED Display (128x64):**
Function: Displays real-time messages such as user ID, name, and attendance status.

Figure 5: OLED Display (128x64)

Specifications:

- Display Size: 0.96 inch
- Resolution: 128×64 pixels
- Interface: I2C (SCL, SDA)
- Operating Voltage: 3.3V to 5V
- Low power consumption

5. **Buzzer:**
Function: Provides audio feedback for successful or failed scans.

Figure 6: Buzzer

Specifications:

- Type: Active Buzzer
- Operating Voltage: 3V – 5V
- Tone: ~2 kHz
- Simple on/off control via digital pin

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6. **Buck Converter (LM2596):**

Function: Steps down battery voltage to a stable 3.3V or 5V for the components.

Figure 7: Buck Converter (LM2596)

Specifications:

- Input Voltage: 4V – 40V DC
- Output Voltage: 1.25V – 35V (adjustable)
- Output Current: Up to 3A
- Efficiency: Up to 90%
- Features: Adjustable screw potentiometer

7. **Battery Pack:**

Function: This Li-ion battery pack provides a rechargeable power source for electronic and portable devices.

Figure 8: Battery Pack

Specifications:

- Type: Li-ion Battery Pack (Model: 18650 4S2P)
- Voltage: 14.8V
- Capacity: 4400mAh
- Charging Voltage: 16.8V

8. **Power Switch:**

Function: Turns the system on or off.

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Figure 9: Power Switch

Specifications:

- Type: SPST slide switch
- Voltage: Up to 12V
- Current: Up to 1A

9. **General Purpose PCB (Perfboard):**

Function: Physical mounting and interconnection of components.

Figure 10: PCB Board

Specifications:

- Material: Phenolic or epoxy
- Type: Dot matrix / grid holes
- Used for soldering and custom wiring

V. DISCUSSION

The PresenceNet RFID Smart Attendance System offers a foundational solution for automating attendance through RFID technology. To enhance its efficiency and security, the system can be advanced by integrating biometric verification, facial recognition, mobile app support, and cloud-based data management. Additional features like SMS notifications, offline data caching, and AI-driven attendance analytics can further improve reliability and user experience. These enhancements not only modernize traditional attendance methods but also support scalability, data accuracy, and real-time monitoring making the system highly suitable for educational institutions and workplaces aiming for smart automation solutions .

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Advantages:

1. Contactless and fast attendance marking.
2. Real-time data logging to remote server or cloud.
3. Attendance automatically saved in Google Sheets for easy access and sharing.
4. Immediate user feedback via OLED display and buzzer.
5. Portable and scalable design.
6. Data stored in Excel-compatible format for analysis.

Challenges:

1. Proxy Attendance: RFID cards can be shared among users, allowing attendance to be marked dishonestly.
2. Wi-Fi Dependency: The system needs a stable internet connection; disruptions can halt real-time data logging.
3. Short Read Range: The RC522 RFID module has a limited detection range (2–5 cm), requiring precise card placement.
4. Limited Local Storage: NodeMCU has minimal onboard memory, risking data loss if network issues occur.
5. Data Security: Without proper encryption, transmitted attendance may be intercepted or altered.

Potential Improvements:

1. Biometric Integration: Add fingerprint or facial recognition to prevent proxy attendance.
2. Offline Data Logging: Use EEPROM or SD card to cache attendance data and sync when Wi-Fi is available.
3. Encrypted Communication: Implement secure protocols (e.g., HTTPS or MQTT over TLS) to protect data.
4. Mobile App Monitoring: Develop a mobile app for admin access, real-time alerts, and remote monitoring.
5. Longer Range RFID or NFC Modules: Improve user convenience and reduce scan failures.

Future Enhancements:

1. Biometric Authentication: Integrating fingerprint or facial recognition could eliminate the risk of proxy attendance, ensuring higher accuracy.
2. Mobile App Integration: A dedicated mobile app could allow administrators and users to monitor attendance in real time, receive notifications, and manage data more efficiently.
3. AI-Powered Analytics: Implementing AI to analyze attendance patterns could provide valuable insights, such as tracking habitual absences or predicting trends.
4. Cloud-Based Dashboard: A web-based dashboard with advanced features, including reports, analytics, and notifications, could offer administrators greater control and accessibility.
5. Multi-Factor Authentication: Combining RFID with another verification method, like QR codes or pin-based access, could improve system security.

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6. Extended RFID Range: Using long-range RFID modules to allow for quicker and more flexible card scanning over larger areas or crowded environments.
7. Energy Efficiency: Optimizing the power consumption of the system, perhaps by using low-power wireless protocols (e.g., LoRa or Zigbee) or incorporating solar charging, for longer battery life.

VI. RESULTS

The PresenceNet system successfully achieved its goal of creating a low-cost, IoT-based smart attendance solution. It accurately identified users through RFID cards used as student or personnel ID cards and marked attendance in real time. Each individual's unique RFID UID ensured reliable identification. Attendance data was automatically stored in a Google Sheets file, providing centralized and accessible records. The system also offered instant visual and audio feedback, reducing manual effort, minimizing errors, and preventing proxy attendance. Testing demonstrated reliable performance in small-scale environments, proving the system's efficiency in automating attendance.

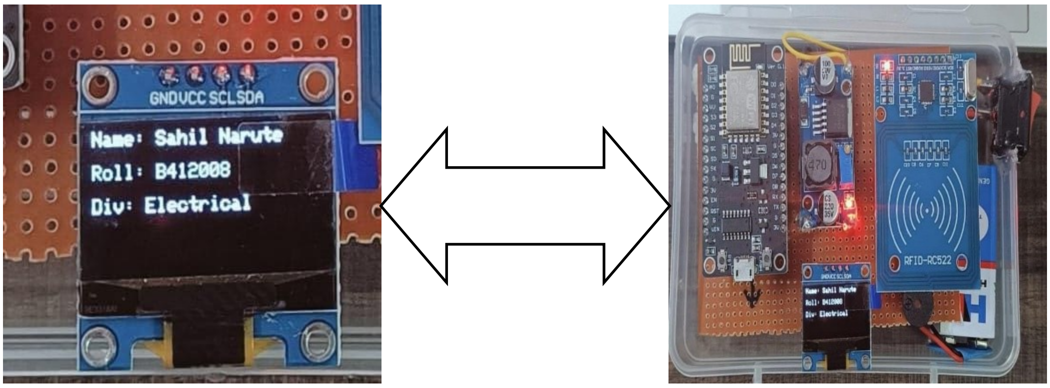

Figure 11: Student ID card (RFID Card) Successful Scanned

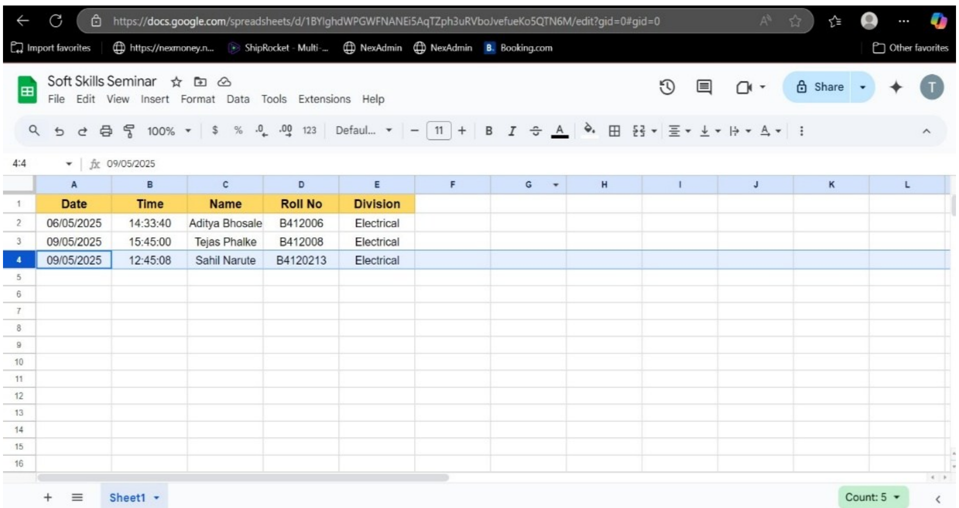

Figure 12: Attendance is Successfully Record in the Excel Sheet

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VII. CONCLUSION

The PresenceNet attendance system offers an efficient, accurate, and automated solution for recording attendance using RFID and Google Sheets integration. By reducing manual errors and streamlining data management, the system enhances reliability and saves time for both students and administrators. While challenges like proxy attendance remain, future enhancements such as biometric verification and mobile integration can significantly improve its effectiveness. Overall, PresenceNet represents a practical step toward smart and digital attendance management in educational and organizational settings.

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