A Project Report On

BIOMETRIC & FACIAL AUTHENTICATION ATTENDANCE MANAGEMENT

Submitted in partial fulfillment of the requirement in

B.TECH. INFORMATION AND COMMUNICATION TECH.

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Internal Guide

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Certificate

This is to certify that the project work entitled

Biometric & facial authentication attendance management

submitted in partial fulfillment of the requirement for the course in

B.Tech. Information and communication tech.

of the Institute of Advanced Research

is a result of the bonafide work carried out by

Dev Ajitkumar Wadhvani – IAR/11947

during the academic year 2023-2024

Faculty Guide **Head of Dept.**

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Dev Ajitkumar Wadhvani – IAR/11947 **Signature: _____**

1.Synopsis

In an increasingly interconnected world, the need for robust security measures is paramount. This project introduces an innovative IoT-based facial and biometric authentication system, leveraging the ESP 8266 NodeMCU and ESP32 CAM module. The system aims to provide secure access control by integrating facial recognition and biometric authentication, ensuring enhanced security for various applications. Using embedded C programming, the project seamlessly merges hardware and software components to create a reliable and efficient authentication mechanism.

In this project , application of this system is to verify facial and biometric data and take attendance .We can say the project is about Facial and Biometric Authentication smart attendance system. Also store this data on a database connected with a website made using PHP. This data base is directly connected to ESP 8266 NodeMCU which has a inbuilt Wi-Fi module.

By harnessing the capabilities of the ESP 8266 NodeMCU, the system establishes a seamless connection to the internet, facilitating real-time data transmission and analysis. The ESP32 CAM module, equipped with a 2MP camera, plays a pivotal role in capturing and processing facial and biometric data, ensuring accurate and reliable attendance records.

Through the implementation of sophisticated sensors, algorithms, and data processing techniques, the system guarantees swift and accurate authentication, minimizing the risk of proxy attendance and unauthorized access.

The successful implementation of this IoT-based facial and biometric attendance system showcases its capacity to modernize attendance management. This project represents a significant advancement in leveraging IoT technology for creating sophisticated, yet user-friendly attendance solutions, with the potential to enhance operational efficiency and accountability in diverse organizational environments.

2.Preamble

2.1 General Introduction

In today's fast-paced digital era, the need for robust security measures and streamlined attendance management has become increasingly critical in various domains, including education, corporate sectors, and sensitive facilities. With the rapid advancement of Internet of Things (IoT) technology, integrating facial and biometric authentication for attendance tracking has emerged as a cutting-edge solution, offering heightened security and enhanced efficiency. This project focuses on the development of an IoT-based facial and biometric attendance system using the ESP 8266 NedeMCU and ESP32 CAM module, with a key emphasis on the authentication of facial and biometric data for attendance management.

The importance of authenticating facial and biometric data for attendance purposes cannot be understated. Traditional attendance systems often suffer from drawbacks such as manual data entry errors, time-consuming processes, and the possibility of proxy attendance, leading to inaccuracies and inefficiencies. By implementing a sophisticated IoT-based solution that integrates facial recognition and biometric authentication, this project addresses these limitations, offering a highly secure and automated method for monitoring attendance.

The integration of facial recognition and biometric authentication not only ensures a more accurate and reliable attendance tracking mechanism but also enhances security by mitigating the risks associated with unauthorized access and fraudulent activities. This project's significance lies in its ability to provide organizations with a comprehensive, technologically advanced, and user-friendly attendance management system, reducing administrative burdens, improving operational efficiency, and fostering a secure environment. By harnessing the power of IoT, this project paves the way for a seamless and intelligent attendance management system that aligns with the demands of the contemporary digital landscape.

2.2 Statement of Problem

The conventional methods of attendance management in educational institutions

and workplaces are often marred by inefficiencies, inaccuracies, and security vulnerabilities. Manual attendance processes are prone to errors, leading to discrepancies in the records and creating challenges for administrators in ensuring the accuracy and reliability of attendance data. Moreover, traditional methods lack the capability to prevent proxy attendance, posing a significant threat to the integrity of attendance records. Considering these challenges, there is a pressing need for a more sophisticated and secure attendance management system that can authenticate facial and biometric data, ensuring the integrity of attendance records while minimizing the potential for fraudulent activities. This project aims to address these shortcomings by developing an IoT-based facial and biometric attendance system that integrates advanced security measures to enhance the accuracy, efficiency, and security of attendance management in various organizational settings.

2.3 Objective of Study.

The primary objective of this study is to design and implement an IoT-based facial and biometric attendance system that can authenticate and track attendance more accurately and securely in educational institutions and workplaces. This project aims to develop a reliable and efficient solution that leverages facial recognition and biometric authentication to create a robust attendance management system, thereby mitigating the risks associated with manual attendance processes. The study focuses on integrating the ESP 8266 NodeMCU and ESP32 CAM module and interfacing camera, R307 Fingerprint Sensor to the main module. We use ESP 8266 NodeMCU's inbuilt Wi-Fi module to establish a secure and seamless connection with the database created in MYSQL linked with website crafted in Apache framework for data transmission and analysis. By employing advanced algorithms and data processing techniques, the project seeks to ensure real-time authentication of facial and biometric data, thereby enhancing the overall integrity and reliability of attendance records. Additionally, the study aims to streamline the attendance management process, reducing administrative overhead and fostering a more secure and accountable environment for organizations relying on precise attendance data for various operational and regulatory purposes.

2.4 Feasibility study

1. Technical Feasibility:

The technical feasibility of this project is supported by the availability of advanced hardware components, such as the ESP 8266 NodeMCU and ESP32 CAM module, which can facilitate seamless data transmission and processing. Additionally, the accessibility of embedded C programming provides a suitable platform for integrating facial recognition and biometric authentication functionalities. The extensive documentation and community support for these technologies ensure that the project's technical requirements can be met effectively.

2. Financial Feasibility:

The financial feasibility of the project is based on the cost-effectiveness of the selected hardware components and the availability of open-source software resources. The affordability and widespread availability of the ESP 8266 NodeMCU and ESP32 CAM module contribute to the project's financial viability. Moreover, the utilization of open-source programming languages and libraries reduces the overall development costs, making the implementation of the IoT-based facial and biometric attendance system a financially feasible venture for educational institutions and small to medium-sized enterprises.

3. Operational Feasibility:

The operational feasibility of the project is supported by the user-friendly nature of the proposed attendance system. The integration of facial recognition and biometric authentication simplifies the attendance management process, reducing the need for manual data entry and supervision. The system's ability to operate in real-time enhances its practicality for various organizational settings, ensuring timely and accurate attendance tracking without significant disruptions to existing operational workflows.

4. **Legal and Ethical Feasibility:**

The project aligns with legal and ethical considerations by prioritizing data privacy and security. By adhering to data protection regulations and ethical standards, the system ensures the confidentiality and integrity of biometric data, thus mitigating potential legal risks. Furthermore, the project's focus on enhancing security measures contributes to creating an ethical framework that

emphasizes the responsible use of biometric and facial recognition data for attendance management purposes.

Based on the comprehensive analysis of technical, financial, operational, and legal aspects, the feasibility study indicates a strong rationale for the successful implementation and deployment of the IoT-based facial and biometric attendance system in various organizational environments.

3. Review of Literature

3.1 Introduction to Tools & Software Used

Tools:

ESP8266 NodeMCU Microcontroller:
The ESP8266 NodeMCU microcontroller served as the central processing unit for handling fingerprint data. Its reliable processing capabilities and compatibility with various components made it an ideal choice for managing the authentication process.

ESP32 CAM Module:
Equipped with a high-resolution 2MP camera, the ESP32 CAM module acted as a pivotal tool for capturing and processing facial data. Its efficient interface capabilities and image processing functionalities were instrumental in facilitating accurate facial recognition.

R307S Fingerprint Scanner:
The integration of the R307S Fingerprint Scanner enabled the secure and reliable authentication of biometric data. Its advanced scanning capabilities and compatibility with the ESP8266 NodeMCU enhanced the system's ability to authenticate users based on their unique biometric profiles.

0.96" OLED Display:
The 0.96" OLED Display by adafruit systems, interfaced with the ESP8266 NodeMCU, provided a convenient visual interface for displaying real-time system status and user authentication information. Its compact design and clear display enhanced the user experience and facilitated seamless interaction with the attendance system.

Software:

Arduino IDE:
Arduino IDE served as the primary software platform for developing and writing embedded C code for each hardware component. Its user-friendly interface and extensive library support streamlined the coding process, enabling efficient integration and programming of the ESP8266 NodeMCU and ESP32 CAM

Module.

Database and Website:
The creation of a comprehensive database using MySQL and a user-friendly website using PHP played a pivotal role in managing and storing attendance data efficiently. The database facilitated the secure storage and retrieval of user information and attendance records, while the website's intuitive interface simplified the process of adding or removing users and managing attendance data effectively.

The strategic utilization of these advanced tools and software not only streamlined the development process but also contributed significantly to the overall functionality and efficiency of the IoT-based facial and biometric attendance system, underscoring its potential for seamless integration into various organizational settings.

3.2 Introduction of System Operations:

The IoT-based facial and biometric attendance system operates through a seamless integration of hardware components and software applications, ensuring secure and efficient attendance management in diverse organizational environments. The system's operations encompass a series of interconnected processes that facilitate real-time authentication, data processing, and storage, thereby creating a comprehensive and reliable attendance tracking mechanism.

Facial Data Authentication:
The system initiates the operation by capturing facial data through the integrated 2MP camera of the ESP32 CAM module. The captured images are then processed using advanced image recognition algorithms to authenticate the identity of the individual attempting to record their attendance. The facial data authentication process involves comparing the captured image with pre-registered facial data stored in the system's database, ensuring accurate and reliable identification of users.

Biometric Data Authentication:
Simultaneously, the system engages the R307S Fingerprint Scanner to authenticate users based on their unique biometric data. The scanner captures the fingerprint data, which is then processed and matched against the stored biometric profiles within the system. The biometric data authentication process enhances the security of the attendance system by providing an additional layer of verification for user identification.

Data Processing and Display:
Following successful authentication, the ESP8266 NodeMCU processes the data and triggers the 0.96" OLED Display to present the authentication status, displaying relevant information such as user identification and attendance confirmation. The OLED display offers a user-friendly interface, providing real-time feedback on the authentication process, thus ensuring transparency and accountability in attendance management.

Data Storage and Management:
The attendance data, including the authenticated facial and biometric information, is securely stored, and managed within the system's database. The database facilitates the systematic organization and retrieval of attendance records, enabling administrators to monitor and track attendance data over time. Additionally, the system's integration with a dedicated website allows for easy

user management, enabling administrators to add or remove users and monitor attendance data remotely.

Through these systematic operations, the IoT-based facial and biometric attendance system ensures a secure, efficient, and user-friendly approach to attendance management, underscoring its potential to streamline operations and enhance security in diverse organizational settings.

4. Technical Description

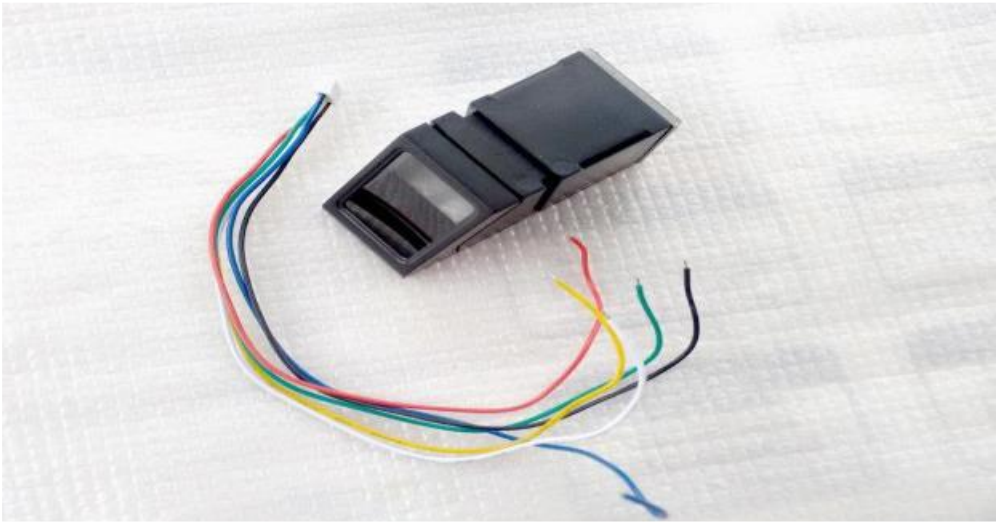
4.1 Hardware Requirements

1.ESP 8266 NodeMCU:

NodeMCU is open source development board integrated with ESP8266-12E Wi-Fi module chip. This helps the board to connect to the internet and upload data collected from sensors to internet. Its low cost, low power, compact design, and wireless connectivity make it perfectly compatible for IoT applications.

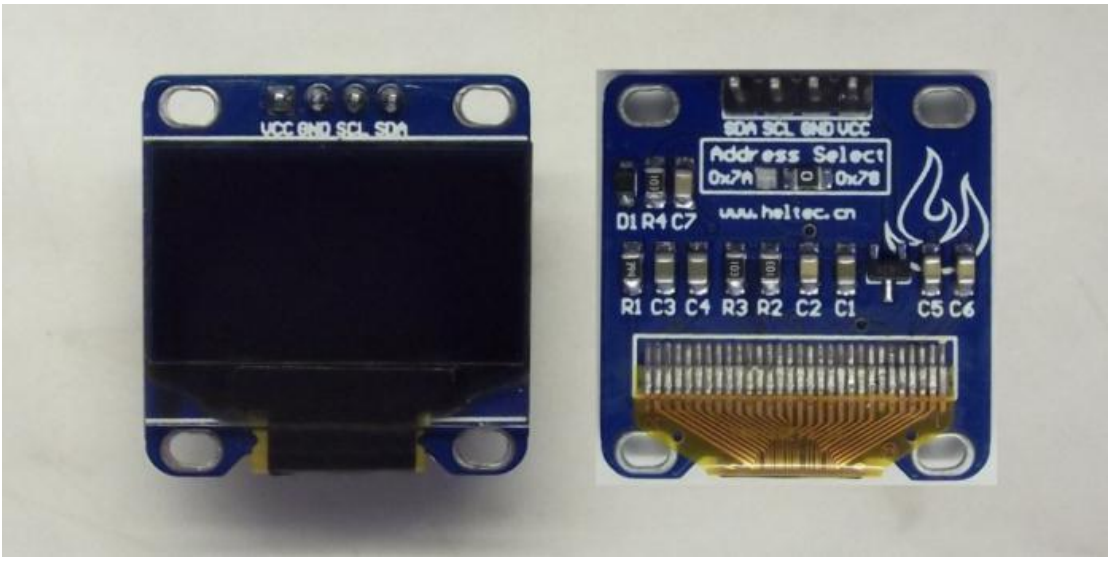
2.R-307 Fingerprint Scanner:

The R-307 is an advanced self-contained optical scanner designed for streamlined fingerprint recognition and authentication. Boasting automatic calibration, it ensures precision and consistency in its operations. With its capacity for encrypting fingerprint data and seamless integration with a system's database, it prioritizes security and data integrity. The device is adept at converting fingerprints into high-quality template files, while its seamless connection with an embedded board enhances its versatility. During enrollment, the scanner captures fingerprints twice, generating a compact 512-byte template stored within a designated finger library location. For matching, it conducts a single scan and employs the 1:N method to compare templates with the data in the library, accommodating storage for up to 1000 fingerprints. Utilizing serial communication at a 9600bps baud rate, it facilitates efficient data transfer. Operating within the range of DC 3.3v to 5v, and drawing approximately 50mA of current, the R-307 underscores its reliability and efficiency in various biometric authentication scenarios.



3. OLED 0.96 Display:

We have used OLED 0.96 Display to display information about Wi-Fi connection, to guide for enroll process, to display the status of fingerprint matching and also to display errors in the system. This is 0.96” OLED display which has a resolution of 128*64. It can be interfaced with any micro-controller using SPI/IIC protocols.



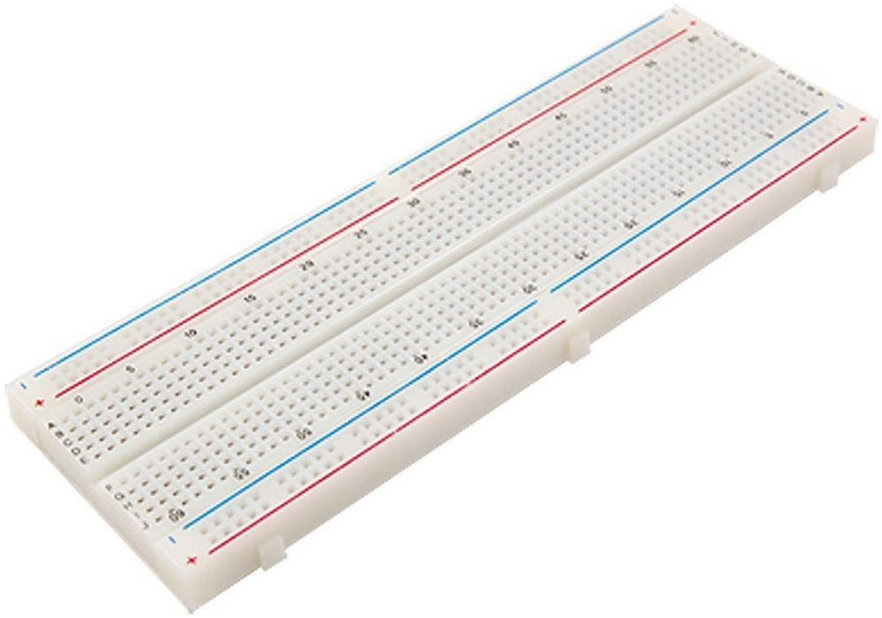
4. ESP32 Cam Module:

Equipped with a high-resolution 2MP camera, the ESP32 CAM module acted as a pivotal tool for capturing and processing facial data. Its efficient interface capabilities and image processing functionalities were instrumental in facilitating accurate facial recognition.

5. Breadboards:

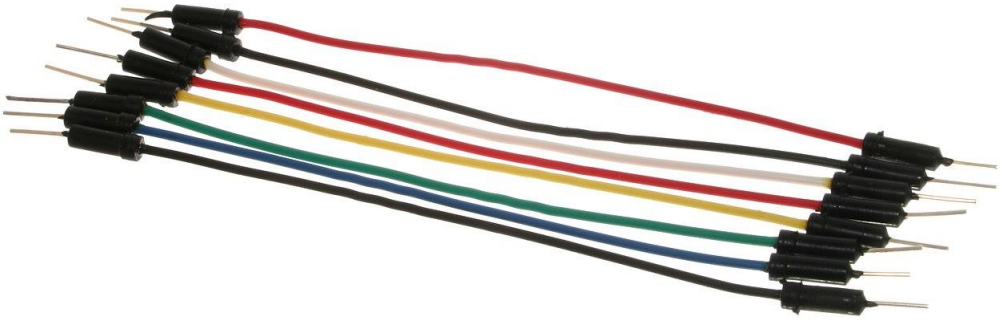
A breadboard is a fundamental tool in electronics prototyping and experimentation. It provides a platform for engineers and hobbyists to quickly and easily build and test electronic circuits without the need for soldering. Essentially, it allows for the temporary connection of electronic components, such as resistors, capacitors, and integrated circuits, by placing them into the array of interconnected sockets on the board. These sockets are typically arranged in rows and columns, facilitating the creation of complex circuits using jumper wires to establish connections between components. Breadboards are

invaluable for rapid iteration and testing of circuit designs before creating permanent soldered versions on a printed circuit board (PCB).



5. Jumper Cables:

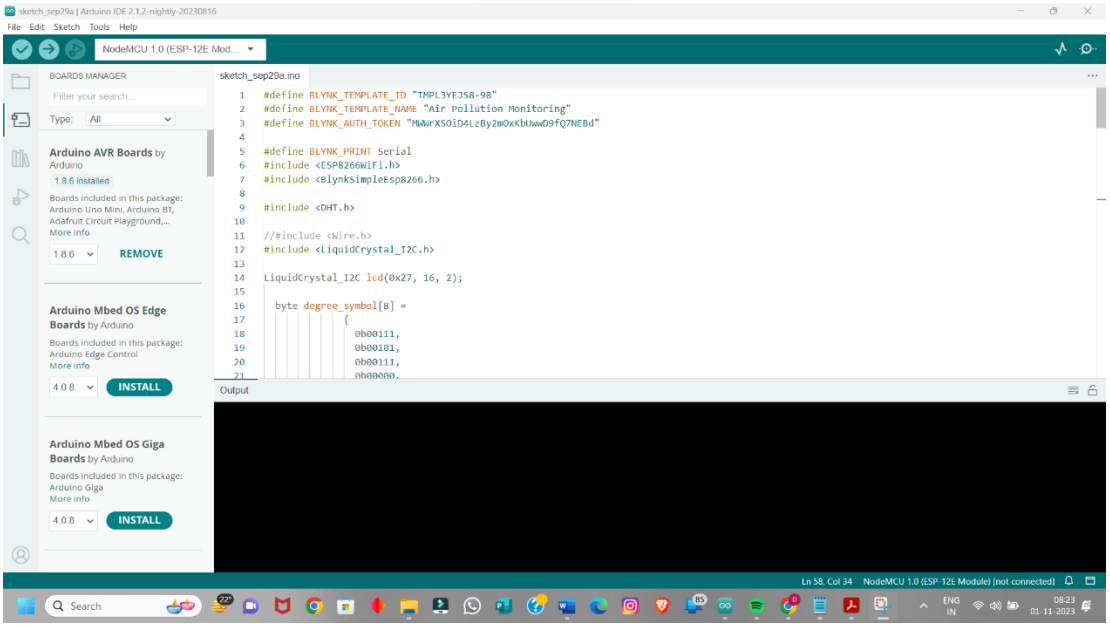
A jump wire (also known as jumper, jumper wire, DuPont wire) is an electrical wire, or group of them in a cable, with a connector or pin at each end (or sometimes without them – simply "tinned"), which is normally used to interconnect the components of a breadboard or other prototype or test circuit, internally or with other equipment or components, without soldering.



4.2 Software Requirements

1.Arduino IDE:

Arduino IDE is a cross-platform software application where we can write programs in C, C++, and java. It is the only platform available for the programming of Arduino boards such as Arduino UNO, NodeMCU, etc. It contains different types of library files that are required for different types of sensor coding. Arduino IDE makes programming easy by providing several example codes and we must modify it according to our need, also it contains different libraries for different sensors.

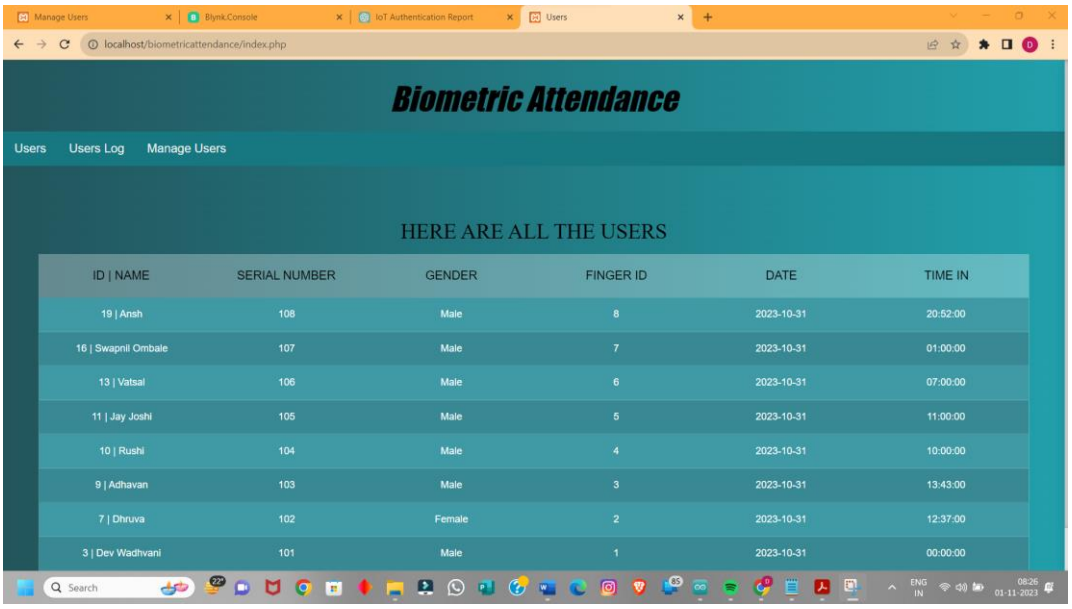


2.Database and Website:

The creation of a comprehensive database and a user-friendly website played a

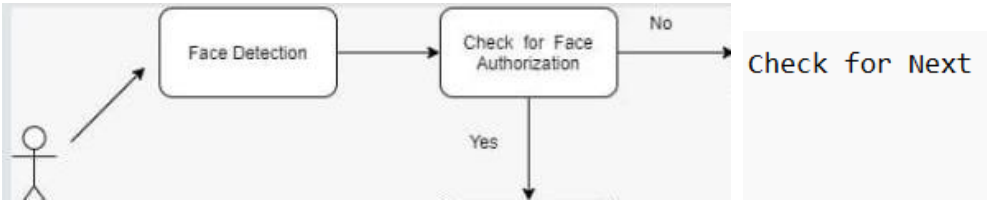
pivotal role in managing and storing attendance data efficiently. The database facilitated the secure storage and retrieval of user information and attendance records, while the website's intuitive interface simplified the process of adding or removing users and managing attendance data effectively.

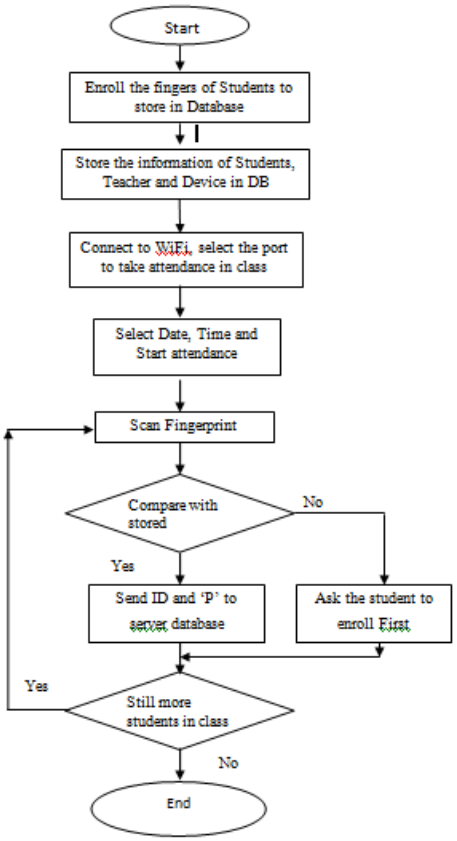
The strategic utilization of these advanced tools and software not only streamlined the development process but also contributed significantly to the overall functionality and efficiency of the IoT-based facial and biometric attendance system, underscoring its potential for seamless integration into various organizational settings



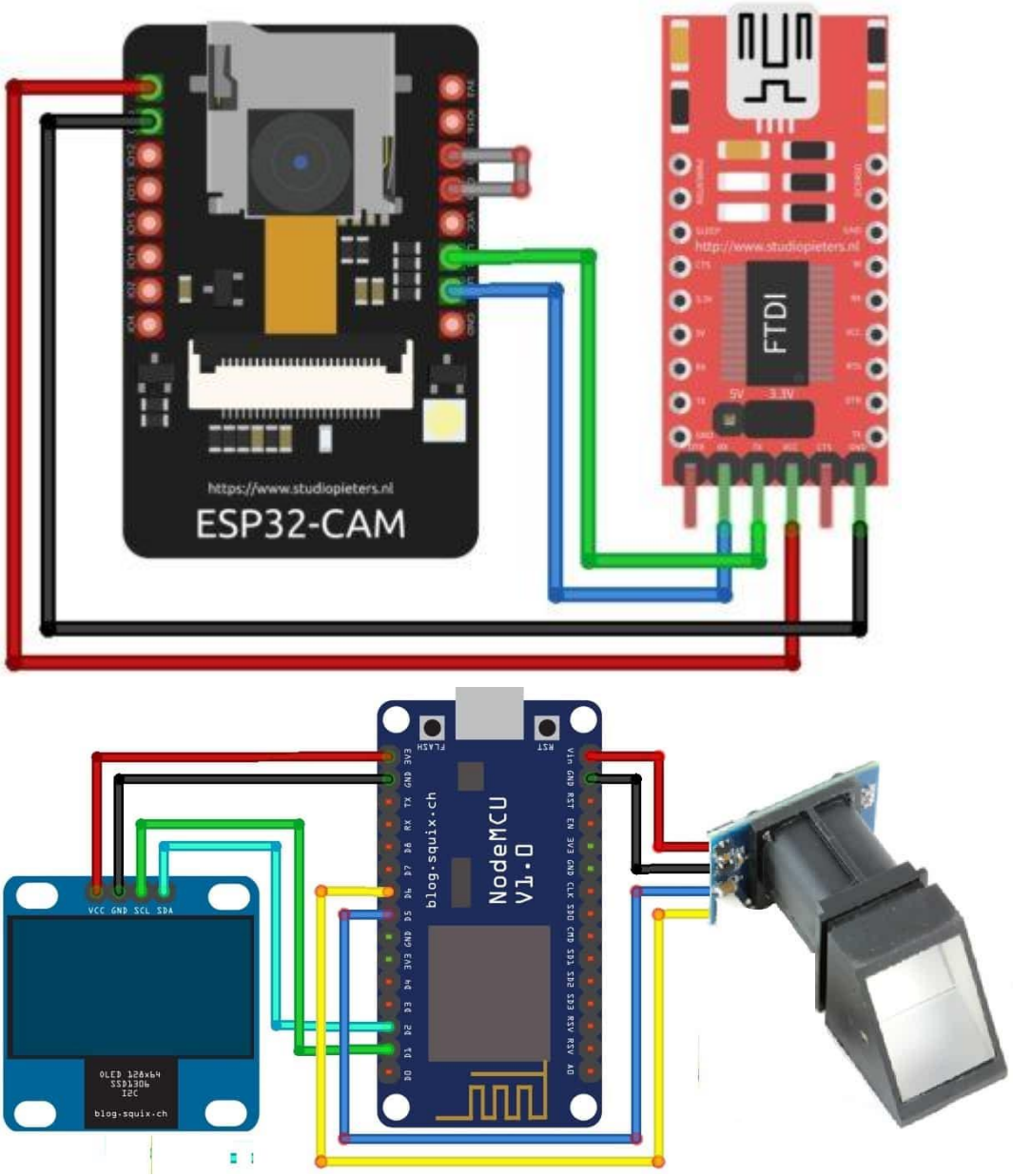
5.System Design & Development

5.1 Flowchart

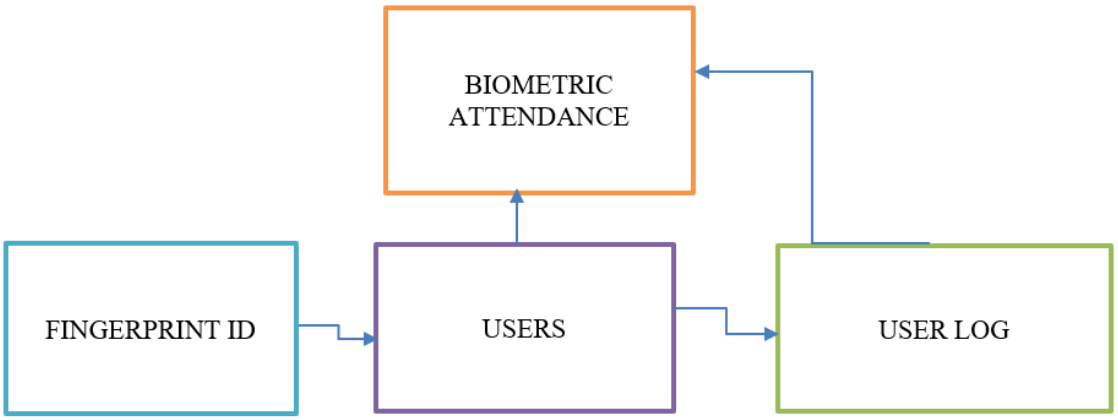




5.2 Circuit Diagram



5.3 Database Design



6.System Testing

6.1 Testing and Implementation

The testing and implementation phase of the IoT-based facial and biometric attendance system involved a comprehensive approach to ensure the functionality, reliability, and security of the system in real-world scenarios. The process encompassed rigorous testing protocols and meticulous implementation strategies to validate the system's performance and usability.

Hardware Integration Testing:
The initial phase focused on conducting hardware integration testing, wherein each hardware component, including the ESP8266 NodeMCU, ESP32 CAM module, R307S Fingerprint Scanner, and 0.96" OLED Display, underwent thorough performance evaluations. The testing protocols involved verifying the seamless integration of the hardware components, assessing their compatibility, and confirming their functionality in tandem with the system's operations.

Facial and Biometric Data Authentication Testing:
The subsequent phase involved extensive testing of the facial and biometric data authentication processes. This included conducting multiple authentication trials using registered user data and assessing the system's accuracy in recognizing facial features and fingerprint patterns. The testing protocols aimed to verify the system's ability to accurately authenticate users based on their unique biometric and facial profiles while minimizing false positives and negatives.

Real-Time Operation Testing:
The testing protocols involved simulating different attendance scenarios and assessing the system's responsiveness, accuracy, and stability in processing and displaying authentication results in real-time.

Database and Website Functionality Testing:
The final phase focused on testing the functionality of the system's database and website. This included verifying the secure storage and retrieval of attendance data, testing the user interface for adding and removing users, and assessing the system's overall responsiveness and reliability in managing attendance records and user data.

Implementation Strategy:
The implementation strategy involved a systematic deployment plan, including the installation of the hardware components on a secure and accessible platform. The software implementation encompassed the integration of the Arduino IDE,

programming the ESP8266 NodeMCU and ESP32 CAM module, and establishing a secure connection between the hardware components and the database. The implementation plan emphasized user training and orientation to ensure effective utilization and management of the IoT-based facial and biometric attendance system in practical organizational settings.

Through the comprehensive testing and meticulous implementation strategy, the IoT-based facial and biometric attendance system demonstrated its robust functionality, reliability, and security, highlighting its potential to revolutionize attendance management in diverse organizational environments.

6.2 Testing Methodology

The testing methodology for the IoT-based facial and biometric attendance system was designed to comprehensively evaluate the system's performance, accuracy, and reliability in authenticating facial and biometric data for attendance management. The testing process involved a systematic approach, encompassing various stages to ensure the seamless integration and functionality of the hardware and software components.

1. Hardware Functionality Testing:
The testing process began with evaluating the hardware functionality by powering the circuit and assessing the connectivity of the ESP8266 NodeMCU with the Wi-Fi network. This phase aimed to confirm the stable operation of the hardware components and their ability to establish a secure connection for data transmission and analysis.

2. Database Integration Testing:
The subsequent phase involved testing the database integration by adding a fingerprint ID and linking it to the corresponding user profile, including relevant information such as name and roll number. This testing phase focused on verifying the accuracy of data storage and retrieval within the database, ensuring the seamless integration of user data for attendance management.

3. Biometric and Facial Data Authentication Testing:
The testing methodology included authenticating the user's fingerprint and facial data by conducting multiple verification trials. This phase aimed to assess the system's accuracy in recognizing and validating the user's biometric and facial features, confirming the successful authentication process, and minimizing the possibility of false positives or negatives.

4. User Interface and Display Testing:
The testing process involved evaluating the user interface and display functionalities by simulating check-in and check-out scenarios. This phase focused on verifying the system's ability to display personalized messages, such as "Hello [User Name]" during check-in and "Goodbye [User Name]" during check-out, ensuring an interactive and user-friendly experience for the attendees.

5. End-to-End System Integration Testing:
The final phase encompassed comprehensive end-to-end system integration testing, including the verification of all interdependent components' functionalities. This phase aimed to validate the seamless coordination and interaction between the hardware

components, software applications, database, and user interface, ensuring the smooth and reliable operation of the complete IoT-based facial and biometric attendance system.

By implementing this rigorous testing methodology, the IoT-based facial and biometric attendance system demonstrated its robust functionality, accuracy, and user-friendly interface, underscoring its potential to revolutionize attendance management in diverse organizational settings.

6.3 Unit Testing

The unit testing phase of the IoT-based facial and biometric attendance system focused on evaluating the individual components' functionality and performance to ensure their seamless operation within the integrated system. The testing process involved a meticulous assessment of each hardware and software unit, emphasizing their ability to function independently and in conjunction with other system components.

The first unit testing phase examined the ESP8266 NodeMCU's functionality, assessing its capacity to establish a stable connection to the Wi-Fi network. The testing protocol verified the NodeMCU's ability to maintain a consistent and reliable network connection, laying the foundation for secure data transmission and communication with the database and other hardware components.

The second unit testing phase focused on evaluating the ESP32 CAM module's performance in capturing and processing facial data. This phase involved verifying the module's camera functionality and its ability to capture high-resolution images for accurate facial recognition. The testing protocols ensured that the ESP32 CAM module could seamlessly integrate with the system, providing precise and real-time facial data for authentication purposes.

The third unit testing phase centered on the R307S Fingerprint Scanner, emphasizing its ability to accurately scan and process fingerprint data. The testing process involved multiple trials to validate the scanner's efficiency in capturing distinct fingerprint patterns and its compatibility with the system's database for seamless user authentication.

The fourth unit testing phase assessed the functionality of the 0.96" OLED Display, focusing on its ability to provide clear and interactive visual feedback to users. The testing protocols evaluated the display's performance in presenting personalized messages, such as "Hello [User Name]" during check-in and "Goodbye [User Name]" during check-out, ensuring a user-friendly and intuitive interface for attendees.

By conducting rigorous unit testing for each hardware component, including the ESP8266 NodeMCU, ESP32 CAM module, R307S Fingerprint Scanner, and 0.96" OLED Display, the IoT-based facial and biometric attendance system demonstrated robust and reliable performance, highlighting its potential to streamline attendance management and enhance security in various organizational settings.

7.Conclusion

The completion of the IoT-based facial and biometric attendance system represents a significant milestone in the realm of attendance management, highlighting the successful integration of advanced hardware components and software applications to create a secure, efficient, and user-friendly solution for diverse organizational environments. Through the rigorous testing, implementation, and evaluation processes, the project has achieved its primary objectives of enhancing the accuracy, reliability, and security of attendance tracking through the authentication of facial and biometric data.

The successful deployment of the system has demonstrated its robust functionality in authenticating users' identities, minimizing the risks associated with proxy attendance and unauthorized access. By leveraging the ESP8266 NodeMCU, ESP32 CAM module, R307S Fingerprint Scanner, and 0.96" OLED Display, the project has effectively showcased the seamless integration of these hardware components, ensuring a smooth and interactive attendance management experience for users and administrators alike.

The implementation of a secure database and a user-friendly website has further enhanced the system's practicality and scalability, enabling administrators to manage user data, track attendance records, and monitor system performance with ease. The system's real-time data processing capabilities, combined with its intuitive user interface, have contributed to creating an efficient and transparent attendance management process, minimizing administrative overhead, and fostering a more secure and accountable organizational environment.

Overall, the project's successful development and implementation underscore its potential to revolutionize traditional attendance management practices, offering a sophisticated, technologically advanced, and reliable solution that aligns with the evolving demands of the digital age. The project's comprehensive approach to integrating facial recognition and biometric authentication signifies a significant step forward in leveraging IoT technology for creating efficient and secure attendance management systems, with the capacity to enhance operational efficiency and accountability in various organizational settings.

8. Learnings from the Project

The completion of the IoT-based facial and biometric attendance system has yielded valuable insights and learnings that have enhanced our understanding of both technical and practical aspects within the realm of IoT development and attendance management. The project has provided numerous key learnings that can be applied to future endeavors and have contributed to personal and professional growth in several areas.

1. Technical Proficiency: The project enhanced our proficiency in working with advanced hardware components, such as microcontrollers, cameras, and sensors, fostering a deeper understanding of their functionalities and integration capabilities within IoT systems.

2. Software Development Skills: The utilization of the Arduino IDE and embedded C programming language improved our software development skills, enabling us to write efficient and effective code for complex hardware interactions and data processing.

3. System Integration and Testing: The rigorous testing and integration of various hardware and software components reinforced our understanding of the importance of systematic testing methodologies in ensuring the seamless integration and functionality of IoT systems.

4. Data Security and Privacy: The project underscored the critical importance of prioritizing data security and privacy, especially when dealing with sensitive biometric information, leading to a deeper understanding of data protection regulations and ethical considerations in IoT development.

5. User-Centric Design: The focus on creating a user-friendly interface for the attendance system highlighted the significance of user-centric design principles in enhancing the overall user experience and ensuring the practicality and adoption of IoT solutions in real-world scenarios.

6. Project Management Skills: The project's execution improved our project management skills, emphasizing the significance of effective planning, coordination, and resource management to ensure the timely and successful completion of complex IoT projects.

7. Innovation and Problem-Solving: The project encouraged a culture of innovation and problem-solving, fostering a proactive approach to addressing challenges and devising creative solutions to complex technical and operational issues.

These learnings serve as a solid foundation for future endeavors in the realm of IoT development and underscore the significance of continuous learning and adaptation in the rapidly evolving landscape of technology and innovation.

Bibliography

how2electronics.com/face-recognition-based-attendance-system-using-esp32-cam/

how2electronics.com/iot-biometric-fingerprint-attendance-system-with-esp8266/

IoT Based Biometric Attendance System for Smart Classroom

Anagha Jadhav, Sudarshan Dutonde, Archana Todarmal, Ashwini Patil

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Development of biometric attendance system using NodeMCU platforms

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