SMART PUBLIC RESTROOM

IoT – Phase – 5

DOCUMENTATION AND SUBMISSION

PHASES OF THE PROJECT

- Problem definition and design thinking.
- Innovative design.
- Development – 1.
- Development – 2.

❖ ***PROBLEM DEFINITION AND THINKING:***

Problem Definition:

1. ***Room Unavailability:***

- Issue: Public restrooms may be unavailable when needed, causing inconvenience.

- Impact: Users may face long wait times or discomfort.

2. ***Water Scarcity or Poor Quality:***

- Issue: Inadequate water supply or poor water quality in restrooms.

- Impact: Hygiene and cleanliness may suffer, leading to user dissatisfaction.

3. ***Unhygienic Restrooms:***

- Issue: Restrooms may not be adequately clean, posing health risks.

- Impact: Users may avoid using the facility, leading to discomfort and potential health concerns.

Project (Potential Solution):

1. ***Efficient Public Restroom Facility:***

- Goal: Create an efficient and user-friendly public restroom facility.

- Solution: Install IoT sensors for real-time monitoring and maintenance.

2. ***IoT Sensors Implementation:***

- Components:
  - Motion sensors (entrance count).
  - Magnetic sensors (room occupancy).
  - Air quality sensors (hygiene check).
  - Water quality and availability sensors.
  - Ultrasonic sensors (wide-range public display).
  - Database for maintenance records.

Real-Time Transit Information Platform:

1. ***Web or Application Design:***

- Purpose: Provide real-time information to users and maintenance teams.
- Components:
  - Navigation bar for cleanliness, water availability, and room availability.
  - Help section for user guidance.
  - Detailed sections for each attribute.
  - Attractive and user-friendly design.
  - Feedback section for user input.

Integration Approach:

1. ***IoT Sensor Deployment:***

- Gateway Installation:
  - Purpose: Facilitate long-range communication.
  - Components: Coordinator, Router, End-point for data transmission.

2. ***Cloud Applications:***

- Purpose: Process and convert raw sensor data into useful information.
- Role: Centralized data analysis and storage.

3. ***User Interface:***

- Purpose: Connect applications or webpages with IoT devices.

- Role: Provides a user-friendly interface for data access and control.

The project aims to address restroom availability, cleanliness, and water quality and availability through the deployment of IoT sensors and a real-time information platform. This integrated approach enhances user experience and overall public restroom efficiency.

❖ ***INNOVATIVE DESIGN:***

Project Objectives:

1. ***Occupancy Check for Restroom Availability:***

- **Passive InfraRed (PIR) Motion Sensors:**

- Description: These sensors detect motion based on the infrared light emitted by nearby objects.

- Role: Used to sense the presence of individuals in the restroom.

- **Occupancy Indicator:**

- Description: Technology for measuring and managing space utilization.

- Role: Provides data on restroom occupancy.

- **Working Model for Occupancy Detection:**

- Description: Implementation model utilizing Arduino, infrared sensors, and IoT technologies.

- **Components:**

- An Arduino-based circuit with an infrared sensor for occupancy detection.

- A WIFI module with a low-cost WIFI microchip (ESP8266) for data transmission to an IoT server.

- Usage of API keys from a platform to import data to a website/application and inform users at regular intervals.

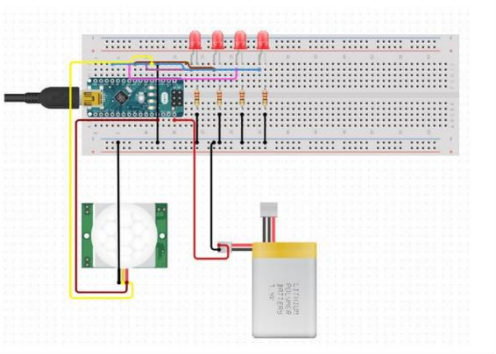
2. ***Restroom Hygiene in Public Restrooms:***

- **MQ135 Sensor:**
  - Description: Detects the presence of odorous gases like ammonia, NH3, C2H6O, and CO.
  - Role: Monitors restroom air quality and identifies foul odors.

- **Water Sensor:**
  - Description: Monitors water levels in the tank supplying water to the toilet.
  - Role: Detects high odor concentrations (above 5ppm) in water.

- **RFID Scanner:**
  - Description: Tracks the attendance of restroom cleaners to ensure regular cleaning.

- **Data Processing:**
  - Description: Data handling and processing using IoT technology.
  - **Process:**
    - Sensors send data to the cloud through a Node MCU, allowing users to connect via WIFI.
    - Data preprocessing is performed in the cloud, involving sensor parameter analysis.
    - Data is normalized, timestamped, and stored.
    - Commonly used database platforms for real-time updates include ThingSpeak.



Hardware Requirements:

- **Micro-controller:**
  - Description: Suitable for machine control and educational purposes.

Figure 2: Microcontroller

- **Smell Sensor:**

  - Description: Detects unpleasant odors, particularly pungent odors.

- **GSM Module:**

  - Description: Used for mobile communication, providing message transfer if WIFI connectivity fails.

This project aims to address restroom occupancy and hygiene concerns by employing a combination of motion sensors, air quality sensors, water level sensors, RFID technology, and data processing via IoT devices. The hardware requirements include micro-controllers, smell sensors, and GSM modules to facilitate the implementation of the system.

❖ ***DEVELOPMENT – 1:***

IoT Project Documentation: Smart Public Restroom IoT Device Setup

1. ***Introduction:***

The Smart Public Restroom IoT device is designed to monitor and manage the availability, hygiene, and water quality in public restrooms. This documentation provides detailed information on the setup and functioning of the IoT device.

2. ***Components Used:***

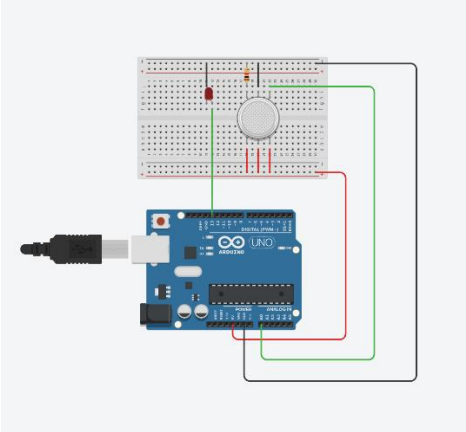
- **Arduino Board:**

- Description: The central microcontroller responsible for data collection, processing, and communication with other components.

- **Gas Sensor (MQ135):**

- Description: A gas sensor capable of detecting a range of gases, including ammonia, CO, and others.

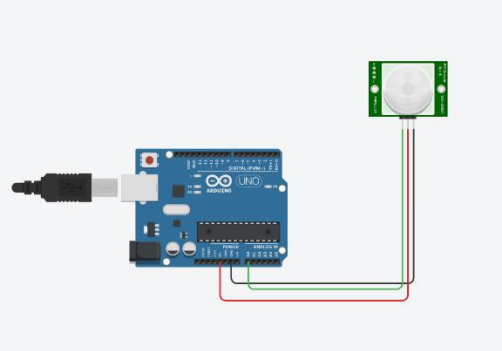
- Role: Monitors air quality in the restroom and detects foul odors.



- **Motion Sensor (PIR):**

- Description: A Passive InfraRed motion sensor that detects human presence.

- Role: Detects restroom occupancy and triggers data collection.



- **Water Quality Sensor:**
  - Description: A sensor designed to check water quality.
  - Role: Monitors the cleanliness and safety of water used in the restroom.

3. ***Hardware Setup:***

- **Connecting Gas Sensor (MQ135):**
  - Connect the MQ135 sensor to one of the analog pins (e.g., A0) on the Arduino board.
  - Ensure proper power (5V) and ground (GND) connections.

- **Connecting Motion Sensor (PIR):**
  - Connect the PIR sensor to a digital pin (e.g., D2) on the Arduino board.
  - Power it using 5V and connect the ground to GND.

- **Connecting Water Quality Sensor:**
  - Connect the water quality sensor to an analog pin (e.g., A1) on the Arduino board.
  - Make sure to provide the appropriate power and ground connections.

4. ***Working of Each Component:***

- **Gas Sensor (MQ135):**
  - The MQ135 sensor continuously measures the concentration of various gases in the air.
  - When foul odors are present in the restroom, the sensor detects them and sends data to the Arduino.

- The Arduino processes this data and can trigger actions like alerting maintenance or updating the public display with cleanliness information.

- **Motion Sensor (PIR):**

- The PIR sensor constantly scans for motion.

- When a person enters the restroom, the sensor detects the motion and sends a signal to the Arduino.

- The Arduino records occupancy data and updates the public display to indicate restroom availability.

- **Water Quality Sensor:**

- The water quality sensor analyzes the quality and safety of water in the restroom.

- If the water quality deteriorates or becomes unsafe, the sensor sends data to the Arduino.

- The Arduino can trigger actions like notifying maintenance or indicating water quality issues on the public display.

5. ***Data Processing:***

- The Arduino processes data from all the sensors.

- It checks for predefined thresholds to determine the status of gas levels, occupancy, and water quality.

- Based on the analysis, the Arduino can take actions, update the database, and relay information to the public display or a web application.

6. ***Communication:***

- The Arduino communicates with the public display through a communication module, typically using WIFI or other networking protocols.

- Data is sent to the display, which is responsible for showing real-time information to the public.

7. ***Conclusion:***

The IoT device, with its components and sensors, plays a critical role in maintaining the cleanliness, availability, and water quality in public restrooms. Through continuous monitoring and data analysis, it helps create a smarter and more user-friendly public restroom experience.

❖ ***DEVELOPMENT – 2:***

IoT Project Documentation: Creating an Interactive Website and Application for Smart Public Restroom IoT Device

1. ***Introduction:***

This documentation outlines the process of creating an interactive website and a mobile application for a Smart Public Restroom IoT project. These platforms will be connected to Firebase Cloud to receive real-time sensor data and display it to users.

2. ***Website Development:***

2.1 **HTML Structure:**

- Create the basic structure of the HTML file, including the `<!DOCTYPE>` declaration, `<html>`, `<head>`, and `<body>` tags.
- Add meta tags for character encoding and viewport settings.
- Include links to external CSS and JavaScript files.

2.2 **CSS Styling:**

- Use CSS to style the website, including fonts, colors, and layout.
- Create an attractive and user-friendly design.
- Apply responsive design to ensure compatibility with various devices and screen sizes.

2.3 **JavaScript Functionality:**

- Use JavaScript to connect to Firebase Cloud.
- Implement Firebase configuration to establish a connection with the database.
- Create functions to fetch real-time sensor data from Firebase.
- Update website elements with the received data.

2.4 **Real-Time Data Display:**

- Design sections for displaying real-time data from the IoT device.
- Use JavaScript to dynamically update content based on the sensor readings (e.g., occupancy status, hygiene, water quality).
- Add interactive features, such as buttons for detailed information and user feedback.

3. ***Application Development (MIT App Inventor):***

3.1 **User Interface Design:**

- Create the app's user interface using MIT App Inventor's drag-and-drop interface.
- Design screens for occupancy, hygiene, and water quality monitoring.
- Add buttons and labels for real-time data display.

3.2 **Firebase Integration:**

- Configure Firebase integration within MIT App Inventor.
- Provide Firebase API keys and connect the app to the Firebase project.

3.3 **Real-Time Data Fetching:**

- Use blocks in MIT App Inventor to fetch real-time sensor data from Firebase.

- Update button colors and label text based on the occupancy, hygiene, and water quality status.

3.4 **User Interaction:**

- Implement additional features, such as user notifications in case of poor hygiene or low water quality.
- Include a feedback mechanism for users to report issues.

4. ***Firebase Cloud Integration:***

- Configure Firebase for your project, creating a Realtime Database to store sensor data.
- Set up security rules to control data access.
- Generate API keys and ensure they are correctly integrated with the website and application.

5. ***Testing and Debugging:***

- Test the website and application on various devices and browsers.
- Check for real-time data updates and user interactions.
- Debug any issues in the functionality, design, or data fetching.

6. ***Deployment:***

- Publish the website on a web server or hosting platform.
- Distribute the mobile application through app stores or other distribution channels.

7. ***Conclusion:***

The website and mobile application provide a user-friendly interface for accessing real-time sensor data from the Smart Public Restroom IoT device. By connecting to Firebase Cloud, both platforms deliver up-to-date information to users, enhancing their restroom experience and promoting hygiene and convenience.