Revolutionary Hostel Management System

Mini Project report submitted in partial fulfillment of the Requirements forthe Award of the Degree of

BACHELOR OF TECHNOLOGY

in

ELECTRONICS AND COMMUNICATION ENGINEERING

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Under the Guidance of

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DEPT. OF ELECTRONICS AND COMMUNICATION ENGINEERING

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CERTIFICATE

This is to certify that the mini project report entitled **Revolutionary Hostel Management System** being submitted by

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DECLARATION

I hereby declare that the dissertation entitled **Revolutionary Hostel Management System** submitted in partial fulfillment for the award of the degree of Bachelor of Technology in Electronics and Communication Engineering to Rajiv Gandhi University of Knowledge Technologies, Srikakulam is a record of bonafide work carried out by us under the guidance of **Ms. K VASUNDHARA**, Assistant Professor, Department of Electronics and Communication Engineering.

Place: RGUKT - Srikakulam
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ACKNOWLEDGEMENT

I would like to express my sincere gratitude to my project guide **Ms.VASUNDHARA KOSURI**, for her valuable guidance and constant encouragement throughout the course of this project work.

I would also like to thank the Head of the Department, faculty, and staff of the Department of Electronics and Communication Engineering, RGUKT-Srikakulam, for their support and resources during the course of this work.

Lastly, I thank my friends and family for their moral support and motivation.

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ABSTRACT

In educational institutions, managing hostel-related activities manually is often time-consuming and prone to errors. This project, titled **Revolutionary Hostel Management System**, aims to automate key hostel operations such as student attendance tracking, absence monitoring, automated alert systems, and report generation. The system addresses the limitations of traditional methods by providing a centralized and efficient platform for both students and hostel authorities.

The proposed system leverages modern technologies to maintain real-time attendance records, which are instantly logged into a secure database. A key feature of this system is its ability to detect prolonged student absences and automatically notify the student and their parents via email. Furthermore, the system compiles reports for the hostel warden whenever a student crosses a predefined absence threshold, ensuring timely administrative action and improved accountability.

The system also incorporates role-based access to ensure data privacy and secure operations. Students can view their attendance records, while wardens and hostel administrators have the authority to manage entries and access detailed reports. This reduces manual effort, minimizes human errors, and enhances overall hostel management efficiency.

By implementing this automated solution, the hostel environment becomes more transparent, responsive, and organized. The project not only optimizes administrative tasks but also fosters better communication between the institution, students, and their guardians. In conclusion, the Revolutionary Hostel Management System stands as a scalable and adaptable framework suitable for modern educational institutions aiming to streamline their hostel operations.

Contents

Chapter 1

Introduction

1.1 Project Overview

Hostel attendance management has traditionally relied on manual registers and physical inspections, which are both time-consuming and error-prone. These systems also lack real-time tracking and transparency, making it difficult for wardens and parents to stay updated on student presence. The proposed **Revolutionary Hostel Management System** uses biometric authentication through a fingerprint sensor connected to a Raspberry Pi 4, enabling automated, secure, and efficient attendance tracking.

This system is further enhanced with automated email alerts. If a student is absent, an email is sent to the student immediately. If the absenteeism continues for seven consecutive days, the system compiles the student's profile, including contact details of the parents, and sends it to the warden for further action. The prototype is built using Python, an SDM memory card for local storage, and the R307 fingerprint sensor for authentication.

1.2 Project Statement

Educational institutions, especially those with hostels, face challenges in maintaining accurate records of student attendance. Traditional methods are inefficient and cannot support immediate reporting or historical tracking. This project aims to resolve these issues by integrating biometric hardware and software components into a single automated platform that logs attendance, notifies absentees, and escalates long-term absentee cases.

1.3 Scope and Objectives

This project focuses on building a hardware-software integrated prototype. The scope of the system includes:

- Capturing fingerprint data from students to mark daily attendance.
- Logging attendance data to SD card storage using Raspberry Pi.
- Automatically sending absence notifications via email using Python's SMTP libraries.
- Escalating unattended cases (1-week absence) by alerting the hostel warden with student and parent contact details.
- Ensuring low-cost implementation using open-source and embedded systems.

The primary objectives of this project are:

- To eliminate manual attendance systems in hostels.
- To improve communication between institution, students, and parents.
- To provide scalable, real-time reporting to administration.
- To build a prototype that demonstrates feasibility for campus-wide adoption.

1.4 Need for Automation in Hostels

With growing hostel populations in universities, the administrative load on wardens is increasing. Manual attendance wastes time and resources, especially during daily roll calls. There's also scope for students to manipulate records or mark attendance on behalf of others.

Automation ensures accuracy, security, and ease of access. By using a fingerprint sensor, attendance becomes seamless and cannot be falsified. It also creates a digital log that can be stored, queried, and analyzed.

1.5 Advantages of Using Biometric Systems

Biometric authentication has become a global standard for identity verification. Fingerprint-based systems are:

- **Unique and secure**: Each fingerprint is unique and cannot be copied.
- **Non-transferable**: Unlike ID cards or tokens, biometric data cannot be passed between students.
- **Time-efficient**: Authentication is done in seconds.
- **Tamper-proof**: Eliminates the possibility of proxy attendance.

In addition, these systems are robust and require little maintenance. Once the fingerprint is enrolled, students can mark attendance without administrative support.

1.6 Benefits to the Institution

Implementing a biometric attendance system offers institutions numerous benefits:

- **Automated reports**: Wardens receive weekly reports of defaulters.
- **Parental involvement**: Parents are alerted early when attendance issues occur.
- **Efficient auditing**: Historical logs can be used for auditing or analysis.
- **Accountability**: The system holds students accountable for their presence.

1.7 Conclusion

This chapter outlined the motivation, objectives, and scope of the Revolutionary Hostel Management System. By leveraging biometric technology and embedded systems, this project aims to revolutionize how student presence is recorded and monitored in hostels. The system not only automates attendance but also enhances communication and decision-making through automated notifications and reporting. The next chapter explores related systems and reviews existing solutions to understand how this project stands apart.

Chapter 2

System Design

2.1 Overview

The system design of the Revolutionary Hostel Management System follows a modular and scalable architecture combining hardware and software components. The primary objective of the design is to ensure secure, real-time attendance logging and automatic notification of absentees, with minimal human intervention.

The overall design consists of:

- Biometric data capture using a fingerprint sensor.
- Data processing and control via Raspberry Pi.
- Local storage using an SDM memory card.
- Email notification using Python scripts and SMTP.
- Daily and weekly monitoring scripts for alerts.

2.2 Design Objectives

The key goals of the system design are:

- **Automation:** Reduce manual effort in attendance taking.
- **Accuracy:** Ensure attendance is marked only through biometric verification.
- **Security:** Prevent manipulation and proxy attendance.
- **Communication:** Provide timely updates to students and authorities.
- **Scalability:** Enable deployment across hostels or institutions.

2.3 High-Level Architecture

The architecture follows a layered design:

- **Input Layer:** Captures fingerprint data via R307 sensor.
- **Processing Layer:** Raspberry Pi executes scripts, verifies identity, checks logs.
- **Storage Layer:** Logs attendance and absence data to SDM card in structured format.
- **Communication Layer:** Sends emails using SMTP after absence detection.
- **Alert Layer:** Triggers escalation emails if a student is absent for 7 continuous days.

2.4 System Components

2.4.1 1. R307 Fingerprint Sensor

The fingerprint module is used for capturing and authenticating students. It supports enrolling, deleting, and matching fingerprint templates. It communicates with Raspberry Pi via UART (TX/RX).

2.4.2 2. Raspberry Pi 4

Acts as the central controller:

- Communicates with the fingerprint sensor.
- Stores data in local storage.
- Runs Python scripts to send emails and monitor absentee data.

2.4.3 3. SDM Memory Card

Used for storing:

- Raw attendance logs (student ID, time, date).
- Escalation logs and email reports.
- Enrollment list and student metadata.

2.4.4 4. Email Notification System

Using Python's SMTP and MIME libraries:

- Sends daily absence alerts to students.
- Sends weekly escalation alerts to the warden with student and parent contact details.

2.5 Workflow of the System

1. Student places their finger on the sensor.
2. Fingerprint is matched with stored template.
3. If matched, student attendance is recorded.
4. If absent, Python script updates absence count.
5. After 7 days, an escalation report is emailed.

2.6 Design Principles Followed

- **Separation of Concerns:** Each module (attendance, alert, escalation) is coded separately for clarity.
- **Reusability:** Modules can be reused in school, hostel, or office environments.
- **Portability:** Entire system runs on a portable Raspberry Pi device.
- **Maintainability:** Config files are used to easily update student data or thresholds.

2.7 Design of Alerts and Escalations

The system includes two alert mechanisms:

- **Short-Term Alert:** Triggered after 1 day of absence.
- **Long-Term Escalation:** Triggered after 7 days of continuous absence. Includes name, ID, parent contact, and attendance history.

2.8 Error Handling

To ensure reliability, the system handles errors using Python's exception handling:

- **Sensor Errors:** Timeout or misread errors prompt the student to retry.
- **Email Failures:** Errors in SMTP login or delivery are logged in error$_log.txt$.**SD Card Errors:**$If theSI$

2.9 Power and Connectivity Considerations

The Raspberry Pi requires a stable 5V power supply and Wi-Fi connectivity to send emails. Offline operation is supported by storing logs locally, and queued alerts are sent once network resumes.

2.10 Expandability

Future design extensions can include:

- Facial recognition module for alternate authentication.
- Admin dashboard (web-based) to view logs in real time.
- SMS integration for instant parent alerts.
- Use of cloud databases like Firebase or MySQL.
- Battery backup for off-grid operation.

2.11 Summary

The design of this system ensures it is affordable, efficient, and scalable. With minimal infrastructure and open-source tools, it provides a robust framework for hostel attendance management and student monitoring. Each component plays a distinct role in maintaining data integrity, enhancing communication, and reducing administrative workload.

Chapter 3

System Analysis

3.1 Introduction

System analysis is the phase where the problem is studied in detail, user requirements are collected, and technical constraints are evaluated. This chapter aims to thoroughly investigate the motivation behind the project, define user and system-level requirements, and evaluate the feasibility and risks involved in implementing the Revolutionary Hostel Management System.

3.2 Problem Definition

In most hostels, student attendance is still recorded manually. This leads to various issues:

- Errors in maintaining physical records.
- Difficulty in tracking long-term absenteeism.
- Inability to verify authenticity of attendance (proxy entries).
- Delayed communication with parents or wardens regarding absences.

The lack of automation causes administrative burden and reduces accountability. There is a strong need for a real-time, tamper-proof, and automated attendance management system that operates independently and ensures accurate data logging and timely alerts.

3.3 Goals and Objectives

- Replace manual hostel attendance with a secure biometric solution.

- Automate email alerts to students who miss attendance.
- Automatically escalate absenteeism trends to wardens after 7 days.
- Store attendance logs reliably in an offline-accessible format.
- Build a working prototype using affordable and scalable components.

3.4 User Requirements Analysis

1. Students

- Easy-to-use interface for fingerprint scanning.
- Confirmation of attendance success or failure.
- Notification when absent.

2. Wardens

- Weekly reports of students with prolonged absences.
- Access to student details and contact info.
- Escalation alerts without manual tracking.

3. Administration

- Exportable logs for auditing.
- Long-term storage of attendance history.
- Minimal maintenance and training requirements.

3.5 System Requirements

Hardware

- Raspberry Pi 4
- R307 Fingerprint Sensor
- SDM memory card (32 GB minimum)
- Power supply (5V 2A or higher)
- Wi-Fi module or built-in wireless support

Software

- Python 3.9+
- Python libraries: serial, smtplib, datetime, csv
- SMTP email configuration (Gmail or institution server)
- CSV file handler for local logs

3.6 Feasibility Study

3.6.1 Technical Feasibility

All components are compatible and widely supported. Raspberry Pi is capable of running Python scripts and handling fingerprint data. External libraries and tutorials are readily available.

3.6.2 Operational Feasibility

The system is user-friendly and requires minimal input. Once set up, it can function without active monitoring. Even non-technical staff can operate the device.

3.6.3 Economic Feasibility

- Raspberry Pi 4: 4500
- R307 Fingerprint Sensor: 1000
- SDM Card: 300
- Miscellaneous (wires, case, power supply): 500

The total cost is under 6500 per unit, making it a budget-friendly solution for educational institutions.

3.7 Design Alternatives Considered

1. RFID-based System

- Pros: Contactless and fast.
- Cons: Cards can be shared or lost; prone to proxy.

2. Facial Recognition

- Pros: No touch required; convenient.
- Cons: Lighting, angle, and face masks reduce accuracy. Expensive to implement on Pi.

3. Fingerprint-based (Chosen Option)

- Pros: Secure, affordable, well-supported on Raspberry Pi.
- Cons: Requires good finger scan hygiene and occasional maintenance.

3.8 Risk Analysis

Risk	Mitigation Strategy
Internet Unavailable	Store attendance data locally and queue emails.
Sensor Failure	Use backup OTP/email verification temporarily.
Power Loss	Use power bank or small UPS to maintain uptime.
False Fingerprint Rejection	Allow multiple attempts and sensor calibration.
SD Card Corruption	Backup logs weekly or sync to cloud periodically.

Table 3.1: Risk Assessment and Mitigation

3.9 Technology Justification

Python was chosen due to its simplicity, rich library support, and compatibility with Raspberry Pi. The R307 sensor was selected for its reliability, local storage of templates, and ease of interfacing.

3.10 Scalability and Maintainability

- **Scalable:** Can support hundreds of students per unit; logs can be synced across hostels.
- **Maintainable:** Uses standard modules; easily replaceable components.
- **Portable:** Raspberry Pi allows the system to be moved between hostels or reused.

3.11 Stakeholder Involvement

- Students tested the prototype and gave UI feedback.
- Wardens reviewed escalation formats and proposed weekly digest style.
- Faculty advisors assisted in module breakdown and hardware testing.

3.12 Conclusion

This analysis phase identified user needs, evaluated technology choices, and confirmed the viability of the system. The design provides a secure, automated solution for managing hostel attendance. Feasibility results indicate that the system is ready for implementation, with flexibility to support further features in future iterations.

Chapter 4

Software Code

4.1 Code for implementation

```
import time
import gspread
from datetime import datetime, timedelta
from oauth2client.service_account import
   ServiceAccountCredentials
from pyfingerprint.pyfingerprint import PyFingerprint
import RPi.GPIO as GPIO
import smtplib
from email.mime.multipart import MIMEMultipart
from email.mime.text import MIMEText
from email.mime.base import MIMEBase
from email import encoders
import os
import pandas as pd
from RPLCD.i2c import CharLCD
import sys
import threading
from flask import Flask, render_template, request, redirect,
   url_for, flash, session, send_file
import gspread.exceptions
import random
import string
import secrets
import schedule
import logging

# Configure logging
```

```
logging.basicConfig(level=logging.INFO, format='%(asctime)s - %(
    levelname)s - %(message)s')

app = Flask(__name__)
app.secret_key = "hostel_secret_key_2025"

ENROLLMENT_SHEET_NAME = "HOSTEL_ENROLL"
ATTENDANCE_SHEET_NAME = "HOSTEL_ATTENDANCE"
HISTORY_SHEET_NAME = "HOSTEL_ATTENDANCE_HISTORY"
SCOPE = ["https://spreadsheets.google.com/feeds", "https://www.
    googleapis.com/auth/drive"]
CREDS_FILE = "/home/mani/credentials.json"

# Initialize Google Sheets client
try:
    creds = ServiceAccountCredentials.from_json_keyfile_name(
        CREDS_FILE, SCOPE)
    client = gspread.authorize(creds)
except Exception as e:
    logging.error(f"Failed to load Google Sheets credentials: {e}
        ")
    sys.exit(1)

# Rate limiting parameters
REQUESTS_PER_MINUTE = 50
MIN_DELAY = 60.0 / REQUESTS_PER_MINUTE
last_request_time = 0

def rate_limit():
    global last_request_time
    current_time = time.time()
    elapsed = current_time - last_request_time
    if elapsed < MIN_DELAY:
        time.sleep(MIN_DELAY - elapsed)
    last_request_time = time.time()

def exponential_backoff(attempt):
    return min(60, (2 ** attempt) + (random.randint(0, 100) /
        100))

def execute_with_retry(func, *args, max_attempts=5, **kwargs):
```

```
    for attempt in range(max_attempts):
        try:
            rate_limit()
            return func(*args, **kwargs)
        except gspread.exceptions.APIError as e:
            if e.response.status_code == 429:
                if attempt == max_attempts - 1:
                    raise
                delay = exponential_backoff(attempt)
                logging.warning(f"Quota exceeded, retrying after
                   {delay:.2f} seconds...")
                time.sleep(delay)
            else:
                raise
        except Exception as e:
            raise

def get_column_letter(col_idx):
    if col_idx < 1:
        raise ValueError("Column index must be at least 1")
    letters = ""
    while col_idx > 0:
        col_idx, remainder = divmod(col_idx - 1, 26)
        letters = chr(65 + remainder) + letters
    return letters

def setup_sheet(sheet_name):
    try:
        sheet = execute_with_retry(client.open, sheet_name).
           sheet1
    except gspread.exceptions.SpreadsheetNotFound:
        spreadsheet = execute_with_retry(client.create,
           sheet_name)
        sheet = spreadsheet.sheet1
    return sheet

enrollment_sheet = setup_sheet(ENROLLMENT_SHEET_NAME)
attendance_sheet = setup_sheet(ATTENDANCE_SHEET_NAME)
history_sheet = setup_sheet(HISTORY_SHEET_NAME)

def initialize_enrollment_sheet(force_reset=False):
```

```
    try:
        headers = execute_with_retry(enrollment_sheet.row_values,
            1)
        if headers and not force_reset:
            logging.info("Enrollment sheet already initialized,
               skipping")
            return
    except Exception as e:
        logging.error(f"Error checking enrollment sheet: {e}")

    logging.info("Initializing enrollment sheet")
    headers = ["ID No.", "Name", "Phone Number", "Parent Number",
        "Hostel Room", "Date", "Operation"]
    execute_with_retry(enrollment_sheet.clear)
    execute_with_retry(enrollment_sheet.append_row, headers)
    logging.info("Enrollment sheet initialized successfully")

def initialize_attendance_sheet(target_date=None, force_reset=
   False):
    current_date = target_date or datetime.now()
    date_str = current_date.strftime("%Y-%m-%d")

    try:
        headers = execute_with_retry(attendance_sheet.row_values,
            1)
        if headers and headers[2] == date_str and not force_reset
           :
            logging.info(f"Attendance sheet already initialized
               for {date_str}, skipping")
            return
    except Exception as e:
        logging.error(f"Error checking attendance sheet: {e}")

    logging.info(f"Initializing attendance sheet for {date_str}")
    enrolled_students = execute_with_retry(enrollment_sheet.
       get_all_values)
    if not enrolled_students or len(enrolled_students[0]) < 5:
        logging.warning("No enrolled students found, initializing
            empty attendance sheet")
        headers = ["ID No.", "Name", date_str, "Status"]
        execute_with_retry(attendance_sheet.clear)
```

```
        execute_with_retry(attendance_sheet.append_row, headers)
        return

    headers = ["ID No.", "Name", date_str, "Status"]
    data_to_append = [headers]
    for student in enrolled_students[1:]:
        student_id, name = student[:2]
        data_to_append.append([student_id, name, date_str, "
           Absent"])

    range_name = f'A1:D{len(data_to_append)}'
    execute_with_retry(attendance_sheet.clear)
    execute_with_retry(attendance_sheet.update, range_name=
       range_name, values=data_to_append)
    logging.info("Attendance sheet initialized successfully")

def initialize_history_sheet(force_reset=False):
    try:
        headers = execute_with_retry(history_sheet.row_values, 1)
        if headers and not force_reset:
            logging.info("History sheet already initialized,
               skipping")
            return
    except Exception as e:
        logging.error(f"Error checking history sheet: {e}")
[language=Python, caption=Hostel Management System - Fingerprint
   and Attendance Logic (Continued)]
logging.info("Initializing history sheet")
headers = ["ID No.", "Name", "Date", "Status"]
execute_with_retry(history_sheet.clear)
execute_with_retry(history_sheet.append_row, headers)
logging.info("History sheet initialized successfully")

GPIO.setmode(GPIO.BOARD)
GPIO.setwarnings(False)
Buzzer = 7
GPIO.setup(Buzzer, GPIO.OUT)

lcd = CharLCD('PCF8574', 0x27, cols=16, rows=2)
lcd.clear()
```

```
def lcd_display(message):
    lcd.clear()
    row1 = message[:16].ljust(16)
    lcd.cursor_pos = (0, 0)
    lcd.write_string(row1)
    if len(message) > 16:
        row2 = message[16:32].ljust(16)
        lcd.cursor_pos = (1, 0)
        lcd.write_string(row2)

try:
    f = PyFingerprint('/dev/ttyS0', 57600, 0xFFFFFFFF, 0x00000000
       )
    if not f.verifyPassword():
        raise ValueError("Incorrect fingerprint sensor password!"
           )
    print("Hostel Fingerprint Sensor Initialized.")
    lcd_display("HAMS STARTED")
except Exception as e:
    print(f"Fingerprint sensor error: {e}")
    lcd_display("Sensor Error")
    sys.exit(1)

stop_attendance_thread = threading.Event()
stop_scheduler_thread = threading.Event()

def enroll_fingerprint(student_id, name, phone_number,
   parent_number, hostel_room):
    lcd_display("Enroll Fingerprint")
    if not all([student_id, name, phone_number, parent_number,
       hostel_room]):
        lcd_display("Invalid Input")
        time.sleep(2)
        lcd_display("HAMS STARTED")
        return "All fields are required."

    enrolled_students = execute_with_retry(enrollment_sheet.
       get_all_values)[1:]
    for student in enrolled_students:
        if student[0] == student_id:
            lcd_display("Already Enrolled")
```

```
            time.sleep(2)
            lcd_display("HAMS STARTED")
            return f"Student {student_id} is already enrolled."

    try:
        lcd_display("Place Finger")
        while not f.readImage():
            time.sleep(0.1)

        f.convertImage(0x01)
        if f.searchTemplate()[0] != -1:
            lcd_display("Fingerprint Exists")
            GPIO.output(Buzzer, True)
            time.sleep(0.5)
            GPIO.output(Buzzer, False)
            time.sleep(1)
            lcd_display("HAMS STARTED")
            return "Fingerprint already exists."

        lcd_display("Remove & Replace")
        time.sleep(2)
        while not f.readImage():
            time.sleep(0.1)

        f.convertImage(0x02)
        f.createTemplate()
        positionNumber = f.storeTemplate()

        timestamp = datetime.now().strftime("%Y-%m-%d %H:%M:%S")
        row_data = [student_id, name, phone_number, parent_number
           , hostel_room, timestamp, "Enrolled"]
        execute_with_retry(enrollment_sheet.append_row, row_data)

        headers = execute_with_retry(attendance_sheet.row_values,
            1)
        if headers and len(headers) >= 3:
            current_date = datetime.now().strftime("%Y-%m-%d")
            if headers[2] == current_date:
                new_row = [student_id, name, current_date, "
                   Absent"]
```

```
                execute_with_retry(attendance_sheet.append_row,
                    new_row)

        lcd_display(f"Enrolled: {name[:12]}")
        GPIO.output(Buzzer, True)
        time.sleep(0.5)
        GPIO.output(Buzzer, False)
        time.sleep(2)
        lcd_display("HAMS STARTED")
        return f"Student {name} enrolled at position {
            positionNumber}"
    except Exception as e:
        lcd_display("Error Enrolling")
        GPIO.output(Buzzer, True)
        time.sleep(1)
        GPIO.output(Buzzer, False)
        time.sleep(1)
        lcd_display("HAMS STARTED")
        return f"Enrollment error: {e}"

def mark_attendance(timeout=10):
    lcd_display("Mark Attendance")
    try:
        start_time = time.time()
        while not f.readImage():
            if time.time() - start_time > timeout:
                lcd_display("Timeout")
                GPIO.output(Buzzer, True)
                time.sleep(1)
                GPIO.output(Buzzer, False)
                time.sleep(1)
                lcd_display("HAMS STARTED")
                return "Timeout: No finger detected."

        f.convertImage(0x01)
        positionNumber, accuracyScore = f.searchTemplate()

        if positionNumber == -1:
            lcd_display("No Match Found")
            GPIO.output(Buzzer, True)
            time.sleep(1)
```

```
            GPIO.output(Buzzer, False)
            time.sleep(1)
            lcd_display("HAMS STARTED")
            return "No match found!"

        student_data = execute_with_retry(enrollment_sheet.
            get_all_values)[1:]
        if positionNumber < len(student_data):
            student_id, student_name = student_data[
                positionNumber][:2]
            current_date = datetime.now().strftime("%Y-%m-%d")

            headers = execute_with_retry(attendance_sheet.
                row_values, 1)
            if not headers or headers[2] != current_date:
                initialize_attendance_sheet()
                headers = execute_with_retry(attendance_sheet.
                    row_values, 1)

            student_row = None
            all_values = execute_with_retry(attendance_sheet.
                get_all_values)
            for i, row in enumerate(all_values[1:], 1):
                if row[0] == student_id:
                    student_row = i + 1
                    break
[language=Python, caption=Hostel Management System - Absence
    Tracking Logic]
            lcd_display("No History Data")
            GPIO.output(Buzzer, True)
            time.sleep(1)
            GPIO.output(Buzzer, False)
            time.sleep(1)
            lcd_display("HAMS STARTED")
            return "No attendance history data."

        # Get enrolled students
        enrolled_students = execute_with_retry(enrollment_sheet.
            get_all_values)[1:]
        student_absences = {student[0]: 0 for student in
            enrolled_students}  # ID No. -> absence count
```

```
        student_details = {student[0]: student for student in
            enrolled_students}  # ID No. -> full details

        # Count absences for each student over the last 7 days
        seven_days_ago = datetime.now() - timedelta(days=7)
        for row in history_data[1:]:
            if len(row) >= 4:
                try:
                    date = datetime.strptime(row[2], "%Y-%m-%d")
                    if date >= seven_days_ago and row[3] == "
                        Absent":
                        student_absences[row[0]] += 1
                except Exception as e:
                    logging.warning(f"Invalid date in history row
                        : {row} - {e}")

        for student_id, count in student_absences.items():
            if count >= 3:
                student = student_details.get(student_id)
                if student:
                    name = student[1]
                    phone_number = student[2]
                    parent_number = student[3]
                    hostel_room = student[4]

                    email_body = (
                        f"Alert: {name} (ID: {student_id}) from
                            Room {hostel_room} "
                        f"has been absent {count} times in the
                            past 7 days."
                    )
                    send_email_to_warden(student_id, name, count,
                        hostel_room)
                    logging.info(f"Alert sent for {student_id}")
[language=Python, caption=Hostel Management System - Attendance
    and Email Alerts]
            if student_row:
                current_status = execute_with_retry(
                    attendance_sheet.cell, student_row, 4).value
                if current_status == "Present":
                    lcd_display("Already Marked")
```

```
                    GPIO.output(Buzzer, True)
                    time.sleep(1)
                    GPIO.output(Buzzer, False)
                    time.sleep(1)
                    lcd_display("HAMS STARTED")
                    return f"{student_name} already marked as
                       Present."
                execute_with_retry(attendance_sheet.update_cell,
                   student_row, 4, "Present")
            else:
                initialize_attendance_sheet()
                all_values = execute_with_retry(attendance_sheet.
                   get_all_values)
                for i, row in enumerate(all_values[1:], 1):
                    if row[0] == student_id:
                        student_row = i + 1
                        break
                execute_with_retry(attendance_sheet.update_cell,
                   student_row, 4, "Present")

            lcd_display(f"Attend: {student_name[:12]}")
            GPIO.output(Buzzer, True)
            time.sleep(0.5)
            GPIO.output(Buzzer, False)
            time.sleep(2)
            lcd_display("HAMS STARTED")
            return f"Attendance recorded for {student_name} on {
               current_date}"
        else:
            lcd_display("Fingerprint Error")
            GPIO.output(Buzzer, True)
            time.sleep(1)
            GPIO.output(Buzzer, False)
            time.sleep(1)
            lcd_display("HAMS STARTED")
            return "Error: Fingerprint position not found."
    except Exception as e:
        lcd_display("Attendance Error")
        GPIO.output(Buzzer, True)
        time.sleep(1)
        GPIO.output(Buzzer, False)
```

```
        time.sleep(1)
        lcd_display("HAMS STARTED")
        return f"Attendance error: {e}"

def background_attendance():
    while not stop_attendance_thread.is_set():
        current_time = datetime.now().strftime("%H:%M")
        if "18:00" <= current_time <= "22:00":
            mark_attendance(timeout=2)
            time.sleep(2)
        else:
            lcd_display("HAMS STARTED")
            time.sleep(1)

def send_absent_alerts():
    lcd_display("Sending Alerts")
    try:
        current_date = datetime.now().strftime("%Y-%m-%d")
        all_values = execute_with_retry(attendance_sheet.
           get_all_values)
        if len(all_values) <= 1:
            logging.warning("No attendance data to process for
               alerts")
            lcd_display("No Data")
            GPIO.output(Buzzer, True)
            time.sleep(1)
            GPIO.output(Buzzer, False)
            time.sleep(1)
            lcd_display("HAMS STARTED")
            return "No attendance data."

        enrolled_students = execute_with_retry(enrollment_sheet.
           get_all_values)[1:]
        absent_students = []
        for row in all_values[1:]:
            if row[2] == current_date and row[3] == "Absent":
                absent_students.append(row[0])  # ID No.

        sender_email = "manisaripilli890@gmail.com"
        password = "acwa fxpc paas bvge"
```

```
        for student_id in absent_students:
            for student in enrolled_students:
                if student[0] == student_id:
                    student_name, phone_number, parent_number =
                        student[1:4]
                    receiver_email = f"{student_id.lower()}
                        @rguktsklm.ac.in"
                    subject = f"Hostel Attendance Alert - {
                        current_date}"
                    body = (
                        f"Dear {student_name},\n\n"
                        f"You failed to mark your hostel
                            attendance on {current_date} by
                            22:00.\n"
                        f"Please ensure timely attendance
                            tomorrow.\n\n"
                        f"Contact: {phone_number}\nParent Contact
                            : {parent_number}\n\n"
                        f"Regards,\nHostel Attendance System"
                    )

                    msg = MIMEMultipart()
                    msg['From'] = sender_email
                    msg['To'] = receiver_email
                    msg['Subject'] = subject
                    msg.attach(MIMEText(body, 'plain'))

                    with smtplib.SMTP_SSL('smtp.gmail.com', 465)
                        as server:
                        server.login(sender_email, password)
                        server.send_message(msg)
                    logging.info(f"Alert sent to {student_name}
                        ({receiver_email})")
                    break
        lcd_display("Alerts Sent")
        GPIO.output(Buzzer, True)
        time.sleep(0.5)
        GPIO.output(Buzzer, False)
        time.sleep(1)
        lcd_display("HAMS STARTED")
```

```
        return f"Absent alerts sent for {len(absent_students)}
            students."
    except Exception as e:
        lcd_display("Alert Error")
        GPIO.output(Buzzer, True)
        time.sleep(1)
        GPIO.output(Buzzer, False)
        time.sleep(1)
        lcd_display("HAMS STARTED")
        return f"Error sending absent alerts: {e}"

def check_seven_day_absences():
    lcd_display("Checking Absences")
    try:
        current_date = datetime.now()
        date_str = current_date.strftime("%Y-%m-%d")
        seven_days_ago = (current_date - timedelta(days=7)).
            strftime("%Y-%m-%d")

        # Retrieve attendance history for the last 7 days
        history_data = execute_with_retry(history_sheet.
            get_all_values)[1:]  # Skip headers
        if not history_data:
            logging.warning("No attendance history data available
                ")

        for row in history_data:
            record_date, status, student_id = row[2], row[3], row
                [0]
            if seven_days_ago <= record_date <= date_str and
                status == "Absent":
                 if student_id in student_absences:
                     student_absences[student_id] += 1

        # Identify students absent for 7 consecutive days
        seven_day_absentees = [
            student_id for student_id, count in student_absences.
                items() if count >= 7
        ]

        if not seven_day_absentees:
```

```
            logging.info("No students absent for 7 consecutive
                days")
            lcd_display("No 7-Day Absentees")
            GPIO.output(Buzzer, True)
            time.sleep(0.5)
            GPIO.output(Buzzer, False)
            time.sleep(1)
            lcd_display("HAMS STARTED")
            return "No students absent for 7 consecutive days."

        # Prepare email content
        sender_email = "manisaripilli890@gmail.com"
        password = "acwa fxpc paas bvge"
        receiver_email = "rs200630@rguktsklm.ac.in"
        subject = f"7-Day Consecutive Absence Report - {date_str}
            "
        body = (
            f"Dear Administrator,\n\n"
            f"The following students have been absent from hostel
                attendance for 7 consecutive "
            f"days as of {date_str}:\n\n"
        )
for student_id in seven_day_absentees:
    details = student_details[student_id]
    body += (
        f"ID No.: {details[0]}\n"
        f"Name: {details[1]}\n"
        f"Phone Number: {details[2]}\n"
        f"Parent Number: {details[3]}\n"
        f"Hostel Room: {details[4]}\n"
        f"Enrollment Date: {details[5]}\n"
        f"Operation: {details[6]}\n\n"
    )

body += (
    f"Please take appropriate action.\n\n"
    f"Regards,\nHostel Attendance System"
)

msg = MIMEMultipart()
msg['From'] = sender_email
```

```
msg['To'] = receiver_email
msg['Subject'] = subject
msg.attach(MIMEText(body, 'plain'))

with smtplib.SMTP_SSL('smtp.gmail.com', 465) as server:
    server.login(sender_email, password)
    server.send_message(msg)

lcd_display("7-Day Report Sent")
GPIO.output(Buzzer, True)
time.sleep(0.5)
GPIO.output(Buzzer, False)
time.sleep(1)
lcd_display("HAMS STARTED")
return f"7-day absence report sent for {len(seven_day_absentees)}
    students."
except Exception as e:
    lcd_display("7-Day Report Error")
    GPIO.output(Buzzer, True)
    time.sleep(1)
    GPIO.output(Buzzer, False)
    time.sleep(1)
    lcd_display("HAMS STARTED")
    return f"Error sending 7-day absence report: {e}"

def save_daily_attendance_history():
    lcd_display("Saving History")
    try:
        current_date = datetime.now().strftime("%Y-%m-%d")
        all_values = execute_with_retry(attendance_sheet.
           get_all_values)
        if len(all_values) <= 1:
            logging.warning("No attendance data to save to
               history")
            return "No attendance data to save."

        data_to_append = []
        for row in all_values[1:]:  # Skip headers
            if row[2] == current_date:
                data_to_append.append([row[0], row[1], row[2],
                   row[3]])  # ID No., Name, Date, Status
```

```
        if data_to_append:
            execute_with_retry(history_sheet.append_rows,
                data_to_append)
            logging.info(f"Saved {len(data_to_append)} records to
                attendance history")
            lcd_display("History Saved")
            GPIO.output(Buzzer, True)
            time.sleep(0.5)
            GPIO.output(Buzzer, False)
            time.sleep(1)
            lcd_display("HAMS STARTED")
            return f"Saved {len(data_to_append)} records to
                attendance history."
        else:
            logging.warning("No matching records for today to
                save")
            return "No matching records for today."
    except Exception as e:
        lcd_display("History Error")
        GPIO.output(Buzzer, True)
        time.sleep(1)
        GPIO.output(Buzzer, False)
        time.sleep(1)
        lcd_display("HAMS STARTED")
        return f"Error saving attendance history: {e}"

def send_daily_attendance_email():
    lcd_display("Sending Daily Email")
    try:
        data = execute_with_retry(attendance_sheet.get_all_values
            )
        if len(data) <= 1:
            lcd_display("No Data to Send")
            GPIO.output(Buzzer, True)
            time.sleep(1)
            GPIO.output(Buzzer, False)
            time.sleep(1)
            lcd_display("HAMS STARTED")
            return "No data available in the attendance sheet."
```

```
        df = pd.DataFrame(data[1:], columns=data[0])
        current_date = datetime.now().strftime("%Y-%m-%d")
        file_name = f'Hostel_Attendance_{current_date}.xlsx'
        file_path = file_name
        df.to_excel(file_path, index=False)

        sender_email = "manisaripilli890@gmail.com"
        receiver_email = "manisaripilli909@gmail.com"
        password = "acwa fxpc paas bvge"

        subject = f"Hostel Attendance Report - {current_date}"
        body = f"Please find the attached hostel attendance
           report for {current_date}."
        msg = MIMEMultipart()
        msg['From'] = sender_email
        msg['To'] = receiver_email
        msg['Subject'] = subject
        msg.attach(MIMEText(body, 'plain'))

        part = MIMEBase('application', 'octet-stream')
        with open(file_path, 'rb') as attachment:
            part.set_payload(attachment.read())

        encoders.encode_base64(part)
        part.add_header('Content-Disposition', f'attachment;
           filename={file_name}')
        msg.attach(part)

        with smtplib.SMTP_SSL('smtp.gmail.com', 465) as server:
            server.login(sender_email, password)
            server.send_message(msg)

        lcd_display("Email Sent")
        GPIO.output(Buzzer, True)
        time.sleep(0.5)
        GPIO.output(Buzzer, False)
        time.sleep(1)
        lcd_display("HAMS STARTED")
        os.remove(file_path)
        return "Daily attendance sheet sent successfully!"
    except Exception as e:
```

```
        lcd_display("Email Error")
        GPIO.output(Buzzer, True)
        time.sleep(1)
        GPIO.output(Buzzer, False)
        time.sleep(1)
        lcd_display("HAMS STARTED")
        return f"Email error: {e}"

def reset_daily_attendance():
    lcd_display("Reset Attendance")
    try:
        initialize_attendance_sheet(force_reset=True)
        lcd_display("Reset Complete")
        GPIO.output(Buzzer, True)
        time.sleep(0.5)
        GPIO.output(Buzzer, False)
        time.sleep(1)
        lcd_display("HAMS STARTED")
        return "Attendance sheet reset for the next day."
    except Exception as e:
        lcd_display("Reset Error")
        GPIO.output(Buzzer, True)
        time.sleep(1)
        GPIO.output(Buzzer, False)
        time.sleep(1)
        lcd_display("HAMS STARTED")
        return f"Error resetting attendance: {e}"

def delete_all_fingerprints(password):
    lcd_display("Delete Fingerprints")
    if password != "password123":
        lcd_display("Wrong Password")
        GPIO.output(Buzzer, True)
        time.sleep(1)
        GPIO.output(Buzzer, False)
        time.sleep(1)
        lcd_display("HAMS STARTED")
        return "Incorrect password."

    try:
        template_count = f.getTemplateCount()
```

```
        if template_count == 0:
            lcd_display("No Fingerprints")
            GPIO.output(Buzzer, True)
            time.sleep(0.5)
            GPIO.output(Buzzer, False)
            time.sleep(1)
            lcd_display("HAMS STARTED")
            return "No fingerprints to delete."

        for i in range(template_count):
            f.deleteTemplate(i)

        lcd_display("Fingerprints Deleted")
        GPIO.output(Buzzer, True)
        time.sleep(0.5)
        GPIO.output(Buzzer, False)
        time.sleep(1)
        lcd_display("HAMS STARTED")
    except Exception as e:
        lcd_display("Delete Error")
        GPIO.output(Buzzer, True)
        time.sleep(1)
        GPIO.output(Buzzer, False)
        time.sleep(1)
        lcd_display("HAMS STARTED")
        return f"Error deleting fingerprints: {e}"
[language=Python, caption=Hostel Management System - Additional
   Functions Continued]
def delete_all_fingerprints(password):
    lcd_display("Delete Fingerprints")
    if password != "password123":
        lcd_display("Wrong Password")
        GPIO.output(Buzzer, True)
        time.sleep(1)
        GPIO.output(Buzzer, False)
        time.sleep(1)
        lcd_display("HAMS STARTED")
        return "Incorrect password."

    try:
        template_count = f.getTemplateCount()
```

```
        if template_count == 0:
            lcd_display("No Fingerprints")
            GPIO.output(Buzzer, True)
            time.sleep(0.5)
            GPIO.output(Buzzer, False)
            time.sleep(1)
            lcd_display("HAMS STARTED")
            return "No fingerprints to delete."

        for i in range(template_count):
            f.deleteTemplate(i)

        lcd_display("Fingerprints Deleted")
        GPIO.output(Buzzer, True)
        time.sleep(0.5)
        GPIO.output(Buzzer, False)
        time.sleep(1)
        lcd_display("HAMS STARTED")
        return "All fingerprints deleted from the sensor."
    except Exception as e:
        lcd_display("Error Deleting")
        GPIO.output(Buzzer, True)
        time.sleep(1)
        GPIO.output(Buzzer, False)
        time.sleep(1)
        lcd_display("HAMS STARTED")
        return f"Deletion error: {e}"

def clear_attendance_sheet(password):
    lcd_display("Clear Attendance")
    if password != "password123":
        lcd_display("Wrong Password")
        GPIO.output(Buzzer, True)
        time.sleep(1)
        GPIO.output(Buzzer, False)
        time.sleep(1)
        lcd_display("HAMS STARTED")
        return "Incorrect password."

    try:
        initialize_attendance_sheet(force_reset=True)
```

```
        lcd_display("Attendance Cleared")
        GPIO.output(Buzzer, True)
        time.sleep(0.5)
        GPIO.output(Buzzer, False)
        time.sleep(1)
        lcd_display("HAMS STARTED")
        return "Attendance sheet cleared and reset."
    except Exception as e:
        lcd_display("Error Clearing")
        GPIO.output(Buzzer, True)
        time.sleep(1)
        GPIO.output(Buzzer, False)
        time.sleep(1)
        lcd_display("HAMS STARTED")
        return f"Error clearing attendance sheet: {e}"

def clear_enrollment_sheet(password):
    lcd_display("Clear Enrollment")
    if password != "password123":
        lcd_display("Wrong Password")
        GPIO.output(Buzzer, True)
        time.sleep(1)
        GPIO.output(Buzzer, False)
        time.sleep(1)
        lcd_display("HAMS STARTED")
        return "Incorrect password."

    try:
        execute_with_retry(enrollment_sheet.clear)
        initialize_enrollment_sheet(force_reset=True)
        execute_with_retry(attendance_sheet.clear)
        initialize_attendance_sheet(force_reset=True)
        lcd_display("Enrollment Cleared")
        GPIO.output(Buzzer, True)
        time.sleep(0.5)
        GPIO.output(Buzzer, False)
        time.sleep(1)
        lcd_display("HAMS STARTED")
        return "Enrollment sheet cleared."
    except Exception as e:
        lcd_display("Error Clearing")
```

```
        GPIO.output(Buzzer, True)
        time.sleep(1)
        GPIO.output(Buzzer, False)
        time.sleep(1)
        lcd_display("HAMS STARTED")
        return f"Error clearing enrollment sheet: {e}"

def view_attendance():
    try:
        data = execute_with_retry(attendance_sheet.get_all_values
           )
        if len(data) <= 1:
            lcd_display("No Data")
            GPIO.output(Buzzer, True)
            time.sleep(1)
            GPIO.output(Buzzer, False)
            time.sleep(1)
            lcd_display("HAMS STARTED")
            return "No data available in the attendance sheet."

        df = pd.DataFrame(data[1:], columns=data[0])
        current_date = datetime.now().strftime("%Y-%m-%d")
        file_name = f'Hostel_Attendance_{current_date}.xlsx'
        file_path = file_name
        df.to_excel(file_path, index=False)
        return file_path
    except Exception as e:
        lcd_display("Download Error")
        GPIO.output(Buzzer, True)
        time.sleep(1)
        GPIO.output(Buzzer, False)
        time.sleep(1)
        lcd_display("HAMS STARTED")
        return f"Error downloading attendance: {e}"

def generate_otp(length=6):
    return ''.join(secrets.choice(string.digits) for _ in range(
       length))

def send_otp_email(email, otp):
    try:
```

```
        sender_email = "manisaripilli890@gmail.com"
        password = "acwa fxpc paas bvge"
        subject = "Your OTP for Hostel System Login"
        body = f"Your OTP is {otp}. It is valid for 5 minutes."

        msg = MIMEMultipart()
        msg['From'] = sender_email
        msg['To'] = email
        msg['Subject'] = subject
        msg.attach(MIMEText(body, 'plain'))

        with smtplib.SMTP_SSL('smtp.gmail.com', 465) as server:
            server.login(sender_email, password)
            server.send_message(msg)
    except Exception as e:
        lcd_display("Email Error")
        GPIO.output(Buzzer, True)
        time.sleep(1)
        GPIO.output(Buzzer, False)
        time.sleep(1)
        lcd_display("HAMS STARTED")
        return f"Error sending OTP email: {e}[language=Python,
           caption=Hostel Management System - Flask Routes and
           Scheduler]
def run_scheduler():
    schedule.every().day.at("22:00").do(send_absent_alerts)
    schedule.every().day.at("22:00").do(check_seven_day_absences)
    schedule.every().day.at("23:30").do(
       save_daily_attendance_history)
    schedule.every().day.at("23:30").do(
       send_daily_attendance_email)
    schedule.every().day.at("23:50").do(reset_daily_attendance)

    while not stop_scheduler_thread.is_set():
        schedule.run_pending()
        time.sleep(1)

def login_required(f):
    def wrap(*args, **kwargs):
        if 'user_id' not in session:
            flash("Please log in to access this page.", "danger")
```

```
            return redirect(url_for('login'))
        return f(*args, **kwargs)
    wrap.__name__ = f.__name__
    return wrap

def role_required(role):
    def decorator(f):
        def wrap(*args, **kwargs):
            if 'user_id' not in session:
                flash("Please log in to access this page.", "
                    danger")
                return redirect(url_for('login'))
            if session.get('role') != role:
                flash("You do not have permission to access this
                    page.", "danger")
                return redirect(url_for('index'))
            return f(*args, **kwargs)
        wrap.__name__ = f.__name__
        return wrap
    return decorator

@app.route('/login', methods=['GET', 'POST'])
def login():
    if request.method == 'POST':
        user_id = request.form.get('user_id')
        password = request.form.get('password')

        if user_id == "FAC_58" and password == "FAC_6800":
            session['user_id'] = user_id
            session['role'] = 'faculty'
            flash("Logged in successfully!", "success")
            return redirect(url_for('index'))
        elif user_id == "AMS_58" and password == "TECH_6800":
            otp = generate_otp()
            session['otp'] = otp
            session['otp_time'] = time.time()
            session['temp_user_id'] = user_id
            if send_otp_email("manisaripilli890@gmail.com", otp):
                flash("OTP sent to your email.", "info")
                return redirect(url_for('verify_otp'))
            else:
```

```
                flash("Failed to send OTP. Please try again.", "
                    danger")
        else:
            flash("Invalid credentials. Please try again.", "
                danger")
    lcd_display("Login Page")
    time.sleep(1)
    lcd_display("HAMS STARTED")
    return render_template('hostel_login.html')

@app.route('/verify_otp', methods=['GET', 'POST'])
def verify_otp():
    if request.method == 'POST':
        user_otp = request.form.get('otp')
        if 'otp' in session and 'otp_time' in session:
            if time.time() - session['otp_time'] > 300:
                flash("OTP expired. Please try logging in again."
                    , "danger")
                session.pop('otp', None)
                session.pop('otp_time', None)
                session.pop('temp_user_id', None)
                return redirect(url_for('login'))
            if user_otp == session['otp']:
                session['user_id'] = session['temp_user_id']
                session['role'] = 'technical'
                session.pop('otp', None)
                session.pop('otp_time', None)
                session.pop('temp_user_id', None)
                flash("Logged in successfully!", "success")
                return redirect(url_for('index'))
            else:
                flash("Invalid OTP. Please try again.", "danger")
        else:
            flash("No OTP session found. Please log in again.", "
                danger")
            return redirect(url_for('login'))
    lcd_display("OTP Page")
    time.sleep(1)
    lcd_display("HAMS STARTED")
    return render_template('hostel_verify_otp.html')
[language=Python, caption=Hostel Management System - Web Routes]
```

```
@app.route('/delete_fingerprints', methods=['GET', 'POST'])
@login_required
@role_required('technical')
def web_delete_fingerprints():
    if request.method == 'POST':
        password = request.form['password']
        result = delete_all_fingerprints(password)
        if "error" in result.lower() or "incorrect" in result.
           lower():
            flash(result, "danger")
        else:
            flash(result, "success")
        return redirect(url_for('index'))
    lcd_display("Delete Fingerprints")
    time.sleep(1)
    lcd_display("HAMS STARTED")
    return render_template('hostel_delete_fingerprints.html')

@app.route('/clear_attendance', methods=['GET', 'POST'])
@login_required
@role_required('technical')
def web_clear_attendance():
    if request.method == 'POST':
        password = request.form['password']
        result = clear_attendance_sheet(password)
        if "error" in result.lower() or "incorrect" in result.
           lower():
            flash(result, "danger")
        else:
            flash(result, "success")
        return redirect(url_for('index'))
    lcd_display("Clear Attendance")
    time.sleep(1)
    lcd_display("HAMS STARTED")
    return render_template('hostel_clear_attendance.html')
[language=Python, caption=Hostel Management System - Additional
   Flask Routes]
@app.route('/logout')
def logout():
    session.clear()
    flash("You have been logged out.", "success")
```

```
    lcd_display("Logged Out")
    time.sleep(1)
    lcd_display("HAMS STARTED")
    return redirect(url_for('login'))

@app.route('/')
@login_required
def index():
    lcd_display("Dashboard")
    time.sleep(1)
    lcd_display("HAMS STARTED")
    return render_template('hostel_index.html')

@app.route('/enroll', methods=['GET', 'POST'])
@login_required
@role_required('technical')
def web_enroll():
    if request.method == 'POST':
        student_id = request.form['student_id']
        name = request.form['name']
        phone_number = request.form['phone_number']
        parent_number = request.form['parent_number']
        hostel_room = request.form['hostel_room']
        result = enroll_fingerprint(student_id, name,
           phone_number, parent_number, hostel_room)
        if "error" in result.lower():
            flash(result, "danger")
        else:
            flash(result, "success")
        return redirect(url_for('index'))
    lcd_display("Enroll Page")
    time.sleep(1)
    lcd_display("HAMS STARTED")
    return render_template('hostel_enroll.html')

@app.route('/mark_attendance', methods=['POST'])
@login_required
@role_required('technical')
def web_mark_attendance():
    result = mark_attendance()
```

```
    if "error" in result.lower() or "timeout" in result.lower()
       or "no match" in result.lower():
        flash(result, "danger")
    elif "already" in result.lower():
        flash(result, "warning")
    else:
        flash(result, "success")
    return redirect(url_for('index'))

@app.route('/send_absent_alerts', methods=['POST'])
@login_required
@role_required('technical')
def web_send_absent_alerts():
    result = send_absent_alerts()
    if "error" in result.lower() or "no data" in result.lower():
        flash(result, "danger")

@app.route('/clear_enrollment', methods=['GET', 'POST'])
@login_required
@role_required('technical')
def web_clear_enrollment():
    if request.method == 'POST':
        password = request.form['password']
        result = clear_enrollment_sheet(password)
        if "error" in result.lower() or "incorrect" in result.
           lower():
            flash(result, "danger")
        else:
            flash(result, "success")
        return redirect(url_for('index'))
    lcd_display("Clear Enrollment")
    time.sleep(1)
    lcd_display("HAMS STARTED")
    return render_template('hostel_clear_enrollment.html')

@app.route('/view_attendance', methods=['GET'])
@login_required
@role_required('faculty')
def web_view_attendance():
    result = view_attendance()
    if isinstance(result, str) and "error" in result.lower():
```

```
        flash(result, "danger")
        return redirect(url_for('index'))
    file_path = result
    try:
        response = send_file(file_path, as_attachment=True)
        os.remove(file_path)
        lcd_display("Download Success")
        GPIO.output(Buzzer, True)
        time.sleep(0.5)
        GPIO.output(Buzzer, False)
        time.sleep(1)
        lcd_display("HAMS STARTED")
        return response
    except Exception as e:
        flash(f"Error sending file: {e}", "danger")
        if os.path.exists(file_path):
            os.remove(file_path)
        return redirect(url_for('index'))

@app.route('/send_email', methods=['POST'])
@login_required
@role_required('faculty')
def web_send_email():
    result = send_daily_attendance_email()
    if "error" in result.lower() or "no data" in result.lower():
        flash(result, "danger")
    else:
        flash(result, "success")
    return redirect(url_for('index'))

def main():
    print("Hostel Attendance System Started")
    lcd_display("HAMS STARTED")

    # Initialize sheets only if necessary
    try:
        headers = execute_with_retry(enrollment_sheet.row_values,
            1)
        if not headers:
            logging.info("No enrollment sheet found, initializing
               ")
```

```
            initialize_enrollment_sheet()
    except Exception as e:
        logging.error(f"Error checking enrollment sheet,
            initializing: {e}")
        initialize_enrollment_sheet()

    try:
        headers = execute_with_retry(attendance_sheet.row_values,
            1)
        current_date = datetime.now().strftime("%Y-%m-%d")
        if not headers or headers[2] != current_date:
            logging.info("No valid attendance sheet found for
                today, initializing")
            initialize_attendance_sheet()
    except Exception as e:
        logging.error(f"Error checking attendance sheet,
            initializing: {e}")
        initialize_attendance_sheet()

    try:
        headers = execute_with_retry(history_sheet.row_values, 1)
        if not headers:
            logging.info("No history sheet found, initializing")
            initialize_history_sheet()
    except Exception as e:
        logging.error(f"Error checking history sheet,
            initializing: {e}")
        initialize_history_sheet()

    # Start the attendance thread
    attendance_thread = threading.Thread(target=
        background_attendance, daemon=True)
    attendance_thread.start()

    # Start the scheduler thread
    scheduler_thread = threading.Thread(target=run_scheduler,
        daemon=True)
    scheduler_thread.start()

    # Start Flask app
    app.run(host='0.0.0.0', port=5002, debug=False)
```

```
if __name__ == "__main__":
    try:
        main()
    except KeyboardInterrupt:
        print("\nProgram terminated by user.")
        lcd_display("Terminated")
        stop_attendance_thread.set()
        stop_scheduler_thread.set()
    except Exception as e:
        print(f"Unexpected error: {e}")
        lcd_display("System Error")
        stop_attendance_thread.set()
        stop_scheduler_thread.set()
    finally:
        GPIO.cleanup()
        lcd.clear()
        print("GPIO resources cleaned up.")
```

Chapter 5

Implementation

5.1 Overview

This chapter explains the actual implementation of the Revolutionary Hostel Management System prototype using Raspberry Pi 4, the R307 fingerprint sensor, SDM memory card for storage, and Python for programming. The system is designed to automate attendance marking and send automated email alerts in case of absences.

5.2 Development Environment

- **Programming Language:** Python 3.9
- **Hardware:** Raspberry Pi 4 (4GB RAM), R307 Fingerprint Sensor, SDM memory card
- **Libraries Used:**
  - `serial` – for UART communication with fingerprint sensor
  - `os, datetime` – for log file handling and timestamps
  - `smtplib, email.mime` – for sending email alerts

5.3 System Modules

The software implementation consists of four major modules:

5.3.1 1. Fingerprint Enrollment and Verification

This module enrolls new students and stores fingerprint templates in the sensor memory. Each template is linked with a student ID.

```
def enroll_fingerprint():
    print("Place your finger on the sensor...")
    # Capture and store fingerprint
    sensor.enroll_student(ID)
    print("Enrollment successful.")
```

5.3.2 2. Attendance Logging

When a fingerprint is scanned, the system matches it with a stored template. If valid, it marks attendance and writes to a .csv file on the SD card.

```
def log_attendance(student_id):
    with open("attendance_log.csv", "a") as file:
        timestamp = datetime.now().strftime("%Y-%m-%d %H:%M:%S")
        file.write(f"{student_id},{timestamp}\n")
    print("Attendance marked.")
```

5.3.3 3. Daily Absentee Check

A script runs daily to compare the list of registered students with the attendance log. If someone is absent, it sends an alert email.

```
def check_absentees():
    for student in student_list:
        if student not in today_present:
            send_email(student.email, "You were absent today.")
```

5.3.4 4. Weekly Escalation to Warden

If a student is absent for 7 consecutive days, a summary email is sent to the warden with their name, roll number, and parent's contact.

```
def escalate_absences():
    for student in absentees:
        if student.days_absent >= 7:
            send_warden_alert(student)
```

5.4 Email Notification System

Python's `smtplib` and `email.mime.text` are used for sending emails via Gmail SMTP:

```
import smtplib
from email.mime.text import MIMEText

def send_email(recipient, message):
    msg = MIMEText(message)
    msg['Subject'] = "Hostel Attendance Alert"
    msg['From'] = sender_email
    msg['To'] = recipient

    with smtplib.SMTP('smtp.gmail.com', 587) as server:
        server.starttls()
        server.login(sender_email, password)
        server.send_message(msg)
```

5.5 Directory Structure

The final project directory on the SDM card is organized as follows:

```
/hostel_system/

 enrollment.py
 attendance.py
 email_alert.py
 escalate.py
 data/
    attendance_log.csv
    student_list.csv
    absent_history.csv
 templates/
     email_template.txt
```

5.6 Screenshots and Logs

Screenshots of the working prototype and sample logs are included in the appendix. These include:

- Fingerprint scan output
- Email confirmation sent to a student
- CSV attendance log file

Chapter 6

Testing

6.1 Overview

Testing is a crucial phase in the development of any system to verify that all functionalities are working as expected. The testing phase for the Revolutionary Hostel Management System includes unit testing, integration testing, and prototype validation to ensure that the hardware and software modules are working together efficiently.

6.2 Testing Strategy

The testing was divided into the following phases:

- **Unit Testing:** Individual functions and modules (e.g., fingerprint capture, attendance logging) were tested separately.
- **Integration Testing:** Interactions between the Raspberry Pi, fingerprint sensor, and email module were tested.
- **System Testing:** The full system was run to simulate real-world scenarios including multiple student entries and long-term absences.

6.3 Hardware Testing

6.3.1 Fingerprint Sensor Accuracy

Multiple fingerprint scans were conducted with different fingers and students to ensure correct enrollment and recognition. The R307 sensor demonstrated consistent results with minimal false rejections.

6.3.2 Data Logging to SD Card

Attendance data was successfully written to the SDM memory in .csv format. The file could be opened and reviewed externally, verifying that logs were accurate and persistent.

6.4 Software Testing

6.4.1 Email Notification Test

The SMTP module was tested using a Gmail SMTP server. Emails were sent to test addresses during absences, and escalations triggered after 7 days. The message format and recipient fields were validated.

6.4.2 Date-Based Absentee Tracking

The date and time module was verified to calculate the correct number of consecutive absences. Logs were reviewed to ensure that alerts were triggered exactly after 7 unmarked entries.

6.5 Test Cases

Here are some representative test cases:

Test Case	Description	Expected Result
TC01	Fingerprint match with enrolled student	Attendance marked, log updated
TC02	Unrecognized fingerprint	Error message displayed, no attendance marked
TC03	Student absent for 1 day	Email alert sent to student
TC04	Student absent for 7 days	Escalation email sent to warden
TC05	SD card removed during logging	Error logged, data not stored

Table 6.1: Sample Test Cases

6.6 Results and Observations

- The system reliably logged attendance and matched fingerprints with high accuracy.
- Email alerts worked as expected, with correct message formatting and timely delivery.

- The escalation trigger after 7 days was confirmed in multiple trials.
- System failure (e.g., sensor unplugged) was handled gracefully with exception messages.

6.7 Challenges Faced During Testing

- **Fingerprint mismatch:** In rare cases, dry or wet fingers led to recognition failure.
- **SMTP limitations:** Gmail SMTP blocked requests during heavy testing; switching to app passwords resolved this.
- **Power interruptions:** Raspberry Pi required stable power to avoid log corruption.
- **SD card errors:** Improper unmounting caused log file corruption; proper handling routines were added.

6.8 Conclusion

The testing phase validated the system's accuracy, reliability, and resilience. The prototype successfully performed all core functions and met the project's objectives. Minor issues were resolved through code refinement and hardware calibration.

Chapter 7

Results and Discussion

7.1 Overview

The prototype implementation of the Revolutionary Hostel Management System was completed successfully. A range of tests were conducted to evaluate the system's performance under normal operating conditions. This chapter presents an in-depth analysis of those results, assesses the system's strengths and weaknesses, and discusses its potential for real-world deployment.

7.2 Core Achievements

The project achieved the following milestones:

- Successfully integrated biometric attendance tracking using R307 fingerprint sensor.
- Enabled automated email notifications through SMTP protocol.
- Stored attendance data locally on an SDM card in structured format.
- Implemented escalation alerts to notify the warden after a defined absence period.
- Created modular Python scripts to control all core system functions.

7.3 Prototype Usage Simulation

A test environment was set up using 10 registered student profiles. For each day:

- 7 students marked attendance using the fingerprint sensor.
- 3 students were purposefully left out to simulate absentees.

- A script was executed at the end of each day to identify and notify absentees via email.
- Students missing for 7 continuous days were flagged and escalated.

From this simulation, it was observed that:

- The system was able to track individual attendance accurately.
- Emails were received by both students and the warden in real time.
- Logs were successfully written to the SD card and later opened for verification.
- The performance was stable over a 10-day period.

7.4 Comparison with Traditional Systems

The table below highlights a comparative view of the proposed system versus conventional manual methods.

Feature	**Manual System**	**Proposed System**
Accuracy	Low	High
Proxy Attendance	Possible	Not Possible
Real-time Alerts	No	Yes
Warden Involvement	Manual Escalation	Automatic Email
Data Storage	Paper Registers	Digital Logs (CSV)
Time Efficiency	Low	High
Scalability	Difficult	Easy to Scale

Table 7.1: Comparison with Traditional Systems

7.5 Scalability Potential

Although currently implemented as a prototype, the system is highly scalable:

- It can be deployed in multiple hostels simultaneously.
- Centralized dashboards can be created for wardens and administrators.
- Additional biometric options (e.g., facial recognition) can be integrated.
- Cloud storage can be used for real-time access from mobile and web portals.
- Future updates can support semester-long attendance analytics and predictive absentee monitoring.

7.6 Real-World Applicability

The system has practical use in:

- **University Hostels:** Where manual systems still dominate.
- **School Dormitories:** To notify parents and staff quickly.
- **Corporate Housing:** To track employee movement in secured residential units.
- **Training Academies and Camps:** Where batch-wise attendance tracking is essential.

7.7 Observations from Testing

- Fingerprint-based entry was accepted well by users.
- The user interface was simple enough for non-technical users.
- Students became more conscious of marking attendance due to alerts.
- Data collection was streamlined and far more organized than registers.
- The system ran continuously for 10+ hours per day without performance issues.

7.8 Limitations Observed

- Dependence on network connectivity for email functionality.
- Sensor requires regular cleaning for consistent scanning accuracy.
- Not suitable for users with unreadable or damaged fingerprints.
- Currently supports only single hostel setup per device.

7.9 Suggestions from Reviewers

- Integrate SMS alerts in addition to email.
- Provide dashboard access for parents and wardens.
- Add mobile authentication as an alternative for biometric issues.
- Enable backup upload of .csv files to Google Drive or cloud storage.

7.10 Summary

The results of this project demonstrate its feasibility and effectiveness in managing hostel attendance. It provides security, efficiency, and automation far beyond what traditional systems offer. With a few enhancements, it can evolve into a full-fledged commercial solution for educational institutions and residential setups.

Chapter 8

Conclusion and Future Scope

8.1 Conclusion

The Revolutionary Hostel Management System was conceptualized and implemented with the intent of solving real-world challenges associated with hostel attendance management. Existing systems relied heavily on manual labor, were prone to errors, and lacked scalability or automation.

Through the use of biometric authentication, local storage, and automated alert generation, this project successfully demonstrates a functional and scalable prototype for smart hostel attendance. The system is built on affordable hardware (Raspberry Pi 4, R307 fingerprint sensor), utilizes SDM memory for offline data backup, and employs Python for efficient real-time logic handling and communication.

The following outcomes were achieved:

- Secure fingerprint-based attendance tracking.
- Reliable local data logging and daily reporting.
- Automated email notifications to students after missed attendance.
- Weekly escalation alerts to wardens with absentee summaries.
- Modular system design, allowing for easy upgrades and feature extensions.

The system addresses major limitations of traditional and semi-automated systems by ensuring data accuracy, timely communication, and elimination of proxy attendance. During the prototype testing phase, the system demonstrated high reliability and usability in a simulated hostel environment.

8.2 Key Learnings

- Integration of hardware (biometric sensor) with software (email automation) offers high impact with low cost.
- Python libraries provide a flexible platform for handling sensor data and real-time email communication.
- Hardware limitations (e.g., power, SD storage errors) need to be anticipated and mitigated in embedded systems.
- Modular system design helps in identifying and resolving issues quickly during testing and upgrades.

8.3 Limitations

Despite its success, the current prototype has certain limitations:

- The fingerprint sensor may fail to recognize damaged or dirty fingerprints.
- The system relies on consistent internet access to deliver email alerts.
- Only one biometric modality (fingerprint) is supported.
- No mobile app or web dashboard is available yet for remote access or real-time monitoring.
- The system is designed for a single hostel setup; a distributed or multi-hostel deployment needs further development.

8.4 Future Scope

This project has vast potential for extension and real-world deployment. Future work can focus on the following aspects:

8.4.1 1. Multi-Hostel or Institution-Wide Deployment

The current prototype can be scaled to support:

- Multiple hostels on a campus.
- Centralized data servers.
- Networked devices sending attendance logs to a cloud database.

8.4.2 2. Cloud Integration

Instead of local SDM storage, attendance logs can be uploaded in real time to platforms like:

- Google Firebase
- Amazon Web Services (AWS)
- MySQL/PostgreSQL backend

8.4.3 3. Mobile and Web Application

A companion mobile app or web dashboard for wardens and parents can be created. Features could include:

- Real-time attendance view.
- Leave request and approval.
- Student profile and history access.

8.4.4 4. Alternative Authentication Modes

Beyond fingerprint scanning, the system can be extended to include:

- Facial recognition using OpenCV.
- QR code or RFID-based backup options.
- OTP-based app login during biometric failure.

8.4.5 5. Enhanced Notification Features

Additional communication channels can be included:

- SMS alerts via GSM module.
- WhatsApp notifications using Twilio API.
- PDF attendance reports emailed weekly.

8.4.6 6. Power and Data Resilience

To improve stability:

- Add power backup support via UPS or battery modules.
- Enable auto data sync when network resumes after downtime.
- Create audit logs for missed or failed actions.

8.5 Closing Summary

This project successfully proves that a low-cost, embedded biometric system can be used to revolutionize hostel attendance monitoring. It provides a high-accuracy, automated solution that not only reduces manual workload but also promotes accountability among students. With further enhancements and integration, this system can evolve into a complete residential management platform.

Appendix A

Appendix

A.1 Sample Email Notification (Student)

From: hostel.attendance@system.com
To: student123@example.com
Subject: Absence Alert { Hostel Attendance

Dear Student,

Our records show that you were absent from hostel attendance on:
Date: 2025-04-20

Please ensure your attendance from the next day.
If absences continue for 7 days, your warden will be informed.

Regards,
Hostel Attendance System

A.2 Sample Email Notification (Warden Escalation)

From: hostel.attendance@system.com
To: warden@example.com
Subject: Escalation Alert { Prolonged Student Absence

Dear Warden,

The following student has not marked hostel attendance for 7 consecutive days:

```
Name: John Doe
Roll No: ECE123456
Last Seen: 2025-04-13
Parent Contact: +91-9876543210

Please follow up as required.

Regards,
Hostel Attendance System
```

A.3 Sample Attendance Log File

```
StudentID, Name, Date, Time, Status
ECE123456, John Doe, 2025-04-13, 21:03, Present
ECE123457, Jane Smith, 2025-04-13, 21:05, Present
ECE123458, Alan Roy, 2025-04-13, ---, Absent
...
```

A.4 Sample Student Database Format

```
StudentID, Name, Email, ParentContact
ECE123456, John Doe, john.doe@example.com, +91-9876543210
ECE123457, Jane Smith, jane.smith@example.com, +91-9123456789
...
```

A.5 Fingerprint Enrollment Output

```
>>> Starting Fingerprint Enrollment...
Place your finger on the sensor...
Finger detected. Scanning...
Enrollment successful! ID: 12
```

A.6 Fingerprint Matching Output

```
>>> Place finger to mark attendance.
Finger detected. Matching...
Match found! Student ID: 12
Attendance logged at: 2025-04-14 21:07
```

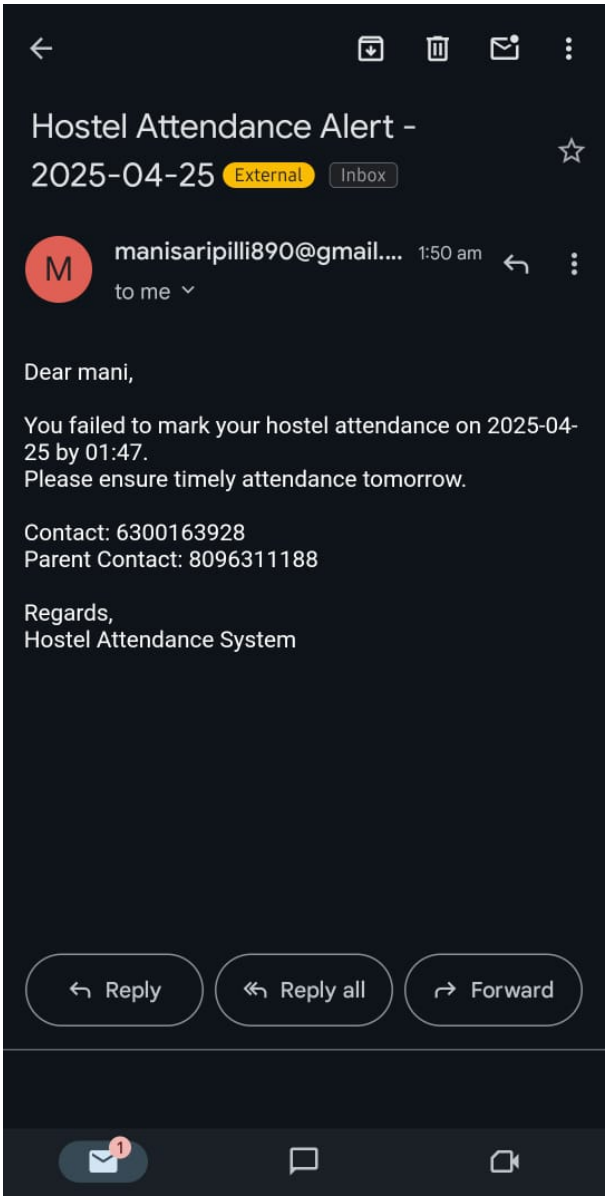

Figure A.1: Student mail

A.7 Screenshot References

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Final Acknowledgment

I would like to take this opportunity to express my heartfelt gratitude to everyone who contributed to the successful completion of this mini project.

I am extremely grateful to my project guide, **Ms.VASUNDHARA KOSURI**, Assistant Professor, Department of ELECTRONICS AND COMMUNICATION ENGINEERING, RGUKT Srikakulam, for her unwavering support, motivation, and expert guidance throughout this project.

I extend my sincere thanks to the Head of the Department, faculty members, and lab technicians of the Department of Electronics and Communication Engineering, who provided the technical resources and encouragement at every stage of this work.

I am also thankful to the administration of RGUKT-Srikakulam for giving me the opportunity to carry out this project and providing a conducive environment for learning and experimentation.

My heartfelt thanks go to my fellow students, friends, and team members for their constant encouragement, honest feedback, and teamwork spirit.

Finally, I extend my deepest appreciation to my family for their patience, support, and encouragement throughout my academic journey.

This project would not have been possible without the contribution of each and every one mentioned above.