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Bio Track-Smart Attendance with Excel & SMS Integration

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ABSTRACT - This paper summarizes design and implementation of an Arduino-based smart biometric attendance system which combines Excel reporting and SMS (WhatsApp) notifications. By automating student tracking through authorization with fingerprints, real-time data logging, and automated communication, the system resolves the inefficiencies associated with traditional attendance methods. An Arduino microcontroller, a fingerprint (FP) sensor for biometric verification, an I2C module interfaced with a 16x2 LCD for user interaction, and an SMPS for a steady power supply make up the hardware setup. Student attendance is automatically entered into an Excel spread sheet via serial communication immediately following a fingerprint scan, removing the requirement of human entry. Students who arrive late are automatically marked absent as part of the system's rule-based attendance policy, which increases accountability. Summarized attendance reports are created in Excel at the end of each day and sent to teachers via email for their consideration. Additionally, the system uses software-based integration to notify parents via WhatsApp each weekend about their child's absences, replacing traditional GSM-based notifications with internet-based communication. This hybrid strategy lowers expenses, improves dependability, and makes integrating with current school administration systems easier. Through a low-cost, scalable system appropriate for educational institutions, the suggested solution aims to improve transparency, automate administrative workload, and ensure accurate attendance tracking.

Key Words: Biometric attendance, Arduino, Excel integration, WhatsApp notification, fingerprint sensor, automated reporting, python script.

I. INTRODUCTION

Attendance tracking is a needed but time-consuming administrative task in educational institutions that has a direct impact on student accountability, academic monitoring, and institutional efficiency. Conventional approaches, like paper- based systems or manual roll calls, are vulnerable to proxy attendance, human error, and processing delays. Furthermore, efficient monitoring of student participation and punctuality is hampered by the absence of real-time communication between parents, teachers, and institutions. To help overcome these challenges, this paper suggests an Arduino-based Smart Biometric Attendance System with SMS Notification and Excel Integration that automates attendance management while enhancing transparency and interaction.

By using a fingerprint biometric module, the suggested system ensures safe and precise student identification while eliminating the possibility of fake attendance. An I2C-enabled 16×2 LCD interface allows the Arduino microcontroller to process and record data in real time when a student scans their fingerprint. Data management and analysis are made easy by the systematic storage of attendance records in an Excel sheet. At the end of each day, the system automatically emails teachers generated attendance reports to facilitate institutional workflows. Students who arrive after a certain time are also marked as absent in order to maintain punctuality and ensure strict schedule compliance.

This system's integration with communication platforms to notify stakeholders is one of its main advancements. This project uses software tools to send WhatsApp messages instead of conventional GSM-based solutions, which lowers hardware costs and makes use of common communication channels. To encourage proactive interaction between schools and families, automated absenteeism alerts are sent to parents via WhatsApp at the end of each week. An SMPS (Switched-Mode Power Supply) provides power stability, ensuring dependable operation even under conditions of fluctuation voltage. This system provides a scalable, affordable, and user-friendly solution for modern attendance management by combining the flexibility of Arduino with biometric security, Excel-based data logging, and software-driven notifications.

II . LAYOUT OF THE PROPOSED SYSTEM

A 230V AC supply controlled by an SMPS powers the Arduino UNO microcontroller, which is connected to an LCD via an I2C interface for real-time display and a fingerprint module for biometric authentication. After a student's fingerprint is authenticated, the attendance is recorded and saved in an Excel sheet on a connected PC, which is automatically emailed to the subject teachers at the end of each day. Additionally, a WhatsApp-based software solution notifies parents whose children were marked absent or late at the end of each week. The overall layout of the Smart Biometric Attendance System is shown in the block diagram in Figure 1.

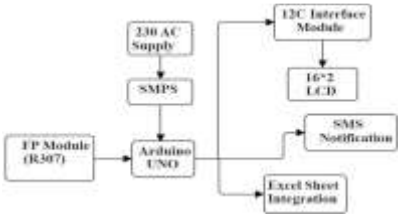

Figure 1: Block diagram of the proposed system

III . Major Components

The following components are used in the designing of Smart Biometric Attendance system:

1) Arduino Uno
2) Fingerprint Module(R307)
3) 12c Interfacing Module
4) 16*2 LCD
5) SMPS

1) ARDUINO UNO:

The most important microcontroller board used in the Smart Biometric Attendance System's design is the Arduino Uno. The Arduino Integrated Development Environment (IDE) is used for programming, and it is based on the ATmega328P microchip. The board has six analog inputs, fourteen digital input/output pins, and a USB port for programming. It operates at 5V. The Arduino Uno works as the main controller in this project, managing the communication between the LCD, I2C module, fingerprint sensor, and other system components. It controls the logic necessary in making decisions, including processing fingerprint sensor input, comparing it to templates that have been stored, and then displaying the results on the LCD screen.

Figure 2: Arduino UNO Microcontroller

2) Fingerprint Module (R307):

The key component of the Smart Biometric Attendance System is the Fingerprint Module (R307). Fingerprints, biometric data used for attendance authentication, are captured and detected by this module. The R307 is an optical fingerprint sensor that takes delicate visuals of each fingerprint's different curves and valleys using fingerprint recognition technology. Fingerprint formats can be stored in its internal memory. By comparing a captured visualize with templates that are stored in the module, the system is able to register and validate fingerprints. Through a serial interface (UART), the R307 exchanges data with the Arduino Uno for matching and processing. This improves the security and dependability of attendance tracking by ensuring that only authorized individuals are able to mark their attendance.

Figure 3: Fingerprint Module(R307)

3) I2C INTERFACING MODULE:

The Arduino Uno and LCD display can communicate more effortlessly due to the I2C Interfacing Module. With just two wires—one for the clock (SCL) and one for data (SDA)—multiple devices can share data via to the Inter-Integrated Circuit (I2C) communication protocol. For projects where reducing the number of connections is crucial, this makes it perfect. Using less pins to interface with the Arduino is made easier by the I2C module, which converts the conventional parallel communication used by the majority of LCDs into I2C format. The I2C module makes easier the wiring in the Smart Biometric Attendance System by connecting the Arduino to the 16x2 LCD. It facilitates the effective display of real-time information, such as "Unauthorized Fingerprint," "Attendance Successful," or "Fingerprint Scanned."

Figure 4: I2C Interfacing Module

4) 16x2 LCD:

A frequent part of microcontroller-based systems for visual output is the 16x2 LCD (Liquid Crystal Display). This LCD screen is ideal for displaying brief status updates and user instructions in the Smart Biometric Attendance System as it can display 16 characters per line on two lines. Usually, the 16x2 LCD transfers data in parallel, but the I2C module allows it to communicate with the Arduino with just two wires. The LCD in this system gives the user feedback by displaying messages such as "Scan Finger," "Attendance enrolled," or "Fingerprint Not Accepted." It improves the user experience by providing real- time feedback and leading the user using the process of scanning their fingerprint for attendance.

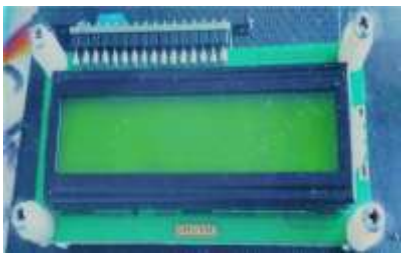

Figure 4:16x2 LCD

5) SMPS (SWITCHED-MODE POWER SUPPLY):

The complete Smart Biometric Attendance System is powered by a switched-mode power supply, or SMPS. An SMPS is more effective than a conventional power supply because it uses less energy to convert power from an AC source to DC voltage. It Works by quickly turning on and off to control the voltage and give the system a stable and efficient supply. The SMPS may control the power required by the LCD display, fingerprint module, and Arduino Uno. Additionally, it ensures steady operation and helps protect the parts from power variations. The SMPS is an appropriate choice for long-term operation in the framework of the Smart Biometric Attendance System because it ensures that all components receive a suitable voltage without producing excessive heat.

Figure 4: SMPS (Switched-Mode Power Supply

IV . SOFTWARE AND TOOLS

1) ARDUINO IDE:

The primary tool for embedded development in this project was the Arduino Integrated Development Environment (IDE). It provided a platform for writing, compiling, and uploading code to the Arduino microcontroller, which operates as the system's hardware base. To handle fingerprint scanning tasks, control LCD display outputs through the I2C module, and send serial data to a connected computer, embedded C/C++ code was generated using the Arduino IDE. Due to the IDE is compatible with a multitude of Arduino-compatible boards and libraries, it can be used to interface with the fingerprint module and control the logic that controls timing checks, attendance marking, and condition-based triggers (such as evaluation students absent if they arrive late). It provided a platform for writing, compiling, and Uploading code to the Arduino microcontroller, which operates as the system's hardware base. To handle fingerprint scanning tasks , control LCD display outputs through I2C module and send serial data to a connected PC.

Figure 5: Arduino IDE

2) MICROSOFT VISUAL STUDIO:

The software layer that communicates with the Arduino system was developed using Microsoft Visual Studio combined with a Python environment. Python scripts developed with Visual Studio were responsible for receiving, parsing, and processing the fingerprint data after it was transmitted from the Arduino via serial communication. Real-time data flow testing and monitoring were made achievable by Visual Studio's properly organized interface and debugging features. This development environment made it achievable to manage code execution with convenience, arranging tasks such as data storage, message automation, and report generation.

Figure 6: Microsoft Visual Studio

3) PYWHATKIT AND PYTHON LIBRARIES

Python libraries were widely used for the purpose to automate the notification system. Pywhatkit was one of the primary libraries used, allowing WhatsApp Web to send messages automatically. This decision removed the requirement for a GSM module or SMS API subscriptions, providing a widely accessible, free internet-based substitute. The Arduino board's real-time data reading, timestamp comparisons to detect absences, and attendance log organization were handled by additional Python libraries like serial, time, datetime, and pandas. Reading, writing, and updating the.csv files featuring attendance data were important responsibilities for pandas in particular.

4) Excel CSV Integration

The CSV (Comma-Separated Values) format, which is suitable with Microsoft Excel and multiple data processing tools, was used to record the attendance data. A structured CSV file containing each student's attendance and a timestamp was kept. As students scanned their fingerprints, these documents were automatically updated in real time. The class teachers were emailed the updated Excel file as a daily attendance report at the conclusion of each school day. Additionally, at the end of each week, the system examined attendance data to determine which students missed class on particular days , and it then sent out notifications to the parents of those students. Using CSV files made it easier to export and share attendance data and allowed for lightweight, effective storage.

V. EXPERIMENTAL SETUP

a) Registering and storing the fingerprint:

The Software Serial library is used to interface the Fingerprint Module (R305 or GT511C3) with the Arduino Uno via serial communication using digital pins D2 (RX) and D3 (TX). The microcontroller waits for input after turning on the fingerprint module during system setup. When the user interacts with the sensor with their finger, the module takes an image of their fingerprint and transmits it to the Arduino via the serial port for verification. The fingerprint is stored in the module's EEPROM with a unique ID if the image quality is proper and it can be recognized. For comparing purposes, the fingerprint image is saved as an assembly of characteristic data rather than in its raw form. Feedback on the 16x2 LCD via an I2C interface is part of the registration process via analog pins A5 (SCL) and A4 (SDA) displays the fingerprint registration procedure flowchart in fig (8).

Figure 7: Storing Fingerprint

b) Displaying the Stored Result and Marking Attendance:

Through serial communication, the Arduino continually monitors the fingerprint sensor once the system is functioning. The module sends the feature data to the Arduino via RX/TX serial interface after reading a fingerprint. The related user ID is obtained and used to record attendance when the fingerprint matches one of the templates that have been stored. To provide the current date and time, the Real-Time Clock (RTC) Module (DS3231) is

connected via I2C to A4 and A5. Using the py serial library, a Python script running on a connected PC receives

Figure 7: Displaying the stored no and marking attendance

attendance with a timestamp via a serial USB port (COM Port). After receiving the data, the Python script adds it to a structured CSV file that is compatible with Excel. If the time that was recorded is the student is marked absent if their absence exceeds a certain limit. They have been recorded as present otherwise. For verification, the LCD displays the student's status in real time. The flowchart for recording attendance and exporting data to Excel is shown in Figure(8).

c) Sending Email and WhatsApp Message:

The system opens the attendance CSV file generated through serial data logging at the conclusion of each school day. A Python script that runs in Visual Studio Code does this task. The pandas library is used for processing the file and create daily attendance reports for every teacher. The smtp lib and email libraries are then used to email the reports. The system looks through the cumulative record for students who have continuously missed class at the end of each week. After filtering the absent list, a pre-written message is created. The system uses the pywhat kit library to send messages via WhatsApp Web rather than GSM. The user's registered number is used to connect the PC's browser to WhatsApp Web, which facilitates communication. The system is waiting. until a certain

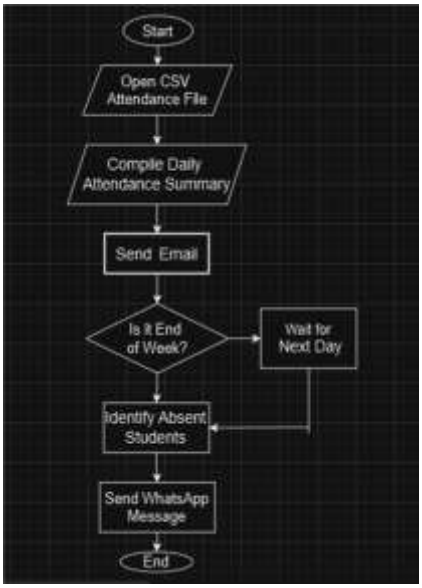

Fig 10. Sending Email and WhatsApp Message

weekly time and notify absentees. The specified flowchart of how weekly WhatsApp messages and daily emails are carried out is shown in Figure (10).

Figure 11: Received Email and WhatsApp Message

VI . Conclusion

The uncertainties and inaccuracies of manual attendance methods are successfully solved by the design of the Smart Biometric Attendance System with Arduino. The system assures exact and impenetrable attendance tracking by integrating the fingerprint sensor with an Arduino Uno and connecting it to real-time data logging via Excel CSV. I2C LCD displays, RTC modules, and serial communication enable smooth hardware coordination and interaction with the user. Also, the system improves its abilities by removing the need for GSM modules and reducing operational costs through the implementation of software-based automation for daily email send to teachers and WhatsApp-based absentee informs to parents at the end of each week.This project simplifies administrative duties for educational institutions while enhancing student transparency and punctuality. Effective scheduling and personal responsibility are ensured by the ability to detect delayed individuals and automate reports. Therefore, the suggested system turns out to be a reasonable, flexible, and easy-to-use solution for modern college and school attendance management.

VII . REFERENCES

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