CHAPTER FOUR

DESIGN, IMPLEMENTATION AND DOCUMENTATION OF THE SYSTEM

4.1 DESIGN OF THE SYSTEM

This is the computation of the particulars of a new system and the determination of what the new system would be and the function it is to perform. This may involve changing from one system to another or modifying the existing system operation.

The most challenging phase of the system life cycle is the change from manual operation to a faster and more accurate one; system design stage covers the technical specifications that will be employed in the implementation of the new system in order to modify the previous system. Some factors are put in consideration. These factors include input design, output design, definitions file and procedure designs and other documentation.

4.1.1 OUTPUT DESIGN

The output design for the smart waste bin system encompasses various visual, auditory, and remote communication methods to relay information effectively to users and administrators. It includes LED indicators for visual cues on system status, an LCD display for real-time feedback on fill levels, and a buzzer or speaker for audible alerts. Additionally, remote output options such as mobile apps and web interfaces enable users to monitor the system remotely and receive notifications on bin status. Notification systems, including SMS alerts and email notifications, further enhance communication by providing timely updates on critical events. Combined, these output mechanisms ensure efficient operation and user awareness, contributing to effective waste management. Things taken into consideration in determining the output are represented below:

Figure 4.1: Trash can A trash can, also known as a garbage can, waste bin, or rubbish bin, is a container used to hold refuse until it is collected and disposed of.

Figure 4.2: Servomotor

A servomotor is a closed-loop servomechanism that uses position feedback (either linear or rotational position) to control its motion and final position.

Figure 4.3: Arduino Uno

The Arduino Uno is a popular microcontroller board based on the ATmega328P microcontroller. It is widely used for a variety of projects and applications due to its ease of use, versatility, and extensive community support.

4.1.2**INPUT DESIGN**

The input design for the smart waste bin system includes various methods to enable user interaction and data entry. It incorporates proximity sensors to automatically detect when users approach, triggering the lid to open. Physical buttons or touch-sensitive panels allow for manual control of the system, such as opening the lid or switching modes. Additionally, ultrasonic and weight sensors monitor the fill level of the bin. Remote input options, such as a mobile app and web interface, provide users with the ability to monitor and control the system from their devices. Advanced input methods like voice and gesture recognition can further enhance user interaction, ensuring a versatile and user-friendly experience.

Figure 4.4: smart waste bin

A smart waste bin is an advanced trash receptacle equipped with various technologies to enhance waste management efficiency and user convenience. These bins typically incorporate sensors, connectivity features, and automation to provide a more sustainable and intelligent waste disposal solution.

4.1.3PROCEDURE DESIGN

These are the steps involved in unifying the whole process to produce the desired output. It involves computer procedures which start from the original input lessons to the output result file. This allows the processing of User information and result to be possible. Menu is provided to aid User in the processing of the output file.

4.2IMPLEMENTATION OF THE SYSTEM

To implement a smart waste bin system, we will integrate an Arduino Uno microcontroller with ultrasonic sensors to monitor fill levels and motion sensors to detect proximity for automatic lid opening. A servo motor will be used to actuate the lid. The system will include wireless connectivity for remote monitoring and alerts, enhancing waste management efficiency and user convenience through real-time data and automated operations.

4.2.1CHOICE OF PROGRAMMING LANGUAGE

The choice of programming language for implementing a smart waste bin system with an Arduino Uno is C/C++ due to its compatibility with the Arduino IDE, efficient performance for real-time hardware control, and extensive community support for troubleshooting and resources.

4.2.2HARDWARE REQUIREMENT

The hardware requirements for implementing a smart waste bin system are as follows:

i. **Microcontroller**:
   - Arduino Uno: Central unit for controlling sensors and actuators.

ii. **Sensors**:
   - Ultrasonic Sensors: For detecting the fill level of the bin.
   - Motion Sensors: For detecting user proximity to automatically open the lid.

iii. **Actuators**:
   - Servo Motor: For actuating the lid mechanism.

iv. **Power Supply**:
   - 9V Battery or DC Power Adapter: To power the Arduino and connected components.

v. **Connectivity**:
   - Wi-Fi Module (e.g., ESP8266 or ESP32): For wireless communication and remote monitoring.

vi. **Additional Components**:
   - Breadboard and Jumper Wires: For prototyping and connections.
   - Resistors and Capacitors: For circuit stability and sensor interfacing.
   - Enclosure: To house the components securely within the waste bin.

This hardware setup will enable the smart waste bin to detect fill levels, open the lid automatically, and provide remote monitoring capabilities.

4.2.3**SOFTWARE REQUIREMENT**

The software requirements for implementing a smart waste bin system with an Arduino Uno include using the Arduino IDE as the development environment, programming the microcontroller in C/C++, and incorporating necessary libraries such as Servo Library for controlling the lid actuator, NewPing Library for ultrasonic sensor management, and WiFi Library (e.g., ESP8266WiFi) for wireless connectivity if remote monitoring is desired. Additional tools like the Serial Monitor for debugging and network configuration interfaces may be necessary. Optional components include an IoT platform for remote data logging and notifications, along with a mobile app for user interaction and alerts.

4.3DOCUMENTATION OF THE SYSTEM

4.3.1**PROGRAM DOCUMENTATION**

The program documentation for the smart waste bin system provides a comprehensive guide to understanding, configuring, and utilizing the software developed for the Arduino Uno. It includes setup instructions for the development environment, details on hardware configuration, an overview of the software structure, explanations of functionality, definitions of configuration parameters, usage instructions, and troubleshooting guidance. This documentation serves as a valuable resource for developers and users, ensuring smooth implementation, operation, and maintenance of the smart waste bin system.

4.3.2**MAINTAINING OF THE SYSTEM**

Maintaining the smart waste bin system involves regular checks, updates, and occasional troubleshooting to ensure its continued functionality and efficiency. This entails inspecting

hardware components for wear or damage, updating software to the latest versions, monitoring sensor data for irregularities, and conducting scheduled calibrations and battery replacements as needed. Troubleshooting efforts include diagnostic checks, component replacements, and meticulous documentation of maintenance activities to facilitate seamless operation and timely interventions.