Mini-Project Report On

Smart Maintenance - Odour Detection and Notification System

Submitted in partial fulfillment of the requirements for the award of the degree of

Bachelor of Technology

in

Computer Science & Engineering

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CERTIFICATE

This is to certify that the mini-project report entitled ***"Smart Maintenance- Odour Detection and Notification System"*** *is a bonafide work done by* ***Mr. Akash Vijay (U2003016), Ms. Aleena Mary Karatra (U2003023), Mr. Alvin George Viji (U2003029), Ms. Ashly Sabu (U2003044)****, submitted to the APJ Abdul Kalam Technological University in partial fulfillment of the requirements for the award of the degree of Bachelor of Technology (B. Tech.) in Computer Science and Engineering during the academic year 2022-2023.*

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ABSTRACT

This Odour Detection and Notification project presents an innovative online application designed to detect and notify the cleaning staff and college students of the presence of odour in washrooms. The system utilizes an MQ-137 NH3 gas sensor for continuous odour monitoring, ensuring timely detection. Upon reaching a predefined threshold level, the cleaning staff receives real-time notifications through a dedicated application.

The project further incorporates an automated spray mechanism to temporarily purify the air upon detecting odour. This feature eliminates the immediate need for cleaning staff to direct their attention, as the automated air freshener provides a short-term solution for the detected odour. The system's primary objective is to enhance washroom cleanliness and hygiene by enabling prompt action from the cleaning staff based on detected odour levels. The application not only simplifies the cleaning staff's task but also assists students in identifying clean washrooms. By prioritizing cleaning based on odour detection, the system ensures a comfortable and pleasant environment for all users.

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Chapter 1

Introduction

1.1 Background

1.1.1 Indoor Air Quality

Indoor air quality (IAQ) plays a critical role in ensuring the well-being and comfort of occupants in various indoor environments, such as offices, schools, residential buildings, and public spaces. Unpleasant odors caused by various sources, including chemicals, pollutants, or biological agents, can significantly impact IAQ, leading to discomfort and potential health risks for those present in these spaces.

Traditional methods of odor detection and management often rely on manual assessments or complaint-based approaches, resulting in delayed responses and inadequate control over the indoor environment. As technology has advanced, there has been an increasing interest in developing automated odor detection and notification systems that can proactively identify and address odor issues in real-time.

1.1.2 Odour Detection Sensors

Odor sensors, such as the MQ137 and MQ135, are crucial components used for gas detection in various environments.

The MQ137 sensor specializes in detecting ammonia (NH3) gas and is commonly employed in industrial settings, agriculture (for animal waste detection), and refrigeration systems. Its chemoresistive sensing principle measures electrical resistance changes upon contact with ammonia, providing qualitative and quantitative indications of gas levels.

The MQ135 sensor, on the other hand, can detect a wide range of gases, including NH3, CO2, benzene, alcohol, and VOCs. Its versatility makes it suitable for applications in air

quality monitoring, indoor environmental assessments, and gas leakage detection.

Both sensors are affordable, easy to use, and widely available, contributing to advancements in air quality control, emission monitoring, and public health. They are often integrated into IoT-based systems for real-time monitoring and remote data access. As technology progresses, ongoing research seeks to improve sensor accuracy, sensitivity, and reliability, expanding their applications and impact in diverse industries and environments.

1.2 Existing System

The existing systems integrated into the Odour Detection and Notification System include User Feedback Systems, Cleaning and Maintenance Schedules, Ventilation and Air Freshening Systems, Air Quality Monitoring Systems, Electronic Nose (E-Nose), and Gas Chromatography-Mass Spectrometry (GC-MS). These systems play vital roles in collecting real-time feedback, preventing odour build-up, ensuring proper airflow, and analyzing odour-causing substances. By utilizing specific functionalities of these systems, the project enhances washroom hygiene and user experience efficiently.

1.3 Problem Statement

Develop an odor detection and notification system that utilizes sensor technology to detect odors and promptly notify the cleaning staff via a dedicated application. The system aims to enhance cleanliness and maintain a pleasant environment by proactively identifying and addressing odor-related issues in real time.

The project also consists of an automatic spray system that purifies the air according to the odor monitored by the sensor, so as to implement a short term solution to the odor observed until the staff is able to direct their attention to it.

The application serves as a pivotal solution in enhancing public hygiene by seamlessly integrating cutting-edge automation technology into the cleaning process.

1.4 Objectives

- **Proactive Odor Detection**-The system aims to detect the presence of odors in the environment using the MQ137 sensor. By continuously monitoring the air quality, it can proactively identify and quantify odors, even before they become noticeable to occupants.

- **Real-Time Monitoring** - The system provides real-time monitoring of odor levels. It analyzes the data from the sensor and promptly detects significant changes or anomalies in odor intensity, allowing for immediate action.

- **Efficient Notification** -The system notifies the cleaning staff promptly when odors reach predefined thresholds. Through the dedicated Flutter application, cleaning staff members receive notifications that provide details about the odor intensity, location, and potentially relevant environmental factors. This enables swift and targeted response to address odor-related issues.

- **Data Storage and Analysis** - The system utilizes Firebase as the real-time database for storing odor data. This enables historical tracking of odor levels, allowing for further analysis, trend identification, and the potential for long-term improvement strategies.

- **Improved Hygiene and Environment**- By promptly notifying the cleaning staff about odors, the system facilitates quick response times and efficient odor remediation efforts. This helps maintain a clean and pleasant environment for occupants, ensuring their comfort and well-being.

- **Integration and Scalability**- The system is designed to integrate seamlessly with various components, including the MQ137 sensor, Arduino Uno, Arduino ESP8266 WiFi module, Firebase, and Flutter application. It provides a scalable architecture that can be expanded to accommodate additional sensors or features in the future.

- **Automatic Reactive Spray**- The system also contains an automatic air purifying module, that sprays an air purifier when the odor levels exceed the set threshold level.

- **Integrating existing hardware**- The system was also extended to be integrated to control the speed and state of the exhaust fans based on the sensor value monitored.

1.5 Scope

The Odor Detection and Notification System offers numerous benefits, contributing to environmental protection, safety, and user well-being. In industrial settings, where ammonia (NH3) emissions may occur as a byproduct, the system's environmental monitoring capabilities are instrumental in ensuring compliance with regulations.

Foul odors can serve as early warning signs of gas leaks or chemical spills, enabling timely intervention to prevent accidents and safeguard the health of workers and occupants.Indoor environments benefit from improved air quality, comfort, and pleasant surroundings. In agriculture and waste management, the system helps manage odors, reducing impacts on communities. Real-time monitoring and automated responses ensure prompt actions, and energy efficiency is achieved through optimized exhaust speed.

The system's remote accessibility and data insights enable informed decision-making. Overall, it proves to be an effective and proactive tool for odor control, positively impacting both the environment and human health.

Chapter 2

Literature Review

Explain the existing methods and their drawbacks. Draw a comparison table to compare the existing methods.

2.1 Cleaning and Maintenance Schedules using odour detection

Incorporating odour detection technology into cleaning and maintenance schedules brings numerous valuable benefits to various facilities and equipment maintenance. By deploying odour sensors throughout the facility, real-time air quality monitoring becomes possible, allowing for the swift detection of foul odours associated with spills, leaks, or cleanliness issues. This early detection enables maintenance teams to address potential problems promptly before they escalate. Moreover, odour detection allows for cleaning interventions to be prioritized based on areas with strong odours, optimizing cleaning efforts and resource allocation. Additionally, integrating odour sensors into machinery and equipment facilitates proactive maintenance by detecting unusual odours that may indicate impending malfunctions.

Odour detection serves as a validation tool, verifying the effectiveness of cleaning efforts and ensuring the elimination of contaminants. Furthermore, it aids in monitoring indoor air quality, identifying areas with poor ventilation, and making targeted improvements for occupants' well-being. Remote monitoring capabilities enable quick response and efficient task coordination for cleaning and maintenance teams. Moreover, in waste management facilities, odour detection helps optimize waste storage and disposal practices by identifying malodorous areas. By ensuring compliance with environmental and health regulations, odour detection provides evidence of adherence to standards.

Overall, the integration of odour detection technology into cleaning and maintenance schedules offers improved efficiency, reduced downtime, enhanced indoor air quality, and

a cleaner, healthier environment for all stakeholders involved. As organizations recognize the potential of odour detection in optimizing cleaning and maintenance efforts, the technology is set to play a crucial role in shaping the future of facility management and maintenance practices, promoting sustainability, cost savings, and improved occupant experiences.

2.2 User Feedback Systems for odour detection

User feedback systems for odour detection play a crucial role in refining and enhancing the accuracy and effectiveness of odour detection technologies. These systems allow users, such as facility managers, maintenance staff, or occupants, to provide valuable input on odour issues, enabling the fine-tuning of the detection system and addressing odour-related concerns. Users can report odour incidents they perceive in specific areas or at certain times, helping identify problem areas and potential sources of odours for further investigation. Additionally, their feedback validates the accuracy of odour detection alerts, ensuring the system's effectiveness in identifying real odour incidents and distinguishing them from false alarms. User input is vital in identifying odour variability, considering that different users may perceive odours differently based on factors such as sensitivity, health conditions, or cultural backgrounds.

This feedback helps in setting appropriate odour detection thresholds to respond appropriately to various odour intensities and concentrations. Furthermore, user feedback allows for the assessment of the effectiveness of cleaning and maintenance efforts in mitigating odour problems. It validates and corroborates odour detection data, providing an additional layer of verification for decision-making and analysis.

The iterative nature of user feedback fosters continuous improvement in odour detection technology, enhancing its reliability and performance over time. Overall, user feedback systems are instrumental in customizing odour detection technology for each facility's unique needs, raising awareness among occupants and staff, and ensuring user satisfaction and engagement in the odour monitoring and management process.

2.3 Electronic Nose (E-Nose) for odour detection

An Electronic Nose, commonly known as an E-Nose, is a sophisticated sensor device designed to replicate the human olfactory system's capabilities for odour detection. It consists of an array of gas sensors, each sensitive to different volatile organic compounds (VOCs) present in the air. As the E-Nose is exposed to an odour, the gas sensors detect various VOCs, generating a distinctive pattern akin to a fingerprint that corresponds to the specific odour. Advanced algorithms, often leveraging machine learning and artificial intelligence, analyze the pattern to identify and classify the odour based on its unique characteristics.

The E-Nose can provide real-time odour detection, making it invaluable in applications such as food quality control, environmental monitoring, healthcare diagnosis, industrial processes, and public safety. By rapidly and accurately identifying odours, the E-Nose contributes to improved product quality, early detection of environmental hazards, enhanced medical diagnoses, and safer industrial practices. Moreover, the technology's versatility extends to agriculture, waste management, and security, promising further advancements and widespread applications in odour-related fields.

2.4 Air Quality Monitoring Systems for odour detection

Air Quality Monitoring Systems equipped with odour detection capabilities are sophisticated sensor networks designed to measure and analyze the quality of the air, particularly concerning the presence of odorous compounds and volatile organic compounds (VOCs). These systems integrate specialized odour sensors, such as Electronic Noses (E-Noses), into their sensor arrays to detect specific odorous compounds and generate unique patterns for odour identification. Additionally, they measure and monitor a wide range of VOCs to assess air quality comprehensively. The data collected from the sensors are analyzed and interpreted by sophisticated algorithms and software, with machine learning techniques applied to distinguish normal odour levels from abnormal or hazardous odours.

These systems provide real-time monitoring of odour levels and VOC concentrations, allowing for prompt responses to changes in odour conditions and potential air quality concerns. They can create odour maps to identify hotspots and emission sources and can be configured to trigger alerts or notifications when odour levels exceed predeter-

mined thresholds. Air Quality Monitoring Systems find applications in urban air quality management, industrial emission monitoring, waste management, environmental impact assessments, indoor air quality assessments, and public complaint management related to odour issues.

Overall, these systems play a critical role in assessing and managing odour pollution and VOC emissions, contributing to improved air quality, regulatory compliance, and healthier living and working environments. As technology advances, Air Quality Monitoring Systems are expected to become even more efficient and integral to odour management strategies.

Chapter 3

System Analysis

3.1 Expected System Requirements

The system of user which is a smart phone is expected to have the following features:

- Android platform with a version above 2.
- A storage space for the application.
- Stable internet connection.
- Notification access for timely delivery of notifications.

3.2 Feasibility Analysis

The various feasibility analysis for the system include :

3.2.1 Technical Feasibility

The matrix below contains the total cost required for one unit of this project to be implemented.

Component	Cost
Node MCU	400/-
MQ 137 Gas Sensor	1800/-
Motor Driver Module	110/-
Battery 12v DC	580/-
LED	4/-
Resistor	4/-

Total Cost = 2898/-

Figure 3.1: Cost Matrix

3.2.2 Operational Feasibility

The operational feasibility of an odor detection system refers to its practicality and viability in real-world use and its assesses whether the system can be effectively implemented, operated, and maintained to achieve its intended objectives. It includes sensor capabilities, data processing and analysis, power requirements, user interface and user experience.

3.2.3 Economic Feasibility

The economic feasibility of an odor detection system refers to its financial viability and whether the benefits of implementing the system outweigh the costs. Cost and implementation, operational costs, expected benefits, scalability and long term viability are the considered factors

3.3 Hardware Requirements

The following are the system requirements for the Odor Detection and Notification System.

- Sensor: MQ 137 Gas Sensor : The MQ137 sensor is a gas sensor module is specially designed to detect and sense gases like ammonia (NH3) and carbon monoxide (CO). The MQ137 gas sensor module comes with digital pins that can be connected to a microcontroller like Arduino boards and come in handy when you are only trying to detect one particular gas.

- Wifi Module: ESP 8266 : The ESP8266 WiFi Module is a self contained SOC with integrated TCP/IP protocol stack that can give any microcontroller access to your WiFi network. The ESP8266 is capable of either hosting an application or offloading all WiFi networking functions from another application processor.

- Motor Driver Module : This L298N Motor Driver Module is a high power motor driver module for driving DC and Stepper Motors. This module consists of an L298 motor driver IC and a 78M05 5V regulator. L298N Module can control up to 4 DC motors, or 2 DC motors with directional and speed control.

- LED : A light-emitting diode is a semiconductor device that emits light when current flows through it. Electrons in the semiconductor recombine with electron holes, releasing energy in the form of photons.
- Air Purifier : Used to purify the air and helps to maintain a good odor.
- Exhaust Fan : Helps to removing unwanted odors, moisture, smoke and other pollutants in the air and helps to bring fresh air inside the room in which it is kept.
- Resistor : A resistor is an electrical component that limits or regulates the flow of electrical current in an electronic circuit. Resistors can also be used to provide a specific voltage for an active device.

3.4 Software Requirements

The following are the softwares used in the development of the app.

Operating System: Windows or Linux

3.4.1 Android Studio for Kotlin app development

Android Studio is a popular Integrated Development Environment (IDE) for developing Kotlin apps, as it provides a wide range of tools and features that can help you build high-quality apps faster. Some of the key features of Android Studio for Kotlin development include:

- A rich set of tools for debugging, testing, and profiling your app. A powerful code editor with support for code completion, refactoring, and more
- A flexible build system with support for building, testing, and deploying your app. Integration with popular version control systems like Git.
- A visual layout editor for building attractive user interfaces

3.4.2 Firebase

Firebase, a powerful Backend-as-a-Service platform, is a product of Google that provides developers with a wide range of tools and services to expedite the development process, enhance user experience, and scale applications effortlessly. This platform's key draw is its

comprehensive features that address a variety of needs in software development, including data storage, user authentication, real-time updates, analytics, and more.

Firebase offers a rich set of services. Among the most important are the Realtime Database, a NoSQL cloud database that allows real-time data storage and synchronization. Firebase Authentication, on the other hand, offers a secure authentication system supporting various methods such as email, password, third-party providers like Google or Facebook, and phone number authentication. Cloud Firestore provides a flexible, scalable database for mobile, web, and server development with real-time listeners and offline support.

3.4.3 Arduino IDE

The Arduino Integrated Development Environment (IDE) is a user-friendly software platform designed for programming and developing applications for Arduino microcontroller boards. As an open-source electronics platform, Arduino is widely utilized for prototyping and building various electronic projects, ranging from robots and home automation systems to wearable devices and more. The Arduino IDE provides a straightforward and accessible interface that simplifies the process of writing, compiling, and uploading code to Arduino boards. Users can write their Arduino sketches, written in the C++ programming language, within the code editor.

The IDE offers syntax highlighting, color-coding different elements of the code for enhanced readability. After writing the code, users can verify and compile their sketches with the click of a button, checking for syntax errors and converting the code into machine code that the Arduino board can understand. The IDE also includes a serial monitor, enabling users to communicate with their Arduino board for debugging and troubleshooting purposes. By selecting the type of Arduino board and the communication port, users can easily upload the compiled code to the board, making it ready for execution.

Additionally, the IDE provides built-in libraries and examples, simplifying the coding process, and users can add external libraries from the Arduino community to extend its capabilities. Being open-source, the Arduino IDE encourages collaboration and continu-

ous improvement, with developers worldwide contributing to its growth and accessibility. Its simplicity, vast community support, and extensive documentation have made it a popular choice among both beginners and experienced developers in the maker and DIY electronics community.

Chapter 4

Methodology

4.1 Proposed Method

- Develop a mobile application that can recognize the odour.
- We plan to build model using both hardware and software that detects the odour in the environment and give the details in an mobile applictaion.
- sensor can sense the varying intensity of air quality and store the data in the database.From the database the details are sent to user through the mobile application.
- Application also contains features like Sign in interface,Sign up interface,Home screen,Washroom display view,Washroom status interface ,Complaint register interface,Complaint view interface,Notification interface.

4.1.1 Odour Detection

The methodology for odour detection using an MQ137 gas sensor, WiFi module, Firebase database, Cotledine app, motor, and spray incorporates a well-structured approach to monitor odours in indoor as well as outdoor environments. The hardware setup, includes the MQ137 gas sensor ,ESP8266 WiFi module,L298N motor driver module,RGB light,Resistors responsible for continuous odour measurement and data transmission.The data flow from the sensor to the Firebase database for secure cloud-based storage and accessibility.

The process begins with calibrating the MQ137 sensor to ensure accurate and reliable odour measurements. The sensor continuously detects odorous compounds in the air, and the WiFi module transmits this data to the Firebase database. The Cotledine app, integrated with Firebase, retrieves real-time odour data and employs sophisticated algorithms

for data analysis . The app compares the detected odour levels with predefined thresholds to trigger the motor and spray mechanism when elevated odour levels are detected. When the value of the sensor is below 25bpm the green led light will display .When the value goes above 25 and below 35,the motor starts working at the speed regulator of 125 and the spray spays once.when the value goes above 35 the motor increases its speed to max and the spray spays thrice.

Users are notified through the Cotledine app ,keeping them informed about odour issues and spraying activities. The system also incorporates user feedback integration, enabling occupants or facility managers to report odour events and customize odour profiles based on individual preferences.

The Cotledine app visualizes odour data , providing insights into odour patterns and trends. Remote control capabilities allow users to initiate deodorizing actions even when not on-site, enhancing convenience and timely odour management.

Additionally, the system synchronizes with building management systems, enabling coordinated responses to odour detection and facilitating energy-efficient operation by activating the spray mechanism only when required.

Real-time reports and analytics empower facility managers to make data-driven decisions for effective odour management strategies. Moreover, the system's expandability and scalability ensure adaptability to changing indoor environments or facility needs.The spraying activity and the motor working by changing the speed based on the intensity of the air quality acts as an temporary solution which can lead to improving the quality of the environment and the cleaning staff can do the needful based on the notification given in the application.

Overall, this comprehensive odour detection methodology, demonstrates an intelligent and user-friendly solution that effectively detects, customizes, and manages odours in diverse indoor settings, contributing to a pleasant and healthier indoor environment.

Chapter 5

System Design

5.1 Architecture Diagram

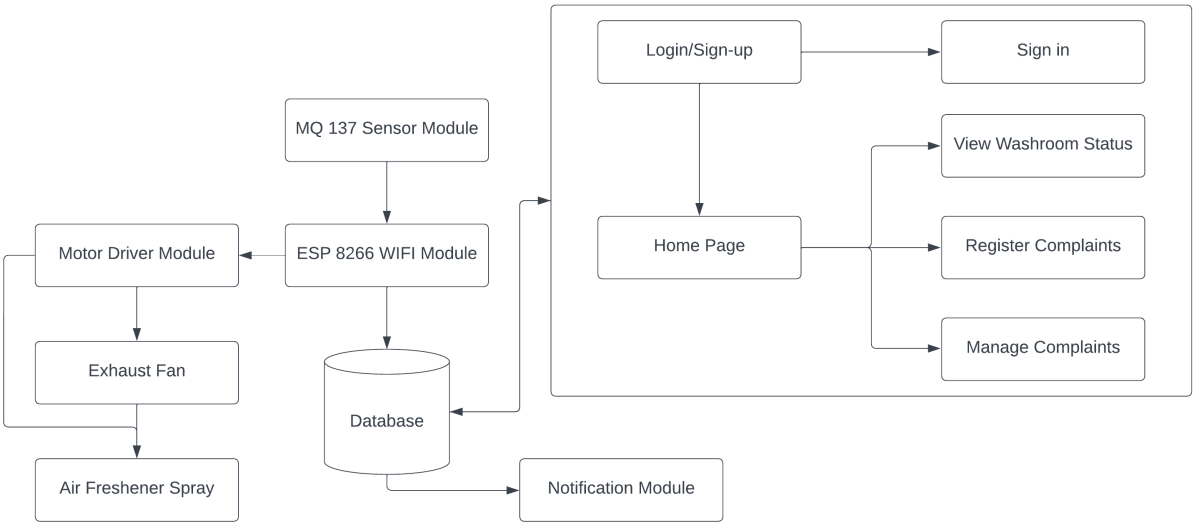

Figure 5.1: Architecture diagram

5.2 Data Flow Diagram

5.2.1 Staff

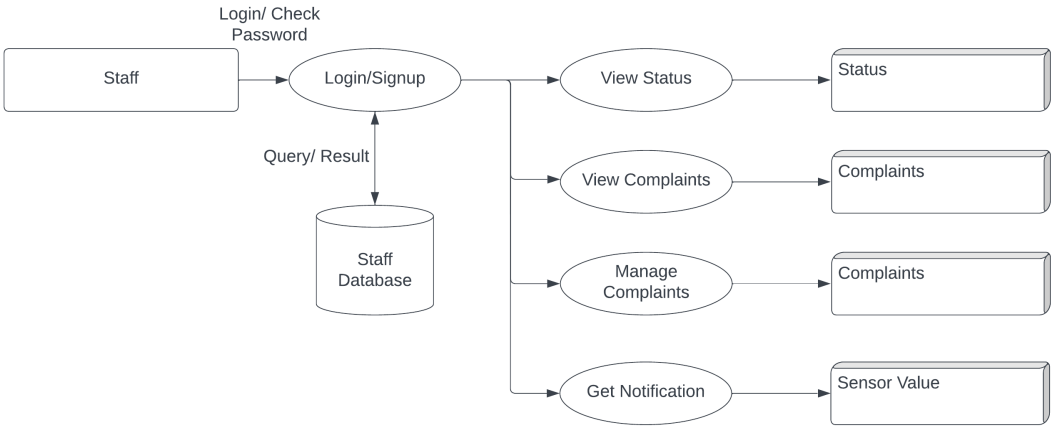

Figure 5.2: DFD - Staff

5.2.2 Student

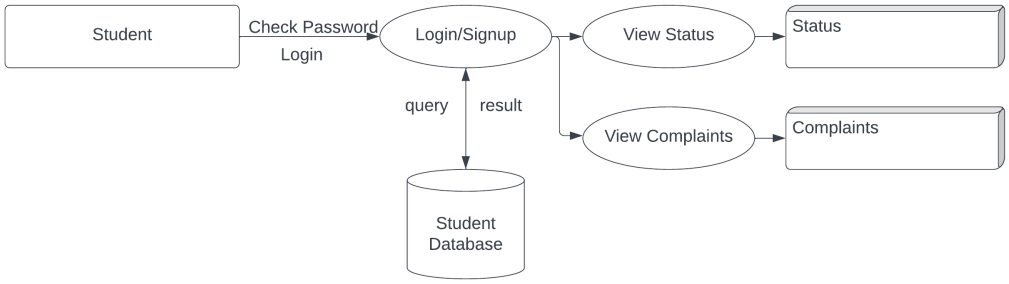

Figure 5.3: DFD - Student

5.3 Use Case Diagram

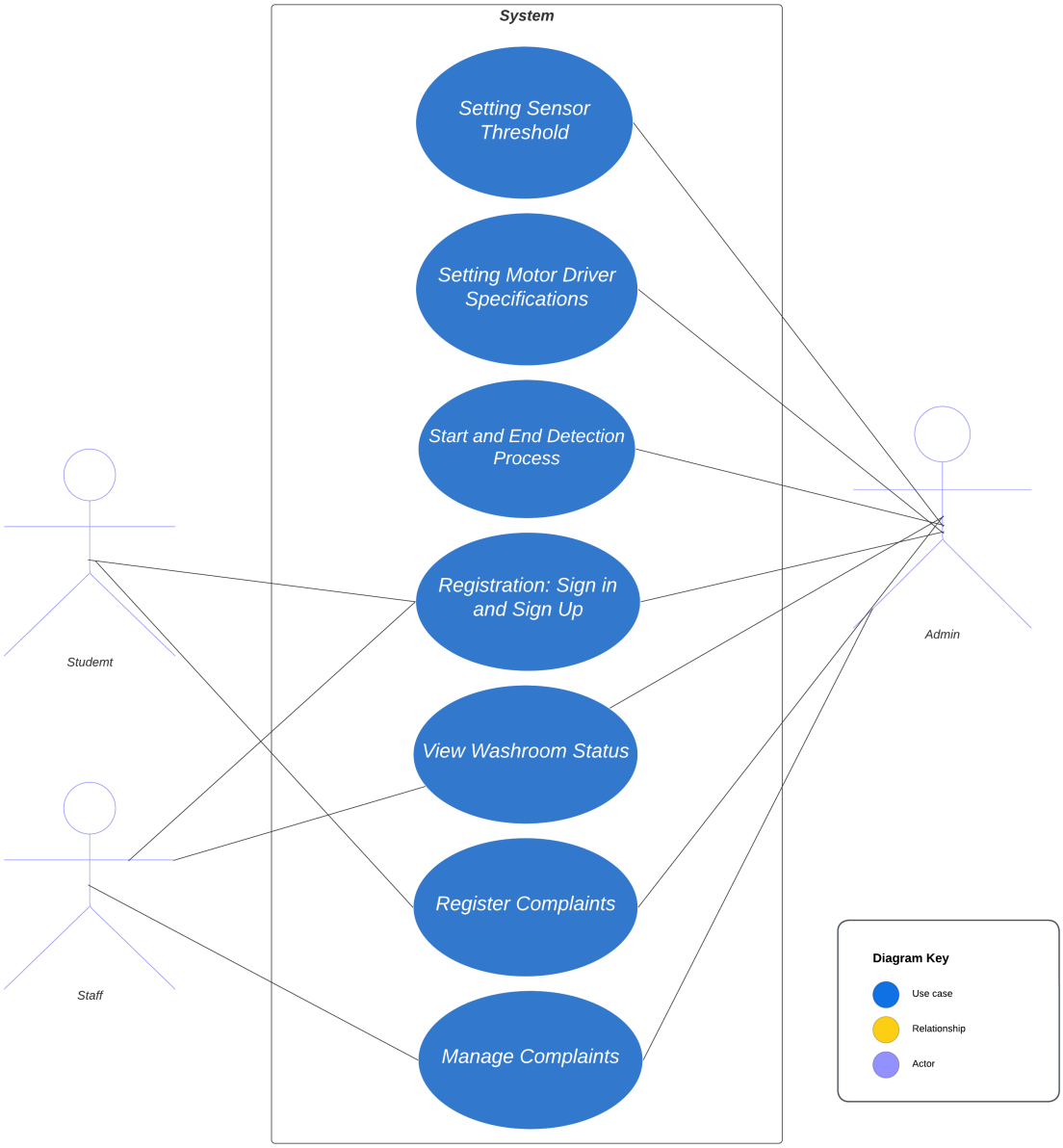

Figure 5.4: Use Case Diagram

Chapter 6

System Implementation

6.1 Hardware Assembly

The first phase of the implementation involves assembling the hardware components required for the Smart Washroom Automated System. The key hardware components include:

6.1.1 ESP8266 / Node MCU

The central microcontroller that will serve as the brain of the system, processing data from sensors and controlling actuators and communication module that enables the Node MCU to connect to the internet and interact with the Firebase server and mobile app.

6.1.2 Sensors

Gas Sensor provide valuable data to the system, such as detecting the presence of Ammonia (NH3), Carbon Monoxide (CO), and trimethylamine as well.

6.1.3 Actuators

Control Logic is implemented to activate or deactivate the appropriate actuators (Exhaust Fan, Mechanical Spray) using the Motor Driver module.

6.1.4 RGB LED

RGB LEDs have three - one which emits red light (R), one for green light (G), and one for blue (B). It works with three components of the LED combined to give color. The LED can control its brightness by changing its Analog value function.

6.1.5 Power Supply

The 12V DC power supply can provide a power source for any electronic device that has an M-type barrel and requires 12 volts and up to 2 amps of power. The power supply is perfect for powering all the hardware modules specified.

6.1.6 Resistors

3 Resistor of 200 Ohm are connected in series with the RED, GREEN, and BLUE pins of the LED for controlling the input voltage and a 10 K Ohm is connected in series with one of the sensor pin outputs that is attached to the ground of the circuit.

6.1.7 Exhaust Fan

DC powered Exhaust fan are connected with the motor driver module with the Positive and Negative terminals.

6.1.8 Mechanical Spray

Mechanical Washroom Freshener Spray is connected with the other Positive and Negative terminals of the motor driver module.

6.2 Firmware Development

The firmware development stage focuses on programming the ESP8266 / Node MCU to operate efficiently and perform the necessary tasks. The firmware is developed using Arduino IDE, which offers the required flexibility and ease of integration. The key aspects of firmware development include:

6.2.1 Data Collection

Code is written to read data from the connected Gas Sensor (MQ137).

6.2.2 Actuator Control

Control logic is implemented to activate or deactivate the appropriate actuators (Exhaust fan and Mechanical Spray) based on commands from the control board.

6.2.3 Internet Connectivity

The firmware is programmed to establish and maintain a stable internet connection with the Wi-Fi module (ESP8266), allowing seamless communication with the Firebase server and mobile app.

6.2.4 Light Indication

The firmware incorporates controlling the signal lights for indicating the threshold values read by the sensor.

6.3 Mobile App Development (Android)

The Android mobile app development is critical to provide users with an intuitive and user-friendly interface to view their smart washroom status. The app is developed using Kotlin, Android platform compatibility, and a consistent user experience. The primary features of the mobile app include:

6.3.1 User Authentication

The app incorporates user authentication mechanisms, allowing users to securely log in and access their app homepage.

6.3.2 Real-time Data Visualization

Sensor data from the washrooms are fetched from the cloud server and displayed in real time within the app, providing users with up-to-date information about their washroom environment.

6.3.3 Register Complaint

The mobile app enables users to complaints about the washroom status or any other personal issues with the associated washroom which can be viewed by the cleaning staff and admin.

6.3.4 Complaint Management

Staff can access the registered complaint from the home app and manage or delete the complaint after solving the issues.

6.3.5 Real-time Notification

The app automatically sends notifications on a fixed time intervals to the cleaning staff by analyzing the sensor value fetched from the database.

6.4 Cloud Server Setup

Setting up the cloud server infrastructure is a crucial component of the Smart Washroom Automated System. The cloud server acts as the central hub for data storage, communication, and data synchronization between the mobile app and the sensor. The key aspects of cloud server setup include:

6.4.1 Cloud Connection

Copy the necessary Firebase link of the real-time database and authentication token generated in the cloud-based backend of the Firebase to the IDE of the firmware control program.

6.4.2 Communication Layer

Not required in this scenario, as Firebase provides a cloud-based backend.

6.4.3 High Availability

The cloud server is designed to be highly available, ensuring that the Smart Washroom system remains accessible and functional at all times, even during peak usage periods.

6.5 Maintenance and Updates

Establishing a maintenance plan is crucial to ensure the ongoing functionality and reliability of the Smart Washroom Automated System. The maintenance phase includes:

6.5.1 Monitoring System Performance

Regularly monitoring the system's performance to identify any potential issues proactively.

6.5.2 Firmware and Software Updates

Periodically updating the mobile app, firmware, and cloud server to add new features, improve security, and fix bugs.

In conclusion, the successful implementation of the Smart Washroom Automated System requires the seamless integration of hardware, firmware, mobile app development, cloud infrastructure, and database management. With proper testing, deployment, and maintenance, the system provides users with a convenient and efficient way to view their washrooms and access real-time data remotely.

Chapter 7

Testing

Testing is crucial in projects as it helps identify and fix bugs, ensuring the functionality and reliability of the final product. It enhances user satisfaction, prevents costly mistakes, and provides confidence in the project's quality and performance. Thorough testing mitigates risks, complies with regulations, and allows for continuous improvement throughout the development process. Testing is performed on both the hardware and software components, and it includes:

7.0.1 Functional Testing

Ensuring the correct operation of sensors, actuators, and communication between devices.

7.0.2 Sensor Testing

The gas sensor is tested with various concentrations of ammonia gas to ensure its proper working and accurate detection. The sensor is then calibrated into the required levels of the gases and which are then identified for the automatic control system.

7.0.3 Exhaust testing

This testing ensures the proper working of the exhaust fan and its capability to exhaust the foul-smelling gas under various conditions.

7.0.4 Spray Module Testing

This testing is deployed to test the mechanical system of the spray module works with the logic provided but the control board and reliability of the module.

7.0.5 Integration Testing

All the hardware and software modules have been integrated and the system is tested as a whole and ensures the proper working of the integrated system, checking whether it delivered the specified functionality or not.

7.0.6 Connection Testing

Connection test ensures there is an easy as well as fast connection establishment between the hardware module and cloud and between the cloud and the software and the dependability of them.

7.0.7 Usability Testing

Evaluating the user experience of the mobile app to ensure it is intuitive and user-friendly.

7.0.8 Cross Device Testing

This test ensures the proper working of the app on different smartphones (Android 8 and above), proper connectivity with the database, and overall performance of the system.

Chapter 8

Results

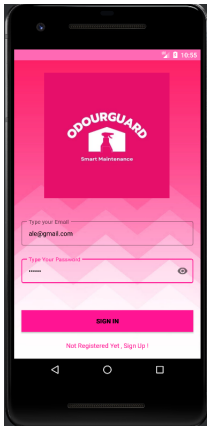

Figure 8.1: Sign In Interface

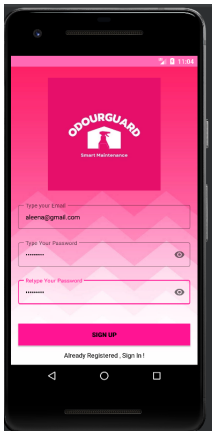

Figure 8.2: Sign Up Interface

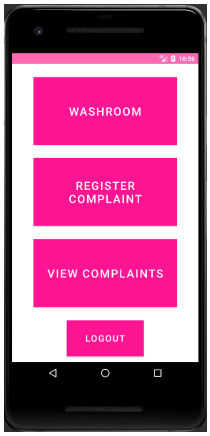

Figure 8.3: Home Screen

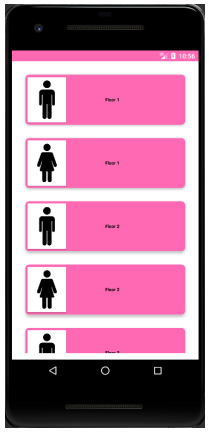

Figure 8.4: Washroom Display View

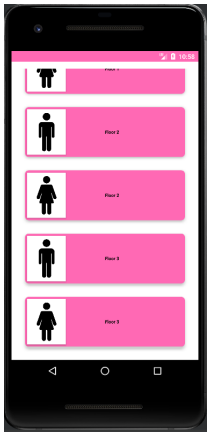

Figure 8.5: Washroom Display View

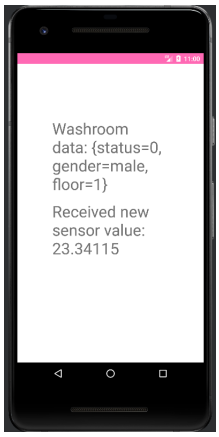

Figure 8.6: Washroom Status interface

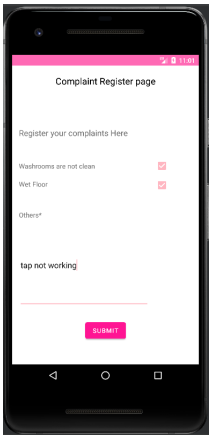

Figure 8.7: Complaint Register Interface

Figure 8.8: Complaint View interface

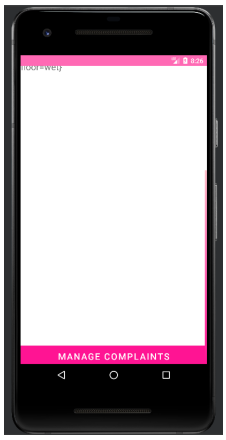

Figure 8.9: Complaint Register Interface

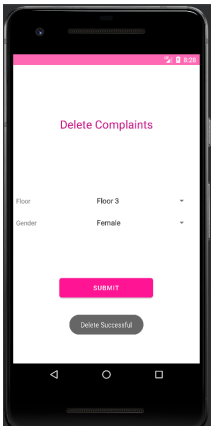

Figure 8.10: Complaint View interface

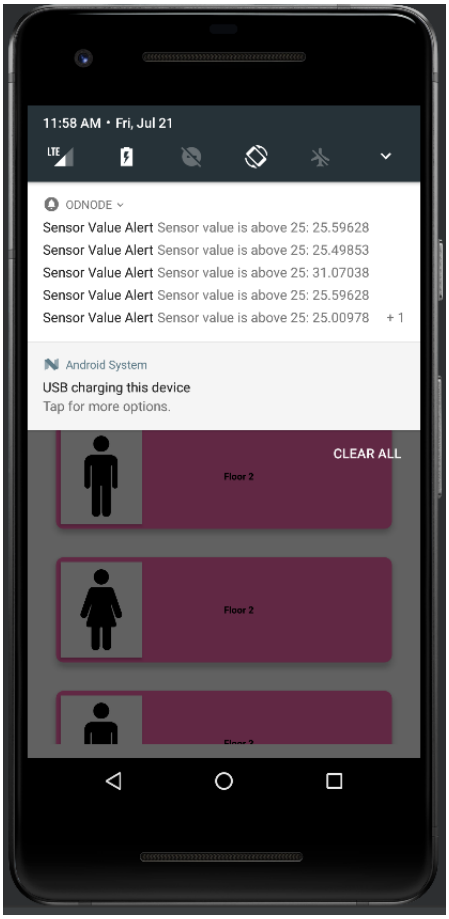

Figure 8.11: Notification Interface

Chapter 9

Risks and Challenges

1. Sensory Complexity: Odor perception is subjective and influenced by individual differences. People may have different interpretations of the same odor, making it difficult to establish consistent and reliable measurements.

2. Sensor Selection: Choosing the right sensors for odor detection is crucial. Different sensors have varying sensitivities towards different odorants.

3. Cost and Scalability: Implementing odor detection systems on a large scale can be expensive. The costs associated with sensor technology, data storage and analysis infrastructure, and system deployment can be significant.

4. Data Analysis and Interpretation: Processing and analyzing large volumes of odor data can be complex. Extracting meaningful information and patterns from the data collected by odor detection systems can be challenging.

Chapter 10

Conclusion

We have developed an Odour Detection and Notification System to detect the presence of an odour. For the same, we developed an Application that sends the logged-in user, a notification, whenever the odour crosses the pre-defined threshold level.

We have used Arduino Programming to implement an automated exhaust and spray, that increases or decreases the speed, or stops the working of the exhaust fan, followed by successive sprays of the air freshener, depending upon the odour level observed.

Both the software and hardware were separately, and tested after they were integrated. Our project showed better results when we compared it with a timer-based spray, as the project sprayed the air freshener based on real-time monitored sensor readings.

A potential future scope for the odor detection and notification system involves implementing an Admin Management feature directly from the mobile application. This enhancement aims to simplify administrative tasks, allowing the system administrator to manage threshold levels, timer specifications, and notification preferences without the need for hardware modifications.

References

[1] https://www.udemy.com/course/practical-iot-using-arduino-uno-and-esp/

[2] https://www.youtube.com/@MalluDeveloper

[3] https://www.youtube.com/watch?v=3pCejvVU7jM

[4] https://www.youtube.com/watch?v=idbxxkF1l6k

[5] https://www.youtube.com/@CodingwithT

[6] A Sensor-based Garbage Gas Detection System by IEEE https://ieeexplore.ieee.org/abstract/document/9376147

[7] https://circuitdigest.com/microcontroller-projects/arduino-mq137-ammonia-sensor

[8] https://www.electroniclinic.com/firebase-project-using-esp8266-mq3-sensor-flame-sensor/

Appendix A: Sample Code

Arduino Code

```
#include <ESP8266WiFi.h>
#include <FirebaseESP8266.h>
#include <Wire.h>

#define WIFI_SSID "Akash"
#define WIFI_PASSWORD "AKASHVIJAY123"

#define FIREBASE_HOST "https://authenticate-79488-default-rtdb.firebaseio.com/"
#define FIREBASE_AUTH "W5V7GFbML4XMt9wVMEz4tVeLBweqfDVrhwdUC6eQ"

// MQ137 sensor pin
#define MQ137_PIN A0
const int RED_PIN = D0;
const int GREEN_PIN = D1;
const int BLUE_PIN = D2;

const int enA = D3;
const int in1 = D4;

const int enB = D8;
const int in4 = D7;
const int in3 = D6;

// Initialize Firebase object
FirebaseData firebaseData;

int i,j,repeat,status=0;

// Firebase database path
#define FIREBASE_PATH "/sensor_values/mq137"

// Create an instance of the Wi-Fi client
WiFiClient client;

void setup()
{
  Serial.begin(115200);
  delay(10);

  // Connect to Wi-Fi
  WiFi.begin(WIFI_SSID, WIFI_PASSWORD);
  Serial.print("Connecting to Wi-Fi...");

  while (WiFi.status() != WL_CONNECTED)
  {
```

```
    delay(500);
    Serial.print(".");
  }

  Serial.println();
  Serial.print("Connected to Wi-Fi. IP address: ");
  Serial.println(WiFi.localIP());

  // Initialize Firebase
  Firebase.begin(FIREBASE_HOST, FIREBASE_AUTH);
  Firebase.reconnectWiFi(true);

  // Set maximum retry count and timeout duration
  Firebase.setMaxRetry(firebaseData, 3);
  Firebase.setReadTimeout(firebaseData, 1000);

  //pinmode LED
  pinMode(RED_PIN, OUTPUT);
  pinMode(GREEN_PIN, OUTPUT);
  pinMode(BLUE_PIN, OUTPUT);

  //pin mode FAN
  pinMode(enA, OUTPUT);
  pinMode(in1, OUTPUT);

  //pin mode Spray
  pinMode(enB, OUTPUT);
  pinMode(in4, OUTPUT);
  pinMode(in3, OUTPUT);

}

void loop() {
  // Read sensor value
  int sensorValue = analogRead(MQ137_PIN);

  // Convert the value to a voltage
  float voltage = sensorValue * (5.0 / 1023.0);
  float gasConcentration = (voltage * 10.0);
  gasConcentration=gasConcentration-5;
  int x = (int)gasConcentration;

  // Print the sensor value and voltage
  Serial.print("Sensor value: ");
  Serial.println(sensorValue);
  Serial.print("Gas Concentration: ");
  Serial.println(gasConcentration);
```

```
// Save the value to Firebase
if (Firebase.setFloat(firebaseData, FIREBASE_PATH, gasConcentration))
{
  Serial.println("Value sent to Firebase!");
}
else
{
  Serial.println("Failed to send value to Firebase.");
  Serial.println("Reason: " + firebaseData.errorReason());
}

//Condition for Exhaust and LED
if( x < 25 )
{
  analogWrite(RED_PIN, 0);
  analogWrite(GREEN_PIN, 255);
  analogWrite(BLUE_PIN, 0);

  digitalWrite(in1, LOW);
  delay(100);
}

if(x > 24 && x < 35 )
{
  repeat=1;

    analogWrite(RED_PIN, 255);
    analogWrite(GREEN_PIN, 10);
    analogWrite(BLUE_PIN, 50);

    digitalWrite(in1, HIGH);
    analogWrite(enA, 125);
    delay(60000);
    digitalWrite(in1, LOW);
    delay(2000);
    if(status==0)
    {
      status=spray(repeat);
    }
    delay(100);
}

status=setTimer();

if(x > 34)
{
  repeat=3;
```

```
      analogWrite(RED_PIN, 255);
      analogWrite(GREEN_PIN, 0);
      analogWrite(BLUE_PIN, 0);

      digitalWrite(in1, HIGH);
      analogWrite(enA, 255);
      delay(60000);
      digitalWrite(in1, LOW);
      delay(2000);
      if(status==0)
      {
        status=spray(repeat);
      }

      delay(100);
  }

  status=setTimer();

  //delay(1000); // Wait for 5 seconds before sending the next value
}

//spray function
int spray(int repeat)
{
  //int s;
  for(j=0;j<repeat;j++)
  {
    //spray using DC motor
    for(i=0;i<=8;i++)
    {
      analogWrite(enB,255);
      digitalWrite(in3, LOW);
      digitalWrite(in4, HIGH);
      delay(14);
    }
    for(i=0;i<=8;i++)
    {
      analogWrite(enB,255);
      digitalWrite(in3, HIGH);
      digitalWrite(in4, LOW);
      delay(14);
    }
    for(i=0;i<=25;i++)
    {
      digitalWrite(in3, LOW);
      digitalWrite(in4, LOW);
      delay(50);
```

```
    }
    //wait 15 seconds
    delay(15000);
  }
  return 1;
}

//timer function
int setTimer()
{
  if(status==1)
  {
    delay(60000);
    status=0;
    return status;
  }
  else
  {
    status=0;
    return status;
  }
}
```

Status Page XML

```
<?xml version="1.0" encoding="utf-8"?>
<androidx.constraintlayout.widget.ConstraintLayout
xmlns:android="http://schemas.android.com/apk/res/android"
    xmlns:app="http://schemas.android.com/apk/res-auto"
    xmlns:tools="http://schemas.android.com/tools"
    android:layout_width="match_parent"
    android:layout_height="match_parent"
    tools:context=".washroomStatus">

    <TextView
        android:id="@+id/textView2"
        android:layout_width="256dp"
        android:layout_height="197dp"
        android:text="@string/status_page"
        android:textSize="35sp"
        app:layout_constraintBottom_toBottomOf="parent"
        app:layout_constraintEnd_toEndOf="parent"
        app:layout_constraintHorizontal_bias="0.496"
        app:layout_constraintStart_toStartOf="parent"
        app:layout_constraintTop_toTopOf="parent"
        app:layout_constraintVertical_bias="0.256" />

    <TextView
        android:id="@+id/sensval"
        android:layout_width="260dp"
        android:layout_height="168dp"
        android:text="@string/sensor_value"
        android:textSize="35sp"
        android:visibility="visible"
        app:layout_constraintBottom_toBottomOf="parent"
        app:layout_constraintEnd_toEndOf="parent"
        app:layout_constraintHorizontal_bias="0.509"
        app:layout_constraintStart_toStartOf="parent"
        app:layout_constraintTop_toTopOf="parent"
        app:layout_constraintVertical_bias="0.613" />

</androidx.constraintlayout.widget.ConstraintLayout>
```

Status Page Kotlin

```
package com.example.login2

import android.annotation.SuppressLint
import android.os.Bundle
import androidx.appcompat.app.AppCompatActivity
import com.example.login2.databinding.ActivityWashroomStatusBinding
import com.google.firebase.firestore.FirebaseFirestore
import com.google.firebase.database.*


class washroomStatus : AppCompatActivity() {
    private lateinit var binding: ActivityWashroomStatusBinding
    private val database: FirebaseDatabase = FirebaseDatabase.getInstance()
    private val sensorRef: DatabaseReference =
database.getReference("sensor_values/mq137")

    override fun onCreate(savedInstanceState: Bundle?) {
        super.onCreate(savedInstanceState)
        binding = ActivityWashroomStatusBinding.inflate(layoutInflater)
        setContentView(binding.root)
        retrieveWashroomStatus()
        startFetchingData()
    }

    @SuppressLint("SetTextI18n")
    private fun retrieveWashroomStatus() {
        val db = FirebaseFirestore.getInstance()
        val washroomId = intent.getStringExtra("washroomId")
        val docRef =
db.collection("Washrooms").document(washroomId.toString())
        docRef.get()
            .addOnSuccessListener { document ->
                if(document!=null){
                    binding.textView2.text = "Washroom data:
${document.data}"
                } else {
                    binding.textView2.text ="No such document"
                }
            }
            .addOnFailureListener { exception ->
                binding.textView2.text ="get failed with $exception"
            }

    }
    private fun startFetchingData() {
        sensorRef.addValueEventListener(object : ValueEventListener {
            @SuppressLint("SetTextI18n")
            override fun onDataChange(dataSnapshot: DataSnapshot) {
                val sensorValue = dataSnapshot.getValue(Double::class.java)
                binding.sensval.text="Received new sensor value:
$sensorValue"
                /* Process the received sensor value as needed */
            }

            @SuppressLint("SetTextI18n")
            override fun onCancelled(databaseError: DatabaseError) {
                binding.sensval.text="Data fetching canceled:
${databaseError.message}"
```

```
                }
            })
        }
}
```

Appendix B: CO PO Mapping

COURSE OUTCOMES:

After completion of the course the student will be able to

SL. NO	DESCRIPTION	Blooms' Taxonomy Level
CO1	Identify technically and economically feasible problems (Cognitive Knowledge Level: Apply)	Level 3: Apply
CO2	Identify and survey the relevant literature for getting exposed to related solutions and get familiarized with software development processes (Cognitive Knowledge Level: Apply)	Level 3: Apply
CO3	Perform requirement analysis, identify design methodologies and develop adaptable & reusable solutions of minimal complexity by using modern tools & advanced programming techniques (Cognitive Knowledge Level: Apply)	Level 3: Apply
CO4	Prepare technical report and deliver presentation (Cognitive Knowledge Level: Apply)	Level 3: Apply
CO5	Apply engineering and management principles to achieve the goal of the project (Cognitive Knowledge Level: Apply)	Level 3: Apply

CO-PO AND CO-PSO MAPPING

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO3
CO1	3	3	3	3		2	2	3	2	2	2	3	2	2	2
CO2	3	3	3	3	3	2		3	2	3	2	3	2	2	2
CO3	3	3	3	3	3	2	2	3	2	2	2	3			2
CO4	2	3	2	2	2			3	3	3	2	3	2	2	2
CO5	3	3	3	2	2	2	2	3	2		2	3	2	2	2

3/2/1: high/medium/low

JUSTIFICATIONS FOR CO-PO MAPPING

MAPPING	LOW/ MEDIUM/ HIGH	JUSTIFICATION
100003/CS622T.1-PO1	**HIGH**	Identify technically and economically feasible problems by applying the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
100003/CS622T.1-PO2	**HIGH**	Identify technically and economically feasible problems by analysing complex engineering problems reaching substantiated conclusions using first principles of mathematics.
100003/CS622T.1-PO3	**HIGH**	Design solutions for complex engineering problems by identifying technically and economically feasible problems.
100003/CS622T.1-PO4	**HIGH**	Identify technically and economically feasible problems by analysis and interpretation of data.
100003/CS622T.1-PO6	**MEDIUM**	Responsibilities relevant to the professional engineering practice by identifying the problem.
100003/CS622T.1-PO7	**MEDIUM**	Identify technically and economically feasible problems by understanding the impact of the professional engineering solutions.
100003/CS622T.1-PO8	**HIGH**	Apply ethical principles and commit to professional ethics to identify technically and economically feasible problems.
100003/CS622T.1-PO9	**MEDIUM**	Identify technically and economically feasible problems by working as a team.
100003/CS622T.1-PO10	**MEDIUM**	Communicate effectively with the engineering community by identifying technically and economically feasible problems.
100003/CS622T.1-P011	**MEDIUM**	Demonstrate knowledge and understanding of engineering and management principles by selecting the technically and economically feasible problems.
100003/CS622T.1-PO12	**HIGH**	Identify technically and economically feasible problems for long term learning.
100003/CS622T.1-PSO1	**MEDIUM**	Ability to identify, analyze and design solutions to identify technically and economically feasible problems.
100003/CS622T.1-PSO2	**MEDIUM**	By designing algorithms and applying standard practices in software project development and Identifying technically and economically feasible problems.
100003/CS622T.1-PSO3	**MEDIUM**	Fundamentals of computer science in competitive research can be applied to Identify technically and economically feasible problems.
100003/CS622T.2-PO1	**HIGH**	Identify and survey the relevant by applying the knowledge of mathematics, science, engineering fundamentals.

100003/CS622T.2-PO2	**HIGH**	Identify, formulate, review research literature, and analyze complex engineering problems get familiarized with software development processes.
100003/CS622T.2-PO3	**HIGH**	Design solutions for complex engineering problems and design based on the relevant literature.
100003/CS622T.2-PO4	**HIGH**	Use research-based knowledge including design of experiments based on relevant literature.
100003/CS622T.2-PO5	**HIGH**	Identify and survey the relevant literature for getting exposed to related solutions and get familiarized with software development processes by using modern tools.
100003/CS622T.2-PO6	**MEDIUM**	Create, select, and apply appropriate techniques, resources, by identifying and surveying the relevant literature.
100003/CS622T.2-PO8	**HIGH**	Apply ethical principles and commit to professional ethics based on the relevant literature.
100003/CS622T.2-PO9	**MEDIUM**	Identify and survey the relevant literature as a team.
100003/CS622T.2-PO10	**HIGH**	Identify and survey the relevant literature for a good communication to the engineering fraternity.
100003/CS622T.2-PO11	**MEDIUM**	Identify and survey the relevant literature to demonstrate knowledge and understanding of engineering and management principles.
100003/CS622T.2-PO12	**HIGH**	Identify and survey the relevant literature for independent and lifelong learning.
100003/CS622T.2-PSO1	**MEDIUM**	Design solutions for complex engineering problems by Identifying and survey the relevant literature.
100003/CS622T.2-PSO2	**MEDIUM**	Identify and survey the relevant literature for acquiring programming efficiency by designing algorithms and applying standard practices.
100003/CS622T.2-PSO3	**MEDIUM**	Identify and survey the relevant literature to apply the fundamentals of computer science in competitive research.
100003/CS622T.3-PO1	**HIGH**	Perform requirement analysis, identify design methodologies by using modern tools & advanced programming techniques and by applying the knowledge of mathematics, science, engineering fundamentals.
100003/CS622T.3-PO2	**HIGH**	Identify, formulate, review research literature for requirement analysis, identify design methodologies and develop adaptable & reusable solutions.

100003/CS622T.3-PO3	**HIGH**	Design solutions for complex engineering problems and perform requirement analysis, identify design methodologies.
100003/CS622T.3-PO4	**HIGH**	Use research-based knowledge including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
100003/CS622T.3-PO5	**HIGH**	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools.
100003/CS622T.3-PO6	**MEDIUM**	Perform requirement analysis, identify design methodologies and assess societal, health, safety, legal, and cultural issues.
100003/CS622T.3-PO7	**MEDIUM**	Understand the impact of the professional engineering solutions in societal and environmental contexts and Perform requirement analysis, identify design methodologies and develop adaptable & reusable solutions.
100003/CS622T.3-PO8	**HIGH**	Perform requirement analysis, identify design methodologies and develop adaptable & reusable solutions by applying ethical principles and commit to professional ethics.
100003/CS622T.3-PO9	**MEDIUM**	Function effectively as an individual, and as a member or leader in teams, and in multidisciplinary settings.
100003/CS622T.3-PO10	**MEDIUM**	Communicate effectively with the engineering community and with society at large to perform requirement analysis, identify design methodologies.
100003/CS622T.3-PO11	**MEDIUM**	Demonstrate knowledge and understanding of engineering requirement analysis by identifying design methodologies.
100003/CS622T.3-PO12	**HIGH**	Recognize the need for, and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change by analysis, identify design methodologies and develop adaptable & reusable solutions.
100003/CS622T.3-PSO3	**MEDIUM**	The ability to apply the fundamentals of computer science in competitive research and prior to that perform requirement analysis, identify design methodologies.
100003/CS622T.4-PO1	**MEDIUM**	Prepare technical report and deliver presentation by applying the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
100003/CS622T.4-PO2	**HIGH**	Identify, formulate, review research literature, and analyze complex engineering problems by preparing technical report and deliver presentation.

100003/CS622T.4-PO3	**MEDIUM**	Prepare Design solutions for complex engineering problems and create technical report and deliver presentation.
100003/CS622T.4-PO4	**MEDIUM**	Use research-based knowledge including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions and prepare technical report and deliver presentation.
100003/CS622T.4-PO5	**MEDIUM**	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools and Prepare technical report and deliver presentation.
100003/CS622T.4-PO8	**HIGH**	Prepare technical report and deliver presentation by applying ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
100003/CS622T.4-PO9	**HIGH**	Prepare technical report and deliver presentation effectively as an individual, and as a member or leader in teams, and in multidisciplinary settings.
100003/CS622T.4-PO10	**HIGH**	Communicate effectively with the engineering community and with society at large by prepare technical report and deliver presentation.
100003/CS622T.4-PO11	**MEDIUM**	Demonstrate knowledge and understanding of engineering and management principles and apply these to one's own work by prepare technical report and deliver presentation.
100003/CS622T.4-PO12	**HIGH**	Recognize the need for, and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change by prepare technical report and deliver presentation.
100003/CS622T.4-PSO1	**MEDIUM**	Prepare a technical report and deliver presentation to identify, analyze and design solutions for complex engineering problems in multidisciplinary areas.
100003/CS622T.4-PSO2	**MEDIUM**	To acquire programming efficiency by designing algorithms and applying standard practices in software project development and to prepare technical report and deliver presentation.
100003/CS622T.4-PSO3	**MEDIUM**	To apply the fundamentals of computer science in competitive research and to develop innovative products to meet the societal needs by preparing technical report and deliver presentation.
100003/CS622T.5-PO1	**HIGH**	Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
100003/CS622T.5-PO2	**HIGH**	Identify, formulate, review research literature, and analyze complex engineering problems by applying engineering and management principles to achieve the goal of the project.

100003/CS622T.5-PO3	**HIGH**	Apply engineering and management principles to achieve the goal of the project and to design solutions for complex engineering problems and design system components or processes that meet the specified needs.
100003/CS622T.5-PO4	**MEDIUM**	Apply engineering and management principles to achieve the goal of the project and use research-based knowledge including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
100003/CS622T.5-PO5	**MEDIUM**	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools and to apply engineering and management principles to achieve the goal of the project.
100003/CS622T.5-PO6	**MEDIUM**	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities by applying engineering and management principles to achieve the goal of the project.
100003/CS622T.5-PO7	**MEDIUM**	Understand the impact of the professional engineering solutions in societal and environmental contexts, and apply engineering and management principles to achieve the goal of the project.
100003/CS622T.5-PO8	**HIGH**	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice and to use the engineering and management principles to achieve the goal of the project.
100003/CS622T.5-PO9	**MEDIUM**	Function effectively as an individual, and as a member or leader in teams, and in multidisciplinary settings and to apply engineering and management principles to achieve the goal of the project.
100003/CS622T.5-PO11	**MEDIUM**	Demonstrate knowledge and understanding of engineering and management principles and apply these to one's own work, as a member and leader in a team. Manage projects in multidisciplinary environments and to apply engineering and management principles to achieve the goal of the project.
100003/CS622T.5-PO12	**HIGH**	Recognize the need for, and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change and to apply engineering and management principles to achieve the goal of the project.
100003/CS622T.5-PSO1	**MEDIUM**	The ability to identify, analyze and design solutions for complex engineering problems in multidisciplinary areas. Apply engineering and management principles to achieve the goal of the project.

100003/CS622T.5-PSO2	**MEDIUM**	The ability to acquire programming efficiency by designing algorithms and applying standard practices in software project development to deliver quality software products meeting the demands of the industry and to apply engineering and management principles to achieve the goal of the project.
100003/CS622T.5-PSO3	**MEDIUM**	The ability to apply the fundamentals of computer science in competitive research and to develop innovative products to meet the societal needs thereby evolving as an eminent researcher and entrepreneur and apply engineering and management principles to achieve the goal of the project.