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IoT Biometric Fingerprint Attendance System using ESP8266

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Abstract: *IoT-based biometric fingerprint attendance system, employing the ESP8266 microcontroller for seamless integration and data transmission. The system offers a secure, accurate, and efficient approach to attendance tracking, improving upon traditional methods in various applications. This paper explores the system's architecture, hardware and software components, advantages, and potential implications across diverse domains. This synopsis presents an innovative Attendance Management System that integrates IoT technology, biometric fingerprint authentication, and GSM module for real-time attendance tracking and notifications. The system utilizes a Nodemcu 12c OLED Display, Fingerprint Sensor, Breadboard, and GSM module, and is powered by the ESP8266 microcontroller. The system provides accurate and reliable attendance tracking, eliminates buddy punching and proxy attendance, and sends instant SMS alerts to parents/guardians or administrators. The system is scalable, cost-effective, and suitable for various institutions, including educational institutions, corporate and industrial settings, healthcare and medical institutions, and government and public sector institutions*

Keywords: Biometric Authentication, Fingerprint Sensor (R307), IoT, NodeMCU ESP8266, GSM Module, Attendance System, Microcontroller

I. INTRODUCTION

The traditional attendance method followed in our school system involves the teacher calling out the roll number or name of the student and marking their attendance accordingly. This process is time-consuming and laborious, especially when dealing with a large number of students. Moreover, there is a high chance of marking fake or proxy attendance. To address these issues, this study proposes a system that utilizes fingerprint recognition to record student attendance for lectures and other activities. Biometric authentication ensures the physical presence of students, unlike RFID card or password security systems which are vulnerable to manipulation. The proposed system integrates NodeMCU ESP8266 (microcontroller), R307 Fingerprint Sensor module, and an online Google sheets display. The system requires a Wi-Fi connection to function. The R305 fingerprint sensor can process finger images within seconds and stores up to 127 fingerprints. Each student is assigned a unique ID number during the fingerprint enrollment process. The built-in Wi-Fi module in ESP8266 enables a connection to the device, allowing the end-user to validate a person's identity using their fingerprint and upload the respective data with time in and time out to the web server. Furthermore, the system also sends SMS alerts to parents' mobile numbers, informing them about their child's attendance in real-time. This feature enhances parental involvement and ensures that parents are kept informed about their child's attendance.

II. LITERATURE REVIEW: AMMONIA DETECTION SYSTEMS

The use of biometric authentication systems, such as fingerprint recognition, has become increasingly popular in recent years due to their high level of accuracy and security. Studies have shown that biometric authentication systems can provide a more secure and efficient way of authenticating individuals compared to traditional methods such as passwords and PINs (Kumar et al., 2018). The use of fingerprint recognition in particular has been shown to be highly effective in identifying individuals, with a high level of accuracy and a low false acceptance rate (Singh et al., 2020).

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The integration of Internet of Things (IoT) technology with biometric authentication systems has also been explored in literature. The use of ESP8266, a low-cost and low-power IoT-enabled microcontroller, has also been explored in literature for biometric authentication systems (Patel et al., 2019).

The use of SMS alerts in attendance tracking systems has also been explored in literature.The use of GSMmodules for sending SMS alerts has also been explored in literature, with studies showing that GSM modules can provide a reliable and efficient way of sending SMS alerts (Singh et al., 2020).

The literature review also highlights the importance of considering the security and privacy of biometric data in IoT-enabled biometric authentication systems. Studies have shown that biometric data can be vulnerable to security breaches and unauthorized access (Jain et al., 2020). Therefore, it is essential to implement robust security measures to protect biometric data and ensure the integrity of the attendance tracking system.

III. PROBLEM IDENTIFIED

- **Inefficiency in Traditional Attendance Systems**: Manual attendance tracking in educational and workplace settings is time-consuming, error-prone, and susceptible to proxy attendance or "buddy punching." This compromises the integrity of attendance data and reduces overall accountability.
- **Lack of Real-Time Monitoring**: Traditional methods lack the ability to provide real-time insights or updates, limiting administrative control and delaying awareness of absenteeism.
- **Security Concerns**: Conventional attendance systems, such as RFID cards or logbooks, can be manipulated, stolen, or misused, posing a security risk and allowing unauthorized access.
- **Communication Gap**: Parents, guardians, or administrators are often unaware of attendance status, especially in institutions where prompt communication is crucial for safety or compliance.
- **Administrative Burden**: Manual processing and validation of attendance data consume valuable staff time and resources, making the system inefficient, especially in large institutions.

IV. SYSTEM OVERVIEW: HARDWARE AND SOFTWARE COMPONENTS AND BLOCK DIAGRAM

Software:

The system utilizes the Arduino IDE for programming and Proteus for simulation and circuit design.

Hardware:

Key hardware components include an Arduino Uno microcontroller, an MQ135 gas sensor, a 16x2 LCD display, a buzzer, a breadboard, and a GSM module for communication.

Software used

1. Arduino Uno
2. Proteus

Hardware used

1. NodeMCU ESP8266 (Microcontroller)
2. I2C OLED Display:
3. Fingerprint Sensor
4. Bread Board
5. GSM Module

The following **Fig.1** shows the **Block Diagram** of this project. This diagram illustrates an IoT-based biometric attendance system using fingerprint authentication. A fingerprint sensor captures the biometric data of a user. This data is then processed by the **NodeMCU ESP8266** microcontroller.

The system performs multiple tasks upon fingerprint verification:

- It displays the attendance status (Success/Failure) on an **OLED Display**.

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- It sends an **SMS alert** to the registered mobile number via the **GSM Module**, notifying about the attendance status.
- It logs the data (e.g., time-in, time-out, user ID) to an **online server** (like Google Sheets or any cloud platform) through Wi-Fi.

The system is compact, efficient, and powered by a standard DC **power supply**. It is designed to improve accuracy, reduce proxy attendance, and ensure real-time communication.

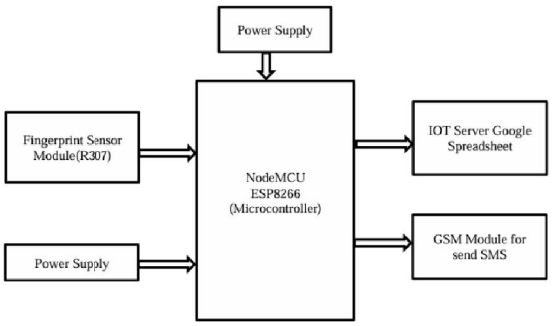

Fig.1 Block Diagram

V. SYSTEM DESIGN

The following Fig 2 Shows the circuit connection of this Work .

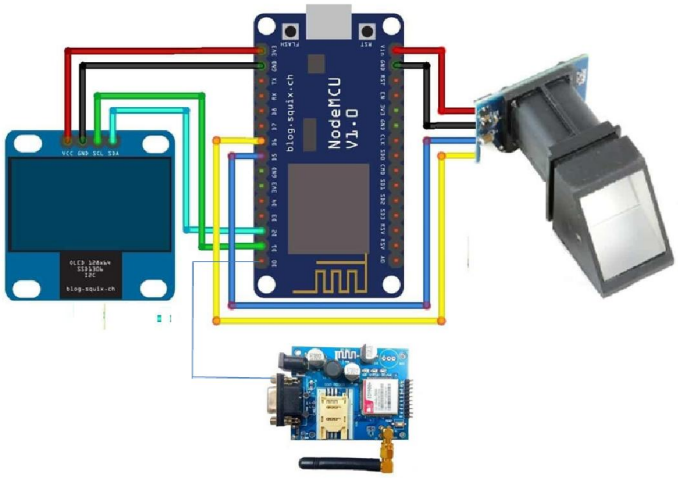

Fig.2 Circuit Diagram

A. Biometric Authentication and Data Processing:

The core of the system is the R307 Fingerprint Sensor, which captures the user's fingerprint. Each fingerprint is linked to a unique user ID during the enrollment phase. When a fingerprint is scanned, the sensor processes the input and transmits the data to the NodeMCU ESP8266, which serves as the main microcontroller. The ESP8266 compares the scanned fingerprint with the stored templates and authenticates the user accordingly.

B. Feedback and Notification Mechanism:

Upon successful verification:

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The 0.96" I2C OLED Display provides immediate on-site feedback by displaying messages such as *"Attendance Marked"* or *"Access Denied"*.
The system utilizes a SIM900 GSM module to send SMS notifications to registered mobile numbers (e.g., parents or administrators), indicating the attendance status along with the timestamp.
This mechanism ensures transparency, real-time communication, and enhanced parental involvement in educational settings.

C. Cloud-Based Data Logging:
The ESP8266's built-in Wi-Fi capability enables the system to upload attendance records to an IoT server or Google Sheet in real-time. This feature allows centralized and automated attendance management without manual data entry. It also facilitates future integration with data analytics tools for attendance pattern analysis.

D. System Workflow:
The overall workflow of the system is as follows:

- The user places their finger on the fingerprint sensor.
- The fingerprint is processed and authenticated by the ESP8266 microcontroller.
- The OLED display shows the authentication result.
- An SMS alert is sent via the GSM module if the attendance is successfully recorded.
- The attendance data is uploaded to a remote server or cloud sheet for centralized access.

E. System Advantages
This system provides multiple benefits:
Eliminates buddy punching and proxy attendance through biometric verification.Enables real-time attendance tracking and SMS-based notifications.
Automates attendance logging and reduces administrative overhead.
Offers scalability and remote access through IoT integration.

VI. CONCLUSION

The proposed IoT-based Biometric Fingerprint Attendance System using ESP8266 offers a secure, efficient, and automated solution for attendance tracking. By integrating biometric authentication with real-time data logging and SMS notifications, the system effectively eliminates proxy attendance and enhances transparency. Its low-cost implementation and scalability make it well-suited for educational institutions, corporate environments, and other organizations seeking reliable attendance managementhe system successfully integrates sensor technology, data processing, and communication modules to provide real-time monitoring of ammonia levels in train bathrooms. This approach enables proactive maintenance, improves hygiene standards, and ultimately contributes to a more comfortable and hygienic travel experience for passengers.

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