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Board of Technical Examinations, Bengaluru

Novel RFID Cloud Based Smart Attendance System

Submitted by

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Under the Guidance of

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In partial fulfilment of the award of Diploma in Electronics and Communication Engineering

Department of Electronics and Communication Engineering

Government Polytechnic College,

Harihar - 577601

2022-2023

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CERTIFICATE

This is to certify that the project report entitled "**NOVEL RFID CLOUD BASED SMART ATTENDANCE SYSTEM**", submitted by **BG LAKSHMINARAYANA (170EC20027)** is the bonafied work completed under my supervision and guidance in partial fulfilment for the award of Diploma in Electronics and Communication Engineering Government Polytechnic College, Harihar during the academic year 2022-23.

Place: Harihar

Date: / /

Cohort Owner Head of Department Principal

DECLARATION

I hereby declare that dissertation entitled of "NOVEL RFID CLOUD BASED SMART ATTENDANCE SYSTEM" is submitted to the board of technical examination, Bangalore as an award of Diploma in Electronics & Communication Engineering carried out by me in the Department of Electronics & Communication Engineering Government Polytechnic, Harihara under the supervision of Mr. Gopalkrishna, Lecturer E&C department, Government Polytechnic Harihara for the year 2022-23.

The primary data in the study of Novel RFID Cloud Based Smart Attendance System project is collected by me together with my project associates. I further declare that the study of the project as not formed the basis for award of Diploma in Electronics & Communication Engineering.

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Government Polytechnic College,
Harihar

Place: Harihar

Date: / /

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The portion of success is brewed by the efforts put in by many individuals. It is constant support provided by people who give you the initiative, who inspire you at each step of your endeavour that eventually helps you in your goal.

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EXECUTIVE SUMMARY

In today's fast-paced digital world, organizations and institutions face the challenge of efficiently managing the attendance records for employees, students, or visitors. Traditional paper-based methods or manual data entry processes are prone to errors, time-consuming, and lack real-time monitoring. To address these limitations, we have combined the power of cloud computing with the RFID (Radio Frequency Identification) which provides an innovative solution for attendance management using the RFID cloud-based technology. The RFID technology has gained significant attention in various industries due to its ability to automate and streamline processes. It offers an efficient and accurate method for tracking and managing attendance records. This abstract presents an overview of a cloud-based attendance System that leverages RFID technology to enhance attendance management processes.

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ABBREVIATIONS & NOTATION

English Symbols / Abbreviations	Meaning
RFID	Radio Frequency Identification
ESP	Espressif
MCU	Microcontroller Unit
UID	Unique Identification Number
OLED	Organic Light Emitting Diode
JSON	JavaScript Object Notation
HTML	Hyper-Text Markup Language
CSS	Cascading Style Sheet
PDF	Portable Document Format
CSV	Comma Separated Values
SQL	Structured Query Language
NoSQL	Non-Structured Query Language
SPI	Serial Peripheral Interface
I^2C	Inter Integrated Circuit
AWS	Amazon Web Services
UI	User Interface
CBS	Cost Breakdown Structure
WBS	Work Breakdown Structure
EC2	Elastic Compute Cloud
S3	Simple Storage Service
SDA	Serial Data Pin
SCL	Serial Clock Pin

UART	Universal Asynchronous Transmitter Receiver
MISO	Master In Slave Out
MOSI	Master Out Slave In
NO	Normally Open
NC	Normally Closed
Wi-Fi	Wireless Fidelity
BLE	Bluetooth Low Energy
SoC	System on Chip
CPU	Central Processing Unit
MHz	Mega Hertz
PCB	Printed Circuit Board
API	Application Programme Interface
CDN	Content Delivery Network
ADC	Analog to Digital Converter
DAC	Digital to Analog Converter
RDBMS	Relational Database Management System
AMI	Amazon Machine Image
LAMP	Linux Apache MySQL PHP stack
VM	Virtual Machine
VPC	Virtual Private Cloud
IP	Internet Protocol
DNS	Domain Name System

CHAPTER 1

1.1 INTRODUCTION

In today's fast-paced digital world, organizations and institutions face the challenge of efficiently managing the attendance records for employees, students, or visitors. Traditional paper-based methods or manual data entry processes are prone to errors, time-consuming, and lack real-time monitoring. To overcome these limitations, in our project with the RFID (Radio Frequency Identification) technology and by using the power of cloud computing we have innovated a solution for attendance management using the RFID cloud-based technology, which in turn helps to store the attendance in a remote database which can be easily accessed from anywhere in the world and at any time. We have used the following hardware/software components in our project:

i. ESP32-WROOM-32E MCU with integrated 2.4GHz Wi-Fi and BLE connectivity which is used in a wide range of applications.
ii. RFID MFRC522 reader module
iii. 1k MIFARE Classic Contactless Smart Card
iv. OLED display module SSD1306
v. 1 Channel 5v Relay Module
vi. Solenoid lock
vii. Frontend of Website
viii. Backend of Website
ix. AWS Cloud for hosting the Website

1.2 SCOPE OF THE PROJECT

- **Hardware Integration:** The project involves integrating an ESP32, RFID Reader Module, Solenoid lock & OLED display to create a cohesive smart attendance system.
- **RFID Card/Tag Management:** The system will provide functionality to manage RFID cards or tags to assign a user with unique identifiers and associating them with user profiles in a database.
- **Attendance Tracking:** The system will automate attendance tracking by allowing users to scan their RFID cards/tags at the RFID reader.
- **Real-time Display:** The OLED display will provide real-time information about attendance status.
- **Web-based User Interface:** A web UI helps to provide an interface for administrators to manage attendance records, view reports, and configure system settings.

CHAPTER 2

2.1 CAPSTONE PROJECT PLANNING

2.1.1 Work Breakdown Structure (WBS)

The work breakdown structure gives the project a definite task to accomplish from lowest level to highest level of the project and also objectives of smart attendance system. It provides a definite way to build project like efficient planning, outcome of project, well defined tasks, team co-ordination and project output

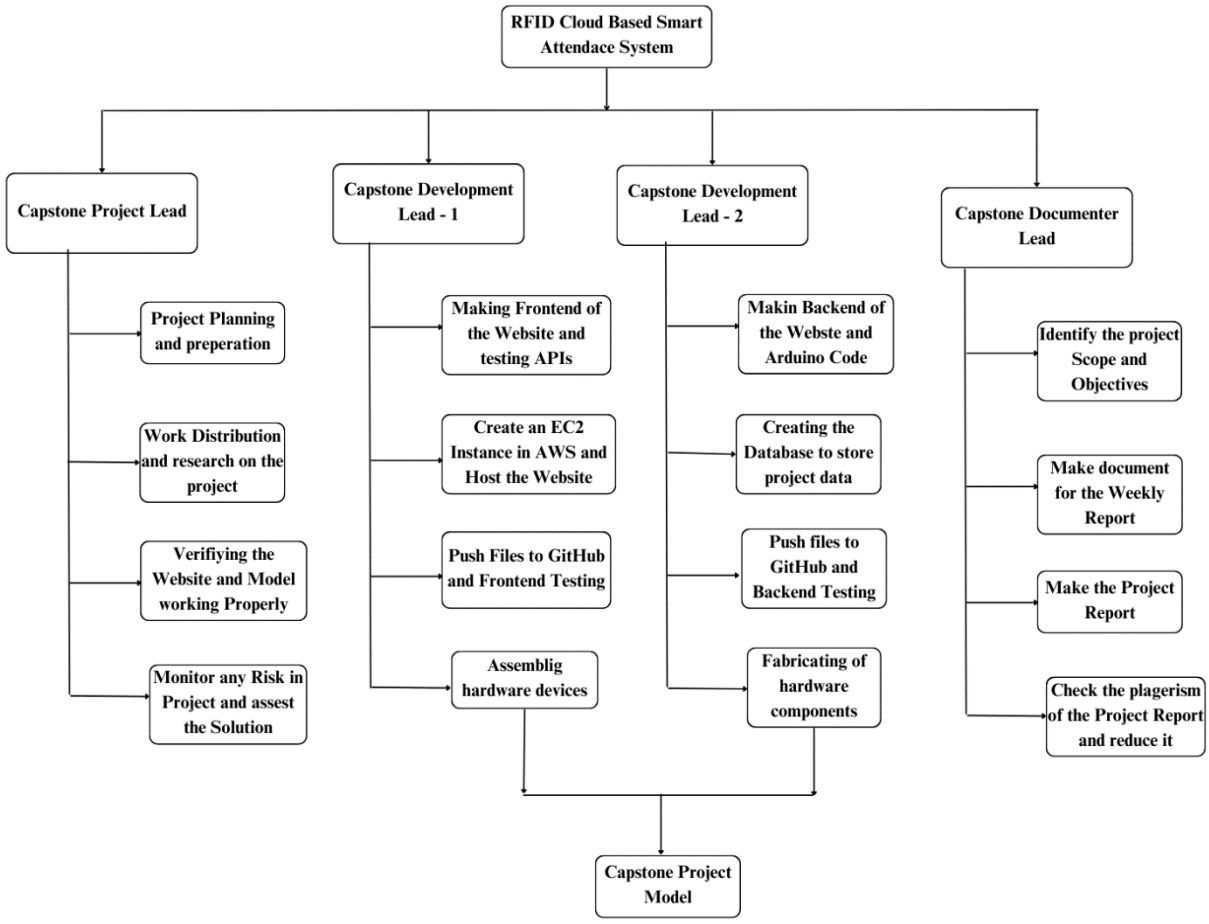

Table 2.1 Flowchart of Work Breakdown Structure for Smart Attendance System

2.1.2 Timeline Development Schedule for Smart Attendance System

Week-1: Discussing and searching ideas for our capstone project concerning the future scope and the demand in the market.

Week-2: Making the literature survey based on the ideas discussed and searches in ‘Week-1’.

Week-3: Planning & designing our project "Novel RFID Cloud Based Smart Attendance System" & collecting related information needed for our project.

Week-4: To buy and test the electronic interfacing modules like Controllers, Sensors, RFID tags, OLED Display and fabrication materials like PCB Board, Screws, etc.,

Week-5: To start making the Frontend of our Websites using HTML, CSS, JavaScript and a frontend framework Bootstrap.

Week-6: To start making the Backend of Website using PHP and to create the database to store the data of the user.

Week-7: To complete the Websites Frontend and Backend and testing the APIs are working correctly or not.

Week-8: To write Arduino code for ESP32 and test the code working properly as expected.

Week-9: To create a EC2 Instance in AWS Cloud and host the website on the Instance and configure the security group to make it visible to public.

Week-10: To connect the hardware components with the controller through jumper wires as per coding instructions then finish up the necessary fabrication works and then to finalize the project model.

Week-11: To check the hardware and website are working as expected and storing the user’s data in database and troubleshoot the error if any.

Week-12: To buy a suitable domain name for the website and push all the code to GitHub Repository.

Week-13: To start necessary document preparation for individual components and make a Capstone Project Report on Chapter 1 - 3.

Week-14: To make a Capstone Project Report of Chapter 4 & 5 and check the report as per DTE plagiarism to check Plagiarism and reduce it upto 35%.

Week-15: Finalize our Project designing, testing and Plagiarism.

Week-16: Planning for PPT and demonstration.

2.1.3 Cost Breakdown Structure for Smart Attendance System

In our project we have used various types of Hardware and Software Components, for which below the Cost Breakdown Structure is listed below for the components which contains the detailed overall cost incurred in the project

Sl. no	Components	Quantity	Cost
1	ESP32	1	600
2	RFID MFRC522	1	320
3	Single channel 5v relay	1	270
4	OLED Display 128x64	1	450
5	Solenoid Lock	1	500
6	AWS Cloud	-	700
7	PCB Board	1	60
8	Header Pins	5	100
9	Screw Adaptor	1	100
10	Miscellaneous	-	700
Total			3,700

Table 2.2 Cost Breakdown Structure Table

2.1.4 Capstone Project Risks Assessment

While making the project there where several risks like Technical Risk, Security Risks, Operational Risk, Hardware Risks, Software risks and many more some the risks faced while making the project and the steps taken to assist the following risks is given below

- **Compatibility Issues:** The components used in the project, such as the ESP32, RFID Reader and solenoid lock may have compatibility issues that could affect the system's functionality.

  Risk Management: Continuously test and validate the compatibility of components during the development phase and addressed any compatibility issues that arise.
- **Software Bugs and Glitches:** The software components, including the Frontend and Backend of the Website and Database may have some of bugs or glitches that could impact the system's performance and reliability.

  Risk Management: Continuously tested the code and debug the code if any errors were found or find a solution for the problem arose and test in multiple times to check that it works properly.
- **Data Breach:** There is a risk of unauthorized access to sensitive data stored in the system, including personal information and attendance records.

  Risk Management: Implement robust Cyber security measures in the backend system and in the database to protect the users' passwords and personal details, all the data of users is encrypted by the backend and then stored in the database which is difficult for someone to hack.
- **RFID Cloning or Spoofing:** Hackers may attempt to clone or spoof RFID cards to gain unauthorized access to the system.

  Risk Management: Implement security protocols and encryption techniques to prevent RFID card cloning or spoofing.

- **System Downtime:** There is a risk of system downtime due to hardware failures, power outages, or network issues.

  Risk Management: Implement the measures, such as backup power supplies and failover systems, to minimize downtime.

  Risk management strategies should include proactive measures such as risk Identification, Analysis, Evaluation and monitor the risks. Regular monitoring and review of risks throughout the project lifecycle will help to ensure that appropriate actions are taken to minimize the potential risks in the project.

2.2 REQUIREMENTS SPECIFICATION

2.2.1 Functional

- Automate tracking of the attendance through RFID card scanning.
- Real-time display of attendance information on the OLED display.
- Granting access or denying through the solenoid lock based on attendance status.
- Administrators can manage the attendance records on the web-based user interface to generate reports.
- Storing attendance data in a database for easy retrieval and analysis.
- Ability to add, edit and delete user profiles via the Web UI.
- Generation of attendance reports in different file format based on specified criteria.

2.2.2 Non-Functional (Quality Attributes)

- The web UI and OLED display should have a user-friendly interface and intuitive design.
- The system should have low latency and respond quickly to RFID card scans and user interactions.
- The system should ensure the confidentiality of the user data and prevent unauthorized access.

- The system should be able to handle a growing number of users and accommodate additional hardware components if required.
- The system should be stable and operate consistently without unexpected failures.
- The system should be available for use during designated time frames and should have minimal downtime for maintenance or updates.
- The system should be designed and documented in a way that allows easy maintenance, troubleshooting, and future enhancements.

2.2.3 User Input

- The functionality to easily add, edit and delete user profiles in the system.
- Attendance reports can be exported to different types of file format.
- Notifications or alerts to be sent to administrators or users in case of abnormal events.
- Compatibility with existing RFID tags or ID cards used by the organization or users.

2.2.4 Technical Constrains

- The availability and compatibility of the chosen RFID reader with the ESP32 Board.
- The processing power and memory limitations of the ESP32 Board.
- The capacity and performance of the chosen solenoid lock to handle the required number of access requests.
- The size and resolution limitations of the OLED display.
- The storage capacity and performance of the database system used to store attendance records.

- The need for reliable and stable power supply to ensure continuous system operation.

2.3 Software and Hardware Details

2.3.1 ESP32

ESP32 is a low power SoC (System on Chip) MCU with integrated Wi-Fi and Bluetooth connectivity for a wide-range of applications. It is created and developed by Espressif Systems, a Chinese company. The pin diagram of ESP32 is given below Figure 2.1

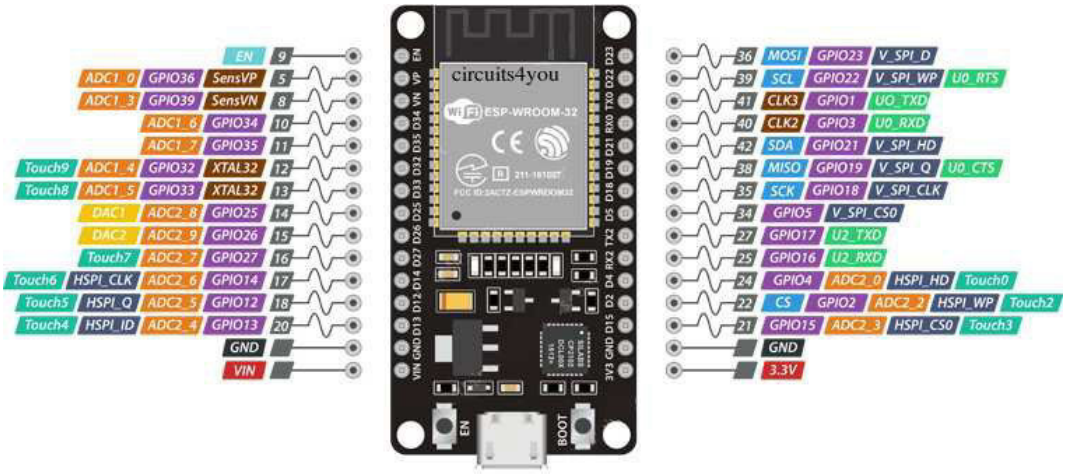

Figure 2.1 Pinout Diagram of ESP-WROOM-32

In our project we have used the ESP-WROOM-32 Development Board to get the data from MFRC522 RFID Reader and analyze it and send the data to Cloud and check it and get back the corresponding output from the server and display it on the OLED Display and make other corresponding actions if any available. The specification of the ESP-WROOM-32 Development Board is tabulated below in table 2.3.

CPU	Xtensa dual-core (or single-core) 32-bit LX6 microprocessor
GPIO	34 Pins
UART	3
SPI	4
I^2C	2
Input Voltage	5 to 12 volts
Output Voltage	3.3 volts
Wi-Fi	802.11 b/g/n
Bluetooth	BLE v5 (shares the radio with Wi-Fi)
Clock Speed	240MHz

Table 2.3 ESP-WROOM-32 Specification Table

2.3.2 OLED display

OLED (Organic Light Emitting Diodes) is a flat light emitting technology, made by placing a series of organic thin films between two conductors. When electrical current is applied, a bright light is emitted. The diagram of OLED Display is given below in Figure 2.2

Figure 2.2 Diagram of OLED display

Driver	SSD1306
Screen size	0.96
Screen dimension	22x11 mm
Resolution	128x64 pixels
Supply voltage	3-5 v
Module size	27x27x3.5mm

Table 2.4 OLED display Specification Table

In our project we have used OLED display for to display the attendance of the student and also, we can see the real time, also we can see the students logged in and logged out status. We have chosen this display for our project because it has a good view angle and pixel density this makes the display reliable for showing small level graphics. OLED display Specification is tabulated above in table 2.4

2.3.3 RFID MFRC522 Reader Module

RFID or Radio Frequency Identification is an automatic identification method that uses wireless non-contact radio frequency waves in which data is digitally encoded in RFID tags or smart labels which can be read by reader through radio waves. The transfer of data takes place between a reader and a movable thing that can be identified & track. The diagram of RFID MFRC522 Reader is given below in Figure 2.3

Figure 2.3 Diagram of RFID MFRC522 reader

Model name	MFRC522 RFID reader
Operating voltage	2.5 to 3.5 v
Communications types	SPI, I2C, UART
Data rate	10Mbps
Reading range	5cm
Current consumption	13-26mA
Power down consumption	10uA
Dimensions	60mmx39mm

Table 2.5 RFID MFRC522 reader Specification Table

We have used RFID technology in our project for smart attendance system in which the student needs to scan the RFID tag to the RFID reader, the student's data will be encrypted in RFID tag which will be exposed to radio waves of RFID reader when it is scanned. When a student scans the RFID tag the students logged in will be shown in OLED display and after it is stored in the database and for logout the student need scan the tag again. This is how we used RFID technology in our project. RFID MFRC522 Reader modules Specification is tabulated above in table 2.4

2.3.4 1k MIFARE Classic Contactless Smart Card

MIFARE is a series of integrated circuit (IC) chips used in contactless smart cards and proximity cards. The brand includes proprietary solutions based on various levels of the ISO/IEC 14443 Type A 13.56 MHz contactless smart card standard. The diagram of 1K MIFARE Smart Card is given below in Figure 2.4

Figure 2.4 Diagram of 1K MIFARE smart card

Card Dimensions	85.5x54mm
Memory	1K Byte
Thickness	0.88mm
Material type	PVC
Data storage time	Minimum 10 years
Frequency	13.56MHZ

Table 2.6 1K MIFARE contactless smart card Specification Table

In our RFID based smart attendance system for RFID reader we have used RFID tags they are called 1K MIFARE contactless smart card. They are used for scanning purpose inside the card the student's data will be stored and encrypted after when it is scanned to reader it is exposed and then the student will be logged in, here we can add new user and a unique id will be given to the new user. We have used this because it easy to use and we can read and write or make corrections in it. Contactless Smart Cards Specification is tabulated above in table 2.6

2.3.5 Solenoid Lock

The solenoid lock denotes a latch for electrical locking and unlocking it is also known as electrical strike. It is used lock/unlock cabinet, door, drawer. The diagram of Solenoid lock is given below in Figure 2.5

Figure 2.5 Diagram of Solenoid Lock

Operating voltage	12VDC
Input voltage	12v
Current consumption	600mA
Holding force	0.20kg
Unlocking time	1-10 seconds
Dimensions	30 x 23 x 15 mm

Table 2.7 Solenoid lock Specification Table

We have used solenoid lock in this project for locking and unlocking purpose of the door. We have directly interfaced it with the cloud so it operates through the cloud and we have given its power source as relay. Whenever the student scans the RFID tag after successful login the solenoid lock will open for period of some 10 seconds in this time student must go inside the class. Using solenoid lock in project makes it look more secure. Solenoid lock Specification is tabulated above in table 2.7

2.3.6 Relay Module

A relay module acts as a switch that is operated by an electromagnet. The electromagnet is activated by a separate low power signal from a microcontroller. The diagram of Relay module is given below in Figure 2.6

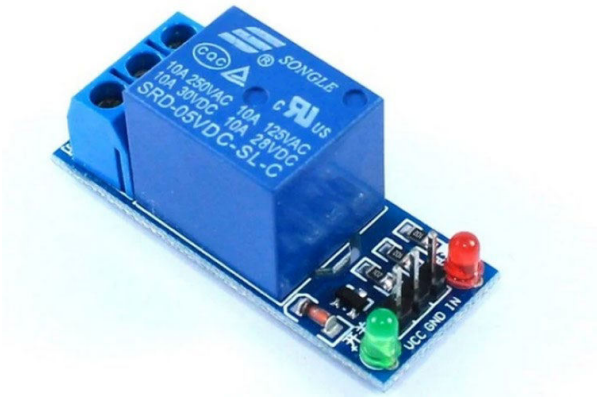

Figure 2.6 Diagram of Relay Module

Supply voltage	3.75V to 6V
Quiescent current	2mA
Current when relay is active	~70mA
Maximum contact voltage	-250VAC or 30VDC
Maximum current	-10A
Maximum switching per minute	300

Table 2.8 Relay module Specification Table

A relay module is switch it operated by electromagnet. The electromagnet pulls to either open or close an electrical circuit. In project we have used relay to control the solenoid lock as it is required 12v to operate as the microcontroller provides 3.3v so we have used relay to control the solenoid lock for to open or close the door. OLED display Specification is tabulated above in table 2.8

2.3.7 Frontend of Website

The frontend is that a user sees and interacts with, when they click on a link or type in a web address. It is made up by mainly HTML used to structure the website also known as the body of the website, CSS is used to make animation transition and some designs to the website and JavaScript is used to write the logic in the website to make it more interactive and user friendly it is also known as a brain of the website.

- **HTML:** HTML stands for Hypertext Markup Language. It is used to design the front-end portion of web pages using markup language. It acts as a skeleton for a website since it is used to make the structure of a website.
- **CSS:** Cascading Style Sheets fondly referred to as CSS is a simply designed language intended to simplify the process of making web pages presentable. It is used to style our website.

- **JavaScript:** JavaScript is a scripting language used to provide a dynamic behavior to our website. In the recent days the ES6 version of JavaScript is widely used to perform optimized tasks.
- **Bootstrap:** Bootstrap is a free and open-source tool collection for creating responsive websites and web applications. It is the most popular CSS framework for developing responsive.

API stands for Application Programming Interface. In the context of APIs, the word Application refers to any software with a distinct function. Interface can be thought of as a contract of service between two applications. This contract defines how the two communicate with each other using requests and responses.

In our project we have used the APIs to bring the data from the database via the backend and display the response data in the frontend which is visible to the user, it updates the data in retime which give a better user experience for the users it helps to interconnect the frontend backend and the database.

2.3.8 Backend of Website

The backend is the server side of the website. It stores and arranges data, and also makes sure everything on the client side of the website works fine. It is part of the website that you cannot see and interact with. It is the portion of software that does not come in direct contact with the users. The parts and characteristics developed by backend designers are indirectly accessed by users through a front-end application. There are many languages and software's used to develop n backend like Nodejs, Python, Java PHP and many more. In our project we have used PHP for the backend and MySQL for the database, and the Arduino language for writing code for ESP32.

- **PHP:** PHP is an open-source server-side scripting language designed specifically for web development which is used to make static and dynamic webpages. It is executed on the server side it is called a server-side scripting language. It is fast, flexible and pragmatic.

- **MySQL:** It is the world's most popular open-source database Engines. It ranks as the second most popular database. It is a relational database management system based on Structured Query Language.
- **Arduino:** Arduino is an open-source electronics platform mainly written in C and C++. It designs and manufactures single-board microcontrollers and microcontroller kits for building digital devices.

In our project we have used PHP to write the backend of our smart attendance system website which helps to bring the data from the database to the frontend via the APIs. The user's data is store is table structure an Relational Database Management System which is written by SQL and Arduino language is used to programme the ESP32 microcontroller to make it functional.

2.3.9 AWS Cloud

Amazon Web Services is a subsidiary of Amazon that provides on-demand cloud computing platforms and APIs as pay-as-you-go basis. It is used in combination with autoscaling (a process that allows a client to use more compute in times of high application usage, and then scale down to reduce costs when there is less traffic). These cloud computing web services provide various services related to networking, compute, storage, middleware, IoT and other processing capacity, as well as software tools via AWS server farms. This frees clients from managing, scaling, and patching hardware and operating systems. We have used some of the AWS feature in our project like EC2, CloudFront.

- **EC2:** It allows users to rent virtual computers on which to run their own computer applications. EC2 encourages scalable deployment of applications by providing a web service through which a user can boot an Amazon Machine Image (AMI) or any other open-source images like Ubuntu, Red-hat, Debian and etc., to configure a virtual machine which are known as "instance".
- **CloudFront:** It is a Content Delivery Network (CDN) which provides a globally-distributed network of proxy servers to cache content, such as web videos or other bulky media, more locally to consumers, to improve access

speed for downloading the content. It has servers around the world which helps for a better content delivery in every remote location around the world.

In our project we have used the EC2 instance to create a LAMP stack in Ubuntu AMI to deploy our website which is running on an Apache server in a Linux VM which is accessed by the IPv4 address of the instance. Later we have pointed that IP to the DNS of our Domain. All the static files are store in the AWS S3 which can be accessed via the AWS CloudFront CDN.

2.4 DESIGN SPECIFICATION

- **ESP32 Microcontroller:** The ESP32 serves as the main control unit for the system. It is responsible for handling all the communication with the RFID RC522 reader, OLED display and controlling the solenoid lock and also managing data flow between different components.
- **RFID RC522 Reader:** This component enables the system to read RFID cards or tags. It communicates with the ESP32 through SPI (Serial Peripheral Interface) Pins and provides unique identifiers for users.
- **Solenoid Lock:** The solenoid lock is controlled by the Relay Module via the ESP32 to grant or deny access based on the attendance status. When a valid RFID card is scanned, the ESP32 sends a signal to release the lock temporarily an lets the user go inside.
- **OLED Display:** The OLED display provides real-time information about the attendance status. It is connected to the ESP32 and displays relevant information.
- **Website UI:** The web user interface, developed using HTML, CSS, and JavaScript, allows administrators to manage attendance records, generate reports, and configure system settings. It communicates with the backend using PHP & store the data into MySQL Database.
- **Backend:** The backend language used in this is PHP, which is used to fetch the data from the Database and render it in the Web UI and make some of the backend operations.

- **Database:** The student's information is stored in the form of tables in MySQL database, which handles data storage, retrieval, and management operations. It communicates with the ESP32 to store attendance data into database and serves as the interface for the Web UI.

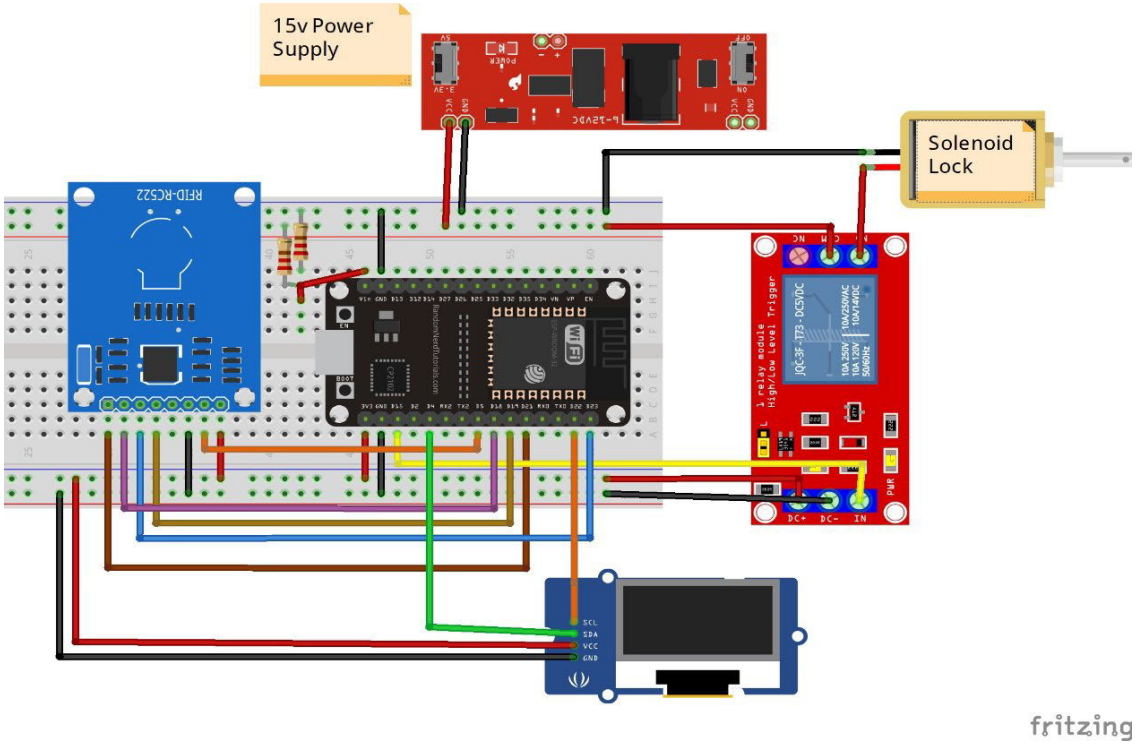

Figure 2.7 Circuit Diagram of Smart Attendance System

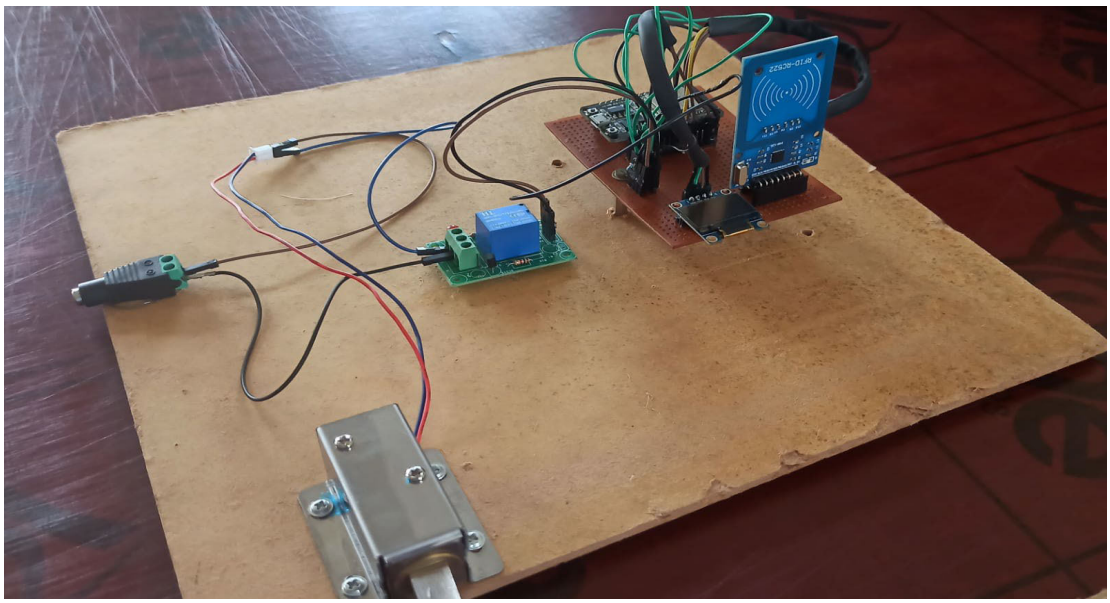

Figure 2.8 Smart Attendance System Project Model

CHAPTER 3

3.1 APPROACH & METHODOLOGY

1. **Requirement analysis:** To analyze the project requirements for a smart attendance system, such as objectives, market demand, user friendliness, and project efficiency. RFID reader, ESP32, solenoid lock, and OLED display are the components we used based on the requirement analysis. We determined the need for a smart attendance system by observing overall outcomes in the environment. This requirement analysis will serve as the foundation for the approach and design of our project.

2. **System design:** Create the system design based on the requirement analysis. System architecture (a conceptual model that defines the structure, behavior, and more views of a system), including hardware and software components, communication protocols, and user interface design, should be created for the smart attendance system. Make the data flow, interfaces, and interactions between system elements. Scalability, flexibility, and usability should all be considered when designing a smart attendance system.

3. **Hardware setup:** Following the system design, connecting and configuring the ESP32, OLED display, RFID MFRC522 reader, and solenoid lock for the smart attendance system. Check that the proper wiring is in place and that everything works as it should. Test the hardware setup to ensure the functionality of project, make sure that hardware commonest are interfaced with specified required libraries and with APIs installed and check that all run seamlessly. Ensure the proper communication and control of the project.

4. **Software Development:** Create the software components, which include the firmware used to programme the ESP32 (Arduino Language) backend with PHP, the Web UI with HTML, CSS, and JavaScript, and the database, which is an RDBMS. This aids in the storage of user data, access control, real-time display, and interaction with web interfaces. Test and debug the software components to ensure proper functionality.

5. **Integration and testing:** Integrate the hardware and software components of the smart attendance system. Examine the system as a whole, including RFID scanning, attendance recording, lock control, and real-time display, as well as the firmware, Web UI, and backend. Projects must be validated and tested. The functionality, performance, and efficiency of the project. Overall, the hardware and software components are well integrated and function as expected, meeting the project requirements.

6. **Deployment:** After all of the hardware has been installed, the project will be integrated. Deploy the system in accordance with the environment, such as a school, college, or office. Install the hardware components in their proper locations and ensure the project's proper power supply and connectivity. Configure the AWS database server for the attendance system. Configure the web UI to analyze the daily attendance log via the web browser. Provide the necessary training and documentation for administrators, teachers, and users to understand and effectively use the system.

7. **Maintenance and support:** Prepare documentation on the system's functionality, system design, hardware setup, software development, integration and testing, deployment, and maintenance and support, all of which document how the installation process is done while doing the smart attendance system and troubleshooting, as well as the guidelines that were used to complete the project. Create the document in such a way that the administrator or teacher can understand the themes and implement software and hardware components in the project. After completing all documentation, distribute it to administrators and users, as well as instruct them on how the smart attendance system works and how to maintain system efficiency.

8. **Documentation:** Prepare documentation on the system's functionality, system design, hardware setup, software development, integration and testing, deployment, and maintenance and support, all of which document how the installation process is done while doing the smart attendance system and troubleshooting, as well as the guidelines that have been used to complete the project. Create the document in such a way that the administrator or teacher can comprehend the themes and implement software and hardware components in the project. After completing all documentation,

distribute it to administrators and users, as well as instruct them on how the smart attendance system operates and how to maintain system efficiency.

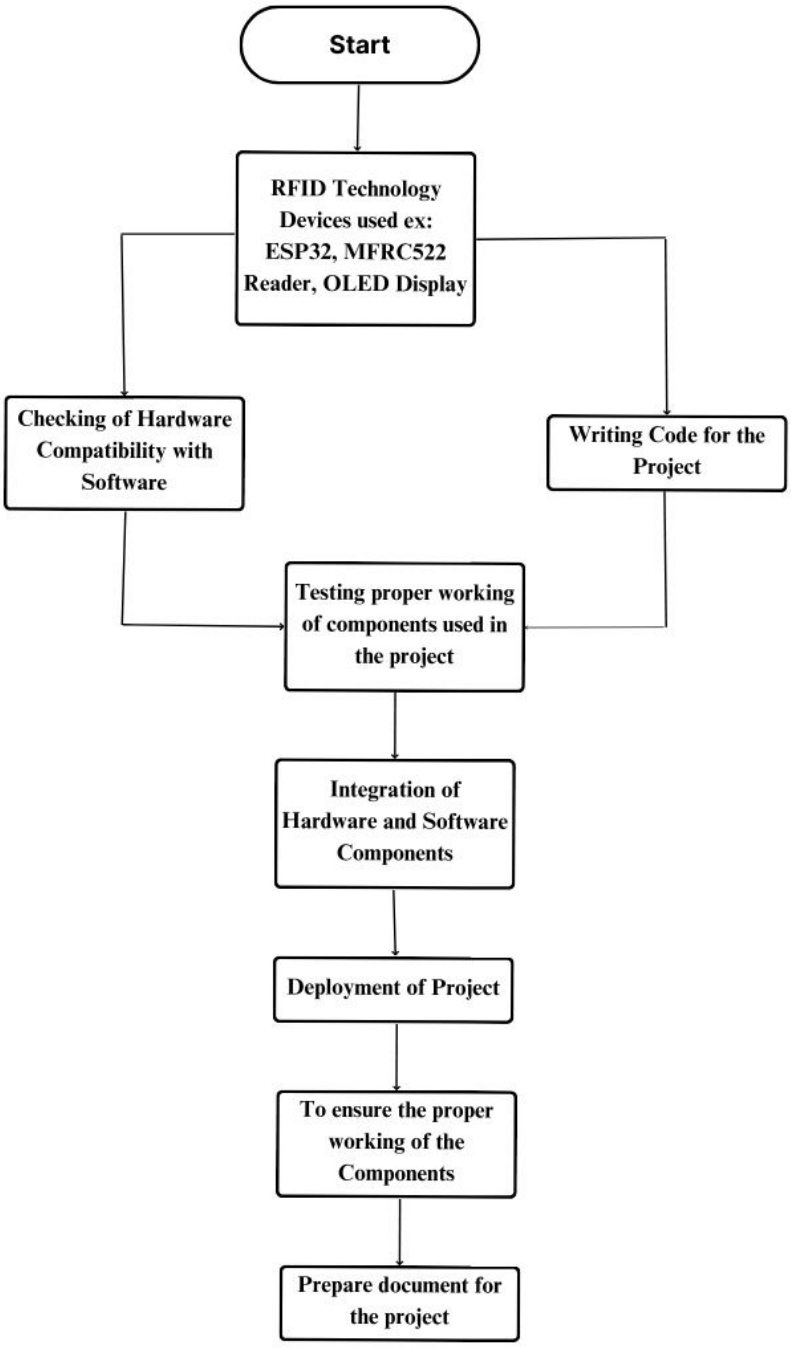

Table 3.1 Flowchart for Methodology of Smart Attendance System

CHAPTER 4

4.1 TEST AND VALIDATION

The test and validation phase plays a crucial role in ensuring the system's functionality, reliability, and adherence to requirements. Through rigorous testing and validation processes, the project team will verify the accuracy of attendance tracking, the effectiveness of access control mechanisms, the usability of the web user interface, and the generation of comprehensive and accurate reports.

4.1.1 Test and Validation for RFID Reader

- Verifying the RFID tags that are detected within the range. Testing the tags in different positions and multiple times.
- Reading the data that are stored in the RFID tags that are scanned in RFID reader. Validate that the reader can accurately collect the information that is programmed into the tags
- Test the RFID tags simultaneously and system’s ability. Make sure that RFID reader can distinguish each and every tag without interference
- Add a new user or the data to the RFID tags and verify that it can correctly read the data and interpret updated information. Make sure that the written data or scanned data are perfect match to the updated data
- Test the scanning and durability of RFID tags in various situation like temperature, physical stress and exposure to moisture. Make sure that the tags remain same and readable after the exposure to the challenging.
- Test the RFID system by increasing the number of scans. Verify that system can handle the large number of scans and does not change the performance

- Integrate the RFID system with other software and hardware. Make sure that the data integrated with other system performs the functions smoothly
- Measure the battery life in the operating conditions if it is used.

The data read by the RFID Reader which is displayed in the serial monitor of Arduino IDE is given in below Figure 4.1

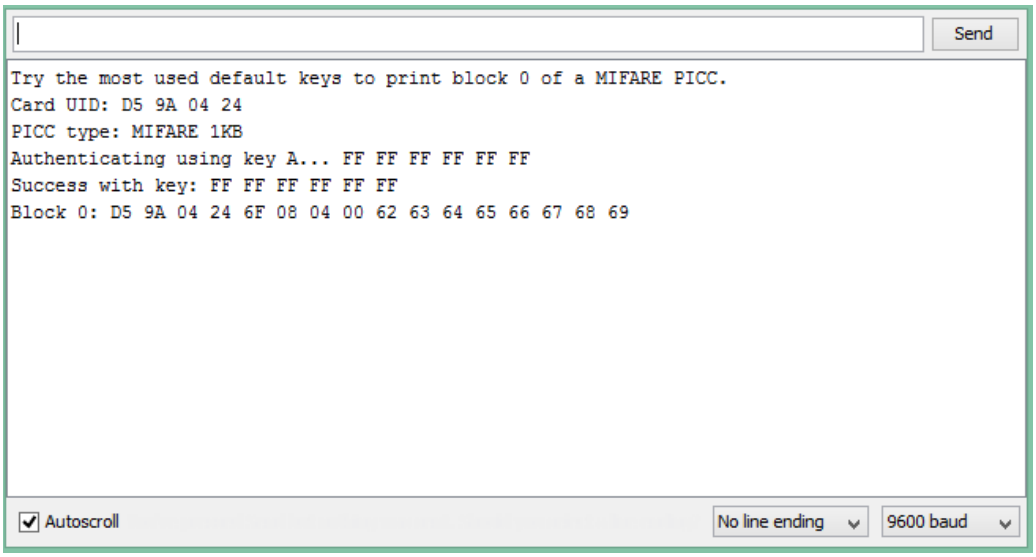

Figure 4.1 RFID Cards Data output displayed in Serial Monitor

4.1.2 Test and Validation for OLED

- Power the OLED display and check it turns on and shows the output. Check for any damages and the pins are soldered clearly or not.
- Display a single color or multiple in the OLED display. Check the color and brightness are okay and does not have any variations or patches.
- To check the refresh rate, check the fast-moving content or any object on the screen. After that check the display if it is running smooth even adding the animations.
- Test the power consumption of OLED display under variety using scenarios.

- Make sure that the OLED display works perfectly in all environmental conditions.
- Test the display over long period of time continuously. Check if there are color shifts, screen blur or burnt in condition

Output of OLED Display after checking all the above conditions continuously is given in the below Figure 4.2

Figure 4.2 OLED Display testing

4.1.3 Test and Validation for ESP32

- Apply the power to the ESP32 and check it boots up successfully. Make sure that the microcontroller can communicate with other electronic devices
- Connect the GPIO pins with led, buttons or any other devices, and check the GPIO pins works correctly.

- Connect any analog devices or potentiometer to ADC (Analog to Digital Converter). Make sure that ESP32 can accurately read and covert the data to analog to the digital
- Connect the ESP32 to the Wi-Fi and check the connection. Check that ESP32 works perfectly and sends data through Wi-Fi.
- Enable the Bluetooth connectivity on the board and test it with other devices by writing the code. Make sure that it has ability to send and receive data over the Bluetooth.
- Check that ESP32 is compatible with requirement of your project like libraries, programming, and cloud that you use for the project. Make that all the things mentioned above works perfectly in ESP32

The below given is the output of Web UI of add user in Figure 4.3 and manage users tab in Figure 4.4

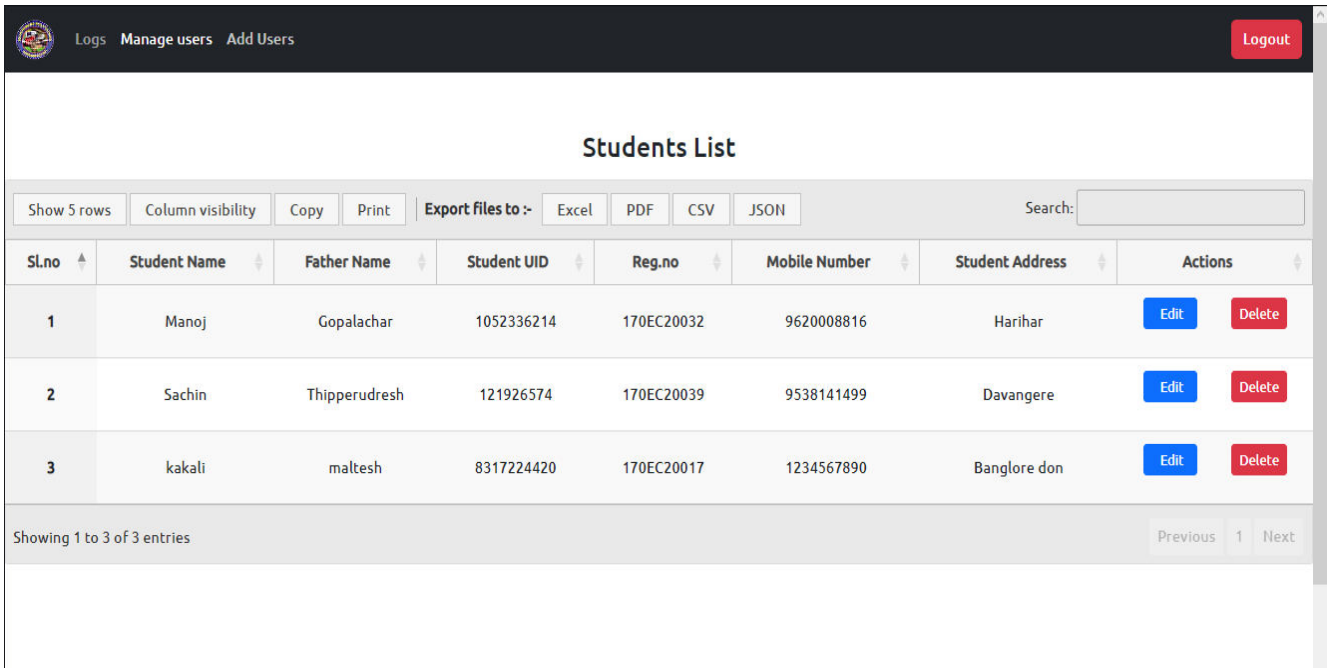

Figure 4.3 Manage Users tab

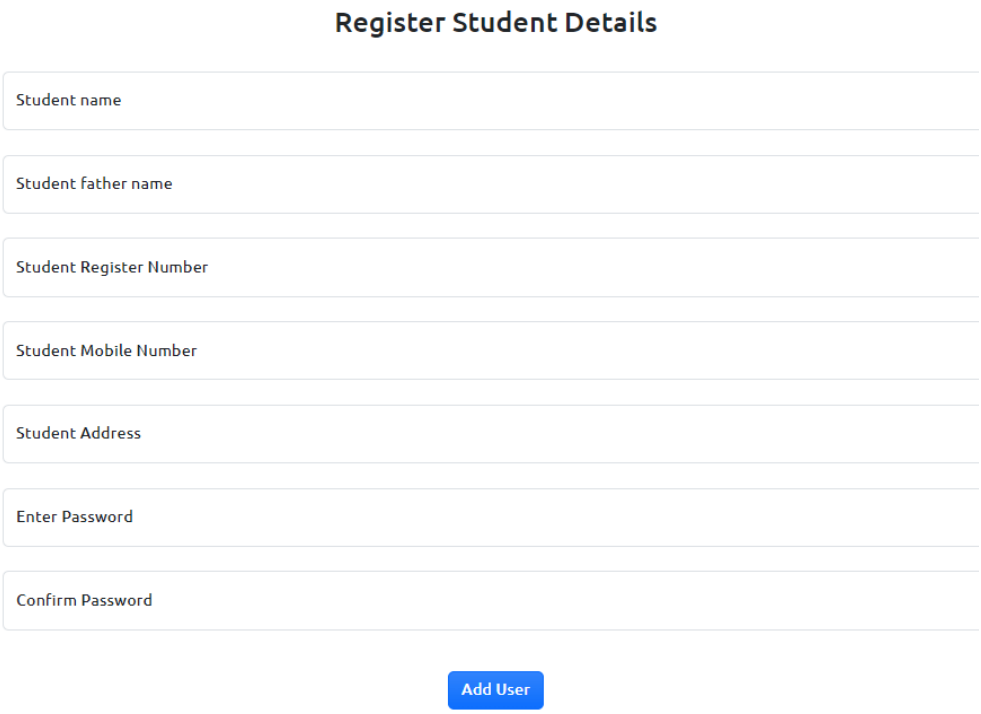

Figure 4.4 Add Users tab

4.1.4 Test and Validation for Relay Module

- Apply the required supply voltage to the relay coil. Verify the switches that contacts form open to closed or closed to open when the coil is energized or de-energized.
- Connect relay to suitable load (i.e., Light or bulb) and also test the relay's ability to handle specified current and voltage rating of load without exceeding maximum capacity
- Measure the time taken by the relay to energize or de-energize the coil. Observe the time with the manufacturer's specification to ensure it works within the acceptable limits.
- Environmental testing of relay: test the relay in various condition like temperature, humidity. Make sure that relay can easily operate in these temperature condition and work perfectly

- Apply minimum voltage that is needed to the relay in which relay works perfectly. Also test the relay by applying over voltage and low voltage make sure that it can handle both.
- Verify the relay with safety measures and conditions. Also check it for overvoltage, isolation protection against the electrical hazards.

The below is the image given for testing a Relay Module in the Figure 4.5

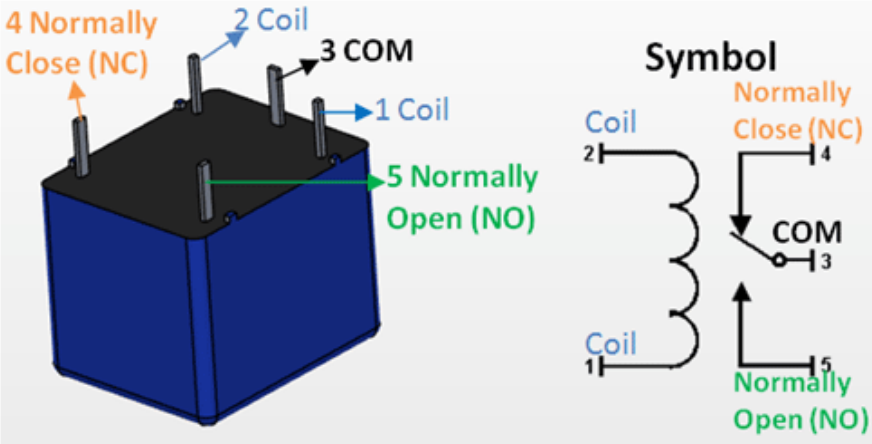

Figure 4.5 Testing of Relay Module

4.1.5 Test and Validation for Solenoid Lock

- Apply the power supply to the power supply. Make sure that lock is correctly working when the lock is energized or de-energized
- Check the force putted by solenoid lock when it is fully locked. Ensure that locking force is sufficient holds the door correctly
- Test the unlocking with various methods such as keypad, writing code for it. Check that lock easily unlocked by those various methods.
- Check the lock for period of time by repeatedly locking and unlocking the door. Make sure that lock can handle many number attempts without failure.

- Check how much power is consumed for lock under normal conditions. Make sure it matches the actual power consumption with the specification as said in it.
- Install and test solenoid lock with real time like installing in the door. Make sure that lock is compatible with door, latch, any other components.

4.2 CAPSTONE PROJECT CODE

```
#include <WiFi.h>
#include <WiFiUdp.h>
#include <HTTPClient.h>
#include <MFRC522.h>
#include <NTPClient.h>
#include <Wire.h>
#include <SPI.h>
#include <SSD1306Wire.h>

#include "Rancho_Regular.h"
#include "secrets.h"

#define SS_PIN 21
#define RST_PIN 5
#define Relay_Pin 15
int relayTriggered;
```

```
String formattedTime;

MFRC522 mfrc522(SS_PIN, RST_PIN);
WiFiUDP ntpUDP;
NTPClient timeClient(ntpUDP);

const char *ssid = WLAN_USERNAME;
const char *password = WLAN_PASSWORD;

#define OLED_SDA 4
#define OLED_SCL 22
SSD1306Wire display(0x3C, OLED_SDA, OLED_SCL);

void setup() {
  Serial.begin(9600);
  pinMode(Relay_Pin, OUTPUT);
  SPI.begin();
  mfrc522.PCD_Init();
  display.init();
  display.flipScreenVertically();
  connectToWiFi();
  timeClient.begin();
  timeClient.setTimeOffset(19800);
}
```

```
void loop() {
  relayTriggered = false;
  if (!WiFi.isConnected()) {
    connectToWiFi();
  }
  timeClient.update();
  formattedTime = timeClient.getFormattedTime();

  display.clear();
  display.setFont(Rancho_Regular_20);
  display.setTextAlignment(TEXT_ALIGN_LEFT);
  display.drawString(13, 10, "Scan Your Card");
  display.drawString(36, 35, formattedTime);
  display.display();

  if (!mfrc522.PICC_IsNewCardPresent()) {
    return;
  }

  if (!mfrc522.PICC_ReadCardSerial()) {
    return;
  }
```

```
  String CardID = "";
  for (byte i = 0; i < mfrc522.uid.size; i++) {
    CardID += mfrc522.uid.uidByte[i];
  }
  CardID.replace(" ", "");
  SendCardID(CardID);
}

void SendCardID(String Card_uid) {
  display.clear();
  display.setFont(ArialMT_Plain_10);
  display.setTextAlignment(TEXT_ALIGN_CENTER_BOTH);
  display.drawString(64, 25, "Verifying the ID");
  display.display();

  if (WiFi.isConnected()) {
    HTTPClient http;
    String getData = String("?uid=") + Card_uid;
    String Link = REQ_URL + getData;
    http.begin(Link);

    int httpCode = http.GET();
    String payload = http.getString();
    Serial.println(httpCode);
```

```
if (httpCode == -1) {
  display.clear();
  display.setFont(ArialMT_Plain_10);
  display.setTextAlignment(TEXT_ALIGN_CENTER_BOTH);
  display.drawString(64, 30, "Internal Server ERROR");
  display.display();
  delay(3000);
} else if (httpCode == 200 || httpCode == 201) {
  if (!relayTriggered) {
    display.clear();
    display.setFont(ArialMT_Plain_10);
    display.setTextAlignment(TEXT_ALIGN_LEFT);
    display.drawStringMaxWidth(10, 10, 128, payload);
    display.display();
    trigger_Relay();
    relayTriggered = true;
  }
} else if (httpCode == 404) {
  display.clear();
  display.setFont(ArialMT_Plain_10);
  display.setTextAlignment(TEXT_ALIGN_LEFT);
  display.drawStringMaxWidth(10, 10, 128, payload);
  display.display();
```

```
      delay(3000);
    } else {
      display.clear();
      display.setFont(ArialMT_Plain_10);
      display.setTextAlignment(TEXT_ALIGN_CENTER_BOTH);
      display.drawString(64, 30, "HTTP ERROR :" + String(httpCode));
      display.display();
      delay(3000);
    }
    ESP.restart();
    http.end();
  }
}

void trigger_Relay() {
  digitalWrite(Relay_Pin, HIGH);
  delay(7000);
  digitalWrite(Relay_Pin, LOW);
}

void connectToWiFi() {
  display.clear();
  display.setFont(ArialMT_Plain_10);
  display.setTextAlignment(TEXT_ALIGN_CENTER_BOTH);
```

```
display.drawString(64, 34, "Initializing");
display.display();

WiFi.mode(WIFI_OFF);
delay(500);
WiFi.mode(WIFI_STA);
WiFi.begin(ssid, password);

unsigned long startTime = millis();
while (WiFi.status() != WL_CONNECTED && millis() - startTime < 10000) {
  delay(500);
  Serial.print(".");
}

if (WiFi.status() == WL_CONNECTED) {
  Serial.println("");
  Serial.println("Connected to");
  Serial.println(ssid);
} else {
  display.clear();
  display.setFont(ArialMT_Plain_10);
  display.setTextAlignment(TEXT_ALIGN_CENTER_BOTH);
  display.drawString(64, 28, "Failed to connect");
  display.drawString(64, 38, "to Wi-Fi");
```

```
  }
  display.display();
  delay(2000);
}
```

The Program Code used for the Frontend, Backend and for the database is pushed to a GitHub repository

https://github.com/bgmanu2426/Smart-attendance-system

CHAPTER 5

5.1 BUSINESS ASPECTS

The smart attendance system developed using ESP32, RFID MFRC522 Reader brings together various technologies to automate attendance tracking and access control. The integration of these components into a seamless solution offers convenience, efficiency, and enhanced security compared to traditional manual attendance systems. The market outlook for the smart attendance system is promising, as organizations across various sectors, are seeking efficient attendance management solutions.

The market demand is driven by the need for accurate attendance tracking. As automation and digitization become more prevalent, the market for smart attendance systems is expected to grow steadily. The economic outlook for the industry is positive, with organizations recognizing the value of investing in technologies that optimize operations, improve productivity, and save costs.

The market for attendance management systems is expected to grow steadily. Educational institutions, corporate offices, government organizations, and various industries can benefit from an efficient and automated attendance solution. The smart attendance system offers several novel features that differentiate it from traditional attendance management methods.

- These features include real-time attendance tracking, automated access control using RFID technology.
- A customizable Web UI, integration with an OLED display for visual feedback.
- A backend system for data storage and reporting.

In the competitive landscape, the smart attendance system stands out due to its comprehensive integration of hardware components, software development, and user interface. While other attendance systems may exist, the combination of RFID

technology, solenoid lock control, OLED display, and a web UI sets this product apart in terms of its functionality, convenience, and user-friendly interface.

The capstone project's targeted clients/customers include some of the below listed:

- **Educational Institutions:** Schools, Colleges, and Universities can benefit from the smart attendance system to automate attendance tracking, improve efficiency, and enhance security for students and staff.
- **Corporate Offices:** Companies of all sizes can utilize the system to streamline attendance management, particularly for large-scale events, meetings, or training sessions. It offers a convenient and accurate way to track attendance, generate reports, and ensure access control.
- **Government Organizations:** Government institutions can leverage the system for attendance tracking in public offices, events, or facilities where access control and accurate attendance records are needed.
- **Event Management Companies:** Companies organizing conferences, seminars, or workshops can utilize the system to manage attendee registration, track attendance during events, and enhance security measures.
- **Healthcare Centers:** Healthcare centers like Hospitals, Clinics, Rehabs and many more, to accurately track the attendance of the employees and can also be used for the purpose of authorization.

5.2 FINANCIAL CONSIDERATIONS

The budget for the capstone project would depend on various factors such as the scale of implementation, hardware and software costs, development resources, and any additional expenses related to research, testing, and documentation. But the budget of the components such as hardware components (ESP32, MFRFID RC522 Reader, Solenoid lock, OLED display), development tools and software licenses, server or hosting costs for the backend, and any other miscellaneous expenses are mentioned in the above Table 2.1.

The cost projections for the smart attendance system can vary depending on the target market and business model (for-profit or nonprofit). For-profit options

would involve considerations such as pricing the product to cover development costs, production costs, marketing and sales expenses, and generating a profit margin. Nonprofit options may focus on covering development and operational costs while ensuring affordability for educational institutions, nonprofit organizations, or community initiatives.

The revenue generation potential for the smart attendance system can be assessed based on factors such as market demand, pricing strategy, target customer base, and competitive landscape. It is crucial to consider factors that can drive revenue, such as licensing fees for the software, hardware sales, service and maintenance contracts, or subscription models for ongoing support and updates. Market research and analysis can provide insights into pricing models and revenue projections.

To evaluate the financial viability of the project, it is important to assess the potential ROI. This can be done by estimating the expected costs and revenues over a defined period and calculating the net return. Factors such as market size, adoption rate, pricing, and cost structure will influence the ROI calculation. The ROI analysis helps investors or stakeholders evaluate the profitability and potential benefits of investing in the project.

The capstone project can explore various funding options, including self-funding, seeking investments from venture capitalists or angel investors, applying for grants or research funding, or partnering with organizations that have an interest in attendance management solutions. It is essential to create a compelling business case and pitch to attract potential investors or funding sources.

5.3 CONCLUSIONS AND RECOMMENDATIONS

The state of completion of the capstone project depends on the progress made during its development. At this stage, the project can be considered to have achieved significant milestones, including the design and implementation of the smart attendance system using the ESP32, RFID RC522 reader, solenoid lock, OLED display, web UI, and backend system. The hardware components have been

integrated and tested, and the software components have been developed to enable attendance tracking, access control, and reporting functionalities. The system is functional and demonstrates the core features outlined in the project requirements.

There are several avenues for future work and improvements in the smart attendance system. Some areas to consider for further development include:

- **Enhanced Security Features:** Explore additional security measures such as biometric authentication or multi-factor authentication to further enhance access control and prevent unauthorized access.
- **Advanced Reporting and Analytics:** Extend the reporting capabilities of the system by incorporating advanced analytics and data visualization tools. This can provide deeper insights into attendance patterns, trends, and performance metrics.
- **Integration with Student Information Systems (SIS):** Integrate the attendance system with existing student information systems used by educational institutions to streamline data management and synchronization.
- **Mobile Application:** Develop a mobile application to complement the web UI, allowing users to conveniently access attendance information, receive notifications, and perform administrative tasks on their smartphones or tablets.
- **Scalability and Performance Optimization:** Optimize the system's performance to handle a larger number of users and attendance records efficiently. Consider techniques such as database optimization, caching mechanisms, and load balancing to ensure scalability.
- **Integration with Learning Management Systems (LMS):** Integrate the attendance system with popular learning management systems to automate attendance tracking and synchronization with course schedules and student enrollment data.
- **User Interface Enhancements:** Continuously improve the user interface of the web UI and explore user experience (UX) design principles to make it more intuitive, visually appealing, and user-friendly.

Based on the current state of completion and future work possibilities, the following recommendations can be made for the capstone project:

- **Conduct User Testing and Feedback:** Engage potential users, such as educational institutions or businesses, to gather feedback on the system's usability, functionality, and overall effectiveness. This will help identify any areas of improvement and validate the system's performance in real-world scenarios.
- **Refine and Document the System:** Continuously refine the system based on user feedback and document the design, implementation, and usage guidelines. This documentation will serve as a valuable resource for future maintenance, support, and expansion.
- **Seek Partnerships and Collaborations:** Explore partnerships or collaborations with educational institutions, organizations, or industry stakeholders to pilot the smart attendance system in real-world settings. This can provide valuable insights, validation, and potential opportunities for scaling the product.
- **Market and Promote the Solution:** Develop a comprehensive marketing and sales strategy to create awareness about the smart attendance system. Highlight its unique features, benefits, and competitive advantages to attract potential clients and customers. Utilize digital marketing channels, industry events, and partnerships to reach the target market effectively.

By addressing the recommended steps, the capstone project can continue to evolve, meet market needs, and provide value to its users, leading to potential growth and success.

REFERENCES

Journals

[1] Q. Miao, F. Xiao, H. Huang, L. Sun and R. Wang, "Smart attendance system based on frequency distribution algorithm with passive RFID tags," in Tsinghua Science and Technology, vol. 25, no. 2, pp. 217-226, April 2020
DOI: 10.26599/TST.2018.9010141.
https://ieeexplore.ieee.org/document/8821515

Conference proceedings

[1] U. Koppikar, S. Hiremath, A. Shiralkar, A. Rajoor and V. P. Baligar, "IoT based Smart Attendance Monitoring System using RFID," 2019 1st International Conference on Advances in Information Technology (ICAIT), Chikmagalur, India, 2019, pp. 193-197
DOI: 10.1109/ICAIT47043.2019.8987434.
https://sci-hub.se/https://ieeexplore.ieee.org/document/8987434

Online Reference

[1] Espressif, arduino-esp32 (Jun 27, 2018). Arduino core for the ESP32, ESP32-S2, ESP32-S3 and ESP32-C3(v 2.0.9).
https://github.com/espressif/arduino-esp32/tree/master/libraries/HTTPClient

[2] Miguelbalboa (Jan 4, 2016). Arduino RFID Library for MFRC522 RFID Readers (v 1.4.10).
https://github.com/miguelbalboa/rfid

[3] ThingPulse (Nov 13, 2015). ThingPulse OLED SSD1306 for ESP8266/ESP32/Mbed-OS (v 4.4.0)
https://github.com/ThingPulse/esp8266-oled-ssd1306

[4] Arduino-libraries (Dec 8, 2015). NTPClient for connecting a NTP server (v 3.2.1)
https://github.com/arduino-libraries/NTPClient

[5] IoT Project Ideas (April 23, 2020). RFID Based Attendance System Using NodeMCU with PHP Web App.
https://iotprojectsideas.com/rfid-based-attendance-system-using-nodemcu

[6] ayushjoshi599, GeeksforGeeks (8 June 2023). Introduction of Radio Frequency Identification (RFID)
https://www.geeksforgeeks.org/introduction-of-radio-frequency-identification-rfid

[7] Components101 (19 October 2020) . ESP32 – DevKitC
https://components101.com/microcontrollers/esp32-devkitc