DEVELOPMENT OF A SMART, WASTE MANAGEMENT SYSTEM FOR MOUNTAIN TOP UNIVERSITY

By

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A PROJECT SUBMITTED TO THE DEPARTMENT OF COMPUTER SCIENCE AND MATHEMATICS, COLLEGE OF BASIC AND APPLIED SCIENCES,
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DECLARATION

I hereby declare that this project has been written by me and is a record of my own research work. It has not been presented in any previous application for a higher degree of this or any other University. All citations and sources of information are clearly acknowledged by means of reference.

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EZEBUIKE, CHIDIEBERE SAMUEL

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Date

CERTIFICATION

This is to certify that the content of this project entitled '**Development of A Smart, Waste Management System For Mountain Top University'** was prepared and submitted by **EZEBUIKE CHIDIEBERE SAMUEL** in partial fulfilment of the requirements for the degree of **BACHELOR OF SCIENCE IN COMPUTER SCIENCE.** The original research work was carried out by him under by supervision and is hereby accepted.

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Coordinator, Department of Computer Science and Mathematics

DEDICATION

I dedicate this project to God Almighty, for all he has been doing in my life and my family including my health and academics. I also dedicate this work to my father, Mr Ezebuike and my mother, Mrs. Ezebuike for being my main source of motivation and support.

ACKNOWLEDGEMENT

My sincere gratitude goes to the God who created all things and manifests himself in diverse ways than we can comprehend for his mercy, loving kindness and presence in the times I was in need.

I also appreciate the entire staff and management of Mountain Top University for the immeasurable impact they have had on my life academically and spiritually, they have made special contributions to the success of my academic pursuit.

ABSTRACT

In recent years, there has been a constant need to automate simple everyday operations and activities for improvement, efficiency, and advancement. One of the activities is waste management which is a very crucial everyday operation to avoid pollution and ensure efficient means of disposal. This study aims to develop a smart waste management system to identify and prepare user, system software, and hardware requirements, identify the waste management system protocols and procedures, system design specification, testing, and implementation of the software.This project covers all fields related to waste management, automation, software, and hardware development as well as wired and wireless sensor networks. This project provides solutions and automation to the traditional waste disposal methods as well as detection sensors. The main purpose is to develop a smart waste bin system that accepts data generated from it and transmits information using Wi-Fi and sensor devices through email. And also, to detect if the bin is full notify the necessary recipients and also detects the type of waste material in the bin. This project involves the use of Arduino Integrated development environment as well as hardware. All these operations are displayed on a web interface for user interaction which can be integrated on a mobile phone.Limitations include storage space capacity, user training on software use, short-range detection signal, and also cost of resources and time constraints. Future recommendations include mobile and web-based applications as well as an increase of storage capacity and more task automation to improve efficiency.

Keywords: GIS - Geographic Information System, GPRS – General Packet Radio Service, IoT – Internet of things, GPS – Global Positioning System, GSM – Global System for Mobile Comm

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Figure Page

CHAPTER ONE

INTRODUCTION

1.1 Background of the study

To put it simply, "solid trash" refers to the unwanted and unusable things that are thrown away as a result of human activity. Following the Resource Conservation and Recovery Act, "solid waste" refers to any solid, semisolid liquid, or enclosed gaseous item that is disposed of in the course of any business or industrial activity, commercial enterprise, mining operation, or agricultural operation. Everyday human activities generate waste, which must be properly managed to protect human health and the environment while also enhancing aesthetics. This is especially true in metropolitan areas, where massive volumes of solid garbage are produced.

Every country has had to deal with the issue of waste management at some point or another. It is not enough to just collect rubbish. Disposal and monitoring of waste products are part of waste management's responsibilities. The problem is getting worse as the global population and the volume of garbage created increase. Modernization and industrialization also contribute to the problem since they carry with them an additional load of increasing rubbish. A rise in trash production has made garbage disposal more challenging.

Any place where people live is going to have some garbage. Waste management is a prerequisite for ecologically sound growth in many nations. A key problem in today's society is waste management and/or removal. Cities and big municipalities are particularly vulnerable to the negative effects of poor solid waste management. In a broad variety of settings, it is necessary to control waste.

A frequent technique of disposing of solid trash is to utilize waste bins. Waste materials from both the workplace and the home are collected in a single bin. The duty of inspecting rubbish bins to see if they have been emptied is arduous. Waste management employees must collect garbage from all of the various waste containers as part of a standard collection process. Garbage management workers must show up in person at all waste pickup locations even if they don't know what's going on with the bins. If there is no garbage to collect, or if the container is overflowing, there are two possibilities: This is a time-consuming and challenging process. Residents are calling for more efficient garbage collection and disposal due to rising disposal prices and increasing visibility of waste collection activities. This necessitates the need for adequate waste management. Keeping the surrounding environment clean is as simple as regularly emptying the rubbish bin.

Debris reduction recycling and re-use are the most important objectives in the field of waste management. The most popular ways of garbage disposal, particularly in rural regions, are dumping on the ground, burying waste underground, burning combustible waste, and disposing of waste in flowing water or drainage. The sight of indiscriminate dump sites along highways, on street corners, in the market, and even in front of people's houses aren't unusual in the Philippines. Uncontrolled dumpsites can cause air pollution, a rise in the trash, and a possible increase of pesticide-resistant bacteria and their related illnesses. These garbage dumps occupy an important land area. These approaches represent a serious problem for society because of rising concerns about environmental pollution, poisoning of groundwater resources, obstruction of drainage systems, public health and safety, and shortage of land.

It takes a significant number of garbage bins and a variety of emptying schedules, from sporadic (a few times per week) to extremely frequent (daily, weekly, or seasonal), to effectively handle urban and suburban waste (several times a day). There is a wide range of other waste categories

(such as organic/inorganic and radioactive waste) that have varying gas emissions that must be tracked.

One of the most critical challenges of our day is the necessity to find a solution to the problem of waste management. A well-functioning waste management system is crucial to a hygienic society and a better world. These wastes must be managed methodically, monitored, and controlled to protect human health and the environment from the possible dangers of delayed waste disposal and environmental contamination. The most cost-effective and efficient strategy to manage trash is to reduce it. In impoverished countries, where solid waste is generated regularly, this is a major concern. This research proposes a method for the intelligent management of garbage.

The Litter-Bin system allows cleaning staff to keep tabs on in-house rubbish bins in real-time, as shown in this research. Overall productivity and cleanliness may be improved as a result of using this technique.

1.2 Statement of the Problem

Litter bins are routinely cleaned out by cleaning crews. There are various drawbacks to this method, including Some litter bins filling up far faster than they are emptied, and they are full before the next planned collection day. Garbage cans overflow due to this, putting people's health at risk. Additionally, certain garbage containers fill up quickly, necessitating longer intervals between collections (for example, during holidays, workplace activities, and busy seasons). Trash cans with a foul odor are also a health danger since they contain harmful gases. Solid waste has been the subject of much research.

1.3 Aim and Objectives

Developing smart-bin management and monitoring prototype is the study's primary goal. It has been decided to pursue the following specific goals:

a. Waste monitoring systems are reviewed and researched in this paper.
b. Organize and compile a list of the necessary hardware and software components for an intelligent trash can.
c. Determine the needs of the smart bin system's users.
d. Define the hardware and software architecture of the system.
e. Prototype a system for detecting waste levels and alerting workers.
f. Build, test, and implement the system.

1.4 Methodology of Study

The following methods will be used to accomplish the stated goals:

a. Research the needs of both users and administrators.
b. A system's functional and non-functional needs must be identified and evaluated.
c. Tools for system description, such as use case, sequential, and flow diagrams, include design specifications, UML tools, and prototypes.
d. Users can request a bin and sign up with an account using our website.
e. Implementation in Hardware
f. Acceptance and integration testing of the system

Data from the esp8266 Wi-Fi module is delivered to permitted email addresses at waste disposal and management facilities, using an ultrasonic range sensor to determine the quantity of trash accumulated in garbage containers. An email will be sent to authorized members at

waste management facilities through the Wi-Fi module, displaying the fill levels of each garbage bin in real-time on the screen. The microcontroller can access certain information. Second, the trashcan's ultrasonic sensor only picks up garbage that is tossed around the bin, not inside it. A sensor that measures distance is then utilized to detect the fullness of the dustbin by making the buzzer sound until the rubbish is deposited. A microcontroller board will manage a Wi-Fi module to send an email alert, which includes a bin status message, to a preset email address.

The position of the newly placed bin is sent through email to the closest trash disposal worker who needs to know about it. The system will go back to its normal state. A blinking LED indicates that the bin is full after the microcontroller has detected this.

1.5 Scope and Limitation of the Study

Using automated trash bin monitoring systems, this study hopes to increase environmental stewardship, waste management, and environmental responsiveness. In this study, we'll look at both individual and commercial users. Users will be able to monitor the condition of the bin and alert the appropriate parties when maintenance is required as this prototype develops. The current garbage situation has been taken into consideration while designing the waste management model, which has been optimized to give a cost-effective rubbish solution.

1.6 Significance of the Study

Some of the problems associated with waste management and tracking are addressed in this study. By cutting costs and resources, enhancing operating efficiency, and minimizing emissions from the roadside, the research contributes to an improved working environment. The Smart Bin may be used on campuses, amusement parks, airports, train stations, and retail

malls. For the sake of everyone's health and safety, everyone in the workplace and at home must do their daily share of cleaning. Cover garbage cans to keep pests and insects out. Leaks and smells can be minimized with container liners designed for the purpose. A minor compaction technique can boost the bin's capacity. Because the research will contribute to current understanding and enhance past studies on the subject, academics will benefit from it as well. This will provide a level playing field for future study into the use of waste bin monitoring systems.

1.7 Definition of terms

GIS - Geographic Information System

Computer systems that analyze and display spatially related data are known as Geographic Information Systems (GIS). It relies on data that is linked to a certain place.

GPRS – General Packet Radio Service

On the 2G and 3G worldwide systems for mobile communications, General Packet Radio Service (GPRS) provides a packet-oriented mobile data standard for data transmission.

IoT – Internet of things

The term "Internet of things" refers to a network of interconnected devices and systems that may share data through the Internet or other communication networks, such as sensors, processing power, software, and the like.

GPS – Global Positioning System

The United States government owns and operates the Global Positioning System (GPS), formerly known as Navstar GPS, a satellite-based radio navigation system.

GSM – Global System for Mobile Communications

An international standard established by the European Telecommunications Standards Institute describes protocols for second-generation digital cellular networks used by mobile devices such as smartphones and tablets. This standard is called the Global System for Mobile Communications.

WSN – Wireless Sensor Network

A wireless sensor network is a network of sensors that are distributed across a large area and that gather and transmit data to a central point.

CHAPTER TWO

LITERATURE REVIEW

2.1 History of Waste management

Garbage management is defined as the activities and actions required to manage waste from its inception to its final disposal. This includes garbage collection, transportation, treatment, and disposal, in addition to monitoring and controlling the waste management process. stated by (Amasuomo & Baird, 2016). The majority of human actions generate waste (Brunner & Rechberger, 2014). As it has been since prehistoric times, waste generation is still a major concern. (A.J. Chandler et al., 1997). Garbage production rates and volumes have increased in recent years. Increasing waste volume and increasing waste diversity are two side effects of increasing waste volume. (Vergara & Tchobanoglousl, 2012) There was a time when trash was an inconvenience that had to be removed, but not anymore. Because the population was so small and there were plenty of lands available, proper management was not a major concern. That is when the term "Waste Management" was first coined. Collection, transportation, sorting, and treatment are among their duties. To improve waste management efficiency, smart waste management relies on technology. Waste collectors who empty the bins can plan more efficient routes as a result. Smart sensors are used to measure the level of garbage. Containers provide data to a data management system about garbage levels or the last collection. Only a small number of bins are designated for waste disposal. Containers are only collected when they are full or overdue.

2.2 Classification and Types of Waste

Wastes come in a variety of shapes and sizes, and their characteristics can be expressed in a variety of ways. Waste is classified based on its physical state, physical properties, reusable potential,

biodegradable potential, source of production, and environmental impact, among other factors. (Dixon & Jones:, 2005) stated that waste can be liquid, solid, and gaseous waste are three main types. Different classifications exist in countries, although it is obvious. According to (Amasuomo & Baird, 2016) The most commonly used classifications are illustrated below.

a. Physical state
b. Solid waste
c. Liquid waste
d. Gaseous waste

Source of waste

a. Household/Domestic waste
b. Industrial waste
c. Agricultural waste
d. Commercial waste
e. Demolition and construction waste
f. Mining waste

Environmental impact

a. Hazardous waste
b. Non-hazardous waste

2.3 IoT-based smart waste management systems

A. Reduce food waste with an IoT-enabled Smart Garbage System (SGS). Using wireless mesh networks, battery-powered smart garbage bins (SGBs) exchange information, which is then collected and analyzed by a router and server. explained by (S. Vishnue et

al., 2021). A large amount of data may be collected and transmitted over the Internet as a result of this. Smart waste management solutions powered by the Internet of Things (IoT) are designed to increase the efficiency of waste collection and recycling as a whole. Most IoT use cases in waste management involve optimizing dumpster-emptying routes to reduce fuel consumption. According to (Hong et al., 2014) Traditionally, the waste-management process begins with the generation of waste materials.

B. To monitor household and public trash bins, a hybrid network architecture has been developed.
C. To extend the lifespan of the end nodes, a solar energy harvesting facility was installed.
D. As part of the design, a wifi module is integrated into the trash bins, and a smart GUI is used to display the status of each trash bin.

They are thrown away as soon as they are made by city residents. Municipal department trucks collect and transport garbage to recycling centers on a predetermined schedule. Municipalities and corporations have a difficult time keeping track of when to clean outdoor bins or whether they are full. Several pressing issues face our society today, including prevention, tracking, and treatment. Manual waste bin inspection is labor-intensive, expensive, time-consuming, and inefficient. Today's technology can eliminate this process. Smart city applications rely heavily on the monitoring and management of city processes in real-time. Smart city applications face many challenges, including solid waste disposal, which harms society's health and the environment. Most solid wastes are considered useless by humans and animals.

2.4 Advantages of smart waste management systems

a. Time and money are saved by using smart waste collection bins and systems with fill level sensors. Automated trucks will only visit containers and bins that are full. A

reduction of up to 30 percent in costs associated with infrastructure, operations, and maintenance can be achieved through the use of this technology.

b. Optimizing waste management makes a city "smart".
c. By using advertising on smart devices, the government can increase revenue.
d. Fewer waste collection vehicles on the road mean less traffic and less noise. The communication between smart dustbins and service operators makes this possible.
e. It promotes a healthy environment and makes cities more attractive by keeping our surroundings clean, green, and free of waste odors

Limitations or disadvantages of Smart Waste Management

Following are the drawbacks or disadvantages of Smart Waste Management:

a. The city's population dictates the number of waste bins required for separate waste collection. It has a high initial cost because smart dustbins are more expensive than other methods.
b. The memory capacity of the sensor nodes in the dustbins is limited.
c. ZIGBEE and WIFI, the wireless technologies used in the system, have a shorter range and slower data rates. Metal objects have an impact on RFID tags in RFID-based systems (if any).
d. Unskilled workers lose their jobs as a result of a reduction in manpower requirements.
e. Participants in the smart waste management system must be trained on how to use the system effectively.

2.5 Main Features of Smart Waste Management System

The main characteristics of smart waste management according to. (Minhaz Uddin Sohag; Amit Kumer Podder;, 2020) are listed below:

a. Real-time waste monitoring
b. Predictions for bin fullness
c. Detailed database of bins and stands
d. Interactive bin map including Street view
e. Route planning for waste collection
f. Overview of scheduled and executed routes
g. Database of citizen reports
h. Fire and tilt alarm

Locations that use smart waste management systems

a. Residential Buildings, Streets, Commercial Buildings, College Campuses, Homes, Public Places
b. Hospitals
c. Airports

2.6 Smart Waste Management System Applications

Application includes:

a. Automatic open-close lid for ease of use and to avoid physical contact, so no germs transmission to collect dustbins placed at public places in the city. Warning message sent to garbage collector when full.
b. It has an automatic lid that opens and closes, making it easy to use.
c. This message appears when a Smart Trash Bin is close to being full. Also, send a text message to the garbage collector in the area.

2.7 The Smart Waste Management System Major Equipment

The main software and hardware requirements in this project are included in this section

2.7.1 Main Development hardware and software features

Simple hardware and software make Arduino a free and open-source electronics platform. For example, Arduino boards can read inputs such as the intensity of the light on a sensor or the pressure of the finger on the button to produce outputs such as operating a motor or turning on an LED, as well as publish information on the internet. explained by (Arduino, 2021).

It has been designed for artists, designers, hobbyists, and hackers, as well as newbies and anyone who wants to use Arduino hardware and software to create interactive objects or environments Arduino can also communicate with Wi-Fi and GPS devices, cameras, the internet, and even your smartphone and TV set, apart from buttons, LEDs, engines and speakers.

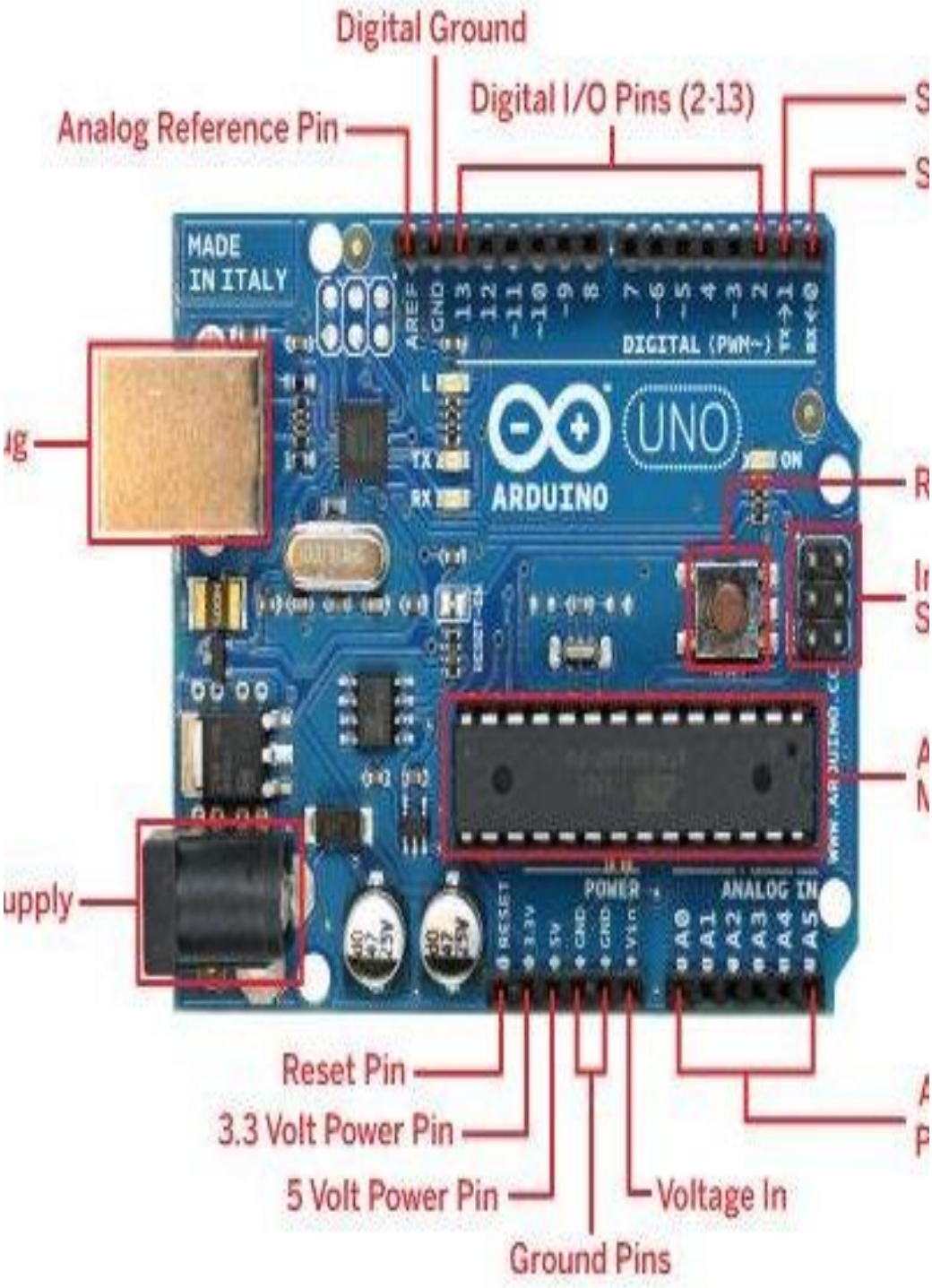

Fig 2.1: Arduino Uno board source (sayan sakar et al., 2017)

Included in the Arduino IDE's features is the ability to create sketches. File. Edit. Sketch. Tools. The compilation, Uploading, and Libraries. Serial Monitor, Third-Party Hardware, Atmel AVR (8-bit), ARM Cortex-M0+ (32-bit), and Intel Quark (x86) CPUs are used in the Arduino Uno SMD R3 board (32-bit).

Wi-Fi module

The ESP8266 Wi-Fi Module is a self-contained SOC with an integrated TCP/IP protocol stack that can provide access to your Wi-Fi network to any microcontroller.

The ESP8266 can host applications or offload all Wi-Fi networking functions from another application processor. The ESP8266 module connects microcontrollers to 2.4 GHz Wi-Fi via IEEE 802.11 bgn. It can be used in conjunction with ESP-AT firmware to provide Wi-Fi connectivity to external host MCUs, or it can be used as a stand-alone MCU by running an RTOS-based SDK. as stated by (Ni Ni san hlaing; Ma naing; san san Naing, 2019) as shown in figure 4.1.

Ultrasonic sensor

According to (Murata., 2021) Objects of any shape, color, or surface texture can be measured with ultrasonic sensors. Objects approaching or receding can also be measured. A visual image of the sensor is shown in figure 4.2.

Led

LEDs directly transform energy into light, which supplies electricity that is a low waste for efficient light production an image is shown in figure 4.5

Buzzer

An audio signals device is a buzzer or beeper that can be mechanical, electromechanical, or piezoelectric (piezo for short). Typical uses for buzzers and beepers include the use of alarms, timers, and user input confirmation such as a mouse button or keystroke.

Breadboard

A small plastic board for holding electronic parts (transistors, resistors, chips, etc) Breadboards can be reused for future jobs to develop electronic circuit prototypes. They are suitable for creating single-style systems.

Jumper Cables

Jumper wire means a leading cable connecting electrically between two circuit points. To modify the system or diagnose problems in a circuit, you can use the jumper wires.

2.9 Review of related works

In the field of smart waste management, the following tasks were completed by distinct researchers: In a research paper proposed by (Sohag & Podder, 2020) for environmental hygiene and sustainable urban life, we proposed a smart IoT-based integrated system composed of an identity system, an automated lid system, a display system, and communication system. As a microcontroller, an Arduino Uno is used to synchronize the four systems. Waste is detected and measured using sensors. As a result of this technology, a liquid crystal display shows how much waste is in the garbage bin at any given time (LCD). As soon as the garbage bin is full, the communication system uses a GSM module to alert the appropriate authority.

In a research paper proposed by (Sarmila, Kumar, & P, 2018) Bins with sensors that detect harmful gases and bin fullness will be available shortly. Using a wireless mesh network, the technology is

designed to collect data and deliver it to users. Using this data, waste bin providers and cleaning contractors can make better decisions.

According to a research project done by (Deshpande & al., 2013) Through the use of this strategy the city's garbage collection is made easier. Air pollution, traffic congestion, manpower, time, and money are reduced. Using appropriate technology, we can direct trucks to the shortest route for garbage collection (GPS & software applications). In their efforts to become smarter and more people-friendly, cities can gain a competitive advantage by implementing this project.

In project research, according to (Kellow Pardini et al., 2020) A new paradigm known as the Internet of Things (IoT) is emerging, and its underlying technologies are causing massive disruptions in global enterprises. Businesses are investing more time and money into modernizing their services to take advantage of IoT's benefits, according to many business owners. Public waste management officials do not want to be outdone, so providing an efficient and real-time waste management system is a challenge. While involving citizens, this study proposes a solution (hardware, software, and communications) for optimizing garbage management. IoT sensors continuously monitor the smart bin for garbage, providing real-time information on each compartment's fill level.

In a research project carried out by (Huh, Choi, & Seo, 2021) Increased manpower could be used to fix the trash disposal system, but the costs of manpower and maintenance would be prohibitive for local governments in financial distress. This paper proposes a smart trash separation bin model based on the Internet of Things (IoT), which can reduce the cost of trash separation work. Three efficient designs are presented, each of which makes use of a sensor, image processing, or spectroscope technology.

According to a project carried out by (Maulana & Widyanto, 2018) With an emphasis on the segregation and garbage collection phases, a waste management system prototype has been built for solid waste in this study. A trash bin equipped with sensors and a communication system for monitoring garbage status and controlling garbage collection schedule makes up the hardware subsystem. The software subsystem, on the other hand, includes a garbage collection schedule and a garbage collection schedule. Data management and data visualization are the other subsystems that are used for management and analysis. As a result, the prototype was built and tested.

In a research project carried out by (G U Fayomi et al., 2021) To address waste management issues such as waste creation, waste collection, transit, waste treatment, and disposal processes it is necessary to conduct regular monitoring. Coevolutionary neural networks and other AI technologies, as well as trash identification, were investigated in the paper.

2.9.1 Summary of related works

The table below includes findings from related publications on smart waste management systems as well as their various author, year, title.

S/N	Author	Year	Title
1	Sohag & Podder	2020	Smart garbage management system for a sustainable urban life: An IoT based application
2	Sarmila, Kumar, & P	2018	Smart Waste Management: Garbage Monitoring Using IoT
3	Deshpande, M.D. Pavan Kumar	2013	Smart waste management system

4	Kellow Pardini	2020	A Smart Waste Management Solution Geared towards Citizens
5	Huh, Jun-Ho; Choi, Jae-Hyeon; Seo, Kyungryong	2021	Smart Trash Bin Model Design and Future for Smart City
6	Maulana, Feisal Ramadhan Widyanto, Theo Adhitya S.	2018	Design and Development of Smart Trash Bin Prototype for Municipal Solid Waste Management
7	G.U. Fayomi	2021	Smart Waste Management for Smart City: Impact on Industrialization

CHAPTER THREE

SYSTEM REQUIREMENT AND METHODOLOGY

3.1 System Development

This chapter explains the procedures for putting the system and hardware together. When developing software or systems, it is critical to design a system. According to this definition, it is a method of determining which software or system components are required to meet all requirements.

3.2 Methodology

It outlines the hardware components, as well as the steps that must be taken to fully implement the system, in this chapter. The ultrasonic sensor senses the waste level in the dustbin and sends a message to the authorities in question as it reaches an alarming level. In certain situations, the level does not be complete, but in that situation, it generates a certain stench, and the dustbin must also be cleaned and identified with a gas sensor and sends a message to the registered mobile number connected to the ARDUINO interface. We use the ultrasound sensor to know the amount of garbage collected from the waste containers and send this data to the authorized email at the waste management center through the ESP8266 Wi-Fi Module.

3.3 Functional requirements

a. The Sensor Node must be able to monitor the state of a garbage bin and relay this information to an external database, based on the following requirements:
b. Create a collection route based on the selected fill level and priority for each bin.
c. With the help of sensors, monitor the performance of each bin and notify authorities.
d. Keep track of the garbage bin sensor data so you can analyze each garbage collection area.

3.4 Non-functional Requirement

To manually intervene and monitor garbage collection from designated Garbage Bins, a user interface is required (if necessary). Routing information is also available to garbage collection truck drivers via their dashboards.

3.5 Software Requirements

These are the software resources needed to complete the project. These resources have to be installed on a computer to complete a project. During the development process, our team used the following software resources.

a. The C++ and C (Dev C++ and VSCode)
b. Arduino IDE
c. HTML 5 and CSS Web Application Building Framework.

3.6 Hardware requirements

Hardware requirements must be met by any operating system or software application. With a hardware requirements list, a hardware compatibility list (HCL) is typically included.

a. Ultrasonic sensor
b. Wi-Fi Module
c. MQ-2 smoke sensor SD-Cards (Class 10,8GB)
d. Jumper wires
e. Buzzer
f. LED.
g. Garbage Container
h. Bread Board

3.6.1 Implementation components

Table 3.1

Sensor Module	Sensor Type
Volume	Ultrasonic Sensor HC-SR04
Notification Module	LED
Communication Module	Esp8266-01 Wi-Fi module
Microcontroller	Arduino UNO
Waste Characteristics	Capacitive and Inductive Sensor

3.7 Computer Requirements

a. Windows 8.1 or greater.

b. 2GB RAM or greater

c. Core 2 Duo processor

3.8 Software Requirements

a. XAMPP local server

b. Arduino IDE

c. No-SQL Firebase Database

d. Text Editor

3.9 System Flow-chart

Every program's flowchart shows the system clearly. The diagram in fig 3.1 shows that the bin is filled up to 100%. If the bin is filled in, the associated waste collection authority is sent a message

containing the position of the waste bin. So, the authority needs to go every day to collect rubbish, reducing in vain the use of workforce and saving vehicles time and fuel. The trash management method provided is substantially more efficient than the traditional waste management system.

3.10 System Design Methods

A UML diagram, such as a use case diagram, sequence diagram, class diagram, and activity diagram were used for the system design. This section also described and developed the system architecture. Different functions are provided in system UML diagrams used to create the system.

3.10.1 Flow-Chart diagram

This smart waste management system Flowchart diagram. The operations in this diagram include waste level detection, showing the filled-up percentage of the bin, sending a notification message, and to also open and closing the lid as described in figure 3.1.

3.10.2 Use-case diagram

Users of this system and the numerous activities they can undertake on the system offer the case diagrams as illustrated in Figure 3.2, It also discusses the many functions and operations of both the user and the administrator.

3.10.3 Sequence diagram

A sequence diagram is a unified modeling language diagram (UML) is the sequence diagram that shows the message sequence in an interaction between objects.in fig 3.3, the bin status and report status were requested and this diagram shows a sequence of system interactions to return the request solution.

3.10.4 System architecture

The system architecture diagram is a system diagram that is used to describe the software system's overall outline and its relationships, limitations, and bounds. This diagram explains the hardware design based on the system's functional requirements, assessment of issues of maintenance, performance, and physical infrastructure.

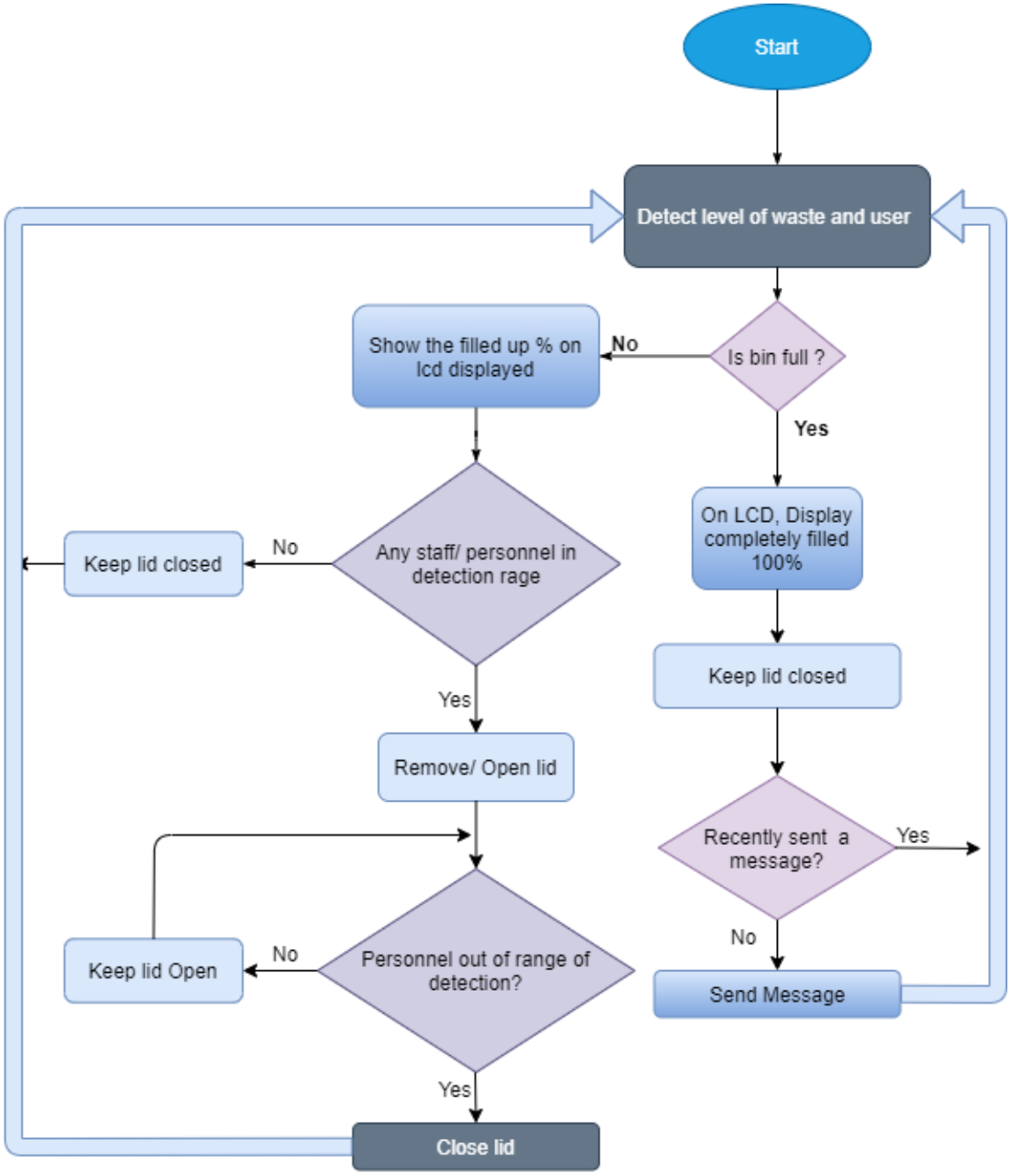

Fig 3.1 Flowchart Diagram for Smart Waste Bin

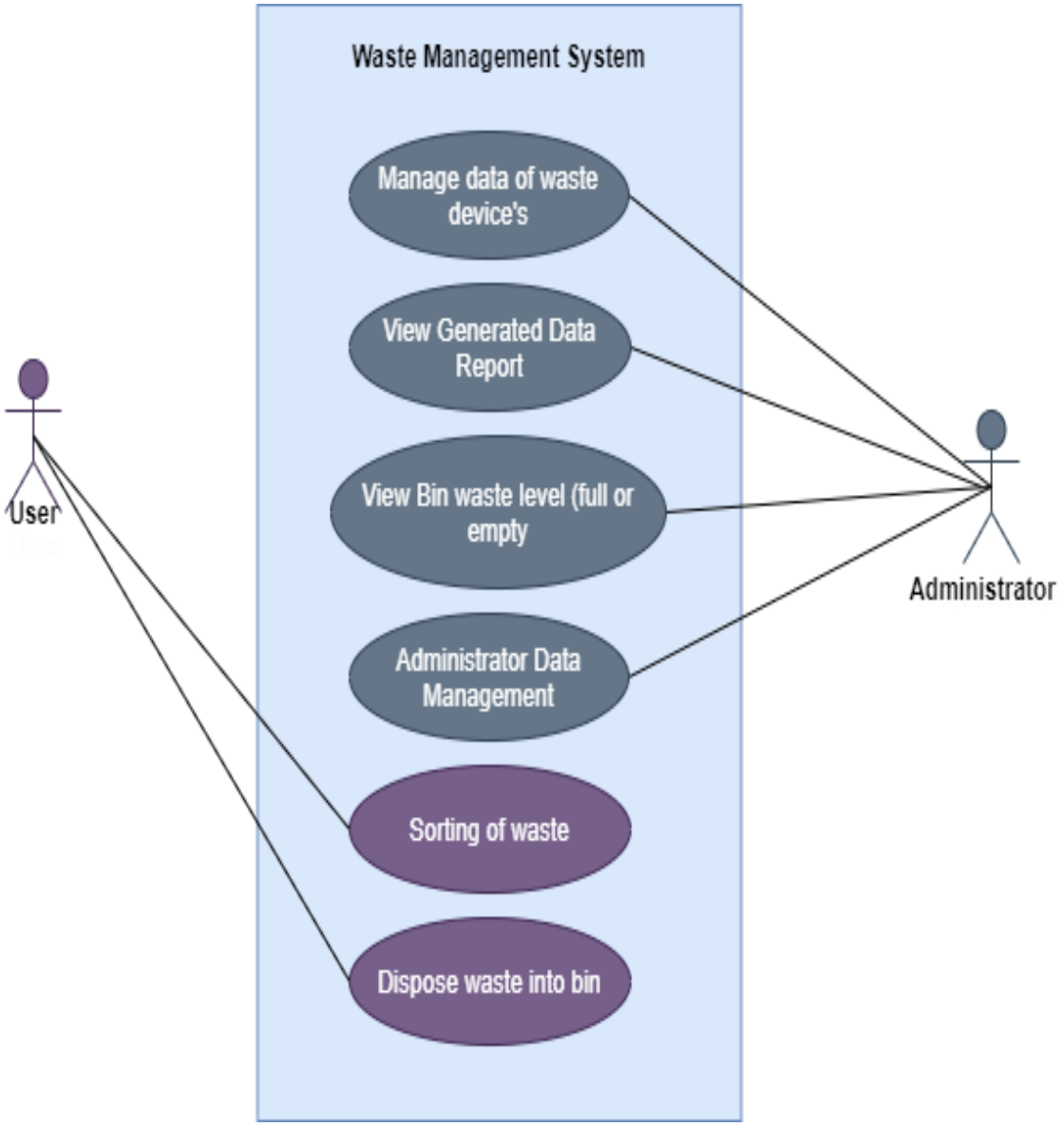

Fig 3.2 Use case diagram

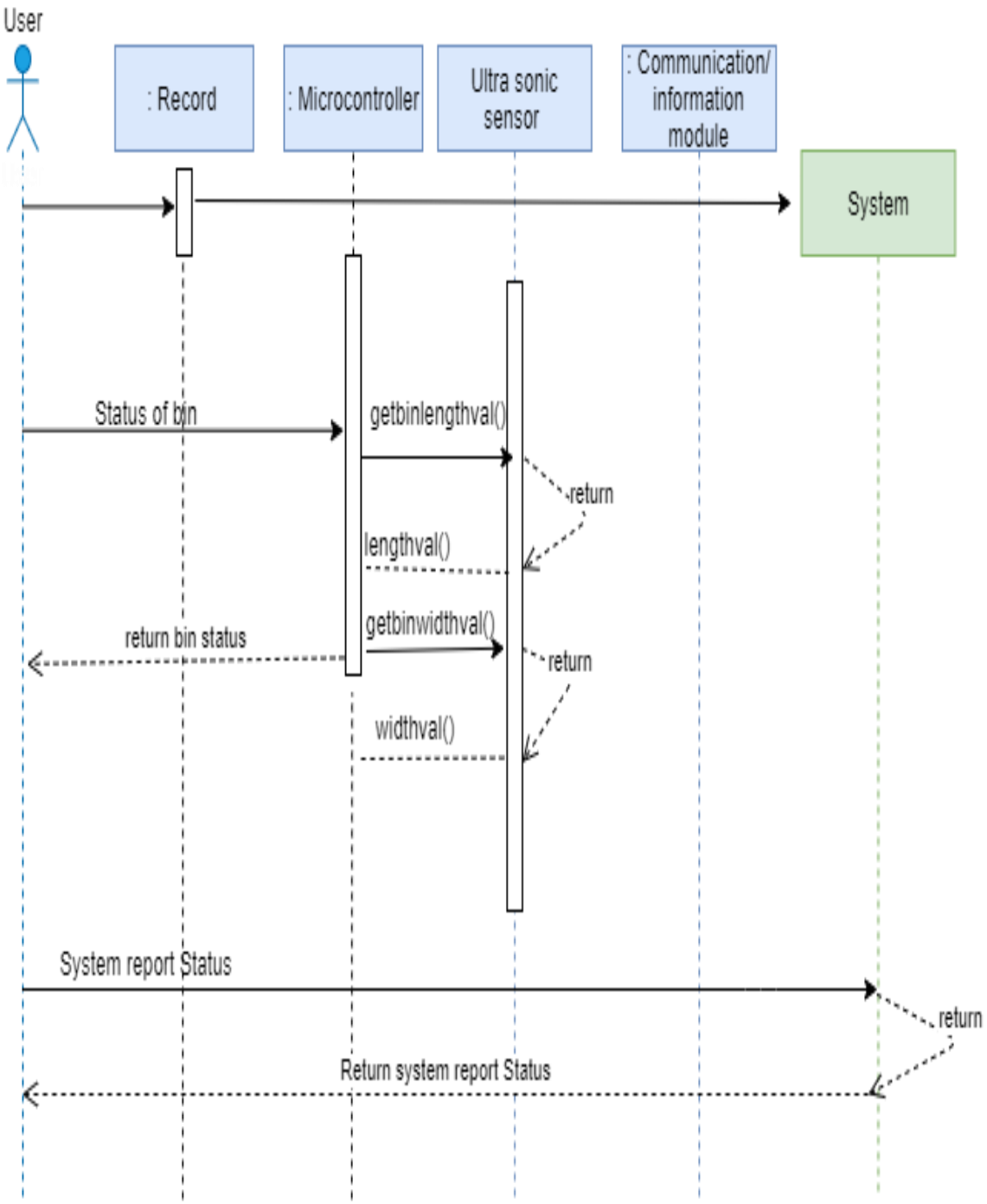

Fig 3.3 Sequence Diagram

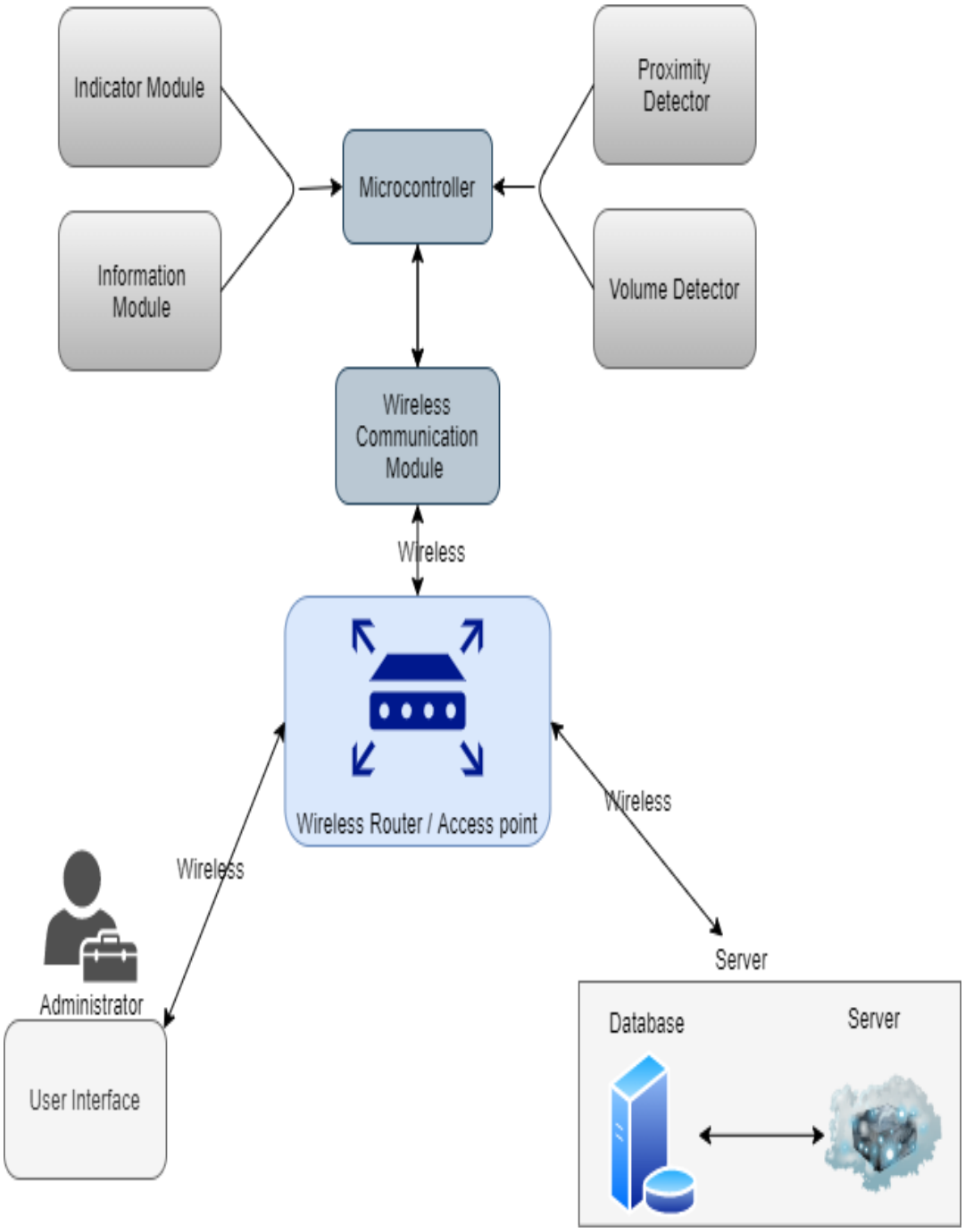

Fig 3.4 System Architecture Diagram

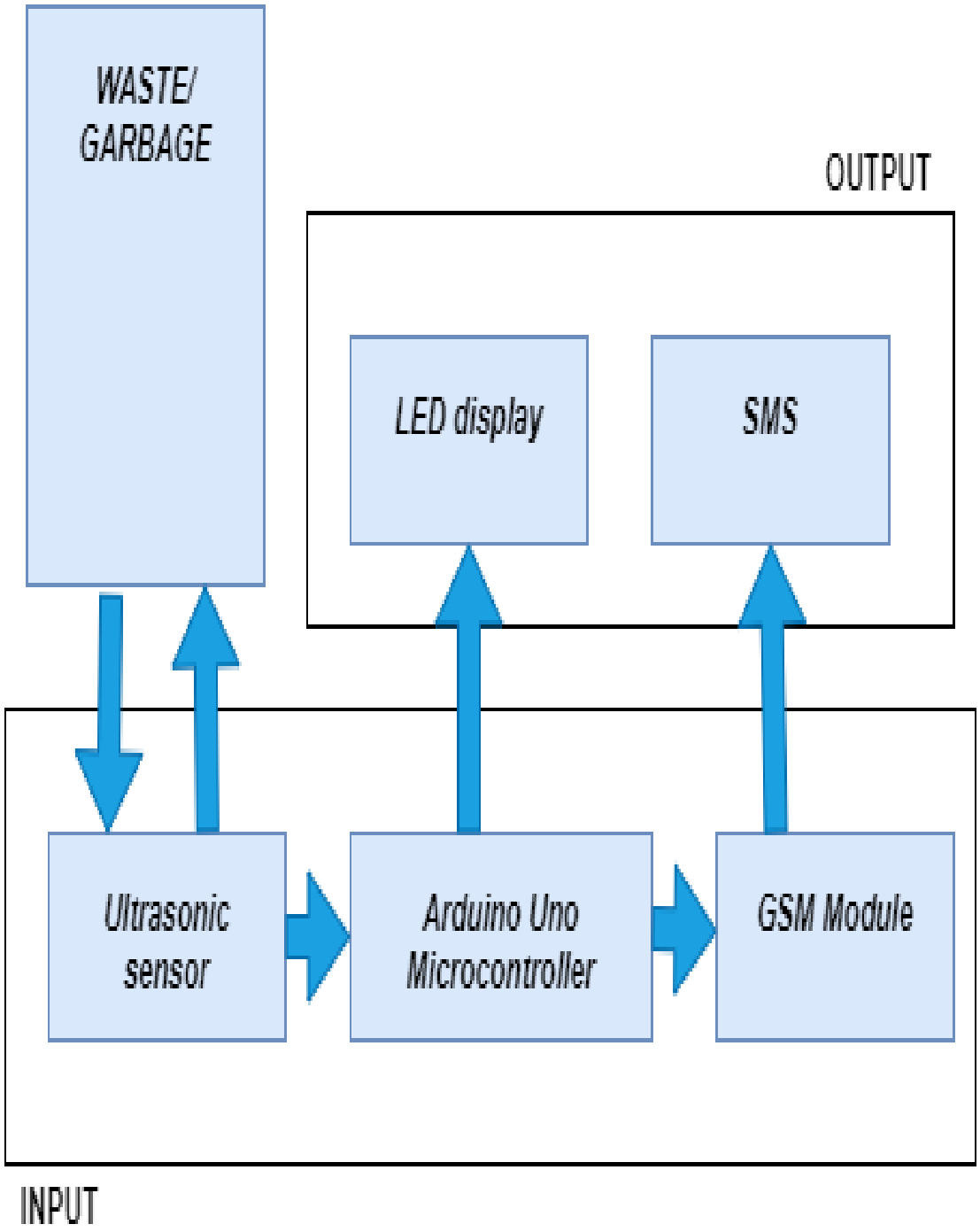

Fig 3.5 Smart waste management block diagram

CHAPTER FOUR

IMPLEMENTATION AND RESULT

4.1 Introduction

In this chapter, you will find a description of the result and the intelligent waste management system. The results of the implemented database are described in this section. The signals are transferred to a web-based waste management application via a mobile communication network. The capability of the container is shown exclusively in the waste container software. Whatever is installed in a robust ultrasonic sensor in the waste container and detects the fill levels, does not matter. The whole system includes a GSM, breadboard, power, and ultrasonic sensor (battery). On the panel is installed the sensor. Utilizing connecting wires is the connection between the Arduino board and the sensor. The Arduino board is provided with the work program. The Wi-Fi module is also connected to the Arduino board via cables. The system's power supply is supplied with the battery.

4.2 System Implementation

This section involves a detailed explanation of the system components, procedures, protocols and shows how the system is implemented as a whole. The setup is displayed in this section. All required design parameters are analyzed and the initial test settings are done.

4.2.1 Images of components

This section provides the images of all the essential hardware components discussed in chapter two.

Fig 4.1 Ultrasonic sensor

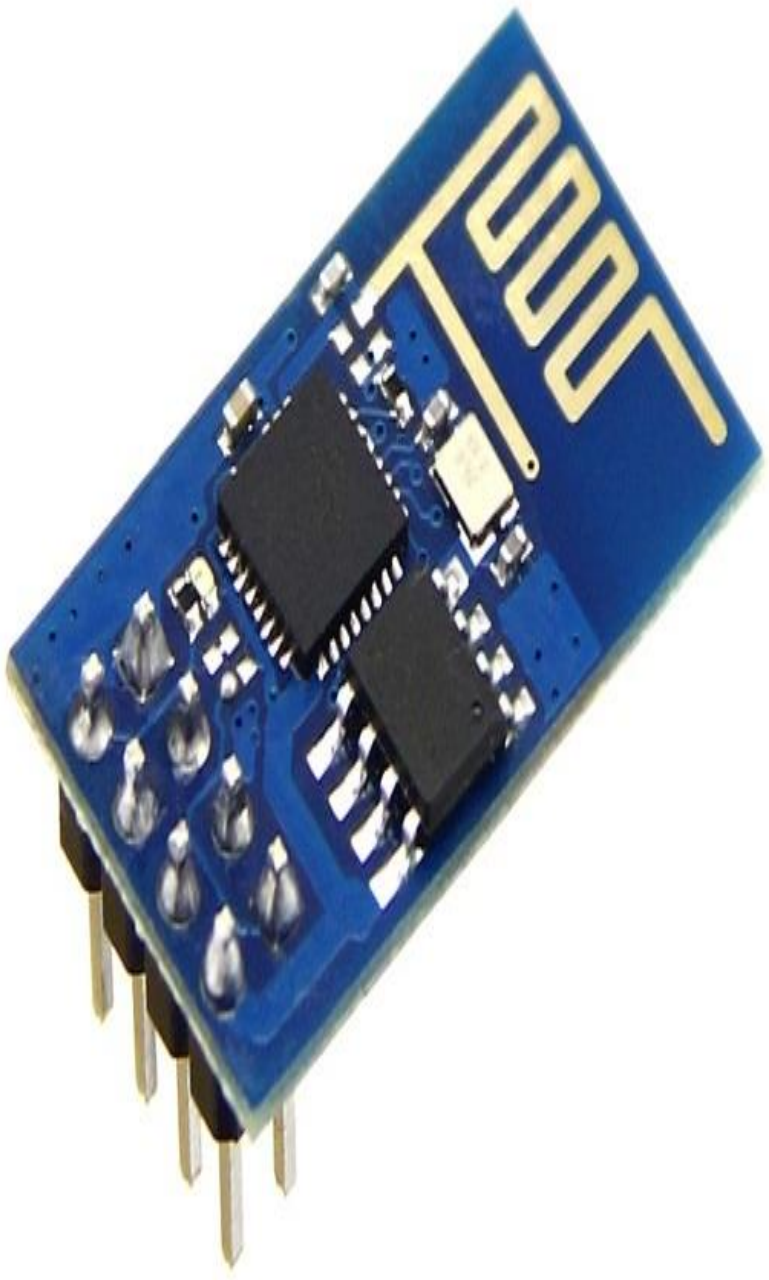

Fig 4.2 Wi-Fi module

Fig 4.4 Buzzer (Squishy, 2018)

Fig 4.5 Led

4.6 Bread board

4.7 Jumper cables

4.3 System snapshots

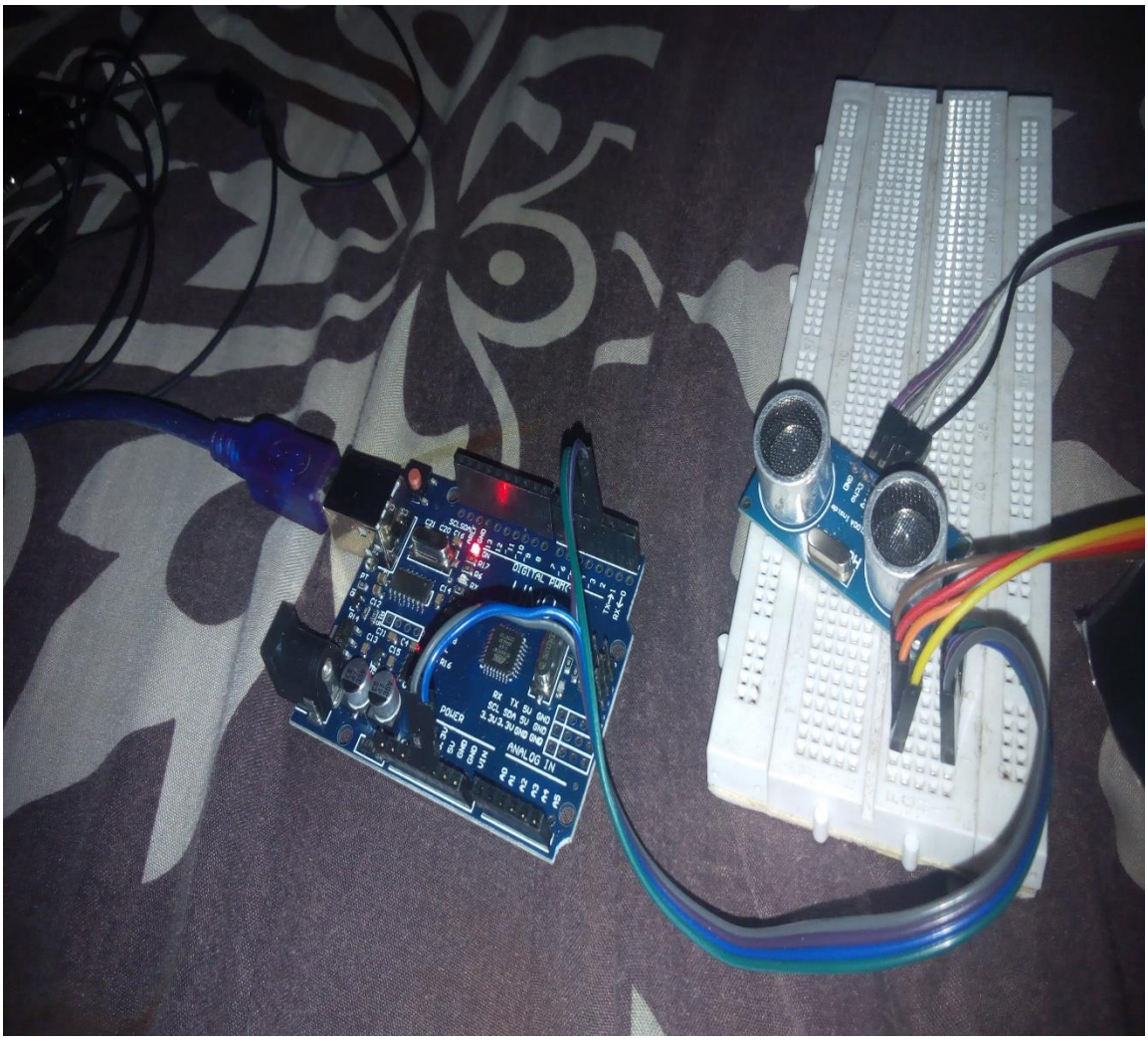

Fig 4.8 Circuit Arrangement

4.4 Website Front-end Implementation

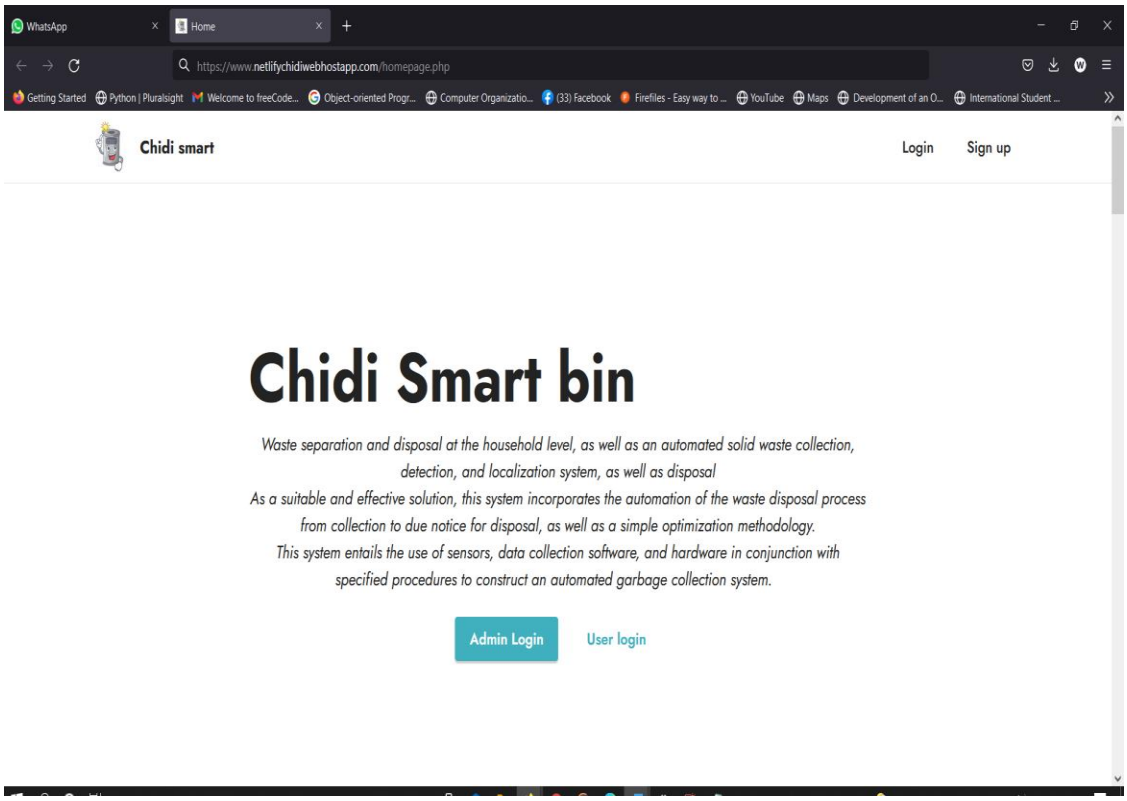

Fig 4.11 Website Homepage

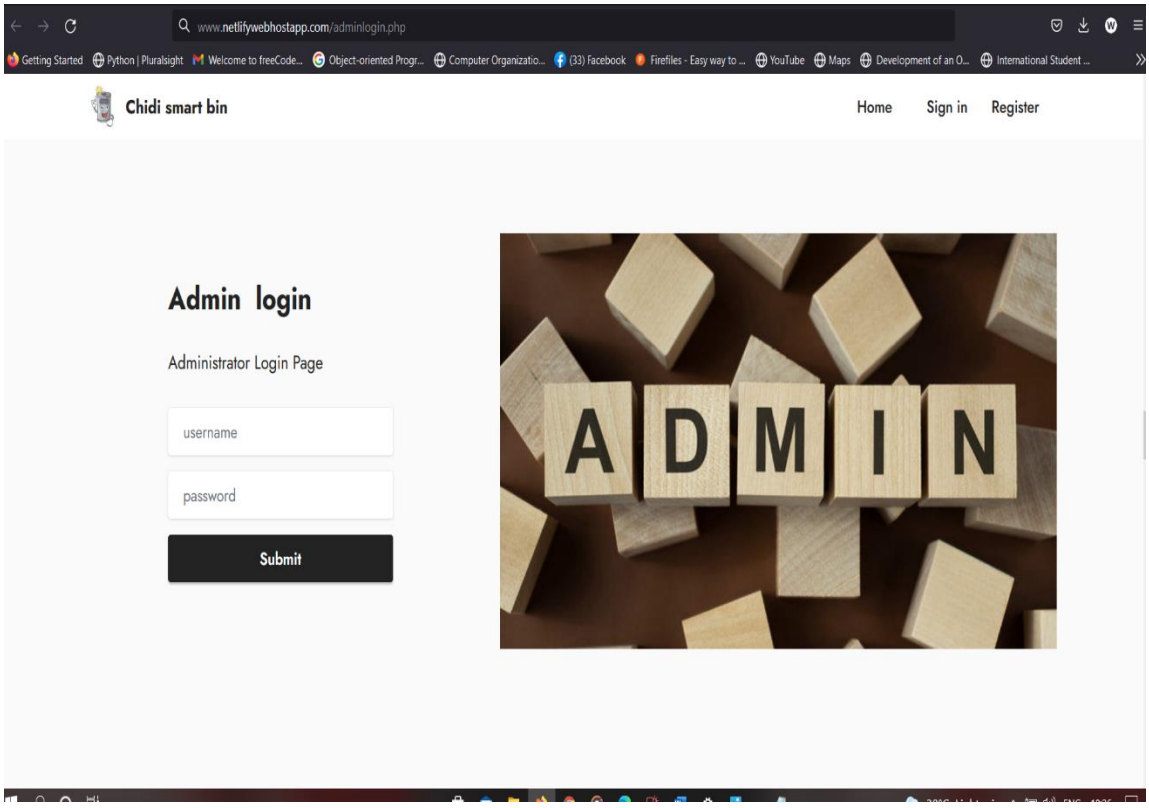

Fig 4.12 Admin Login

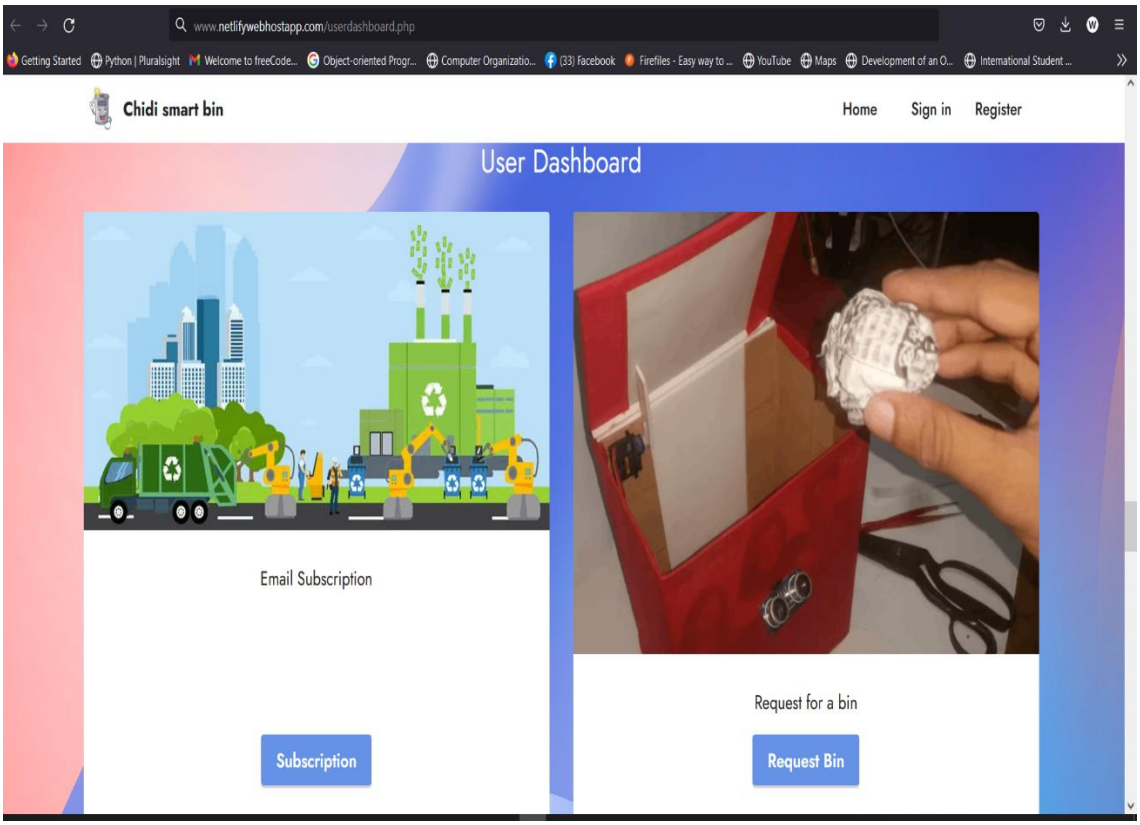

Fig 4.13 User Dashboard

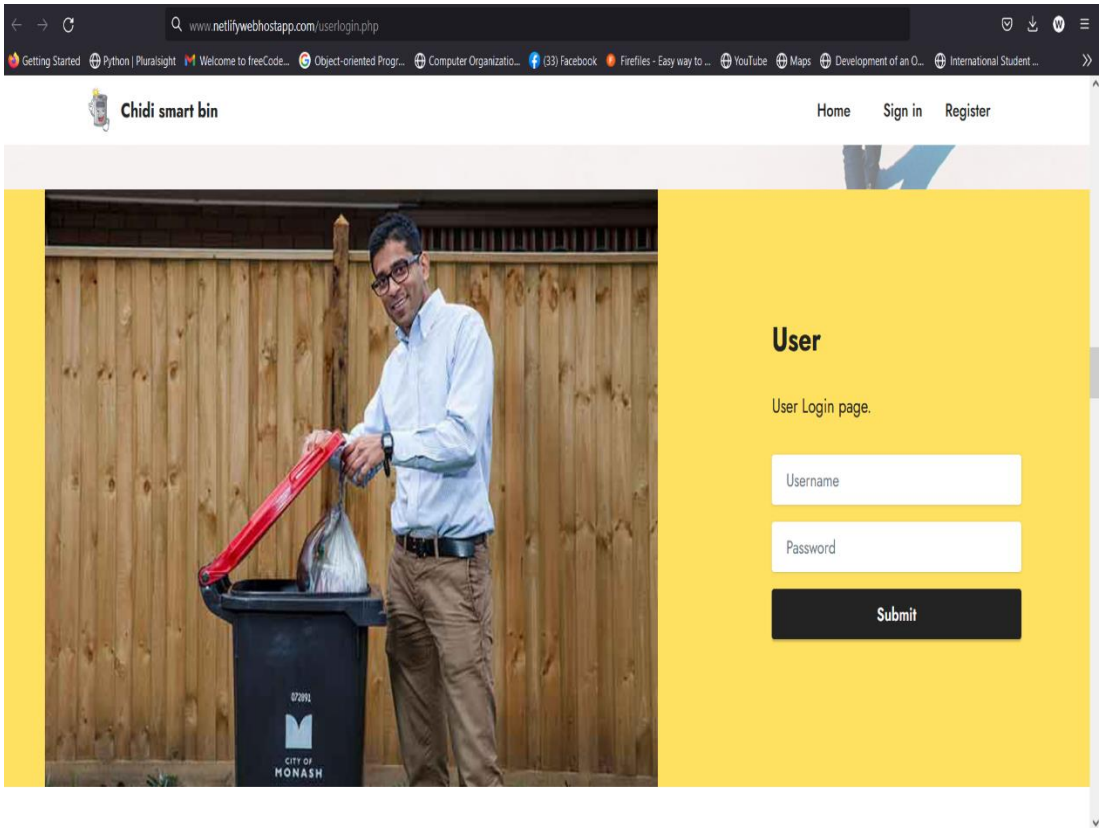

Fig 4.14 User Login

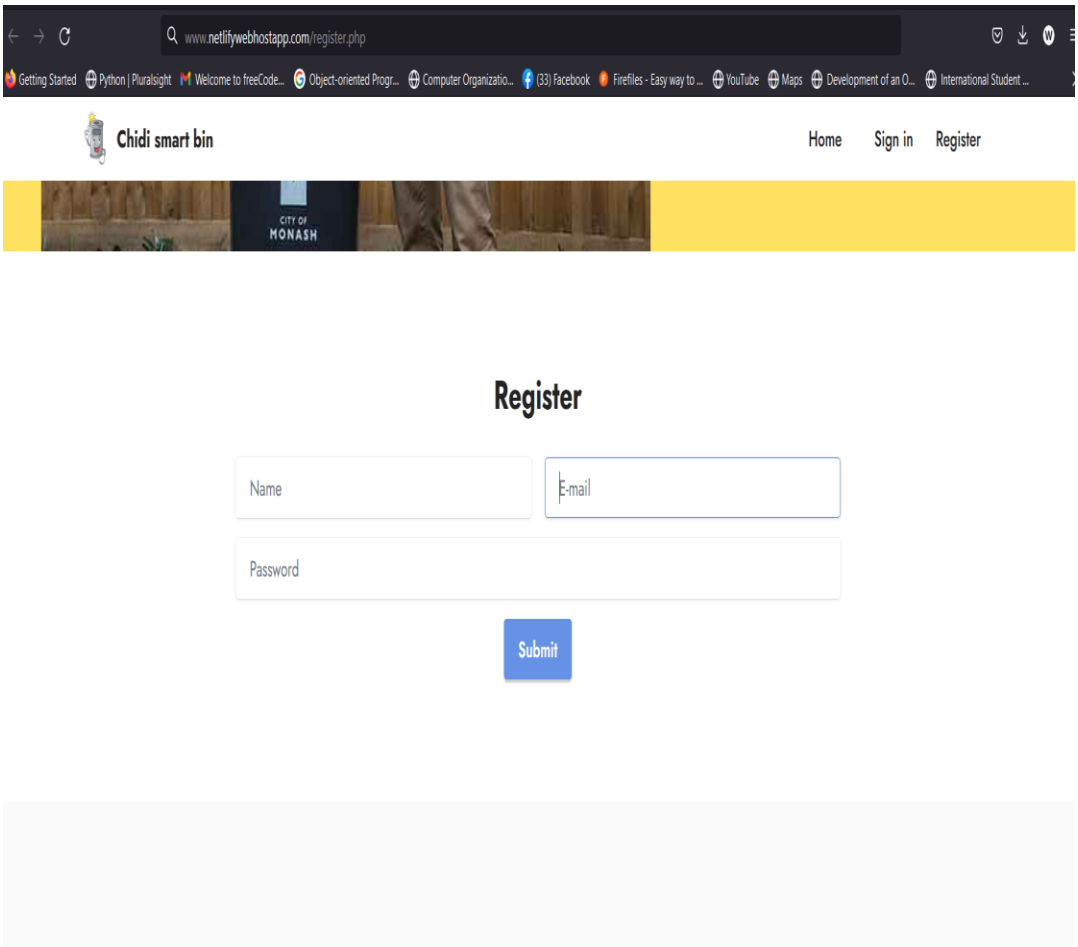

Fig 4.14 Registration Page

4.5 System Testing

Systematic Testing Unit

The test unit has the primary aim of using the smallest testing part of the software, isolating it from the remaining code, and checking whether the test part meets your needs. Before each unit is integrated into the modules, the interfaces between modules are individually checked.

Testing of the component

Testing components is focused on software component testing. The software modules are covered by this project. The unit cases are combined to ensure that the modules function properly.

Comprehensive testing

Integration Testing (I&T) is a software process that combines and tests program units in a variety of ways. In this context, a smallest test section is defined. Integration tests can detect interface issues between program components before they cause real-world problems with program implementation.

CHAPTER FIVE

SUMMARY AND CONCLUSION RECOMMENDATION

5.1 Summary

The limitations, conclusion, and recommendation are presented in this chapter. This project introduced intelligent waste management and traditional waste management system, as well as their advantages and limits, including research techniques, problem definition, and effective methodology for development. A series of flowcharts, case applications, and sequence schedules have been presented for system analysis and design. This paper introduced an effective clever waste management model, to reduce the stress associated with the traditional waste management system, focused on the use of bin users. The system uses sensors and communications modules to collect waste from a smart bin and forward it to a platform where notifications are available for public access. A case study found that the proposed system can improve efficiently the way people deal with waste and optimize economic and material resources by creating a genuine smart container protocol and implementing the relevant web application for the treatment and testing of new waste. This research study will be developed in the future via new facilities, which could lead to greater communication between management systems and platform integration to calculate the best route to collect routes and efficiency while reducing operating costs for trucks.

5.2 Conclusion

This smart waste management system is capable of simplifying the waste management process in Nigeria, in terms of collection sorting and disposal. This system is mainly characterized into two main subsystems which are the data collection and management subsystem and visualization user interaction subsystem.

With very few roadblocks and issues encountered like response delay, communication errors, object/actor placement, and proximity detection. Each test carried out generates specific correct results.

5.3 Recommendation for Further Study

This system requires further improvement in both hardware and software as well as speed and accuracy improvement like contacting waste disposal companies and vendors.

As well as further automation of basic disposal activities and training of waste/ garbage disposal officers in the use and operation of the system software. Including future waste material separation and processing.

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Appendix

IMPLEMENTATION CODE

Ultrasonic Sensor Code with Arduino Uno:

```
fdefine echopin 2

tdefine trigpin 3

ii defines variables

long duration;

int dist-ance;

void setup()0

pinmode {trigpin, output); pinmode {echopin, input); serial.begin{9600);

serial . println{"chidiebere ultrasonic sensor project") :

serial . println{'0 with arduino uno") :

void loop() {      digitalwrite {trigpin, low);

 delaymicroseconds{2); digitalwrite {trigpin, high);

delaymicroseconds{lo); digitalwrite {trigpin, low);

duration = pulseln {echopin, high);

distance = duration '0.034 i  2:  i i  speed of sound wave divided by 2 {go and back)

serial . print {"distance :  ") : serial .print {distance );

serial . println{" cm") :
```

Results:

```
12 :05 :41. 668  ->Distance : 0 cm

12 :05 :41. 702  ->Dist-ance : lcm

12 :05 :41. 702 ->Dist-ance : lcm
```

12 :05 :41. 736 ->Dist-ance : 0cm

12 :05 :41. 736 ->Dist-ance : 0cm

12 :05 :41. 770 ->Dist-ance : 0cm

12 :05 :41. 770 ->Dist-ance : 0cm

12 :05 :41.804 ->Dist-ance : 0cm

12 :05 :41.804 ->Dist-ance : 113 cm

12 :05 :41.839 ->Dist-ance : 44 cm

12 :05 :41.839 ->Dist-ance : lcm

12 :05 :41.874 ->Dist-ance : 0 cm

12 :05 :41.874 ->Dist-ance : 0 cm

12 :05 :41. 908 ->Dist-ance : 36 cm

12 :05 :41. 908 ->Dist-ance : 0 cm

12 :05 :41. 942 ->Dist-ance : 107 cm