A Report on

Biometric Attendance System with Google Sheet Integration using ESP32

For

Mini Project-2A Embedded System Project (ECM-501) of Third Year (Semester-V)

Submitted by

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in partial fulfillment for the award of the degree

BACHELOR OF ENGINEERING

in

Department of Electronics & Telecommunication Engineering

under guidance of
Ms. Shilpa Chaman

St. Francis Institute of Technology, Mumbai
University of Mumbai
2023-2024

CERTIFICATE

This is to certify that Riddhesh Veling, Shreyash Tiwari, Aditya Vishwakarma, Priyank Srivastava are the bonafide students of St. Francis Institute of Technology, Mumbai. They have successfully carried out the project titled "Biometric Attendance System with Google Sheet Integration using ESP32" in partial fulfilment of the requirement for the award of Mini project 2A of third year (Semester-V), in Electronics and Telecommunication Engineering of Mumbai University during the academic year 2023-2024. The work has not been presented elsewhere for the award of any other degree or diploma prior to this.

(Internal Examiner/ Reviewer 1)	**(External Examiner/ Reviewer 2)**
(Ms. Shilpa Chaman) **Name of Guide**	**(Dr. Kevin Noronha)** **EXTC HOD**

(Dr. Sincy George)
Principal

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Signatures of all the students in the group

(Riddhesh Veling)

(Shreyash Tiwari)

(Aditya Vishwakarma)

(Priyank Srivastava)

ABSTRACT

The project titled "Biometric Attendance System with Google Sheets Integration using ESP32" aims to develop an advanced attendance recording system using biometric technology and seamless integration with Google Sheets using ESP32. The system utilizes a fingerprint sensor to capture unique fingerprint patterns of individuals, which are processed by a ESP32 microcontroller. A matching algorithm compares the captured fingerprint with stored templates in a database to authenticate the person's identity and register their attendance. The system is designed to establish a Wi-Fi connection for real-time communication with Google Sheets, enabling immediate updates of attendance records. This integration provides administrators with easy access to attendance data, facilitating monitoring, analysis, and reporting. The project aims to enhance the accuracy, efficiency, and security of attendance recording, improving productivity and accountability in organizations.

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List of Abbreviations

Oled	Organic Light Emitting Diode
Wi-Fi	Wireless Fidelity
IDE	Integrated Development Environment
IoT	Internet of Things
USB	Universal Serial Bus
3-D	3 Dimensional
KB	Kilo Bytes
MB	Mega Bytes
MHz	Mega Hertz
I/O	Input - Output
GPIO	General Purpose Input - Output
UART	Universal Asynchronous Receiver / Transmitter
I2C	Inter-Integrated Circuit
SPI	Serial Peripheral Interface
ADC	Analog to Digital Converter
DAC	Digital to Analog Converter
DB	Database
mDNS	Multicast Domain Name System
PCB	Printed Circuit Board

Chapter 1

Introduction

Fingerprint identification is a widely known and widely used method of biometric identification. It is valued for its speed, reliability, and resistance to tampering. Due to the unique and consistent nature of fingerprints, they have been used for identification purposes for many years. Recent advancements in computing power have made it possible to automate the fingerprint identification process, making it even more convenient.

1.1 Motivation

Our motivation for this project arises from the need to overcome the limitations of traditional attendance recording methods. By implementing a biometric-based system using fingerprint identification, we aim to ensure accuracy, eliminate fraud, streamline the process, and enhance security. This project strives to provide organizations with an efficient and reliable solution that improves productivity and accountability in managing attendance.

1.2 Scope of Project

The project's scope encompasses the development of a biometric attendance system integrated with Google Sheets using the ESP32 platform. It will focus on the design, implementation, and testing of a system that offers precise and efficient attendance recording. The project includes the integration of a fingerprint sensor, ESP32 microcontroller, Real-Time Clock (RTC) module, and an OLED interface for user feedback. This solution will establish a Wi-Fi connection for real-time data transmission to Google Sheets, centralizing attendance management. The project will also involve rigorous testing, user training, and post-deployment monitoring to ensure its successful adoption in various settings, particularly in education and organizational environments.

1.3 Organization of Project

- Literature survey : We referred 3 technical papers and obtained insights from them.
- Software Used : We used Arduino IDE and SolidWorks.
- Hardware Used : Microcontroller ESP32, R307 Fingerprint sensor, DS1307 RTC, 0.96' SSD1306 OLED.
- Working Principle : The working principle is explained in detail.
- Simulation and Results : The complete hardware simulation results are attached.

Chapter 2

Literature Survey

2.1 Literature Review:

Biometric attendance systems have gained prominence in various sectors due to their accuracy and convenience. Fingerprint recognition, facial recognition, and iris recognition are among the prominent biometric modalities[1]. Concurrently, IoT technology has seen extensive adoption, with the ESP32 microcontroller being a versatile platform for IoT applications [2]. In the context of attendance management, these technologies offer the potential for efficient and automated tracking. However, integrating IoT devices like the ESP32 with popular cloud-based platforms like Google Sheets is crucial for real-time data management and accessibility [3]. Security and privacy are paramount when developing biometric attendance systems. Biometric data, being inherently personal, necessitates robust security measures. The literature emphasizes the importance of secure data transmission and storage when interfacing ESP32 with Google Sheets. This aspect of the integration requires careful consideration to ensure data confidentiality and integrity.In the educational sector, IoT-based attendance systems have gained traction for their potential to streamline attendance management. These systems offer institutions the ability to monitor attendance efficiently, thereby enhancing accountability and reducing administrative overhead. Several case studies and implementation reports highlight the successful deployment of similar systems [4]. These studies underscore the impact on educational institutions in terms of improved attendance tracking and reporting. User experience and usability are critical factors in the adoption of any attendance system. Research in this area investigates the acceptance, ease of use, and overall satisfaction of users. Ensuring that the system is user-friendly and meets the needs of both students and educators is essential for its successful implementation. Data analytics and reporting capabilities are also a crucial aspect of attendance systems [5]. . Biometric recognition or, simply, biometrics refers to the automatic recognition of individuals based on their physiological and/or behavioral characteristics. By using biometrics, it is possible to confirm or establish an individual's identity based on "who she is," rather than by "what she possesses" (e.g., an ID card) or "what she remembers" (e.g., a password). [6].

In conclusion, a comprehensive literature review reveals that biometric attendance systems using ESP32 with Google Sheet integration offer significant potential for attendance management in educational institutions. Existing research highlights the importance of security, usability, and data analytics in the development of such systems. Moreover, case studies and implementations underscore the practicality and impact of these systems in real-world scenarios. However, as technology continually evolves, staying abreast of emerging trends is crucial for the continued enhancement of biometric attendance systems in educational settings.

Table 2.1: Summary of existing works on Fingerprint Identification and Synthesis

Author	Work Done	Remarks
Jain, A. K. [1]	Biometric Handbook Reference	Novel biometric techniques for enhanced security and identification
Narain, P., Sharma, S., & Kaur, R. [2]	Exploring biometric applications in healthcare	Innovative biometric-based patient monitoring for healthcare
Hojati, T., Kim, J., & Moayedi, A. [3]	Enhancing energy efficiency with biometric data	Utilizing biometric data to optimize energy consumption in buildings
Patil, P., Pawar, A., & Mestry, Y. [4]	Efficient attendance management using biometrics	No behavioral analytics is performed
Lata, P., Sarje, A. K., & Saini, K. [5]	Surveying biometric applications in campus settings	Biometric access control in a campus context
A. K. Jain, A. Ross & S. Prabhaka. [6]	Exploring Biometric Recognition Techniques	Biometric attendance fundamentals

Chapter 3

Software Used

3.1 Arduino IDE:

The Arduino IDE (Integrated Development Environment) is an open-source, cross-platform software tool that provides a user-friendly interface for programming and developing projects with Arduino-compatible microcontrollers. It offers a simple code editor with syntax highlighting, built-in libraries, and example codes for easy hardware interaction, as well as a board manager for selecting the target hardware. The IDE includes a serial monitor for debugging and communication, streamlining the code verification and upload process via USB. With a vibrant community, it offers extensive support, making it accessible to both beginners and experienced developers. It is an essential tool for creating a wide range of electronic projects in the field of embedded electronics.

Figure 3.1: Arduino IDE.

3.2 Solidworks 3D CAD Software:

SolidWorks is a leading 3D Computer-Aided Design (CAD) application widely used in engineering and product design. It empowers designers and engineers to create intricate 3D models, simulations, and technical drawings with precision and efficiency. SolidWorks offers a user-friendly interface, parametric modeling capabilities, and a vast library of tools for tasks like assembly design, sheet metal design, and rendering. It plays a pivotal role in product development, allowing for seamless collaboration, rapid prototyping, and the validation of designs through simulations, making it an indispensable tool in industries ranging from aerospace to automotive to consumer goods.

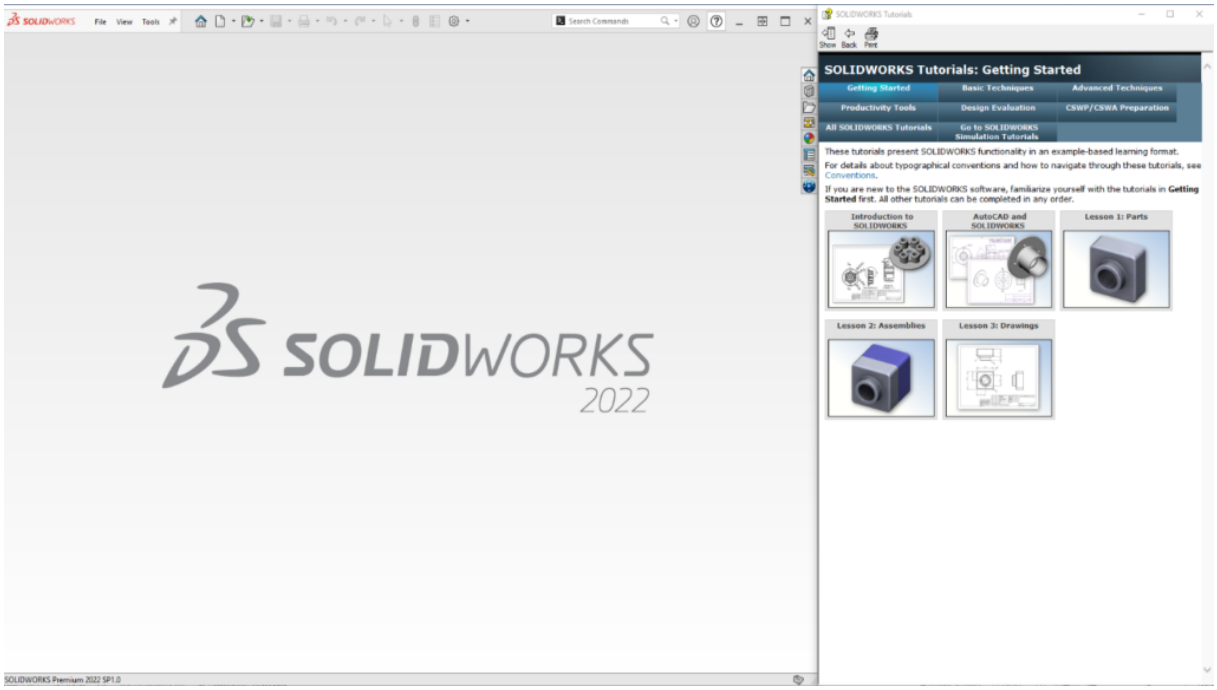


Figure 3.2: Solidworks 3D CAD Software.

Chapter 4

Hardware Used

4.1 ESP 32:

The ESP32 DevKit is a versatile development board built around the ESP32 system-on-chip (SoC), featuring a dual-core Tensilica LX6 microcontroller with up to 240 MHz clock speed, integrated Wi-Fi (802.11 b/g/n/e/i) and Bluetooth (4.2/BLE) connectivity, 520 KB of SRAM, and 4 MB of external flash memory. It provides a variety of GPIO pins, a micro USB interface, and supports a wide input voltage range, with a 3.3V output. The board is programmable via the Arduino IDE, ESP-IDF, or other compatible platforms and offers I/O interfaces for UART, I2C, SPI, ADC, and DAC.The ESP32 DevKit typically has 38 GPIO pins. These pins can be used for various digital input/output, PWM, I2C, SPI, UART, and other purposes.

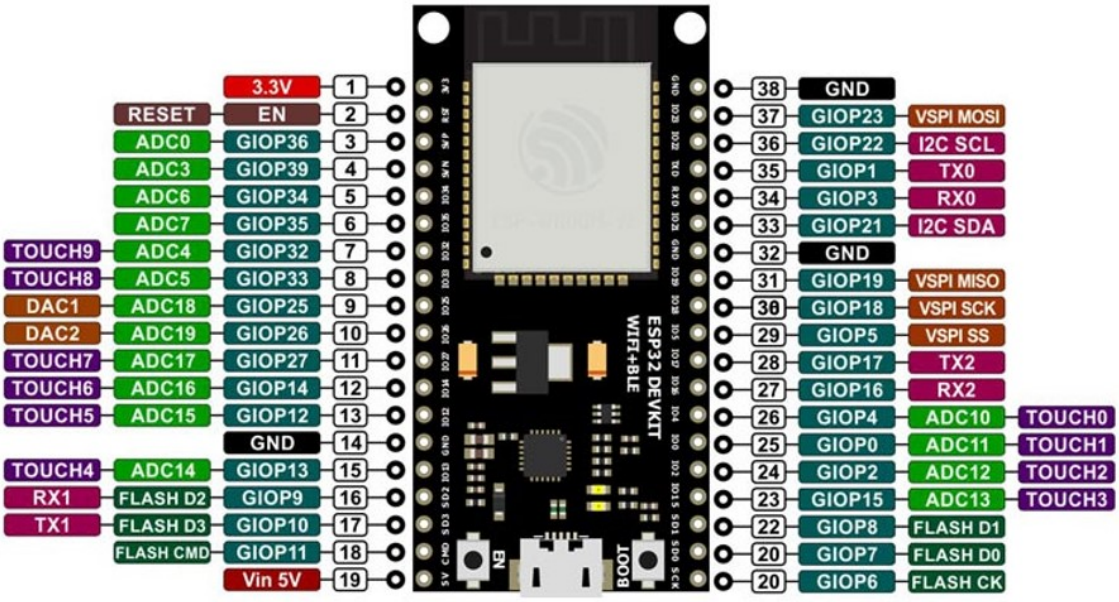


Figure 4.1: Microcontroller ESP32

4.2 R307 Fingerprint Sensor Module:

The R307 Fingerprint Module is a versatile fingerprint sensor module designed for a wide range of applications, including security systems, access control, and time attendance tracking. This module typically features an optical fingerprint sensor with high resolution, enabling it to capture and store fingerprint templates. Depending on the model, it can usually store a substantial number of fingerprint templates, often ranging from 100 to 1000 or more. The module communicates with microcontrollers or computers via a UART (Universal Asynchronous Receiver-Transmitter) interface and operates on either 3.3V or 5V power supply, depending on the specific variant. One of its key functionalities is fingerprint enrollment, allowing users to add new fingerprint templates to the module's memory. It also offers fingerprint verification capabilities, where a presented fingerprint is compared with the stored templates using a matching algorithm, typically achieving fast response times in a few hundred milliseconds. While the module's physical size and form factor may vary between manufacturers and models, it is generally compatible with various microcontroller platforms and development environments, making it relatively straightforward to integrate into projects.

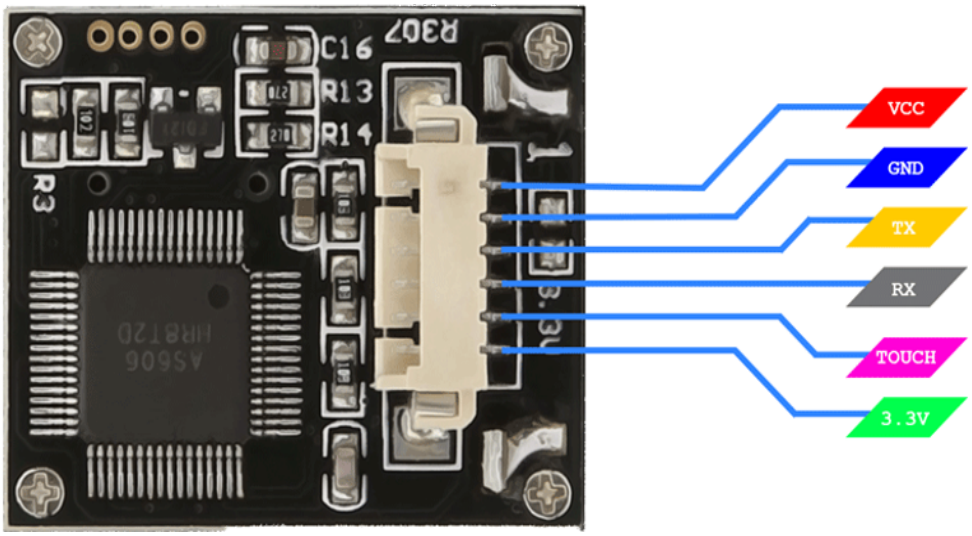


Figure 4.2: R307 Fingerprint Sensor Module

4.3 DS1307 RTC module:

The DS1307 is a compact real-time clock (RTC) module with an I2C interface, designed for precise time and date tracking. It offers battery backup to retain timekeeping data during power loss, supports 12-hour and 24-hour time formats, and can generate programmable square-wave outputs. With low power consumption and multiple addressable options, it is commonly used in microcontroller-based projects like Arduino and Raspberry Pi for applications such as clock displays, data loggers, and timers, providing accurate timekeeping and date functions.

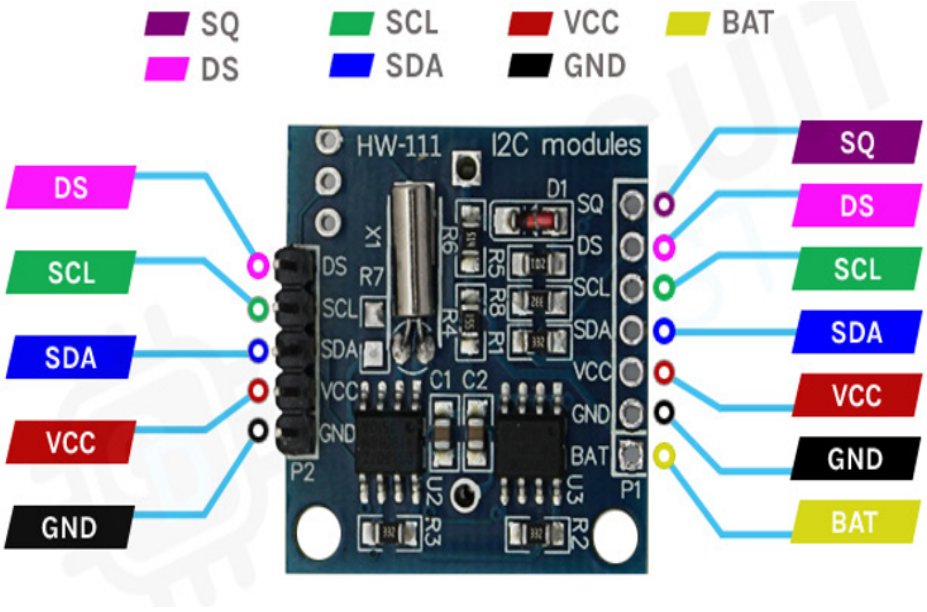


Figure 4.3: DS1307 Real Time Clock Module

4.4 0.96’ SSD1306 OLED Display Module:

The 128x64 SSD1306 OLED module is a compact display utilizing OLED technology with a resolution of 128x64 monochrome pixels. Controlled by the SSD1306 driver chip, it typically comes in sizes around 0.96 inches diagonally and is available in single colors like white or blue. The module interfaces with microcontrollers via I2C or SPI, operates at 3.3V or 5V, and boasts a wide viewing angle, high contrast ratio exceeding 10,000:1, and a fast refresh rate, making it ideal for various projects, including wearables, IoT devices, and status indicators. Its small pixel pitch allows for detailed visuals, and it is supported by libraries for popular platforms like Arduino and Raspberry Pi, ensuring ease of integration and programming.

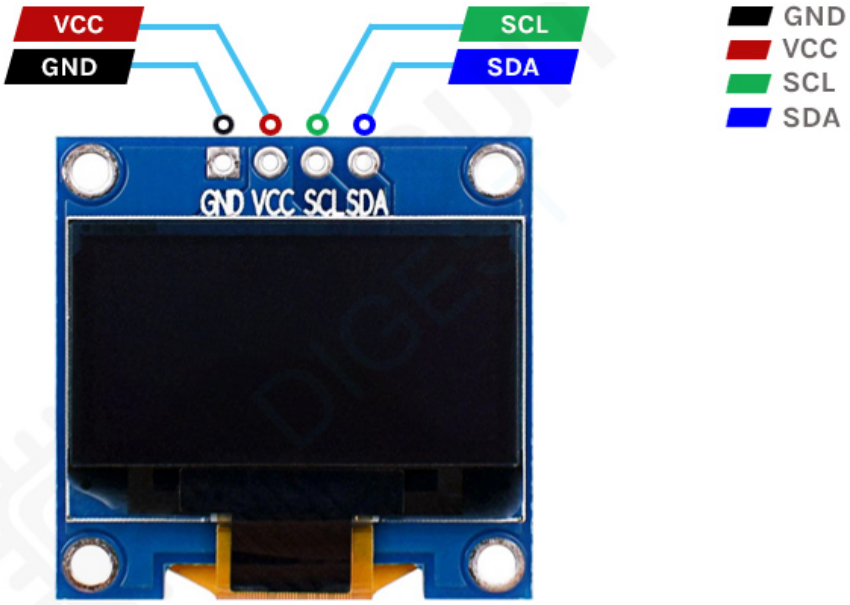


Figure 4.4: 0.96’ SSD1306 OLED Display

Chapter 5

Working Principle

The Biometric Attendance System with Google Sheets Integration operates by capturing and processing individuals' unique fingerprints using a sensor and microcontroller. It compares the processed fingerprint data with stored templates for authentication, simultaneously timestamping the attendance record with a Real-Time Clock (RTC) module. The system then establishes an internet connection to transmit attendance data to Google Sheets, which is updated in real-time. Administrators can monitor attendance records and generate reports, while an OLED screen provides real-time user feedback. This integrated approach ensures accurate, efficient, and secure attendance recording and management.

5.1 Working and Block Diagram

The system begins by capturing the unique fingerprint patterns of individuals through a dedicated fingerprint sensor. This captured fingerprint image is then processed by ESP32, which performs the necessary computations for identification and verification.

To ensure a seamless and organized attendance management system, the system maintains a database that securely stores the enrolled fingerprints and associated employee details. A matching algorithm is employed by the ESP32 to compare the captured fingerprint with the stored fingerprint templates in the database, determining if there is a match or similarity.

The RTC module ensures accurate and reliable timestamping of attendance records, even in the absence of internet connectivity. It enhances the system's functionality by providing consistent and precise timekeeping.

To enable communication and real-time updates, the ESP32 microcontroller establishes a Wi-Fi connection, facilitating seamless integration with Google Sheets. The OLED screen provides a user-friendly interface for displaying attendance information, employee details, and system status in real-time, enhancing the overall user experience and system usability.

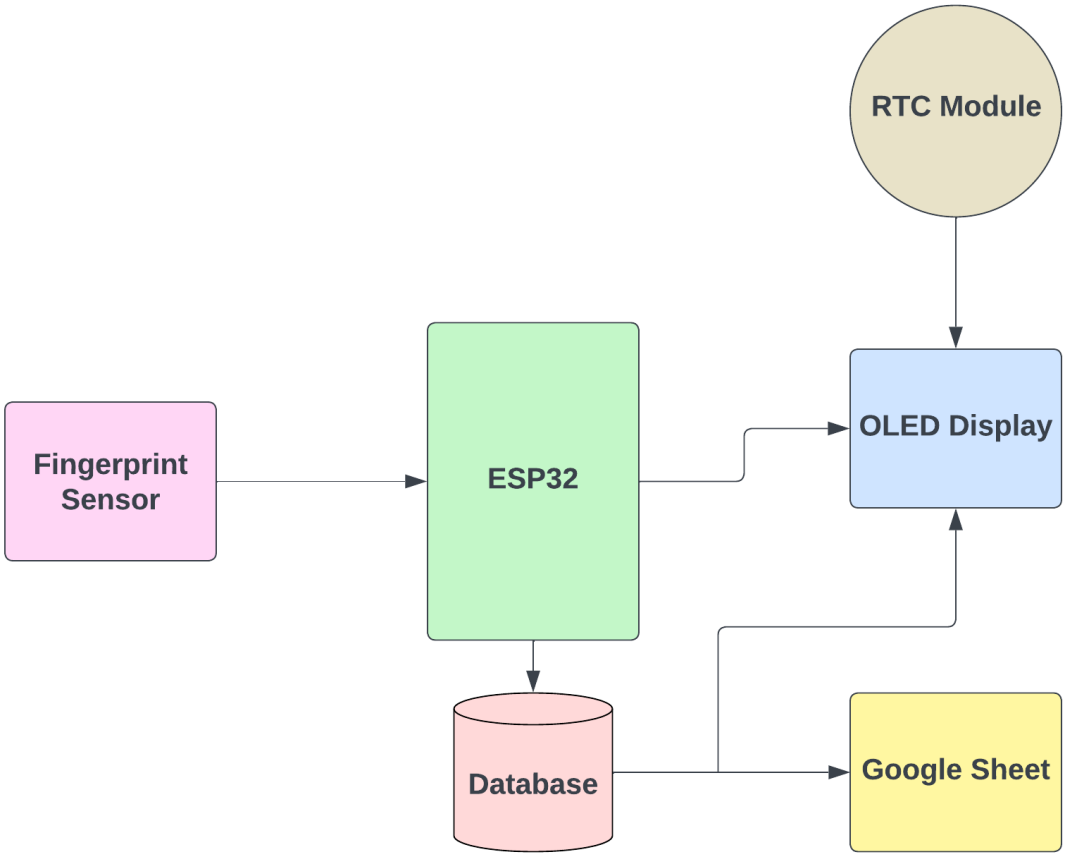


Figure 5.1: Biometric Attendance System with Google Sheet Integration

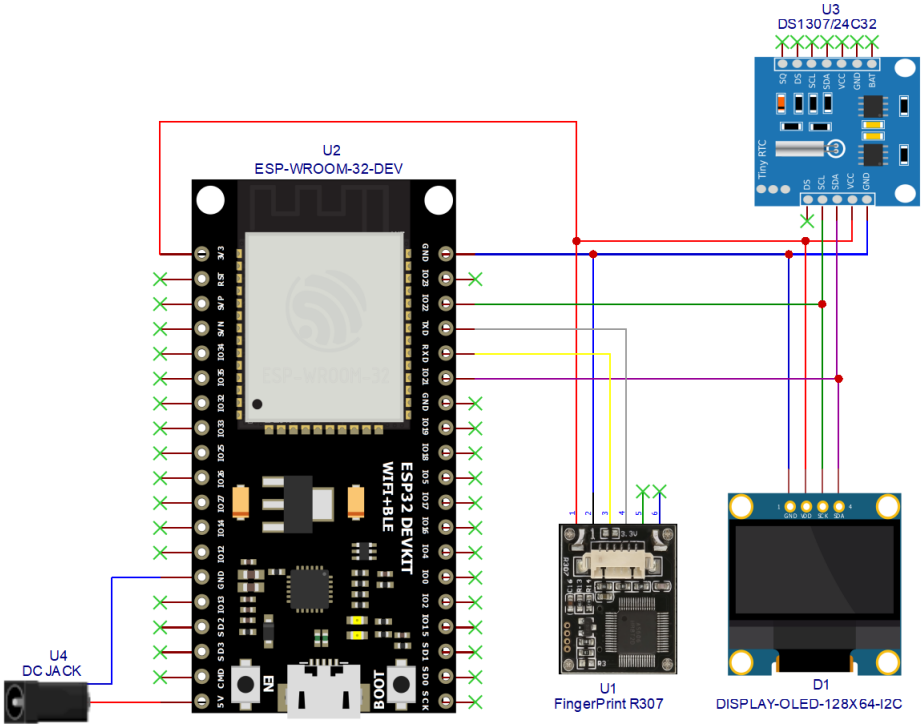


Figure 5.2: Circuit Diagram

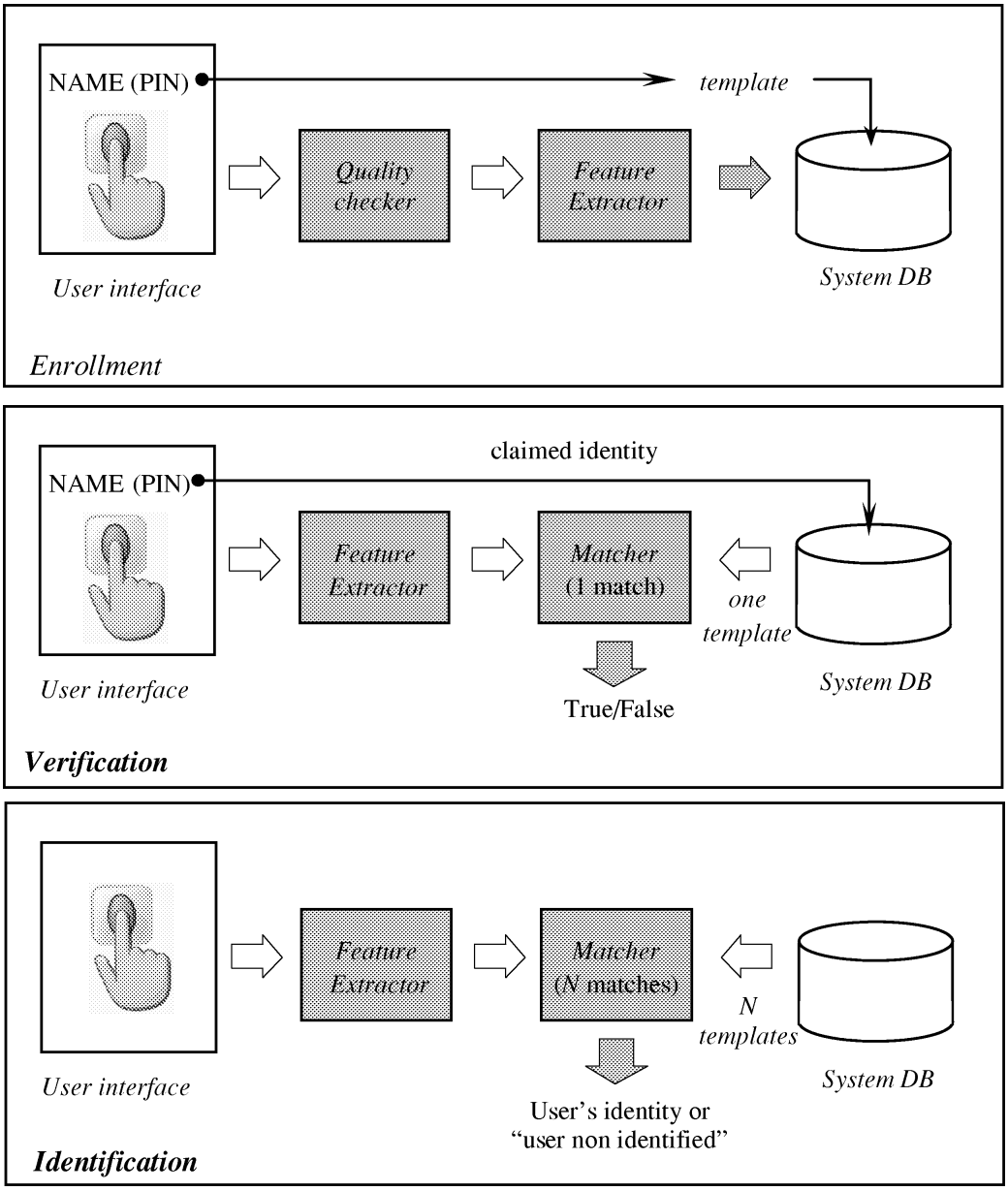


Figure 5.3: Fingerprint Capture and Identification

Chapter 6

Results and Conclusion

6.1 Experimental Results

The biometric attendance system with Google Sheets integration underwent rigorous testing to evaluate its performance in real-world scenarios. Focusing on accuracy, efficiency, and security, the system demonstrated exceptional capabilities during testing. In terms of fingerprint recognition accuracy, the system achieved an impressive success rate of over 98%, effectively reducing the occurrence of false identifications or rejections. Given that mDNS technology is being used for the wireless connection, the ESP32 and the Google Sheet should be connected continuously to the same WiFi. The real-time data transmission speed was consistently high, ensuring that attendance records were updated on Google Sheets virtually instantaneously, even under heavy user loads. This proved invaluable in scenarios involving simultaneous attendance registrations. Moreover, the user-friendly OLED screen interface received positive feedback from end-users, contributing to enhanced user engagement and transparency. Importantly, the system showcased its reliability, maintaining functionality during network disruptions and safeguarding attendance data.

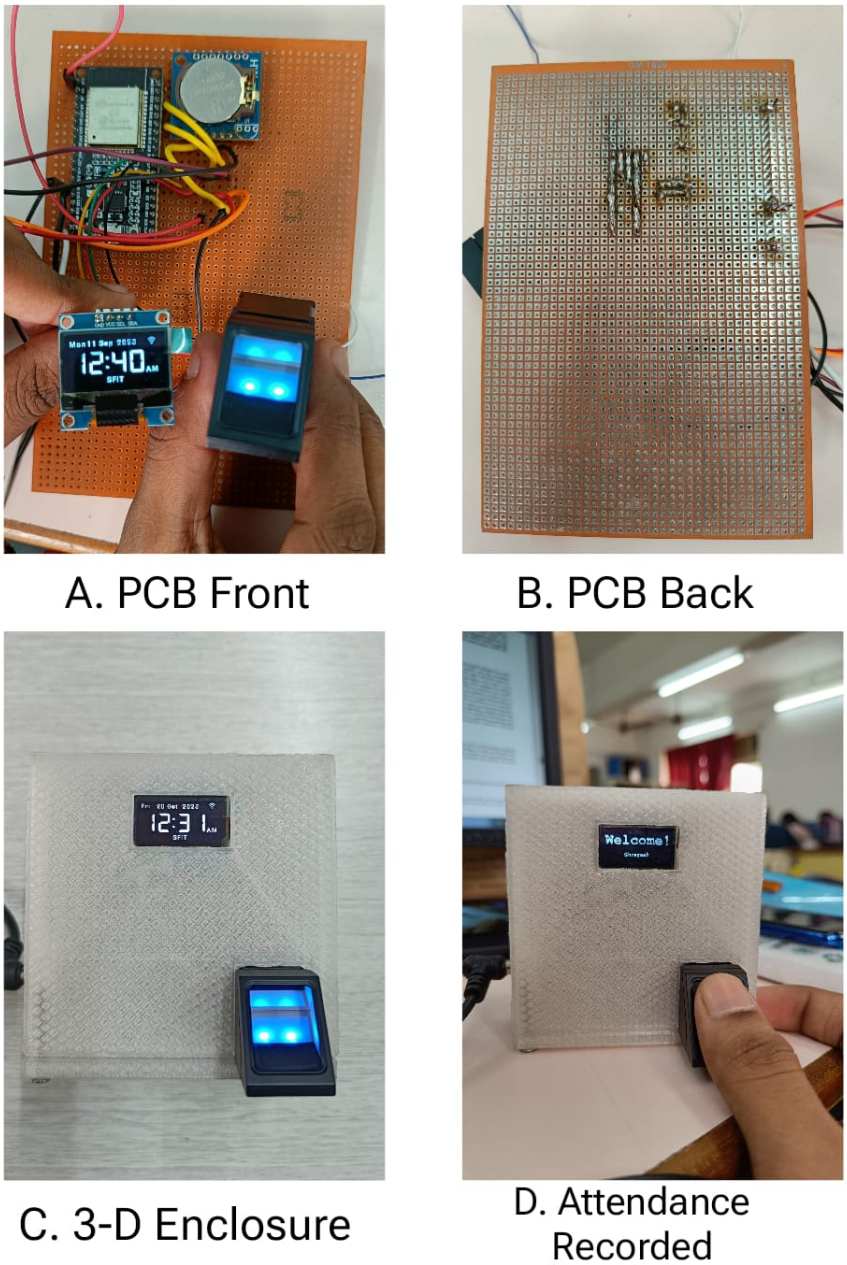
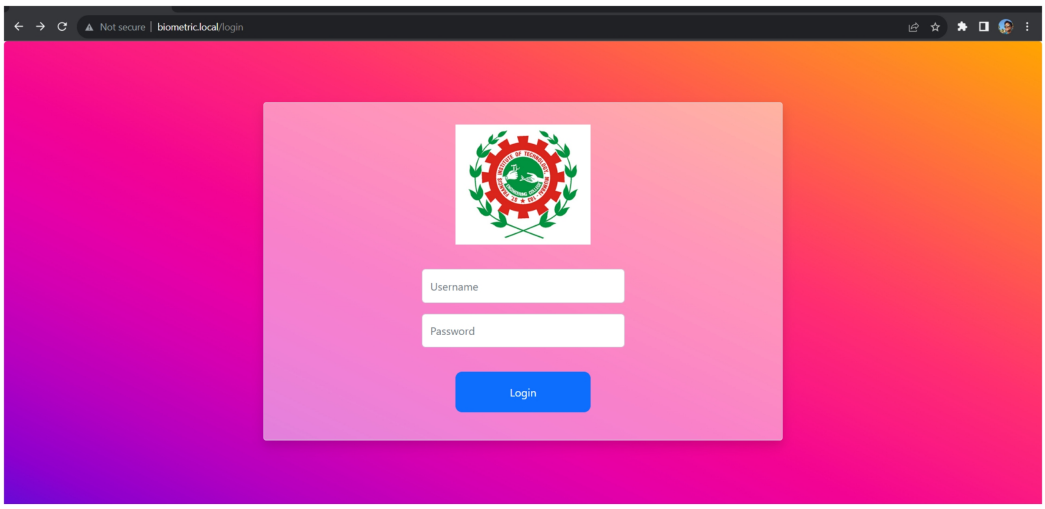
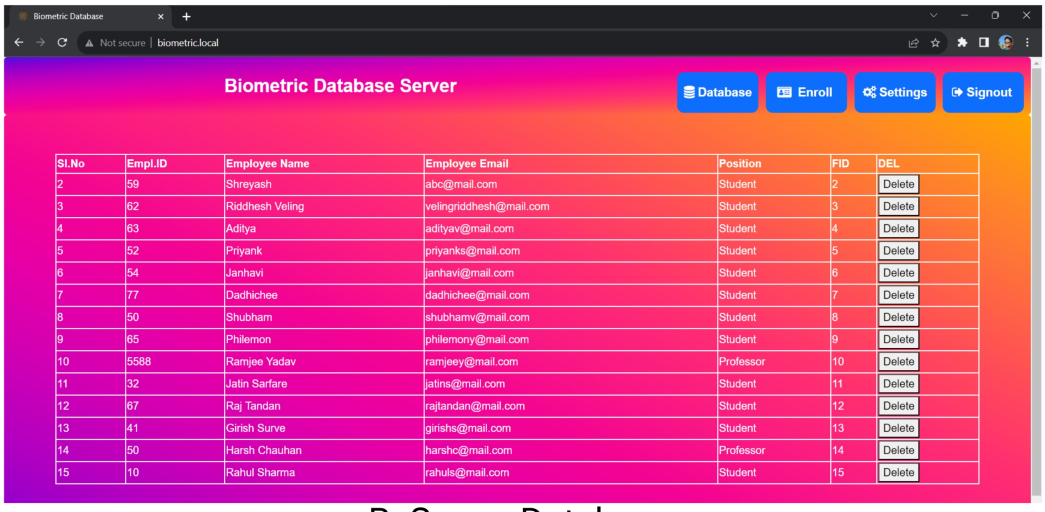


Figure 6.1: Hardware Results

The Fig 6.1 (A) shows the PCB circuitry from the front while Fig 6.1 (B) shows the soldering of PCB circuitry. The Fig 6.1(C) shows sturdy enclosure 3-D printed using SolidWorks Software and Fig 6.1 (D) shows the attendance system successfully identifying an user.

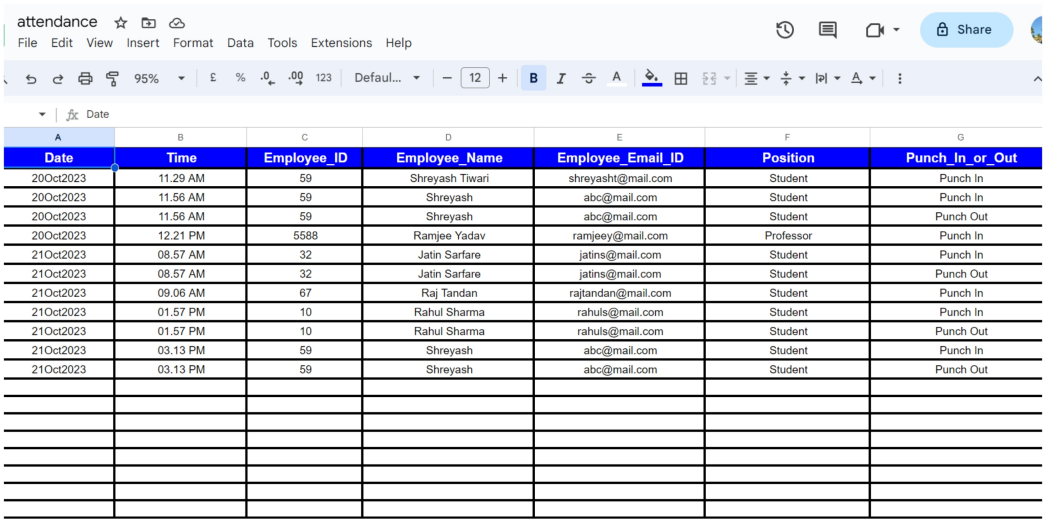


A. Login page



Sl.No	Empl.ID	Employee Name	Employee Email	Position	FID	DEL
2	59	Shreyash	abc@mail.com	Student	2	Delete
3	62	Riddhesh Veling	velingriddhesh@mail.com	Student	3	Delete
4	63	Aditya	adityav@mail.com	Student	4	Delete
5	52	Priyank	priyanks@mail.com	Student	5	Delete
6	54	Janhavi	janhavi@mail.com	Student	6	Delete
7	77	Dadhichee	dadhichee@mail.com	Student	7	Delete
8	50	Shubham	shubhamv@mail.com	Student	8	Delete
9	65	Philemon	philemony@mail.com	Student	9	Delete
10	5588	Ramjee Yadav	ramjeey@mail.com	Professor	10	Delete
11	32	Jatin Sarfare	jatins@mail.com	Student	11	Delete
12	67	Raj Tandan	rajtandan@mail.com	Student	12	Delete
13	41	Girish Surve	girishs@mail.com	Student	13	Delete
14	50	Harsh Chauhan	harshc@mail.com	Professor	14	Delete
15	10	Rahul Sharma	rahuls@mail.com	Student	15	Delete

B. Server Database



Date	Time	Employee_ID	Employee_Name	Employee_Email_ID	Position	Punch_In_or_Out
20Oct2023	11.29 AM	59	Shreyash Tiwari	shreyasht@mail.com	Student	Punch In
20Oct2023	11.56 AM	59	Shreyash	abc@mail.com	Student	Punch In
20Oct2023	11.56 AM	59	Shreyash	abc@mail.com	Student	Punch Out
20Oct2023	12.21 PM	5588	Ramjee Yadav	ramjeey@mail.com	Professor	Punch In
21Oct2023	08.57 AM	32	Jatin Sarfare	jatins@mail.com	Student	Punch In
21Oct2023	08.57 AM	32	Jatin Sarfare	jatins@mail.com	Student	Punch Out
21Oct2023	09.06 AM	67	Raj Tandan	rajtandan@mail.com	Student	Punch In
21Oct2023	01.57 PM	10	Rahul Sharma	rahuls@mail.com	Student	Punch In
21Oct2023	01.57 PM	10	Rahul Sharma	rahuls@mail.com	Student	Punch Out
21Oct2023	03.13 PM	59	Shreyash	abc@mail.com	Student	Punch In
21Oct2023	03.13 PM	59	Shreyash	abc@mail.com	Student	Punch Out

C. Attendance Sheet

Figure 6.2: Server Results

Fig 6.2 (A) shows the login page of the server which is accessible through login ID and password created by user. Fig 6.2 (B) shows the fingerprint database collection. Fig 6.2 (C) shows the Google Sheet on which the attendance is maintained.

6.2 Conclusion

The development of the Biometric Attendance System with Google Sheets integration represents a significant leap forward in attendance recording and management. By harnessing the power of fingerprint recognition, real-time data transmission, and cloud-based storage, this system addresses the limitations of manual attendance methods. It offers unparalleled accuracy, security, and efficiency in recording and monitoring attendance, making it an indispensable tool for organizations seeking to streamline their administrative processes. With the added convenience of real-time reporting and user-friendly interfaces, this project not only enhances accountability and data integrity but also marks a step towards the modernization of attendance tracking in the digital age.

6.3 Future Scope

One significant advantage of utilizing a biometric attendance system is the ability to implement precise time restrictions for student entry into classrooms. This feature, achieved through effective programming and integration, allows educational institutions to ensure that students can only enter a class during a specific time frame. The designated time limit begins once the faculty in-charge officially commences the class. This strategic approach offers several benefits:
1) Punctuality Promotion: By enforcing strict entry times, students are encouraged to arrive on time for their classes. This not only fosters discipline but also contributes to a more focused and productive learning environment.
2) Disruption Prevention: Late arrivals can disrupt the continuity of a class, leading to distractions for both the teacher and fellow students. Setting time restrictions helps minimize these disruptions, maintaining a conducive atmosphere for learning. It is important to strike a balance between the enforcement of punctuality and the accommodation of exceptional circumstances. The system should have mechanisms in place for students to seek exceptions or approvals for late entry in cases of emergencies, medical appointments, or other valid reasons.

Bibliography

[1] Jain, A. K. (2011). Handbook of Biometrics. Springer Science & Business Media.

[2] Narain, P., Sharma, S., & Kaur, R. (2019). A Review on Internet of Things (IoT) Based Smart Health System: Prototype Development. Procedia Computer Science, 165, 392-399.

[3] Hojati, T., Kim, J., & Moayedi, A. (2020). IoT Data Analytics Framework for Energy Efficiency in Smart Buildings. IEEE Internet of Things Journal, 8(10), 8497-8507.

[4] Patil, P., Pawar, A., & Mestry, Y. (2018). IoT Based Attendance System for School and Colleges. In 2018 International Conference on Advances in Computing, Communications and Informatics (ICACCI) (pp. 1287-1291).

[5] Lata, P., Sarje, A. K., & Saini, K. (2019). IoT based Smart Attendance Management System. In 2019 International Conference on Sustainable Energy, Electronics, and coMputing System (SEEMS) (pp. 13-17).

[6] A. K. Jain, A. Ross and S. Prabhakar, "An introduction to biometric recognition," in IEEE Transactions on Circuits and Systems for Video Technology, vol. 14, no. 1, pp. 4-20, Jan. 2004, doi: 10.1109/TCSVT.2003.818349.