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Internship Project Report

On

"Smart Waste Management System"

Submitted in partial fulfillment of the requirement for the award of

BACHELOR OF ENGINEERING

In

INFORMATION SCIENCE & ENGINEERING
COMPUTER SCIENCE & ENGINEERING

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2024-2025

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CHAPTER 1

ABSTRACT

The Smart Waste Management System is an innovative solution leveraging Artificial Intelligence of Things (AIoT) to address challenges in urban waste collection and monitoring. This system integrates IoT devices, such as ultrasonic sensors and Raspberry Pi, with AI-driven analytics to provide real-time tracking, predictive maintenance, and optimized waste collection schedules. By automating waste management processes, it mitigates risks of overflowing bins, reduces operational costs, and ensures better hygiene in public spaces. Future enhancements include integrating waste segregation systems, expanding AI capabilities for predictive analysis, and supporting autonomous waste collection vehicles.

CHAPTER 2

INTRODUCTION

2.1 Objective:

The smart waste management system tracks garbage levels in bins using IoT sensors and predicts waste collection schedules with AI analytics. It provides real-time alerts to authorities via a web-based interface, ensuring timely waste disposal. This enhances efficiency, reduces costs, and promotes cleanliness.

2.2 Problem statement:

- Overflowing garbage bins in urban areas create hygiene challenges.
- Bad odors and potential disease outbreaks result from improper waste management.
- Manual inspection of bins is time-consuming and inefficient.
- A smart, automated solution can effectively address these issues.

CHAPTER 3

APPLICATION

1. **Healthcare Facilities:**
   Monitor hazardous medical waste bins in hospitals and clinics to prevent overflow, ensuring compliance with biohazard disposal standards.
2. **Educational Institutions:**
   Automate waste management in schools and colleges by monitoring bin levels and optimizing collection schedules across campuses.
3. **Public Parks and Recreational Areas:**
   Ensure timely waste disposal in outdoor spaces to maintain cleanliness and enhance visitor experience.
4. **Shopping Malls and Commercial Centers:**
   Manage multiple waste bins across food courts, stores, and public areas to handle large volumes of waste efficiently.
5. **Event Management:**
   Use temporary smart waste bins during large events or festivals to maintain hygiene and avoid overflows in high-traffic areas.
6. **Ports and Airports:**
   Monitor and manage waste from passengers and cargo areas to streamline operations and maintain environmental standards.
7. **Smart Agriculture:**
   Extend functionality by integrating with irrigation systems, managing agricultural waste, and monitoring compost bins for efficient resource use.
8. **Transportation Hubs:**
   Install smart waste bins in bus stops, train stations, and metro platforms to ensure cleanliness and reduce manual labor.

CHAPTER 4

COMPONENTS

1. Raspberry Pi 3 Model B:

The Raspberry Pi 3 Model B is the central processing unit (CPU) of the Smart Waste Management System. It acts as a bridge between the sensors and the web application. This single-board computer has sufficient processing power to handle real-time data collection from sensors, process that data, and transmit it to a cloud platform or web interface. The Raspberry Pi 3 Model B is also equipped with built-in Wi-Fi, which allows seamless communication and data transfer between various components in the system, ensuring that monitoring and alerting can happen in real-time. It enables both local and cloud-based processing, providing flexibility and scalability for future enhancements.

2. Ultrasonic Sensor:

The ultrasonic sensor plays a key role in determining the fill level of the waste bins. By emitting high-frequency sound waves and measuring the time it takes for the waves to return after hitting the waste, the sensor calculates the distance to the surface of the waste. This measurement is then used to estimate the amount of waste in the bin. When the sensor detects that the fill level has surpassed a predefined threshold, it triggers an alert, notifying authorities of the need for collection. Ultrasonic sensors are widely used for such distance measurements due to their accuracy and reliability in diverse environments.

3. Buzzer:

A buzzer is an electromechanical device used to generate sound. In the Smart Waste Management System, the buzzer is activated when the ultrasonic sensor detects that the garbage bin is nearing full capacity. It emits an audible sound, alerting nearby personnel to take action. There are two main types: **active buzzers** (which generate sound on their own when powered) and **passive buzzers** (which require an external signal to produce sound). In this project, the buzzer provides immediate local feedback to ensure quick action in waste collection.

4. Soil Moisture Sensor:

The soil moisture sensor detects the moisture level in soil, helping to automate irrigation systems. It consists of two probes that are inserted into the soil, measuring the electrical resistance between them. The higher the moisture content, the lower the resistance; lower moisture increases the resistance. When the moisture level falls below a set threshold, the sensor sends a signal to trigger irrigation (e.g., activating a stepper motor). This ensures efficient water usage, preventing overwatering and saving resources.

5. Stepper Motor:

A stepper motor is a type of motor that divides a full rotation into several precise steps, offering more control than standard DC motors. In this system, the stepper motor is used to control the irrigation valve. It allows the valve to open or close in discrete steps, ensuring accurate control over the irrigation process. This precise movement is ideal for situations where small and specific changes (such as watering at certain intervals) are required. The motor's movement is controlled by electrical pulses sent from the Raspberry Pi.

6. **Flask Framework:**

   Flask is a lightweight web framework for Python that is used to build the web-based interface for the Smart Waste Management System. Flask provides the necessary routes and views to allow users to monitor the status of the garbage bins in real-time via a web dashboard. The framework is particularly useful in handling HTTP requests from users, displaying data from the Raspberry Pi, and sending notifications if the bin reaches the threshold level. The Flask application can be accessed remotely, allowing authorized personnel to manage waste collection schedules and monitor system status from anywhere. Its simplicity and flexibility make it an ideal choice for creating web applications in this project.

CHAPTER 5

FLOW CHART

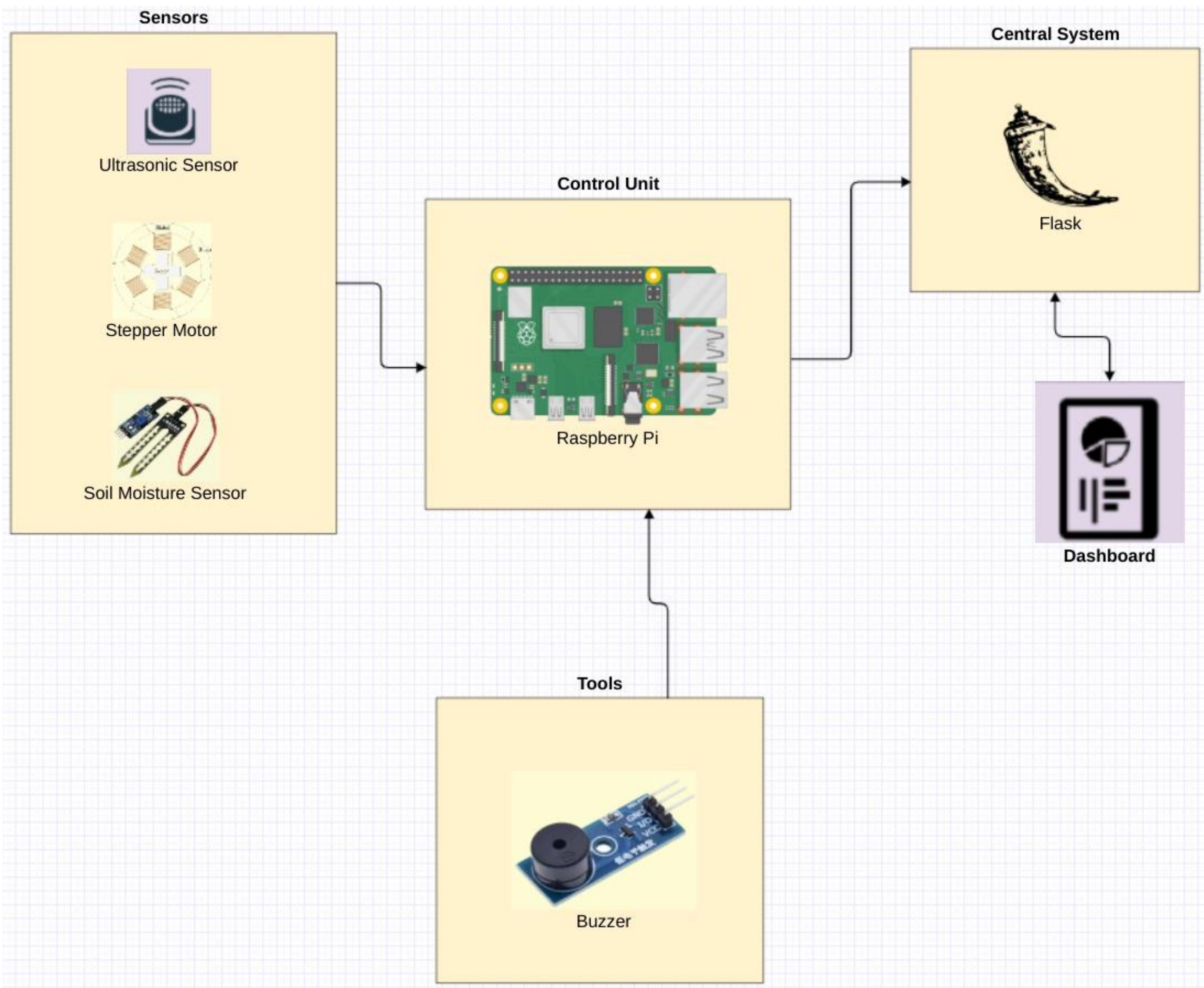

Figure 5.1

The figure 5.1 flowchart represents a system architecture for a project involving sensors, a Raspberry Pi as the control unit, and a central system for data processing and visualization.

1. **Sensors:**
    - Ultrasonic Sensor: Measures distance or detects obstacles using ultrasonic waves.
    - Servo Motor: Performs controlled angular motion, often used for opening/closing mechanisms or precise rotations.
    - Stepper Motor: Executes precise rotational movements, suitable for tasks like automated irrigation or positioning.
    - Soil Moisture Sensor: Monitors soil moisture levels, which can inform decisions about irrigation or water management.
2. **Tools:**

    Buzzer: Provides audible alerts, such as warnings or notifications when thresholds (like low soil moisture) are crossed.
3. **Control Unit:**

    Raspberry Pi: Acts as the central processing hub, interfacing with sensors, processing the collected data, and sending commands to the actuators. It runs the logic to determine actions based on sensor inputs.
4. **Central System:**
    - Flask Framework: A web framework for building a lightweight backend that connects the Raspberry Pi to a database and dashboard.
    - Dashboard: A user interface for visualizing the data and controlling the system. This allows users to monitor real-time data and configure settings remotely.

CHAPTER 6

CONCLUSION

The AIoT-based Smart Waste Management System represents a transformative approach to handling urban waste challenges. By integrating real-time IoT monitoring with AI-driven analytics, this system ensures timely action, reduces waste overflow, and promotes cleaner cities. The modular design supports scalability and adaptability for future technological advancements, such as waste segregation and autonomous waste collection.

CHAPTER 7

FUTURE SCOPE

- **Waste Segregation and Categorization:**
  Integrating AI-driven vision systems to classify waste types (recyclable, organic, non-recyclable) directly at the bin level, reducing the need for manual sorting and improving recycling efficiency.
- **Autonomous Waste Collection Vehicles:**
  Extending the system to include robotic vehicles that use bin data to navigate autonomously, collect waste, and optimize routes based on real-time bin status updates.
- **Predictive Waste Management:**
  Leveraging machine learning models to predict waste accumulation patterns, enabling authorities to plan collection schedules proactively and prevent overflows.
- **Scalability for Large Networks:**
  Expanding the current system to manage hundreds of bins in a smart city infrastructure, with a centralized dashboard for unified monitoring and decision-making.
- **Integration with Mobile Apps:**
  Developing mobile applications for real-time tracking of bin statuses, allowing citizens to report overflowing bins and track waste collection schedules.
- **Solar-Powered Bins:**
  Adding solar panels to power the sensors and Raspberry Pi, making the system more sustainable and reducing operational costs.
- **Public Awareness Features:**
  Displaying real-time bin statuses and waste management statistics on public dashboards to promote awareness and encourage citizen participation.
- **Advanced Multisensor Integration:**
  Incorporating additional sensors (e.g., gas sensors for detecting harmful gases) to enhance the monitoring capabilities of the bins and ensure environmental safety.

CHAPTER 8

APPENDIX

8.1 Pseudo Code:

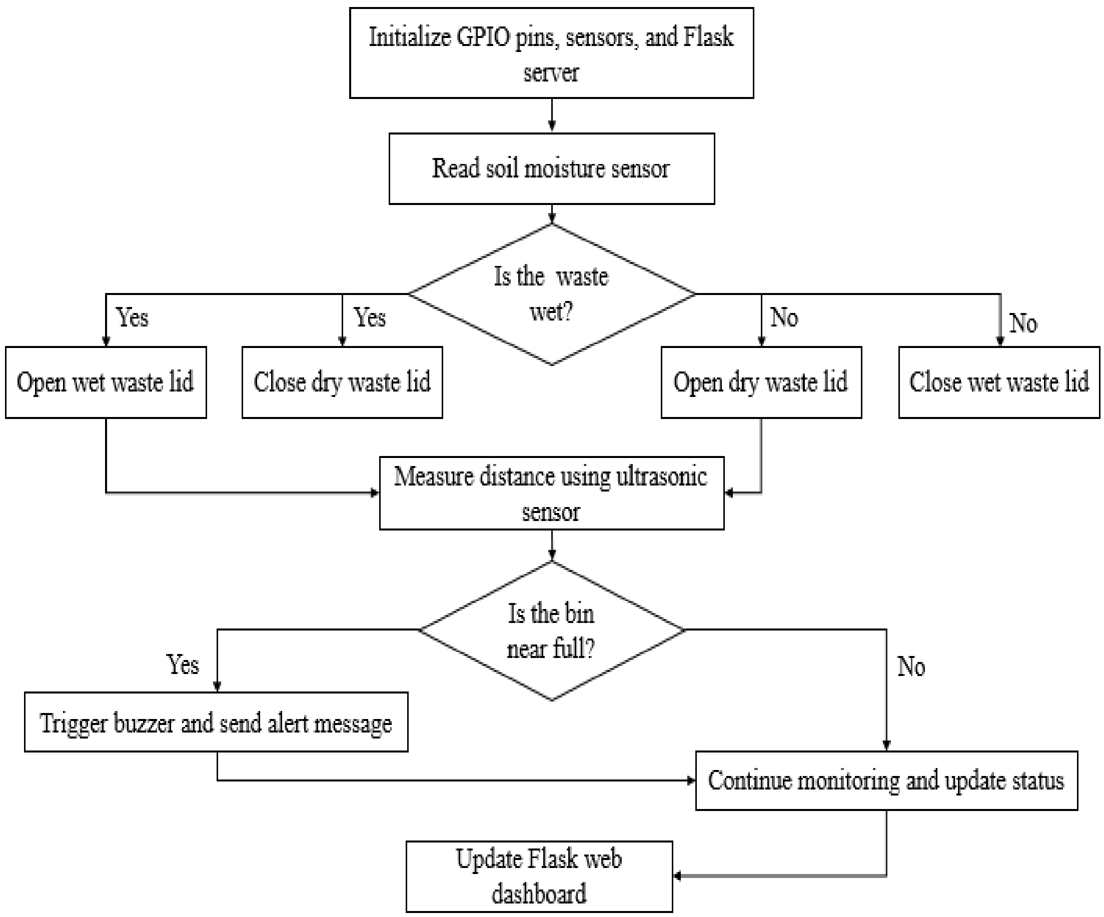

Figure 8.1 Pseudo Code

➢ **Steps and Description:**

1. **Initialization**:

   - The system initializes GPIO pins, sensors, and the Flask server for monitoring and interaction.

2. **Soil Moisture Sensor Reading**:
   - The sensor checks if the waste is wet or dry by analyzing the moisture level.
   - If the waste is **wet**, the wet waste lid is opened, and the dry waste lid is closed.
   - If the waste is **dry**, the dry waste lid is opened, and the wet waste lid is closed.
3. **Ultrasonic Sensor for Bin Monitoring**:
   - Measures the distance between the bin's top and the waste level to determine how full the bin is.
4. **Waste Level Decision**:
   - If the bin is **near full**, the system triggers a buzzer and sends an alert message to notify the user or operator.
   - If the bin is **not near full**, the system continues monitoring and updates the status on the Flask web dashboard.
5. **Flask Web Dashboard**:
   - Displays real-time updates about the bin's status (e.g., wet/dry waste, fill level, and alerts).

➢ **Purpose and Functionality:**

- The system ensures proper segregation of wet and dry waste based on moisture levels.
- It continuously monitors waste levels and sends alerts when the bin is nearly full.
- The web interface enhances user accessibility and tracking.

8.2 APPENDIX-A

AIoT	Artificial Intelligence of Things
IoT	Internet of Things
LED	Light Emitting Diode
CPU	Central Processing Unit
RAM	Random Access Memory
DC	Direct Current
Wi-Fi	Wireless Fidelity
JSON	JavaScript Object Notation
GPIO	General-Purpose Input/Output

8.3 APPENDIX-B: Key Code Functions

1. **measure_distance()**
   - Uses the ultrasonic sensor to calculate the distance to the garbage in the bin.
   - Triggers alerts if the distance indicates a near-full bin.
2. **control_irrigation()**
   - Reads soil moisture levels and operates the stepper motor to control the irrigation valve.
3. **Flask Routes:**
   - /get_data: Returns sensor data (bin distance, moisture level, and alerts) in JSON format.
   - /index: Renders the main dashboard for bin monitoring.