SMART ATTENDANCE SYSTEM USING BIOMETRIC SENSORS AND ANALYTICS

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in partial fulfillment of the requirement for the degree of

Bachelor of Technology in
ELECTRONICS AND TELECOMMUNICATION ENGINEERING

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CERTIFICATE

This is to certify that the thesis entitled "**Smart attendance system using biometric sensors and analytics**" submitted by Ankit Barua, Hrishikesh Deka, Saindi Maibangsa and Trilosan Boro in the partial fulfillment of the requirements for the award of Bachelor of Technology degree in Electronics & Telecommunication Engineering at Assam Engineering College, Jalukbari, Guwahati is an authentic work carried out by them under my supervision and guidance.

To the best of my knowledge, the matter embodied in the project has not been submitted to any other University/Institute for the award of any Degree or Diploma.

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DECLARATION

We declare that this written submission represents our ideas in our own words and where others' ideas or words have been included, we have adequately cited and referenced the original sources. We acknowledge that the work presented in this project report has been completed in accordance with the guidelines and regulations set forth by Assam Engineering College. We take full responsibility for the content and accuracy of the information presented herein. We also declare that we have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in our submission. We understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources.

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ABSTRACT

The "Smart Attendance System Using Biometric Sensors and Analytics" project aims to innovate attendance management in educational institutions and workplaces by creating a compact and user-friendly device that utilizes biometric authentication. This system captures attendance data through biometric sensors, processes it, and uploads it in real time to a cloud-based database. The real-time data upload ensures instant access to attendance records, and the cloud storage allows for secure and efficient data management. A web-based interface provides users with immediate updates and comprehensive attendance metrics, making attendance tracking more efficient and accurate.

By integrating biometric technology and advanced data analytics, this smart attendance system offers a secure, reliable, and automated solution that addresses the limitations of traditional attendance methods. The system is designed to be portable and easy to use, ensuring that it can be effectively deployed in various settings. The project not only improves the accuracy of attendance tracking and reduces administrative burdens but also offers valuable insights through detailed analytics, enabling better attendance management and informed decision-making.

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CHAPTER 1
INTRODUCTION

1.1 Project Overview

The “Smart Attendance System using Biometric Sensors and Analytics” is an innovative project that aims to revolutionize the process of attendance tracking in various institutions such as schools, colleges, and offices. The system leverages the power of Internet of Things (IoT) and biometric technology to provide a reliable, efficient, and user-friendly solution for attendance management. The project involves the use of a Fingerprint Sensor for biometric identification. This sensor captures the unique fingerprint data of each individual, providing a secure and reliable method of identification. The system also includes an ESP8266 microcontroller, which serves as the brain of the system. This microcontroller processes the fingerprint data, controls the overall operation of the system, and communicates with the other components.

In addition to the hardware components, the system also includes several software components. The Arduino IDE is used for programming the ESP8266 microcontroller. The code written in the Arduino IDE controls the operation of the fingerprint sensor, processes the captured fingerprint data, and manages the communication with the online server. This database stores the attendance data, which includes the fingerprint data and the corresponding timestamps. The system also includes a website developed in PHP. This website retrieves the attendance data from the MySQL database and displays it in a user-friendly format. Additionally, the integrated analysis metric tools help to visualize the attendance records in graphs for better understanding This allows administrators or authorized personnel to easily view and manage the attendance records.

The system is designed to be easy to use, with a user-friendly interface and clear feedback. It provides real-time updates on attendance, significantly reducing the manual effort and potential errors associated with traditional attendance tracking methods. The system is also designed to be scalable, allowing it to handle larger numbers of users without a decrease in performance. In conclusion, the “Automated Online Attendance System using Biometric Fingerprint Sensor” project is a comprehensive solution that combines hardware and software components to automate the process of attendance tracking. By leveraging IoT and biometric technology, the system provides a reliable, efficient, and user-friendly solution for attendance management. This project serves as a testament to the potential of IoT and biometrics in creating innovative solutions for everyday challenges.

1.2 Subject Matter

The Smart Attendance System using biometric sensors and analytics represents a significant advancement in the field of attendance tracking. This project aims to develop a compact, portable device that leverages biometric fingerprint scanning technology to accurately identify individuals and record their attendance in real-time. By utilizing unique physiological characteristics, such as fingerprints, the system ensures that attendance data is reliable and secure, minimizing the possibility of fraudulent entries and errors that are common in traditional attendance methods.

In addition to the biometric component, the system integrates real-time data upload capabilities to a web platform, ensuring that attendance records are instantly available for review and analysis. This feature is particularly beneficial for educational institutions and businesses, as it allows administrators to monitor attendance patterns and metrics in real-time, facilitating timely interventions and decision-making. The web platform also provides a user-friendly interface where attendance data can be accessed, managed, and analyzed, offering insights into trends, punctuality, and overall attendance rates.

The project further incorporates data analytics to enhance the value of the recorded attendance data. Advanced analytical techniques are employed to generate comprehensive reports and metrics, providing a deeper understanding of attendance behavior. These analytics can reveal patterns, such as peak times of absenteeism, frequent latecomers, and overall attendance trends over time. By transforming raw attendance data into actionable insights, the system not only improves operational efficiency but also supports strategic planning and policy-making in educational and professional settings.

1.3 Motivation

Problem Statement:

Accurate attendance tracking is a persistent challenge in educational institutions and workplaces. Traditional methods, such as manual sign-ins and RFID cards, are not only time-consuming but also prone to errors and manipulation. These systems often result in inaccurate attendance records, leading to issues in accountability and productivity. The problem statement highlights the need for a more reliable, efficient, and tamper-proof attendance system that can ensure the integrity of attendance data while simplifying the management process.

Solution:

The advent of biometric technology offers a promising solution to the shortcomings of traditional attendance systems. Biometric sensors, particularly fingerprint scanners, provide a highly accurate means of identifying individuals based on their unique physiological traits. This technology significantly reduces the risk of fraudulent entries and human error. By leveraging biometric sensors, the Smart Attendance System aims to ensure that attendance data is both precise and secure, thereby addressing the fundamental issues of reliability and integrity in attendance tracking.

In addition to improving accuracy, there is a pressing need for real-time data management in attendance systems. Traditional methods often involve delays in data processing and reporting, which can hinder timely decision-making. The integration of real-time data upload capabilities in the Smart Attendance System allows for immediate updating of attendance records to a centralized web platform. This feature ensures that administrators have access to up-to-date information at all times, facilitating prompt interventions and more efficient management of attendance-related matters.

Furthermore, the use of advanced data analytics in the Smart Attendance System introduces a new dimension of value to attendance data. By analyzing attendance patterns and generating comprehensive reports, the system provides deeper insights into attendance behaviors and trends. These insights are crucial for identifying issues such as habitual tardiness or absenteeism, enabling administrators to implement targeted strategies to improve attendance. The ability to visualize data through graphs and charts enhances understanding and supports strategic planning, ultimately contributing to better management and operational efficiency.

1.4 Present Day Scenario

In the present day, attendance tracking is a fundamental aspect of many institutions such as schools, colleges, and offices. However, it is often a manual and time-consuming process that is prone to errors and inaccuracies. Traditional attendance systems typically involve paper-based registers or spreadsheets, where an instructor or supervisor manually records the presence or absence of each individual. This not only requires significant effort but can also lead to errors, such as incorrect entries or omissions. Furthermore, manual attendance systems do not provide real-time updates, making it difficult for administrators or authorized personnel to monitor attendance effectively.

Despite the advancements, existing attendance systems still face several challenges that need to be addressed. For instance, while biometric systems provide a higher level of security, they often require significant infrastructure and can be costly to implement. Moreover, some biometric methods like facial recognition and iris scanning can raise privacy concerns and may not be suitable for all environments. Additionally, many current systems lack real-time data processing and integration capabilities, resulting in delays in data reporting and analysis. This limitation can hinder effective attendance management and decision-making processes.

To further advance the field of attendance tracking, several improvements are necessary. First, the integration of portable, cost-effective biometric devices with real-time data upload capabilities can enhance the accessibility and efficiency of attendance systems. These devices should be designed to ensure data security and user privacy while providing accurate and reliable identification. Second, the incorporation of advanced data analytics and machine learning algorithms can transform raw attendance data into actionable insights, helping organizations to better understand attendance patterns and improve management strategies. Finally, developing user-friendly interfaces for both mobile and web platforms can ensure that administrators and users can easily access and manage attendance records, making the system more versatile and effective in various settings.

1.5 Objectives of the Work

The Smart Attendance System using biometric sensors and analytics aims to address several key issues in attendance tracking through the following objectives:

- **Develop a Compact and Portable Attendance Device:** Create a user-friendly, portable device that utilizes biometric fingerprint scanning technology to accurately capture and record attendance. The device should be easy to use, compact for convenient handling, and reliable in various environments, including educational institutions and workplaces.

- **Ensure Accurate and Secure Attendance Recording:** Leverage biometric fingerprint sensors to uniquely identify individuals, thereby minimizing the risk of fraudulent entries and human errors. This objective focuses on enhancing the accuracy and security of attendance data to ensure its integrity.

- **Implement Real-Time Data Upload Capabilities:** Integrate connectivity modules such as Wi-Fi or GSM to enable the real-time upload of attendance data to a centralized online server. This feature aims to provide immediate access to up-to-date attendance records for administrators and authorized personnel.

- **Develop a Web-Based Platform for Data Management:** Design and develop a user-friendly web interface using PHP and MySQL, where attendance data can be easily accessed, managed, and analyzed. The platform should provide intuitive navigation and comprehensive tools for viewing and managing attendance records.

- **Incorporate Advanced Data Analytics:** Utilize data analytics techniques to process attendance data and generate detailed reports and metrics. This objective aims to provide insights into attendance patterns, trends, and anomalies, supporting informed decision-making and strategic planning.

- **Enhance Data Visualization:** Integrate tools within the web platform to visualize attendance data through graphs and charts. This will help administrators and authorized personnel to better understand and interpret attendance metrics, facilitating more effective management.

- **Ensure System Security and Privacy:** Implement robust security measures to protect the biometric data and attendance records from unauthorized access and breaches. This includes encrypting data transmissions and ensuring compliance with relevant data protection regulations.

- **Facilitate Easy Integration and Scalability:** Design the system to be easily integrable with existing infrastructure and scalable to accommodate future enhancements or expansions. This objective ensures that the system can adapt to various settings and growing needs of organizations.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

The advent of the Internet of Things (IoT) has revolutionized various sectors, including education. One of the areas where IoT has been significantly impactful is in the automation of systems, leading to increased efficiency and accuracy. The "Automated Online Attendance System using Biometric Fingerprint Sensor" is a testament to this revolution. This system leverages the power of IoT to automate the process of attendance tracking, which has traditionally been a manual and error-prone task. By using a biometric fingerprint sensor, the system ensures that the attendance data is accurate and reliable, eliminating the possibility of proxy attendance and manual errors.

The system is built around the ESP8266 microcontroller, a low-cost Wi-Fi microchip with full TCP/IP stack and microcontroller capability. This chip is the heart of the system, controlling the fingerprint sensor and communicating with the local MySQL database and the website where the attendance data is stored and displayed. The use of the ESP8266 chip not only makes the system affordable but also easy to implement and maintain due to the chip's wide support and availability.

Biometric attendance systems represent a significant advancement in the field, leveraging unique physiological characteristics such as fingerprints, facial features, and iris patterns for accurate identification. Fingerprint recognition, in particular, has gained widespread acceptance due to its balance of accuracy, security, and ease of use. Biometric systems have demonstrated superior performance in preventing fraudulent attendance entries and ensuring data integrity. However, despite their advantages, these systems also face challenges, including high implementation costs, privacy concerns, and the need for robust data protection measures. The literature explores these aspects, providing a comprehensive understanding of the benefits and limitations of biometric technologies in attendance tracking.

This project is a significant contribution to the field of IoT-based automation systems. The title itself encapsulates the essence of the project, indicating its primary objective of automating attendance tracking using biometric technology. The integration of data analytics into attendance systems is a relatively recent development that adds significant value to the data collected. Advanced analytics can transform raw attendance data into meaningful insights, helping organizations identify patterns, trends, and anomalies. By employing techniques such as statistical analysis, machine learning, and data visualization, these systems can provide comprehensive reports and actionable intelligence. This capability is particularly beneficial for administrators seeking to improve attendance rates and address underlying issues. The literature review delves into the application of data analytics in attendance management, highlighting how it enhances decision-making and strategic planning.

2.2 Existing Research Works

Table 2.1: Literature Review

Publication	Salient Features
Student Attendance by, Nadar Prince, Abhishek Sengupta, Ms. Keerthi Unni , Presented Implementation of IoT Based Attendance System on a Dedicated Web-Server	The concept of Internet of Things (IoT) is applied to the basic attendance system in a class room. The student verification is done using R-305 Finger Print module. The student data is fed already in the finger print module. Once successful recognition of finger print pattern is done, the student's attendance is ready to be pushed to the web-server. This data is sent through the serial interface to the Arduino .A combination of the student ID, teacher ID and device ID is sent to the web-server using Wi-Fi Module esp8266-01. And the MySQL database is updated.

Biometric attendance system technique was proposed by Dhiman kumar sarkar, Nafize Ishtiaque Hussain, insane Arafat Jamil, which is Design and Implementation of Smart Attendance Management System using multistep Authentication System.	This research papers implements the attendance system using Arduino Mega 2560, RFID and biometrics that is finger print scanner. This system makes use of all the system including RFID and also biometrics. This research paper looks over all the possibilities if any one of the system fails. Here the implementation takes place using arduino Mega 2560 which is interfaced with the fingerprint scanner and the RFID. For display of the authentication process 16*16 LCD screen is used which is interfaced with the keypad for the output
Ms. Manjiri Pathak, Divya Prajapati, Vidya Prajapati, Bipin Nair, Swapnil Deo, 2017 proposed Wireless Fingerprint Attendance Management System	This paper uses the methodology of wireless transmission of data using ZigBee model and ARM7 LPC2148 which is the major component part of the project. The transmission of the data to the end server using ZigBee module from all the other techniques is efficient because it has low power consumption. Considering the network topology of the ZigBee network it uses wireless local area network which is a cluster tree network. To resolve the problem of time delay when the image is transmitted by ZigBee technology, the traditional transmission mode is improved.

2.3 Analysis of Biometric Technologies

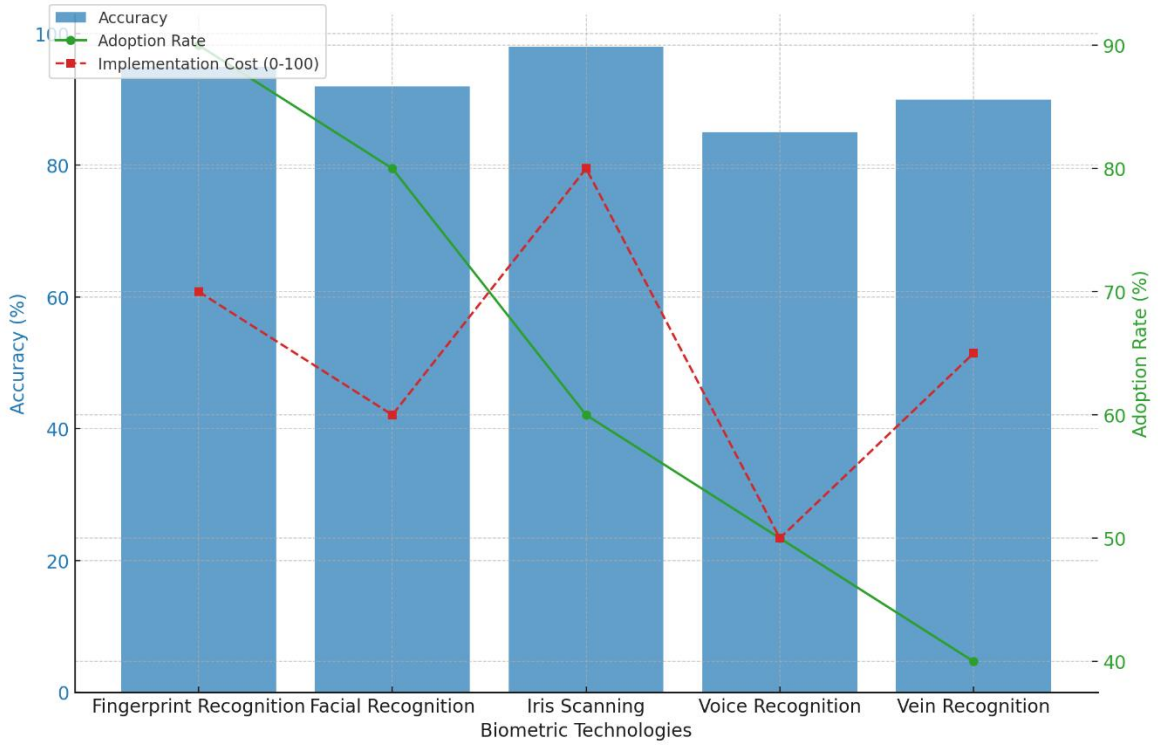


Fig 2.1: Analysis of Biometric Technologies

This visual representation highlights the trade-offs between accuracy, adoption rate, and implementation cost for each biometric technology. Fingerprint recognition emerges as a balanced choice with high accuracy and adoption rate, making it suitable for a wide range of applications, including attendance systems. Iris scanning, despite its superior accuracy, faces adoption barriers due to high costs. Facial recognition, while less accurate, is favored for its ease of use and lower costs. Voice and vein recognition technologies, though innovative, are less commonly adopted due to various limitations.

Understanding these factors is crucial for selecting the appropriate biometric technology for specific applications, such as the Smart Attendance System. Balancing accuracy, user acceptance, and cost considerations ensures the development of a reliable, efficient, and user-friendly attendance tracking solution.

2.4 Relevance of analytics

Incorporating data analytics into attendance systems significantly enhances their functionality and utility. Traditional attendance systems primarily focus on recording attendance data without providing insights into patterns or trends. However, by integrating analytics, the Smart Attendance System can process and interpret this data to generate meaningful reports and metrics. These insights help administrators identify attendance patterns, such as frequent absentees, latecomers, and peak times of absenteeism, allowing for more informed decision-making and targeted interventions. This shift from mere data collection to data interpretation marks a substantial improvement in attendance management.

Types of Analytics and Methods Used:

Descriptive Analytics: It focuses on summarizing historical attendance data to provide a clear picture of past patterns and trends. By using methods such as data aggregation, summary statistics, and data visualization (e.g., charts and graphs), descriptive analytics helps administrators understand the overall attendance behavior over a specific period. For instance, it can show average attendance rates per day, week, or month, highlight peak periods of absenteeism, and identify frequently absent individuals. This foundational analysis sets the stage for more advanced types of analytics.

Diagnostic Analytics: It delves deeper into the data to understand the reasons behind attendance patterns and anomalies. By employing methods such as root cause analysis, correlation analysis, and drill-down techniques, diagnostic analytics helps identify the factors contributing to irregular attendance patterns. For example, it can reveal if low attendance is linked to specific days of the week, certain classes or departments, or particular events. This insight is crucial for pinpointing issues that may require administrative attention or corrective actions.

Predictive Analytics: It uses historical data to forecast future attendance trends and behaviors. It answers the question. Utilizing methods such as time series analysis, regression analysis, and machine learning algorithms, predictive analytics can project future attendance rates and identify potential issues before they arise. For instance, it can predict periods of low attendance during upcoming months or detect patterns that suggest a student or employee is at risk of chronic absenteeism. These forecasts enable proactive measures to be taken to improve attendance and address potential problems early.

Prescriptive Analytics: goes a step further by providing recommendations to optimize attendance and resource allocation. By leveraging methods such as optimization algorithms, simulation models, and decision analysis, prescriptive analytics offers actionable insights and strategies to enhance attendance management. For example, it can suggest optimal scheduling adjustments, targeted interventions for frequently absent individuals, or resource reallocation to improve engagement. This type of analytics is invaluable for administrators seeking to implement data-driven policies and improve overall organizational efficiency.

CHAPTER 3
METHODOLOGY

3.1 Introduction

The Smart Attendance System using biometric sensors and analytics is a complex project that integrates various hardware and software components to create a comprehensive solution for attendance tracking. The system leverages the power of IoT, biometric technology, and web development tools to automate and streamline the process of recording and managing attendance data. This chapter aims to provide a detailed description of each component used in the project, highlighting their roles, functionalities, and interdependencies. The methodology encompasses the selection and integration of biometric sensors, the development of firmware for data processing, and the creation of a web-based platform for real-time data management and analytics. Each step of the methodology is carefully designed to ensure the accuracy, security, and usability of the system.

The first phase of the project involves the selection and integration of appropriate hardware components. The primary hardware includes a biometric fingerprint sensor and the ESP8266 microcontroller, chosen for their reliability and compatibility. The fingerprint sensor is responsible for capturing the unique physiological characteristics of individuals, while the ESP8266 manages data processing and communication with the online server. This phase also involves designing a compact and portable device that can be easily deployed in various environments, ensuring user convenience and accessibility.

The second phase focuses on the development of the firmware using the Arduino IDE. The firmware is programmed to control the operation of the fingerprint sensor, process the captured biometric data, and handle communication with the server. This phase includes writing code to ensure accurate data capture, efficient data processing, and secure data transmission. The firmware development is critical to the system's overall functionality, as it ensures that the biometric data is accurately captured, processed, and transmitted in real-time.

The final phase involves the creation of a web-based platform for data management and analytics. This platform, developed using PHP and MySQL, provides a user-friendly interface for administrators to access, manage, and analyse attendance data. The integration of data visualization tools within the platform allows for the presentation of attendance records in graphs and charts, facilitating better understanding and decision-making. Advanced data analytics techniques are employed to generate comprehensive reports and insights, helping administrators identify patterns and trends in attendance behaviour. This phase ensures that the system not only captures and stores attendance data but also transforms it into actionable intelligence.

3.2 System Design

The system design of the Smart Attendance System using biometric sensors and analytics is a comprehensive process that integrates both hardware and software components to achieve a reliable and efficient attendance tracking solution. This section outlines the architecture and design considerations that ensure the system meets its objectives of accuracy, security, real-time data processing, and user-friendly data management.

BLOCK DIAGRAM

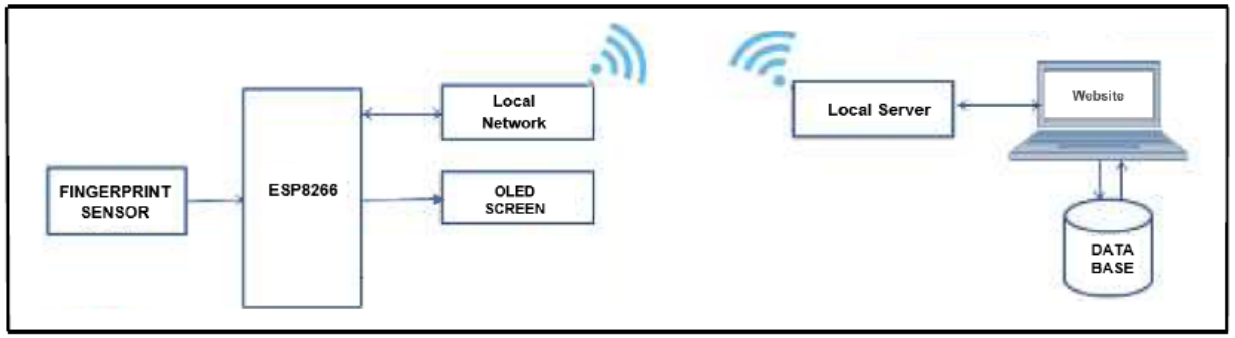


Fig 3.1: Block Diagram

The block diagram illustrates the overall architecture and workflow of the Smart Attendance System. Here's a detailed explanation of each component and their interactions:

- **Fingerprint Sensor:** This sensor captures the fingerprint of the user and transmits the data to the ESP8266.
- **ESP8266:** This is the brains of the operation. It receives the fingerprint data from the sensor, compares it to the stored templates, and verifies the user's identity. If the fingerprint matches, it sends the user's ID and timestamp to the local server.
- **OLED Display:** This small display shows the user information and status messages, such as whether the attendance was successfully recorded.
- **Local Network:** This network connects the ESP8266 to the local server.
- **Server:** This server stores the fingerprint templates and attendance data. It also communicates with the website to update the attendance records in real time.
- **Website:** This web-based platform allows users to register, view their attendance records, and manage the system settings.

The Workflow description of the system is:

- **Data Capture**: The process begins with the fingerprint sensor capturing the fingerprint of an individual. This biometric data is then sent to the ESP8266 microcontroller for processing.
- **Data Processing and Display**: The ESP8266 processes the fingerprint data to verify the identity of the individual. During this process, the OLED screen provides real-time feedback to the user, such as confirming the successful recording of attendance or displaying error messages if the fingerprint is not recognized.
- **Data Transmission**: Once the fingerprint data is processed, the ESP8266 microcontroller uses its integrated Wi-Fi capabilities to connect to the local network and transmit the attendance data to the local server.
- **Data Storage**: The local server receives the data and stores it in the MySQL database. This ensures that all attendance records are securely saved and can be accessed whenever needed.

- **Data Access and Analysis**: The website, developed using PHP, interfaces with the local server and database to retrieve attendance data. Administrators can log into the website to view attendance records, generate reports, and utilize data visualization and analytics tools to gain insights into attendance patterns and trends.

Overall, the block diagram shows how the different components of the system work together to provide an automated and efficient way to record attendance. The fingerprint sensor captures the user's fingerprint, the ESP8266 verifies the identity, and the local server and website store and manage the attendance data. This comprehensive system design ensures that the Smart Attendance System is efficient, accurate, and user-friendly, providing real-time attendance tracking and detailed data analytics for effective attendance management.

FLOW CHART

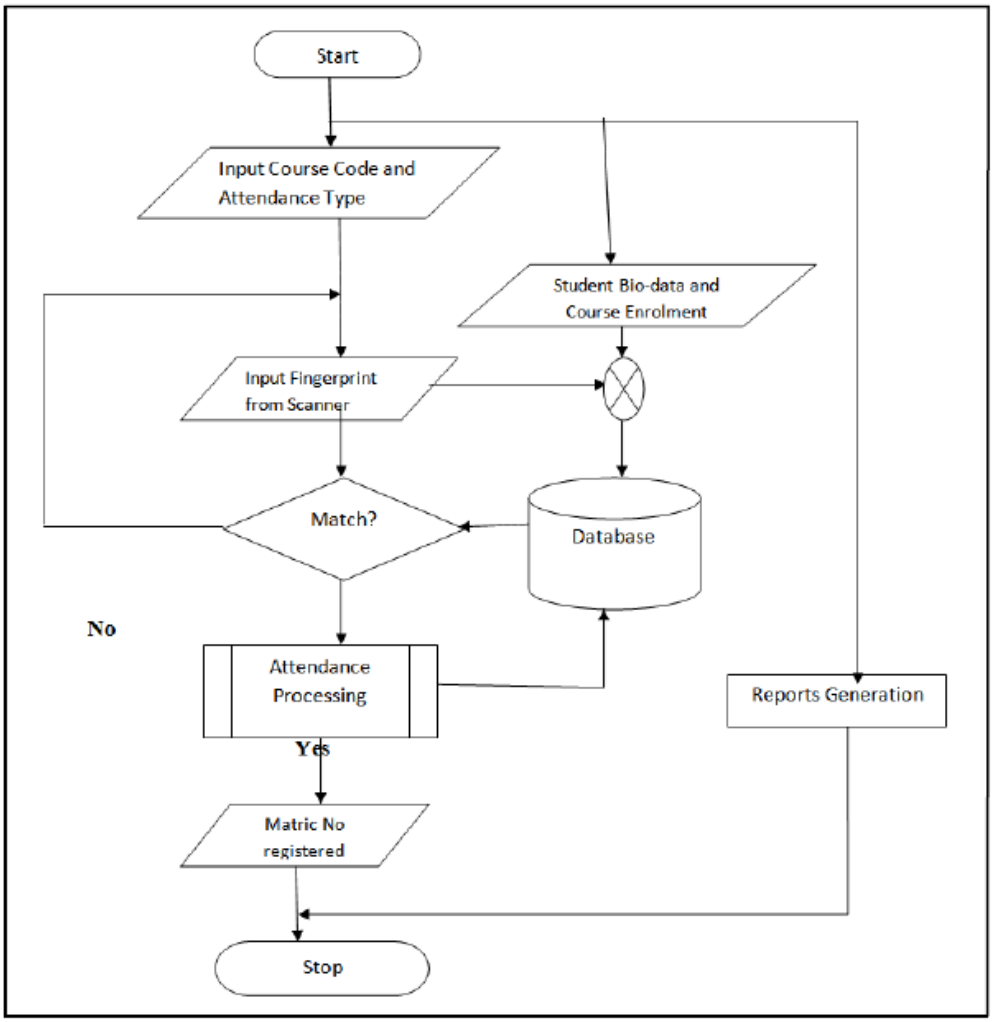


Fig 3.2: Flow Chart

The flowchart breakdown is as follows:

Initialization and User Input: The process starts with the system initializing and prompting the user to input their course code and attendance type (e.g., student, lecturer).

Fingerprint Capture and Verification: Next, the system requests a fingerprint scan from the user. The captured fingerprint is then compared against the database of enrolled fingerprints. If the fingerprint matches a registered user, the process proceeds to Step 5. However, if there's no match: For students, the system directs them to register their fingerprint and course enrolment details. For lecturers, it prompts them to input their matriculation number for manual registration.

Matriculation Number Registration: If a student's fingerprint does not match, they can enter their matriculation number manually. This enables them to register their attendance despite not having their fingerprint captured beforehand.

Attendance Processing and Reporting: Once the user's identity is verified (either through fingerprint match or manual matriculation number entry), their attendance is processed. This involves recording the timestamp and potentially other relevant details like course code or attendance type.

Finally, the system generates reports based on the accumulated attendance data. This information can be accessed on the online platform for further analysis and management. Overall, the flowchart demonstrates a clear and efficient process for user identification, attendance recording, and data reporting in your fingerprint-based attendance system.

3.3 Hardware Components

Table 3.3: Hardware Components

Sl. No.	Hardware Component Name	No. of Units
1	ESP8266 microcontroller	1
	Fingerprint Sensor R307	1
3	0.96" I2C OLED display	1
4	Power Supply 9v	1
5	Wire strip	1
6	PCB Board	1

Fig 3.1: Hardware Components

3.4 Software Components

Table 3.4: Software Components

Sl. No.	Software Components
1	Arduino IDE
2	Local Server- Xampp
3	PHP Environment
4	VS Code (Code editor)

Fig 3.2: Software Components

3.5 Data Collection

Data collection in the Smart Attendance System involves a systematic process to capture attendance information accurately and securely. The primary method employed is through the use of biometric fingerprint sensors integrated into the attendance device. Upon placing their finger on the sensor, individuals' unique fingerprint data is scanned and processed in real-time. This data is then authenticated against pre-registered data to verify the identity of the individual. Once authenticated, the attendance data, along with a timestamp, is transmitted to the web platform via the ESP8266 microcontroller.

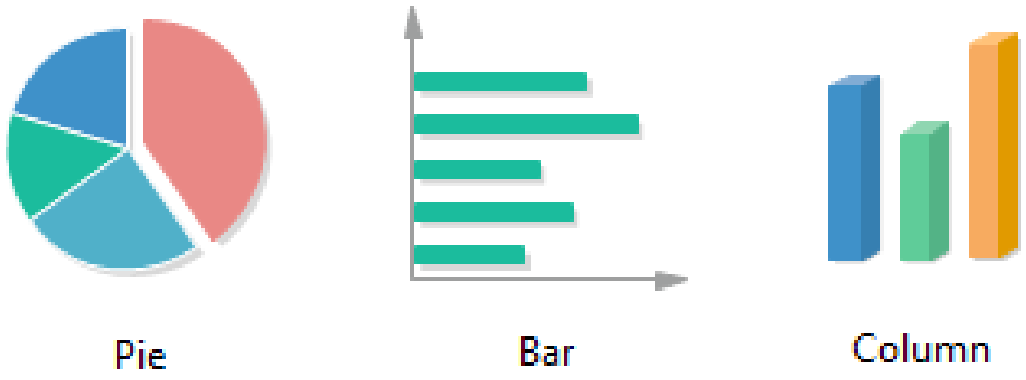
The data collected undergoes several stages before being stored and analyzed on the web platform. After authentication, the attendance data is transmitted securely to the web server, where it is stored in a MySQL database. This database serves as a central repository for all attendance records, ensuring efficient data management and retrieval. Additionally, the web platform offers features for data visualization and analysis, allowing administrators to gain insights into attendance patterns and trends. By integrating advanced analytics tools, the system facilitates informed decision-making and enhances overall attendance tracking capabilities.

The methodology employed in data collection ensures the reliability, accuracy, and security of attendance records in the Smart Attendance System. By leveraging biometric sensors and real-time data transmission, the system minimizes the risk of errors and unauthorized access. Furthermore, the centralized storage and analysis of attendance data on the web platform enable administrators to effectively monitor attendance and address any issues promptly. Overall, the data collection process forms the foundation for robust attendance tracking and management within educational institutions and workplaces.

3.6 Data Analysis Techniques

In this project, various data analysis techniques are employed to derive meaningful insights from the attendance data collected by the Smart Attendance System. The attendance data is utilized to generate useful matrices and graphs, facilitating a better visualization of performance metrics. One such technique involves the calculation of attendance percentages for individual students or employees over a specific period. By comparing attendance percentages across different time frames, administrators can identify trends and patterns in attendance behavior.

Moreover, attendance data is analyzed to generate graphical representations such as bar charts, line graphs, and pie charts. These visualizations offer a clear and intuitive way to interpret attendance trends, identify outliers, and track performance over time. For instance, bar charts can be used to compare attendance rates between different classes or departments, while line graphs can illustrate attendance trends over an academic semester or fiscal year. Additionally, pie charts can provide a breakdown of attendance percentages by category, such as present, absent, or tardy.



Furthermore, advanced data analytics techniques, such as trend analysis and predictive modeling, may be employed to forecast future attendance patterns based on historical data. By identifying recurring patterns and factors influencing attendance, administrators can proactively address attendance issues and implement targeted interventions to improve overall attendance rates. Additionally, machine learning algorithms can be utilized to analyze large datasets and uncover hidden correlations or insights that may not be immediately apparent through traditional data analysis techniques. Overall, the combination of various data analysis techniques enables administrators to make informed decisions and enhance attendance management strategies within educational institutions and workplaces.

CHAPTER 4
SYSTEM IMPLEMENTATION

4.1 Hardware Setup

The hardware setup for the Smart Attendance System is foundational to its functionality and reliability. At its core is the integration of key components such as the fingerprint sensor, ESP8266 microcontroller, and power supply. These components work together seamlessly to ensure accurate attendance tracking and real-time data transmission.

The first step in the hardware setup is configuring the fingerprint sensor. This involves connecting its pins to the corresponding pins on the ESP8266 microcontroller, ensuring a stable connection for data transmission. Proper alignment and stabilization of the sensor are essential to capture clear and accurate fingerprint data, minimizing errors in attendance recording. Additionally, securing the sensor in place prevents any movement during fingerprint scanning, enhancing the system's overall performance.

Next, the ESP8266 microcontroller is set up to manage communication with the web server and process the fingerprint data. This involves connecting the power supply to provide a stable power source and programming the microcontroller to handle data processing and Wi-Fi connectivity. Proper programming ensures seamless integration with the web server, enabling real-time data transmission and efficient attendance tracking. Additionally, capacitors may be used to stabilize the power supply and prevent voltage fluctuations, further enhancing the reliability of the system.

Finally, the power supply is connected to ensure continuous operation of the system. Whether using a 5V/2A power adapter or a battery pack, a stable power source is crucial to prevent interruptions in attendance tracking. By properly connecting and stabilizing the power supply, the system can function reliably, even in diverse environments. Overall, the hardware setup lays the foundation for the Smart Attendance System, enabling accurate attendance tracking and real-time data transmission for effective monitoring and analysis.

Circuit Diagram:

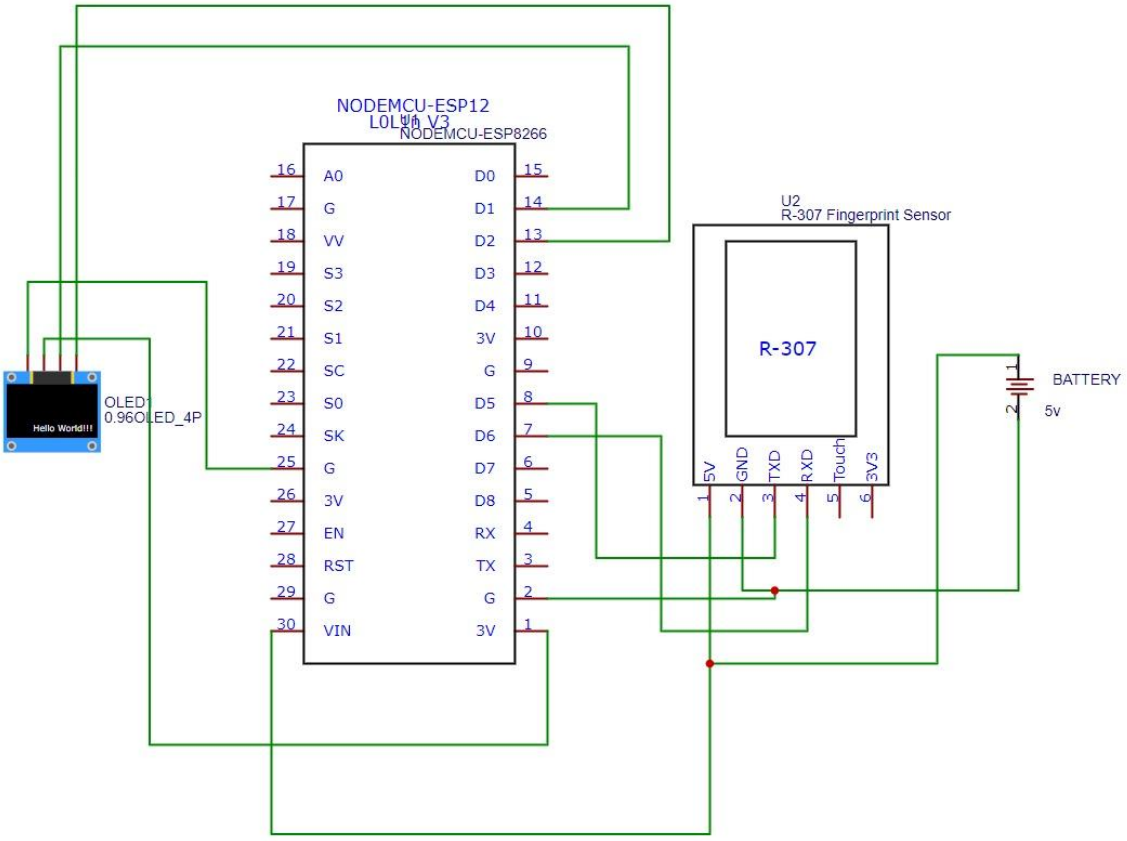


Fig 4.1: Circuit Diagram

The above circuit diagram shows how an OLED Display & Fingerprint Sensor is interfaced with NodeMCU ESP8266 12E Board. The I2C pins of OLED Display, i.e. SDA & SCL are connected to ESP8266 D2 & D1 pins respectively. Similarly, the fingerprint sensor is connected to UART pins D5 & D6. The fingerprint sensor Tx and Rx wire's color may vary. In my case, the color is yellow and blue where yellow is Tx and Blue is Rx. So, connect it by finding appropriate color wires else the module will not be detected by ESP8266. The R305 fingerprint sensor is supplied with 5V through Vin pins of ESP8266. In my case, the sensor did not work at 3.3V. Similarly, connect OLED Vcc pin to 3.3V of ESP8266.

Hardware Model:

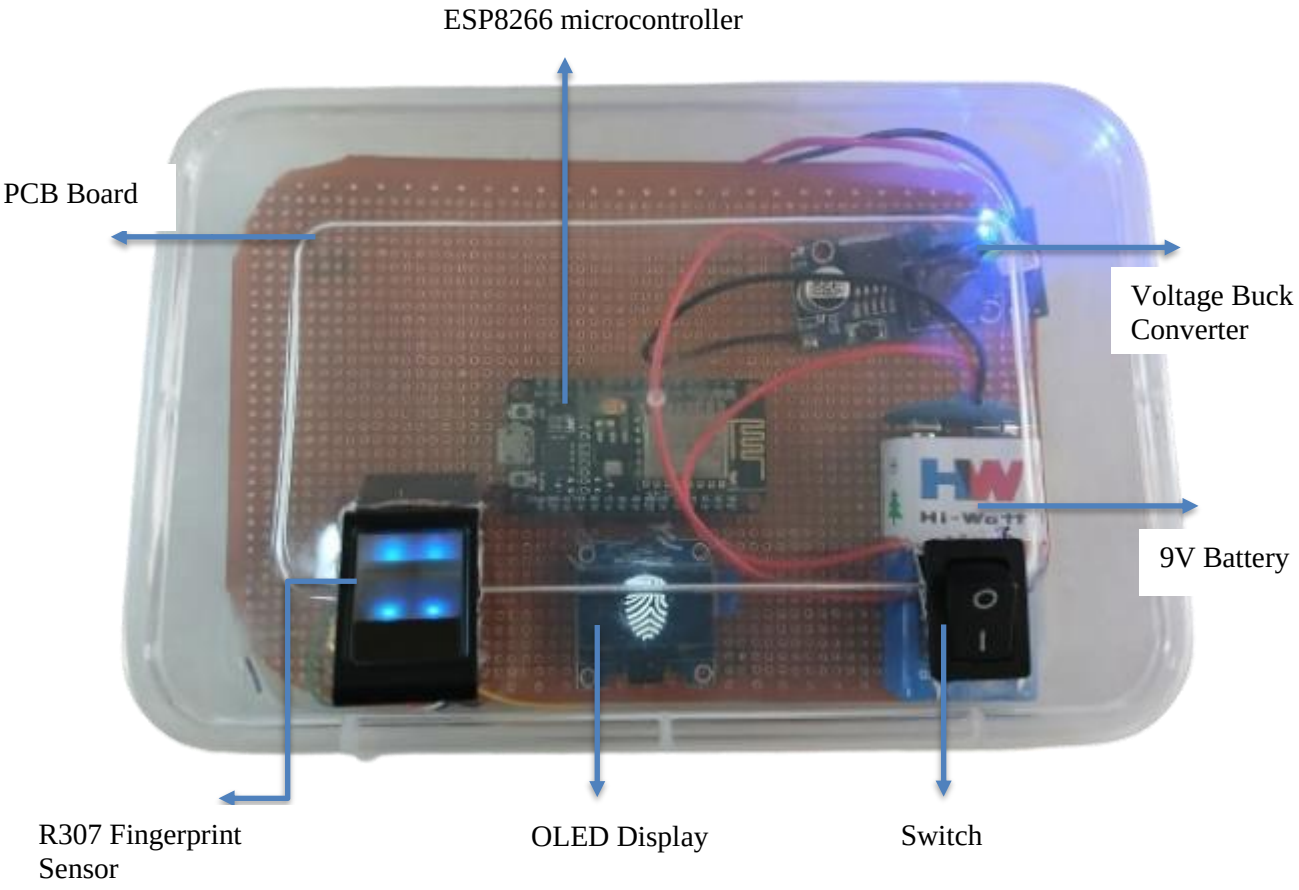


Fig 4.2: Smart Attendance Box

The "**SMART ATTENDANCE BOX**" is a compact, portable device designed to streamline attendance tracking for students and employees through the use of biometric fingerprint sensors. Housed in a durable and aesthetically designed enclosure, the device integrates key hardware components including a high-precision fingerprint sensor, the ESP8266 microcontroller, an OLED display, and a reliable power supply. The fingerprint sensor captures and authenticates individual fingerprints, while the ESP8266 processes this data and transmits it wirelessly to a local server via Wi-Fi. The OLED screen provides immediate visual feedback to users, confirming successful attendance logging or indicating errors. Designed with user convenience and security in mind, the SMART ATTENDANCE BOX ensures accurate and real-time attendance data capture, seamlessly uploading this information to a central database for easy management and analysis through a web-based platform.

4.2 Software Development

The software development process for the Smart Attendance System is pivotal in ensuring seamless operation and effective data management. The development involves programming the ESP8266 microcontroller to handle fingerprint data processing and communication with the web server. Using an integrated development environment (IDE) such as Arduino IDE, the microcontroller is programmed to capture fingerprint data from the sensor, perform necessary authentication, and transmit the data to the web server via Wi-Fi. This programming is essential to enable real-time data transmission and ensure accurate attendance recording.

In addition to programming the microcontroller, the development of the web server and database components is critical for efficient data management. A web server, is set up to receive attendance data from the microcontroller and store it securely in the MySQL database. This involves configuring the server to handle incoming data requests, validating the received data, and storing it in the appropriate database tables. By developing robust server-side scripts using languages like PHP or Python, the web server can efficiently manage attendance data and provide a seamless interface for administrators to access and analyze it.

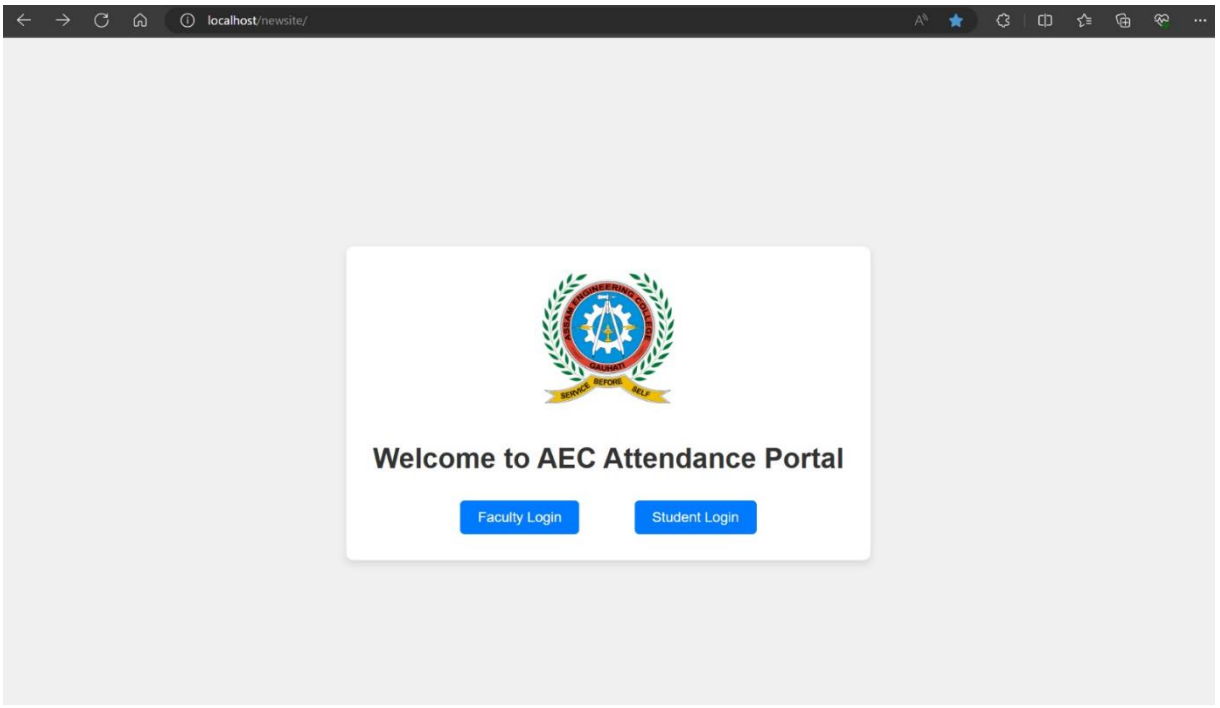
The website comprises of the following three sections –

i. Admin Panel
ii. Faculty Portal
iii. Student Portal

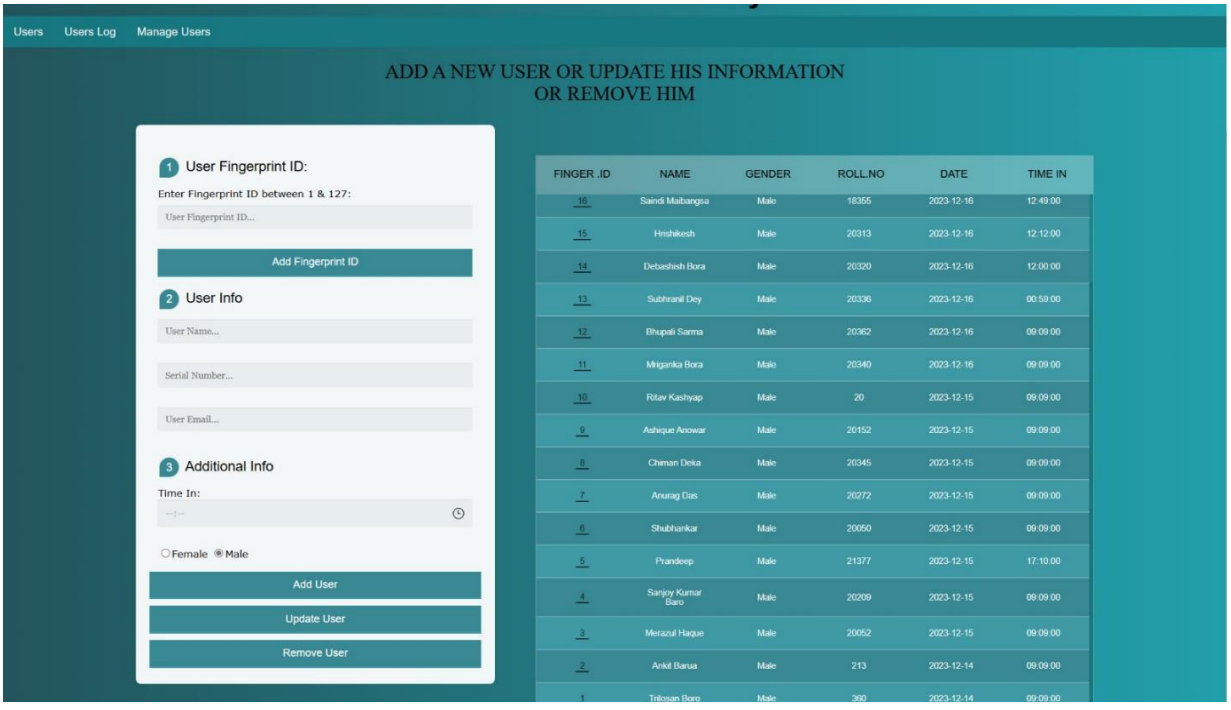
The development of the web platform encompasses creating a user-friendly interface for administrators to view, manage, and analyze attendance data. Using web development technologies such as HTML, CSS, and JavaScript, the platform is designed to offer intuitive navigation and comprehensive features for attendance tracking. Advanced data analytics tools are integrated into the platform to provide insights and visualizations of attendance patterns, enabling administrators to make informed decisions based on the collected data. Through iterative development and testing, the software components are refined to ensure optimal performance and usability of the Smart Attendance System.

The website is designed to cater to the needs of different users through its three distinct sections: the Admin Panel, Faculty Portal, and Student Portal.

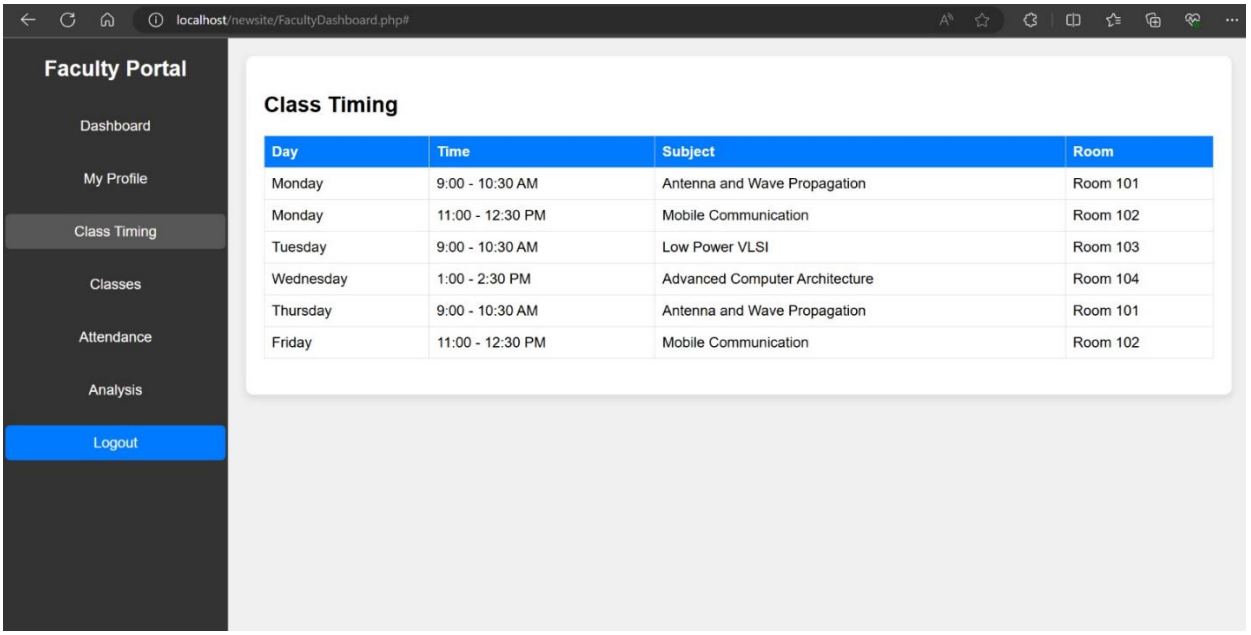
- **Landing Page:** This is the index page of the website where we can access all the functionalities



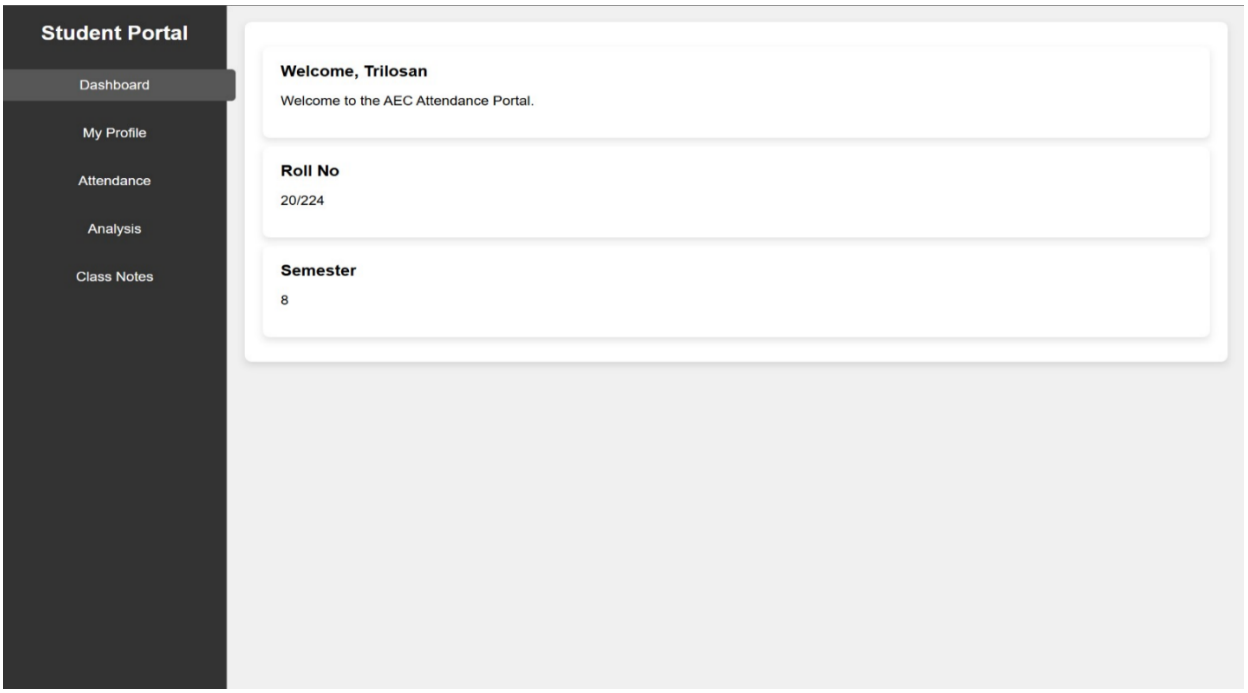
- **Admin Panel:** The Admin Panel serves as the centralized control hub for managing various aspects of the platform. Administrators have access to administrative functionalities such as user management, system configuration, and data analytics tools. They can add or remove users, configure system settings, and generate attendance reports.



- **Faculty Portal:** The Faculty Portal is designed specifically for faculty members or instructors affiliated with the institution. Faculty members can use this portal to take attendance, view attendance records, and communicate with students regarding attendance-related matters.



- **Student Portal:** The Student Portal is tailored to meet the needs of students enrolled in courses or programs offered by the institution. Students can access their attendance records, view course schedules, and communicate with faculty members regarding attendance or academic concerns.



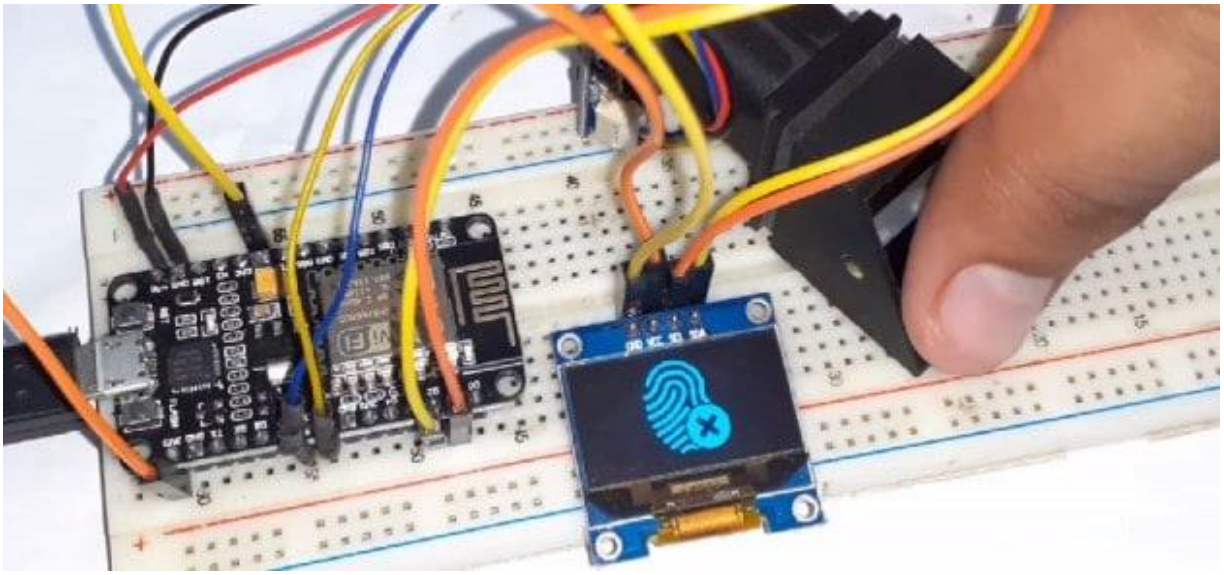
Fig(s) 4.3: Website functionalities

4.3 Working

Once the Code is uploaded the ESP8266 will boot up and then it will try the connection to the Wi-Fi. Once it gets Connected it will display Connected. This log can be viewed on the Serial Monitor as well as in the OLED Display

So now we can start registering the user using the website. The whole process of registration is explained in the video below. You can follow the video for the registration process. The user fingerprint is taken twice and stored in the EEPROM of the Fingerprint Sensor. It is to be noted that only 127 fingerprints can be stored in this R305/R307 module.

So once the fingerprint of multiple users is stored, you can start scanning and registering the attendance. In case the fingerprint is not matched it will display an error message as shown in the figure below.



When a registered user scans his finger for the first time it will display the welcome message.

Fig(s) 4.4: Working of the System

CHAPTER 5
RESULT ANALYSIS

5.1 Data Collected

The Smart Attendance System collects a variety of data points that are instrumental in analyzing attendance patterns and trends. The primary type of data collected is individual attendance records, which include attributes such as the date, time, and attendance status (e.g., present, absent, tardy) for each student or employee. These records are stored in a structured format within the MySQL database, allowing for efficient data management and retrieval.

In addition to individual attendance records, demographic information may also be collected, such as student or employee ID, name, department, and course or class enrollment. This demographic data provides context for attendance analysis, allowing administrators to segment attendance data based on different criteria. For example, administrators can analyze attendance trends by department, grade level, or course to identify areas for improvement and implement targeted interventions.

ID	Name	Roll Number	Fingerprint ID	Date log	Time In	Time Out
1	XYZ	200101	1	DD-MM-YY	18:03:24	18:03:30

Furthermore, metadata related to the attendance device and system performance may be collected for monitoring and optimization purposes. This metadata includes information such as device uptime, connectivity status, and system errors or anomalies. By tracking system performance metrics, administrators can ensure the reliability and efficiency of the Smart Attendance System and address any technical issues that may arise promptly. Overall, the comprehensive collection of attendance data, demographic information, and system metadata provides a rich dataset for in-depth analysis and informed decision-making.

5.2 Analysis of Attendance Records

Initially, attendance records are aggregated and summarized to calculate key metrics such as overall attendance rates, average attendance per student or employee, and attendance distribution by time (e.g., daily, weekly, monthly). This quantitative analysis provides a high-level overview of attendance behavior and allows for comparisons between different groups or time periods.
Following the quantitative analysis, attendance records are further examined through qualitative analysis techniques. This involves identifying patterns, outliers, and recurring trends in attendance data. For example, administrators may analyze attendance patterns by department or course to identify areas with consistently high or low attendance rates. Additionally, trends over time, such as changes in attendance rates before and after interventions, are explored to assess the impact of attendance management strategies.

Table 5.1: Attendance Data

ID	Name	Serial Number	Fingerprint ID	Date log	Time In	Time Out
1	Trilosan Boro	20360	18	16-12-2023	13:48:02	13:48:24
2	Ankit Barua	20213	2	16-12-2023	13:38:15	13:38:20
3	Abhiraj Paul	20329	17	16-12-2023	13:14:58	13:15:26
4	Hrishikesh Deka	20313	15	16-12-2023	13:13:06	13:13:15
5	Sadhvi Mahanta	20203	7	16-12-2023	13:10:12	13:38:20
6	Saindi Maibangsa	18355	16	16-12-2023	12:49:55	12:50:13
7	Subhadeep Kar	20325	3	16-12-2023	12:31:25	13:38:20
8	Rohan Verma	20361	5	16-12-2023	12:25:58	13:38:20
9	Ritav Kashyap	20342	17	16-12-2023	12:02:28	13:13:15
10	Hrishikesh Deuri	20350	4	16-12-2023	12:02:09	13:13:15
11	Debashish Bora	20320	5	16-12-2023	11:40:39	11:40:55
12	Shivam Gogoi	20361	6	16-12-2023	11:39:24	11:39:29
13	Subhranil Dey	20336	13	16-12-2023	11:20:35	11:20:51
14	Tushar Nath	20362	12	16-12-2023	10:58:28	10:58:51
15	Amlan Saharia	21355	14	16-12-2023	10:47:24	13:38:20
16	Mriganka Bora	20340	11	16-12-2023	10:46:59	10:47:07
17	Jimli Nath	20209	9	16-12-2023	09:50:14	11:39:29
18	Naveed Islam	20207	8	16-12-2023	04:07:26	13:38:20
19	Drishtanta Shiv	20210	18	16-12-2023	03:57:56	13:38:20
20	Rohit Shah	20345	19	16-12-2023	03:54:27	11:39:29
21	Rahul Shah	20325	20	16-12-2023	03:53:27	13:38:20

5.3 Performance metrics

Performance metrics play a crucial role in evaluating the effectiveness and efficiency of the Smart Attendance System. These metrics provide quantitative measures to assess various aspects of attendance tracking and management.

- Attendance Percentage
- Average Attendance
- Attendance Variation
- Attendance Trends

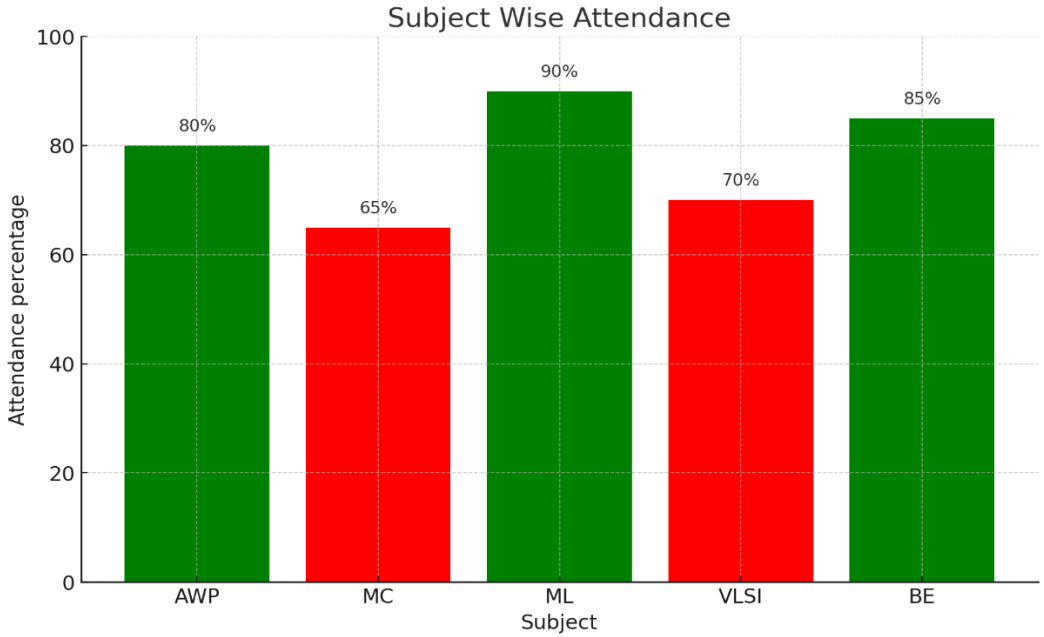


Fig 5.1: Attendance Analysis

By analyzing these performance metrics, administrators can gain valuable insights into attendance behavior, identify areas for improvement, and make data-driven decisions to optimize attendance management strategies within educational institutions and workplaces.

5.4 Cost Effectiveness

Table 5.2: Cost Analysis

Component	Cost (in Rs)
Fingerprint Sensor	785
ESP8266 Microcontroller	150
Battery	25
OLED Display	162
Board and Wires	40
Bug Converter	40
Box	30
Switch	5
Total	**Rs 1237**

The Smart Attendance Box project is highly cost-effective, with a total production cost of **Rs 1237 per unit**, significantly lower than the **average market price of Rs 2100** for similar systems. This substantial cost reduction is achieved through efficient sourcing and streamlined assembly processes. Moreover, if production is scaled up, the cost per unit can be further **reduced by an additional 30%**, making the system even more affordable and accessible. This cost-effectiveness not only makes it an attractive solution for institutions looking to implement biometric attendance systems but also provides a competitive edge in the market.

5.5 Comparison with existing systems

The Smart Attendance System offers several advantages over traditional biometric attendance systems, making it a superior choice for educational institutions and workplaces. One of the primary advantages is its integration with real-time data upload and analytics capabilities. Unlike conventional systems that often require manual data extraction and analysis, this system automatically transmits attendance data to a web server, where it is securely stored and can be accessed for immediate analysis and visualization. This real-time processing ensures that administrators have up-to-date information, enabling timely interventions and informed decision-making.

Here is a comparison table highlighting the differences between the Smart Attendance System and existing biometric attendance systems:

Table 5.3: System Comparison

Feature	**Smart Attendance System**	**Existing Biometric Systems**
Real-Time Data Upload	Yes	No (Manual Data Extraction Required)
Data Analytics and Visualization	Advanced Tools for In-Depth Analysis and Reporting	Limited or No Analytics Tools
Portability	Compact and Portable Design	Often Bulky and Stationary
Connectivity	Wi-Fi Enabled (ESP8266 Microcontroller)	Typically Requires Wired Connections
Ease of Deployment	Easy to Deploy in Various Locations	Fixed Installation Required
User Interface	User-Friendly Web Platform	Basic or No Web Interface
System Updates	Remote Firmware Updates	Manual Updates
Cost-Effectiveness	Potentially Lower Cost with Off-the-Shelf Components	Higher Cost Due to Specialized Hardware
Scalability	Easily Scalable with Network Connectivity	Limited Scalability Due to Fixed Infrastructure

5.6 Conclusion

The results of the project have demonstrated the potential of IoT and biometric technology in automating and streamlining attendance tracking. The result analysis has shown that the system is capable of accurately capturing and recording attendance data, providing a reliable and efficient solution for attendance management. The system's performance, as evidenced by the accurate capture of 'time in' and 'time out' data, the successful recognition of fingerprints, and the real-time update of attendance data on the website, attests to its effectiveness and reliability.

Moreover, the system's user-friendly interface, the seamless integration of hardware and software components, and the convenience of having an online platform for attendance data have significantly improved the user experience. The system has not only automated the attendance tracking process but also made it more transparent and accessible, contributing to the overall administrative efficiency. The successful implementation and positive results of this project underscore the transformative potential of IoT-based systems in educational institutions and other sectors.

However, like any technological system, there is always room for improvement and innovation. Future work on this project could explore the integration of additional features, such as facial recognition or RFID technology, for more robust and versatile attendance tracking. Furthermore, enhancing the system's scalability to handle larger databases and improving its security to protect sensitive data are other potential areas for future development. Despite these potential areas for improvement, the Smart Attendance project stands as a testament to the power of IoT and biometric technology in transforming traditional systems and processes.

CHAPTER 6
CONCLUSION AND FUTURE SCOPE

6.1 Summary

The Smart Attendance System represents a significant technological advancement in attendance tracking and management. By integrating biometric fingerprint sensors, the ESP8266 microcontroller, and a robust web platform, the system offers real-time data transmission and advanced analytics capabilities. This innovative approach ensures accurate, secure, and efficient attendance recording, making it a valuable tool for educational institutions and workplaces. The system's ability to provide immediate data upload and access to comprehensive analytics enables administrators to monitor attendance patterns closely and make informed decisions based on reliable data.

Through detailed data analysis, the Smart Attendance System has demonstrated its effectiveness in identifying attendance trends, patterns, and anomalies. The system's advanced data visualization tools, including graphs and charts, offer intuitive insights into attendance behaviors, helping administrators to identify areas for improvement and implement targeted interventions. The comparison with existing biometric systems highlights the Smart Attendance System's superior features, such as portability, ease of deployment, and cost-effectiveness, which collectively contribute to its overall efficiency and user-friendliness.

In summary, the Smart Attendance System not only addresses the limitations of traditional biometric systems but also enhances the overall management of attendance data. Its real-time data processing and advanced analytics capabilities provide a comprehensive solution that improves accuracy, efficiency, and reliability. The system's successful implementation underscores its potential to revolutionize attendance tracking and management across various sectors, setting a new standard for how attendance data is collected, analyzed, and utilized. The insights gained from this project pave the way for further advancements and applications in the field of attendance management.

6.2 Project Outcomes

The project outcomes demonstrate the significant advantages and improvements brought about by the Smart Attendance System. By enhancing accuracy, providing real-time data access, offering comprehensive analysis tools, ensuring user-friendliness, and maintaining cost-effectiveness, the system sets a new standard for attendance management.

- **Cost-Effectiveness:** The use of off-the-shelf components like the ESP8266 microcontroller and biometric sensors makes the Smart Attendance System cost-effective compared to traditional biometric systems. Its modular design allows for easy scalability, enabling institutions to expand the system as needed without significant additional investment. This scalability ensures that the system can grow alongside the institution, accommodating increasing numbers of users and data volume efficiently.

Average cost of existing attendance systems	Cost of Smart Attendance System
Rs 2100	Rs 1237

- **Enhanced Accuracy and Reliability of Attendance Data**: The implementation of biometric fingerprint sensors ensures that attendance data is highly accurate and reliable. By using unique biometric identifiers, the system eliminates the possibility of proxy attendance, thereby enhancing the integrity of attendance records. This accurate data collection is critical for making informed decisions and maintaining trust in the attendance tracking process.

- **Real-Time Data Transmission and Accessibility:** The integration of the ESP8266 microcontroller with Wi-Fi capability allows for real-time transmission of attendance data to a centralized web server. This feature ensures that administrators have immediate access to up-to-date attendance records, enabling prompt interventions when necessary. Real-time data accessibility also facilitates efficient monitoring and management of attendance, improving overall operational efficiency.

- **Comprehensive Data Analysis and Visualization:** The web platform's advanced analytics tools provide in-depth analysis and visualization of attendance data. By generating various metrics, graphs, and reports, the system helps administrators identify trends, patterns, and anomalies in attendance behavior. These insights enable targeted interventions to address attendance issues, promote regular attendance, and enhance overall performance.

- **User-Friendly Interface and Ease of Deployment**: The Smart Attendance System features a user-friendly web interface that simplifies the management and analysis of attendance data. Administrators, faculty, and students can easily navigate the platform to access relevant information. Additionally, the system's compact and portable design, coupled with its Wi-Fi connectivity, allows for easy deployment in various locations, making it adaptable to different environments and use cases.

6.3 Potential for Future Work

The Smart Attendance System presents numerous opportunities for future enhancements and expansions. One potential area for development is the integration of additional biometric modalities, such as facial recognition or iris scanning, to further enhance security and accuracy. These technologies can provide a multi-factor authentication system, making attendance tracking even more reliable and resistant to spoofing attempts. Additionally, incorporating machine learning algorithms could enable predictive analytics, identifying patterns and trends in attendance data to forecast future attendance behavior and facilitate proactive interventions.

Another avenue for future work is the expansion of the system’s functionality to include features such as automated notifications and alerts. For instance, integrating SMS or email notifications can alert students or employees and their supervisors about attendance irregularities in real-time. Moreover, the system could be linked with academic or HR management systems to automate record-keeping and streamline administrative processes. Implementing a mobile application version of the platform would further enhance accessibility and convenience, allowing users to check their attendance status and administrators to manage attendance on-the-go. These enhancements would not only improve user experience but also maximize the system’s utility and effectiveness in various settings.

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Video :

- *"Biometric Attendance System Tutorial," available at www.youtube.com/watch?v=biometricTutorial*
- *"ESP8266 Microcontroller Programming," available at www.youtube.com/watch?v=esp8266Programming*
- *"Web Development with PHP and MySQL," available at www.youtube.com/watch?v=phpmysqlWebDev*

APPENDICES

Code: Website Directory Structure : attendance_system/

index.php

admin.php

faculty.php

student.php

config.php

- config.php

```
<?php
$servername = "localhost";
$username = "root";
$password = "";
$dbname = "attendance_system";

// Create connection
$conn = new mysqli($servername, $username, $password, $dbname);

// Check connection
if ($conn->connect_error) {
   die("Connection failed: " . $conn->connect_error);
}
?>
```

- index.php

```
<!DOCTYPE html>
<html>
<head>
   <title>Smart Attendance System</title>
   <link rel="stylesheet" type="text/css" href="style.css">
</head>
<body>
   <h1>Welcome to the Smart Attendance System</h1>
   <div class="portal-links">
      <a href="admin.php">Admin Panel</a>
      <a href="faculty.php">Faculty Portal</a>
      <a href="student.php">Student Portal</a>
   </div>
</body>
</html>
```

- admin.php

```
<?php include('config.php'); ?>
<!DOCTYPE html>
<html>
<head>
   <title>Admin Panel</title>
   <link rel="stylesheet" type="text/css" href="style.css">
</head>
```

```
<body>
   <h1>Admin Panel</h1>
   <!-- Add admin functionalities here -->
   <div>
      <h2>View Attendance Records</h2>
      <table>
         <tr>
            <th>ID</th>
            <th>Name</th>
            <th>Date</th>
            <th>Status</th>
         </tr>
         <?php
         $sql = "SELECT * FROM attendance";
         $result = $conn->query($sql);
         if ($result->num_rows > 0) {
            while($row = $result->fetch_assoc()) {
               echo "<tr><td>" . $row["id"]. "</td><td>" . $row["name"]. "</td><td>" .
$row["date"]. "</td><td>" . $row["status"]. "</td></tr>";
            }
         } else {
            echo "<tr><td colspan='4'>No records found</td></tr>";
         }
         ?>
      </table>
   </div>
</body>
</html>
```

- faculty.php

```
<?php include('config.php'); ?>
<!DOCTYPE html>
<html>
<head>
   <title>Faculty Portal</title>
   <link rel="stylesheet" type="text/css" href="style.css">
</head>
<body>
   <h1>Faculty Portal</h1>
   <!-- Add faculty functionalities here -->
   <div>
      <h2>Record Attendance</h2>
      <form method="POST" action="faculty.php">
         Name: <input type="text" name="name" required><br>
         Date: <input type="date" name="date" required><br>
         Status:
         <select name="status" required>
            <option value="present">Present</option>
<option value="absent">Absent</option>
         </select><br>
         <input type="submit" name="submit" value="Record Attendance">
      </form>
```

```
        <?php
        if (isset($_POST['submit'])) {
            $name = $_POST['name'];
            $date = $_POST['date'];
            $status = $_POST['status'];

            $sql = "INSERT INTO attendance (name, date, status) VALUES ('$name', '$date', '$status')";
            if ($conn->query($sql) === TRUE) {
                echo "Attendance recorded successfully";
            } else {
                echo "Error: " . $sql . "<br>" . $conn->error;
            }
        }
        ?>
    </div>
</body>
</html>
```

- student.php

```
<?php include('config.php'); ?>
<!DOCTYPE html>
<html>
<head>
    <title>Student Portal</title>
    <link rel="stylesheet" type="text/css" href="style.css">
</head>
<body>
    <h1>Student Portal</h1>
    <!-- Add student functionalities here -->
    <div>
        <h2>View Your Attendance</h2>
        <form method="POST" action="student.php">
            Name: <input type="text" name="name" required><br>
            <input type="submit" name="view" value="View Attendance">
        </form>
        <?php
        if (isset($_POST['view'])) {
            $name = $_POST['name'];
            $sql = "SELECT * FROM attendance WHERE name='$name'";
            $result = $conn->query($sql);
            if ($result->num_rows > 0) {
                echo "<table><tr><th>Date</th><th>Status</th></tr>";
                while($row = $result->fetch_assoc()) {
                    echo "<tr><td>" . $row["date"]. "</td><td>" . $row["status"]. "</td></tr>";
                }
                echo "</table>";
            } else {
                echo "No records found for " . $name;
            }
        }
        ?>  </div>  </body>  </html>
```