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NOVEL BIOMETRIC CLOUD-BASED ATTENDANCE SYSTEM

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ABSTRACT
In today's context, impersonation poses a significant challenge across various sectors, including both public and private domains. Issues like the ghost worker syndrome in government sectors, high absenteeism among employees, and difficulties in monitoring student attendance in universities highlight the need for robust solutions. Our proposed solution leverages the reliability of fingerprint biometrics, known for its uniqueness and consistency throughout an individual's life. This paper outlines an attendance management system tailored for university environments, using fingerprint technology.
Keywords—fingerprint, attendance management, enrolment, authentication, Crossing Number, minutiae.

I. Introduction
Attendance management [1] is crucial for monitoring and optimizing attendance or presence in a workplace, aiming to reduce losses from employee downtime. While traditional tools like time clocks and timesheets have been staples for attendance tracking, contemporary approaches focus on creating a workplace culture that promotes consistent and enthusiastic attendance. Role in Modern HR Systems In today's advanced human resource systems, attendance management stands out as a key component driving organizations towards improved human resource practices and operational excellence [2]. Employers expect employees to maintain regular attendance and be punctual. Any disruptions caused by unplanned absences or late arrivals can hamper productivity, leading to workload shifts [3] and potential morale issues among staff. Traditional Methods include time sheets, which can be either electronic or paper-based documents that record the hours employees [4] dedicate to specific tasks. An Attendance Register serves as an official roster or list that identifies who is present at a given institution or organization. Additionally, a Time Clock, whether mechanical or electronic, is used to track the hours an employee works.

On the other hand, Automated Methods [5] offer more technologically advanced solutions. In a Barcode Attendance System, employees are provided with badges or cards embedded with barcodes. To log their attendance, they swipe these badges or cards on a designated time clock, which captures the relevant data. In a Magnetic Stripe Attendance System, [6] data is stored on the magnetic stripe of employee cards. When employees swipe their cards through a time clock, the system reads and records the data from the stripe. Lastly, the Radio Frequency Identification (RFID) system utilizes radio waves to transfer data from an electronic tag (RFID tag) attached to an object. In the context of attendance, employees' ID cards are equipped with RFID tags. As employees enter or exit, RFID readers detect and relay this data to a computer-linked database.

Each automated attendance management system [7] comes with its own set of advantages and challenges, designed to align with the unique requirements and infrastructure of an organization [8]. The primary objectives of these systems are to streamline attendance monitoring, minimize errors, and enhance the overall efficiency of attendance management. In [9] the authors have introduced an embedded computer-based system for managing lecture attendance. This system utilizes single-chip computer subsystems, consisting of an improvised electronic card and a card reader, which are serially connected to a digital computer's serial port. According to the second author, the electronic card is designed as a smart card that stores student details such as ID, name, matriculation number, and a five-pin encrypted code. When a student swipes the card through the reader, the card reader authenticates the student's ID by comparing the entrance code with the encrypted code on the card.

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The backend software system, running on the PC to which the card reader is connected, determines whether to grant or deny attendance based on the comparison results [10]. While this system offers a cost-effective solution for managing lecture attendance in developing countries, it does not entirely eliminate the risk of impersonation. Additionally, this system relies on RFID cards that students must carry, and RFID detectors need to be installed for the system to function.

Another approach proposed in [11-12] involves real-time computer vision algorithms integrated into automatic attendance management systems. This system employs face recognition algorithms to automate the attendance process, eliminating traditional methods like calling out student names or checking ID cards. However, this system faces challenges in accurately identifying each student due to potential changes in facial features between enrollment and verification. Moreover, the installation of this system incurs significant costs and lacks privacy protection mechanisms.

In a separate study, an author explored a wireless attendance management system based on iris recognition using Daugman's algorithm [13]. This system employs an offline iris recognition process that includes capturing iris images, extracting minutiae, storing, and matching them. However, the implementation of this system is challenging in areas with difficult topography due to the need for transmission lines.

In this paper authors have proposed a prototype that monitors attendance through biometric recognition. It provides substantial advantages by saving precious time for both students and instructors, minimizing paper consumption, and producing prompt reports. It accurately captures clock-in and clock-out times through fingerprint authentication, preventing impersonation and reducing absenteeism. Additionally, it simplifies administrative processes, minimizes human errors, eliminates proxy attendance issues, resolves time-related disputes, and enables effortless updating and maintenance of attendance records.

II. Circuit design and Implementation

fx Date

	A	B	C	D
1	Date	Time	Name	
2	05/09/2019	16:30:16	Debasis	
3	05/09/2019	16:40:57	Debasis	
4	05/09/2019	16:41:40	Manas	
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				

Figure 1: Excel sheet generated by the prototype to monitor

IoT-enabled biometric attendance system has been developed to sync with Google Sheets for storing attendance data. This system utilizes an ESP8266 NodeMCU module paired with an R305

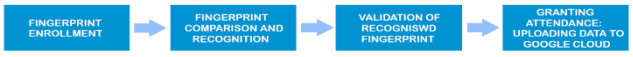

Figure 2: Block diagram prepared for prototype design

fingerprint sensor and an LCD display. Fig. 1 shows the Google sheet interfaced to the developed prototype for attendance monitoring. Block diagram for the overall prototype development has been shown in Fig.2. To transfer the biometric data to Google Sheets, we integrated the Pushing Box API with our NodeMCU. This solution is ideal for corporate settings, educational institutions, hospitals, and other sectors needing reliable attendance tracking. Unlike RFID-based systems that rely on RFID tags for attendance, our biometric system offers enhanced security and simplicity.

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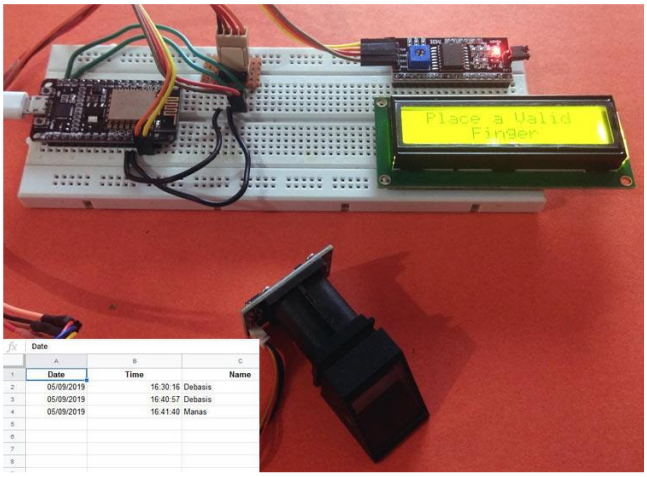

Figure 3: Prototype working for attendance monitoring

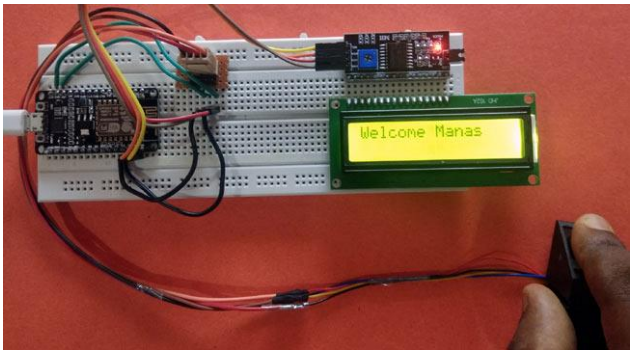

Figure 4: Biometric input has been identified

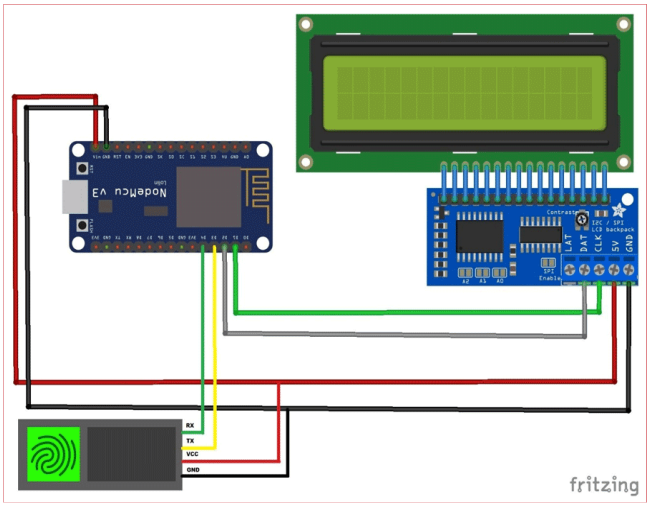

Figure 5: Schematic diagram prepared for simulation

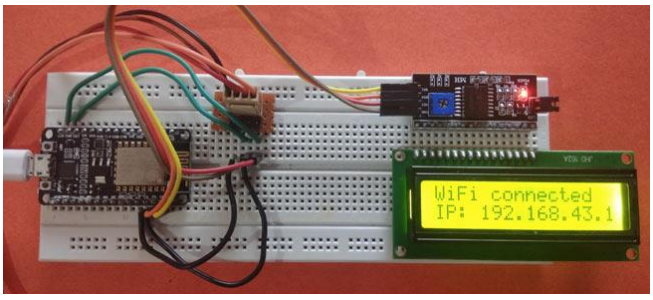

Figure 6: Prototype connected to the WiFi

A. Components Used:

Components identified for realization of the prototype (Fig. 3) incudes NodeMCU, R305 Fingerprint sensor, I2C Module for 16x2 (1602) Alphanumeric LCD, Breadboard, 16*2 Alphanumeric LCD, Jumpers.

Before the hardware setup, we have established the Google Sheet creation for recording attendance and configured the same for our Biometric Attendance system.

B. Programming NodeMCU to send Attendance Data to Google Sheet*:*

We have configured the NodeMCU to interface with Google Sheets using its device ID and transmit data using the PushingBox API. Before programming, necessary board details for the ESP8266 NodeMCU in the Arduino IDE have been verified (Fig. 4) via the board manager.

C. Programming for the Fingerprint Attendance System*:*

After enrolling the fingerprint, the attendance system relevant program has been uploaded to the hardware. The first step in the program is to include all the necessary libraries. In our setup, we have incorporated "Adafruit_ Fingerprint.h" to interface with the R305 fingerprint sensor, "ESP8266WiFi.h" for the ESP8266 NodeMCU Wi-Fi module, and "LiquidCrystal_I2C.h" for the I2C connection with the LCD display. Next, we have set up the serial port to which the fingerprint sensor will be connected. In our configuration, we have assigned D3 as the RXPin and D4 as the TX pin.

Once the connections are successfully established, a program block has been written to verify the availability of the fingerprint sensor. This has confirmed that the fingerprint sensor has been successfully paired with the NodeMCU. A schematic configuration of the prototype shown in Fig. 5 for simulation and verification before hardware realization.

Once the client connection has been established, we have created a full URL using the device ID obtained from the Pushing Box API.

If there's no response from the client for over 5 seconds, it will indicate a "client timeout". Otherwise, the data will be transmitted to Google Sheets using the URL through the Pushing Box API.

In essence, the future of biometric attendance systems will revolve around technological innovation, increased security, mobile connectivity (Fig. 6), and adaptability to different organizational and environmental contexts.

III. Future Scope of the project

Following have been identified for further development of the project work reported in this paper.

1. IoT and AI Integration: Real-time monitoring and analytics to ensure accuracy and detect anomalies.
2. Multimodal Biometrics: Utilizing multiple biometric techniques to enhance security.
3. Mobile Biometrics: Allowing attendance logging via mobile devices and seamless app integration.
4. Cloud-based Solutions: Offering scalability, remote accessibility, and immediate reporting.
5. Blockchain Technology: Providing a secure and immutable storage solution for attendance data.
6. Wearable Biometrics: Continuous tracking using smartwatches or fitness trackers.
7. Adaptive Learning Systems: Systems that adjust based on user patterns to improve precision.
8. Advanced Security Measures: Implementing top-tier encryption and cybersecurity features.
9. Scalability and Flexibility: Solutions that can expand with growing organizations and sync with HR systems.
10. Environmental Durability: Biometric systems designed to operate in various environmental conditions.

IV. CONCLUSION

In this study, we have introduced a fingerprint-based attendance management system. This embedded system utilizes fingerprint recognition/authentication technology based on minutiae points. The system captures the unique features of a fingerprint, specifically the minutiae points, and uses these as templates for both registration and verification processes.

Our developed system offers significant benefits, saving valuable time for both students and lecturers, reducing paper usage, and generating timely reports. It efficiently records clock-in and clock-out times using fingerprint verification, thereby preventing impersonation and decreasing absenteeism. Moreover, it streamlines administrative tasks, reduces human errors, eliminates issues like proxy attendance, resolves time-related disputes, and facilitates the easy updating and maintenance of attendance records.

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