# VISVESVARAYA TECHNOLOGICAL UNIVERSITY

“Jnana Sangama”, Belagavi - 590 018 Karnataka India

A PROJECT REPORT ON

## “SMART WASTE MANAGEMENT SYSTEM : AUTOMATION SEGREGATION AND REAL-TIME MONITORING ”

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

**BACHELOR OF ENGINEERING**

in

**ELECTRONICS AND COMMUNICATION ENGINEERING**

by

Tejas M S USN: 1BC21EC008

Naresh N USN: 1BC21EC004

Sudarshan R USN: 1BC21EC006

Deepak R USN: 1BC21EC002

Under the Guidance of

Mrs. Chethana L Badiger

Dept. of ECE

**BCET**

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

BANGALORE COLLEGE OF ENGINEERING & TECHNOLOGY

Opp, Heelalige Railway Station, Chandapura

Hosur Main Road, Bengaluru-560099

**BANGALORE COLLEGE OF ENGINEERING & TECHNOLOGY**

**Chandapura, Bengaluru – 560099**

**Department of Electronics & Communication Engineering**

## DECLARATION

We, **Tejas M S**, bearing USN: 1BC21EC008, **Naresh N**, bearing USN: 1BC21EC004, **Sudarshan R**, bearing USN: 1BC21EC006, **Deepak R**, bearing USN: 1BC21EC002, hereby declare that, the project work entitled **"SMART WASTE MANAGEMENT SYSTEM:AUTOMATED SEGREGATION AND REAL-TIME MONITORING"** is independently carried out by us at Department of Electronics and Communication Engineering, **Bangalore College of Engineering & Technology, Bengaluru-560099**,under the guidance of **Mrs.KARTHIKA . V**, Professor, HOD of Electronics and Communication Engineering. The Project work is carried out in partial fulfillment of the requirement for the award of degree of Bachelor of Engineering in Electronics and Communication Engineering during the academic year 2023- 2024.

Place: Bengaluru　　　　　　　　　　　　Name & Signature of students

Date:

**BANGALORE COLLEGE OF ENGINEERING & TECHNOLOGY**

**Chandapura, Bengaluru – 560099**

**Department of Electronics & Communication Engineering**

**Certificate**

Certified that the project work entitled **"SMART WASTE MANAGEMENT SYSTEM:AUTOMATED SEGREGATION AND REAL-TIME MONITORING"**, carried out by, **Tejas M S**, bearing USN: 1BC21EC008, **Naresh N**, bearing USN: 1BC21EC004, **Sudarshan R**, bearing USN: 1BC21EC006, **Deepak R**, bearing USN: 1BC21EC002, bonafide students of **Bangalore College of Engineering & Technology**, in partial fulfillment for the award of Bachelor of Engineering in Electronics and Communication Engineering of the Visvesvaraya Technological University, Belagavi during the year 2023–2024. It is certified that all the corrections/suggestions indicated for Internal Assessment have been incorporated in the report deposited in the departmental library. The project report has been approved as it satisfies the academic requirements.

| ___________________ | ___________________ | ____________________ |
|---|---|---|
| Signature of the guide | Signature of the HOD | Signature of the Principal |
| Mrs. Chethana L Badiger | Mrs. Karthika V | Dr N.S.Badrinarayanan |
| Department of ECE | Professor and HOD | Principal |
| BCET, Bangalore | BCET, Bangalore | BCET, Bangalore |

External Viva

Name of the Examiners                                        Signature with Date

1. __________________

2. __________________

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First of all, we would like to thank Dr N.S.Badrinarayanan, Principal, Bangalore College of Engineering & Technology, for permitting to do this project work and providing the facilities required.

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We would like to express our sincere thanks to Mrs. Karthika V, Professor and HOD, Department of Electronics and Communication Engineering, Bangalore College of Engineering & Technology for his support.

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Name: TEJAS M S [1BC21EC008]

Name: NARESH N [1BC21EC004]

Name: SUDARSHAN R [1BC21EC006]

Name: DEEPAK R [1BC21EC002]

## ABSTRACT

The issue of waste management poses significant environmental and health challenges globally. Traditional waste collection and segregation methods are inefficient, labour-intensive, and often result in improper waste disposal.

To address these challenges, this project presents a "Smart Waste Management System" designed to automate waste segregation and provide real-time monitoring of waste levels, thereby enhancing efficiency and sustainability in waste management practices.

The system integrates various sensors and an Arduino microcontroller to automate the segregation of waste into different categories—biodegradable, non-biodegradable, and metallic.

The Smart Waste Management System aims to revolutionize traditional waste management by incorporating automated segregation and real-time monitoring. This innovative system utilizes an Arduino UNO microcontroller as its core, integrating various sensors to categorize waste efficiently.

Ultrasonic sensors measure the fill levels of waste bins, ensuring timely disposal. IR sensors detect the presence of waste, while a soil moisture sensor differentiates between wet and dry waste.

An LCD display provides real-time updates on the system’s status, and a buzzer alerts when bins are full or any irregularities are detected. buzzer alerts* provide audible notifications when the bins are full, ensuring that waste management personnel are promptly informed.

This automated approach not only enhances the efficiency of waste management but also promotes environmental sustainability by ensuring proper segregation and timely disposal of waste.

Through this project, we aim to address the inefficiencies of conventional waste management systems and contribute to a cleaner and more organized waste disposal process.

The Smart Waste Management System aims to revolutionize waste management by incorporating advanced automation and real-time monitoring.

# Table of Contents

# CHAPTER-1

## 1 . 1 INTRODUCTION

The Smart Waste Management System project is designed to address the growing need for efficient and intelligent waste management solutions in urban environments. By leveraging modern technology, this system automates the segregation of waste into categories such as wet, dry, and metallic, optimizing the recycling and disposal processes. Equipped with various sensors, including ultrasonic, IR, soil moisture, and metal detectors, the system provides real-time monitoring and accurate waste bin status updates via an LCD display.

Buzzer alerts notify personnel when bins are full, ensuring timely collection and preventing overflow. This innovative approach aims to enhance urban cleanliness, promote sustainability, and streamline waste management operations, contributing to a cleaner and more efficient urban environment.To address these challenges, this project presents a "Smart Waste Management System" designed to automate waste segregation and provide real-time monitoring of waste levels, thereby enhancing efficiency and sustainability in waste management practices.

**Key Objectives:**

**1. Automate Waste Segregation:** The system uses advanced sensors to automatically sort waste into wet, dry, and metallic categories. This improves the efficiency and accuracy of recycling processes by ensuring waste is correctly categorized without manual intervention.

**2. Real-Time Monitoring:** Continuous monitoring of waste bin levels is provided through an LCD display. This allows for immediate updates on the status of the bins, ensuring that waste management personnel can respond promptly to avoid overflows.

**3. Timely Alerts:** Buzzer notifications are used to alert personnel when waste bins are full. This system prevents overflow by ensuring that bins are emptied in a timely manner, maintaining the cleanliness and orderliness of the area.

4. **Enhance Urban Cleanliness:** By streamlining the waste management process, the system helps keep urban environments cleaner. This contributes to improved public health by reducing the risks associated with improperly managed waste.

5. **Promote Sustainability:** The system encourages proper waste disposal and recycling practices. By efficiently managing waste segregation and collection, it supports environmental conservation efforts and promotes a sustainable approach to waste management.

## 1.2 MOTIVATION

**1. Enhance Efficiency in Waste Management:** Traditional methods of waste segregation are often manual and time-consuming, leading to inefficiencies. By automating the segregation process using sensors, the project aims to significantly improve the efficiency of waste management operations.

2. **Ensure Timely Waste Collection:** Overflowing waste bins are a common problem in many urban areas, leading to unhygienic conditions and public health risks. The project seeks to provide real-time monitoring and timely alerts, ensuring that waste bins are emptied promptly to maintain cleanliness.

3. **Leverage Technological Advancements:** With the advent of IoT and sensor technologies, there is a significant opportunity to revolutionize waste management practices. The project seeks to leverage these advancements to create a smart, automated system that can be widely adopted in urban areas for better waste management.

## 1.3 OBJECTIVES.

**Resource Efficiency:**

Specific : Optimize power consumption of the Arduino-based system by implementing sleep modes and efficient sensor polling.

Measurable : Reduce overall power consumption by 30% compared to a non-optimized version of the same system.

Achievable : Implement power-saving techniques within the Arduino code and utilize low-power components where possible.

Relevant : Enhances the system's battery life and reduces energy waste, making it more suitable for long-term or remote deployments.

**Environmental Impact:**

Specific : Develop an environmental monitoring system using the ultrasonic sensors to detect water levels or measure distances for conservation purposes.

Measurable : Achieve 95% accuracy in environmental readings compared to professional-grade equipment.

Achievable : Calibrate sensors and implement error-correction algorithms to improve measurement precision.

Relevant : Contributes to environmental awareness and potential conservation efforts through accurate data collection.

**Technology Integration:**

Specific : Create a fully integrated system that combines sensor data collection, processing, and visual output through the LCD display.

Measurable : Successfully interface at least 4 different types of sensors/actuators (ultrasonic, LED, LCD, and others) with real-time data processing and display.

Achievable : Utilize Arduino libraries and develop custom code to ensure all components work together seamlessly.

Relevant : Demonstrates practical application of IoT principles and embedded systems design in a real-world context.

### 1.4 Existing System

The IoT-based Smart Garbage Alert System using Raspberry Pi is an innovative solution to improve waste management in urban areas. This system uses sensors and internet connectivity to monitor garbage levels in bins and alert authorities when they need to be emptied. The heart of the system is a Raspberry Pi, a small, affordable computer that acts as the central control unit.The system typically employs ultrasonic sensors attached to garbage bins to measure the fill level. These sensors are connected to the Raspberry Pi, which processes the data. When the garbage level reaches a predefined threshold, the Raspberry Pi sends an alert to the waste management authorities via the internet.The Raspberry Pi can be programmed using Python to handle sensor data, process information, and send alerts. It can also be configured to upload data to a cloud platform for real-time monitoring and analytics. This allows waste management teams to optimize their collection routes and schedules based on actual needs rather than fixed schedules.This smart system helps reduce overflow of garbage bins, improves the efficiency of waste collection services, and contributes to cleaner, more hygienic urban environments. It's a practical application of IoT technology that demonstrates how simple, low-cost solutions can have a significant impact on city management and quality of life.

### 1.5 Proposed System

The system likely involves reading inputs from the ultrasonic sensors and soil moisture sensor, processing this data with the Arduino, and then displaying relevant information on the LCD screen while using LEDs and the buzzer for alerts. This project could be for a range of applications, such as a smart gardening system, an obstacle detection system, or a similar interactive setup.

The Utilization of this project involves ultrasonic sensors can be used to measure distances, which can be applied in various contexts such as obstacle detection, level measurement (e.g., water level), or security systems.

The soil moisture sensor helps in monitoring the moisture level of soil, which is crucial for automated gardening or agricultural projects. This data can be used to automate irrigation systems, ensuring plants receive the right amount of water.

The LEDs and the buzzer provide visual and auditory alerts, respectively. These can be utilized for signaling different statuses or warnings, such as low soil moisture, proximity alerts, or system errors.

The Efficiency of this project involves monitoring of distance and soil moisture levels, reducing the need for manual checks and ensuring continuous operation. This increases operational efficiency.

The Arduino processes data in real-time, allowing for immediate responses to changing conditions. This quick feedback loop enhances the system's efficiency in maintaining optimal conditions.With automated alerts and displays, the system reduces the need for manual intervention, saving time and labor. Users can quickly see data and receive alerts without needing to manually check each component.

The Maintenance of this project involves checking all connections, sensors, and components to ensure they are securely connected and functioning properly.

Ensure that ultrasonic sensors and the soil moisture sensor are calibrated correctly for accurate readings. Recalibrate if necessary.

This project leverages an Arduino Uno to create a multifunctional monitoring system, integrating various sensors and output devices. Key components include ultrasonic sensors for distance measurement, a soil moisture sensor for environmental monitoring, an LCD display for real-time data visualization, and LEDs and a buzzer for alerts.

# CHAPTER 2

## 2.1 LITERATURE SURVEY

## RESEARCH AND TECHNICAL PAPERS

### 2.1.1 Automatic Waste Segregator Based on IoT & ML Using Keras model and Streamlit

The Automatic Waste Segregator project leverages IoT and machine learning to create an efficient and intelligent waste sorting system. The core of the system is an Arduino Uno, connected to ultrasonic sensors that gather data on the waste materials. This data is sent to an ESP8266/ESP32 module for Wi-Fi connectivity, which then transmits it to a server. On the server, a machine learning model built with Keras processes the data to classify the waste into categories such as plastic, organic, and metal. Based on these classifications, servo motors are actuated to direct the waste into the appropriate bins, ensuring accurate segregation.The system features LEDs and a buzzer to provide visual and auditory alerts for different statuses, such as errors or successful sorting operations. A Streamlit-based web interface offers a user-friendly platform for real-time monitoring and control. Users can view live data, see the classification results, and manage the system remotely through the web interface. This enhances user interaction and allows for better oversight and management of the waste segregation process.Regular maintenance is required to ensure the system operates smoothly. This includes checking sensor connections, calibrating the sensors, and updating the software. Cleaning the components to remove dust and preventing corrosion on the connections are also important maintenance tasks. The integration of IoT and machine learning in this project not only automates the waste segregation process but also improves its efficiency and accuracy. This promotes environmental sustainability by ensuring that waste is properly sorted and disposed of, which can facilitate recycling and reduce landfill use. The modular nature of the system allows for scalability and future enhancements, making it a robust solution for smart waste management.

### 2.1.2 Smart Waste Management using Internet-of-Things

The Smart Waste Management system utilizes the Internet of Things (IoT) to revolutionize the way waste is collected, monitored, and managed. Central to the system is an Arduino Uno, equipped with ultrasonic sensors to detect waste levels and a soil moisture sensor to identify organic waste characteristics. These sensors gather real-time data on waste conditions and transmit it via an ESP8266/ESP32 module for Wi-Fi connectivity to a central server. On the server, the data is processed to determine the type and level of waste, enabling efficient categorization and management.

The system features automated alerts through LEDs and a buzzer to signal different statuses such as full bins or system errors. The use of IoT allows for remote monitoring and control, with a user-friendly interface developed using Streamlit. This web-based interface provides real-time visualization of waste data, alerts, and system status, making it easy for users to oversee and manage the waste management process from any location.Automated waste segregation is achieved through the integration of servo motors that direct waste into appropriate bins based on sensor readings. This automation reduces the need for manual intervention, improves efficiency, and ensures accurate waste sorting. Additionally, the system can be programmed to optimize waste collection schedules based on real-time data, reducing operational costs and enhancing service efficiency.Regular maintenance involves checking sensor connections, calibrating sensors for accurate data, and updating the software to ensure optimal performance. It supports recycling efforts, reduces landfill use, and provides a scalable and adaptable solution for future waste management needs. The integration of real-time data processing and remote monitoring not only enhances operational efficiency but also empowers users with greater control over waste management processes.

### 2.1.3 IOT Based Smart Garbage alert system using Arduino

The IoT-Based Smart Garbage Alert System using Arduino aims to optimize waste management by providing real-time monitoring and notifications for garbage bins. At the core of the system is an Arduino Uno, which integrates ultrasonic sensors to measure the fill levels of garbage bins. These sensors continuously collect data and detect when bins are full. This information is transmitted wirelessly via an ESP8266/ESP32 Wi-Fi module to a central server.The system employs a web-based interface developed with Streamlit, allowing users to monitor bin statuses in real-time from any location. This interface displays the fill levels of all connected bins, sending alerts when bins reach a specified capacity. Such alerts help in timely waste collection, preventing overflow and ensuring cleaner environments.Visual and auditory alerts are also integrated into the system through LEDs and a buzzer, which provide immediate on-site notifications. This ensures that even without internet access, on-site personnel are aware of the bin status. The system's automation reduces the need for frequent manual checks, enhancing efficiency and allowing waste management personnel to focus on other tasks.Regular maintenance of the system involves checking sensor connections, recalibrating sensors for accurate readings, and updating the software to maintain optimal performance. Cleaning the sensors and protecting them from environmental damage ensures long-term reliability.By implementing this smart garbage alert system, waste collection services can become more efficient and responsive. The system not only helps in maintaining cleanliness by ensuring timely bin emptying but also optimizes resource allocation by enabling dynamic scheduling of waste collection based on real-time data.

### 2.1.4 IoT-based Smart Garbage Alert System using Raspberry Pi and Blynk

The IoT-based Smart Garbage Alert System using Raspberry Pi and Blynk combines affordable hardware with a user-friendly mobile platform to create an efficient waste management solution. This system leverages the computational power of the Raspberry Pi and the versatility of the Blynk platform to monitor garbage levels and alert authorities when bins need emptying.At the core of the system is a Raspberry Pi, which interfaces with ultrasonic sensors attached to garbage bins. These sensors measure the fill level of the bins. The Raspberry Pi, programmed in Python, processes this data and communicates with the Blynk server over the internet.Blynk, a popular IoT platform, provides a simple way to create mobile apps for IoT projects. In this system, a custom Blynk app serves as the user interface for waste management authorities. The app displays real-time fill levels of bins, sends push notifications when bins are nearly full, and can show the location of bins on a map if GPS modules are included.The Raspberry Pi sends data to the Blynk server using the Blynk library for Python. This data is then accessible through the Blynk app on smartphones or tablets. The app can be customized with various widgets like gauges to show fill levels, LED indicators for alerts, and buttons for manual override or system reset.

# CHAPTER 3

## BLOCK DIAGRAM

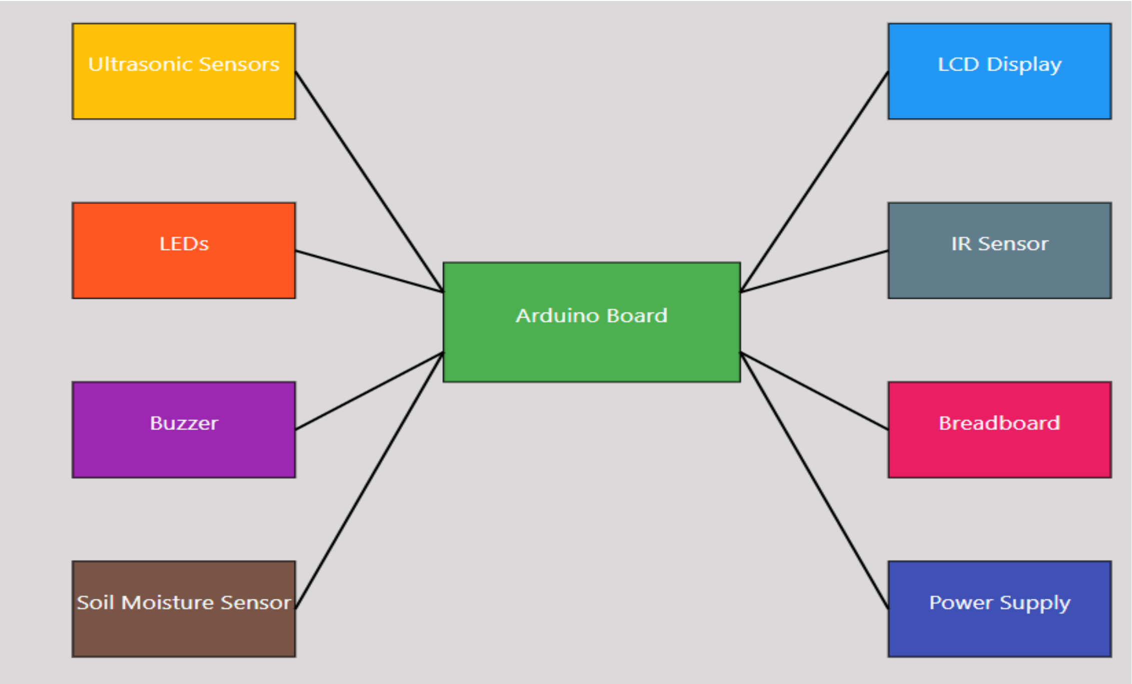



Fig 3.1

**Arduino Board:**The Arduino is the brain of the system, a programmable microcontroller that coordinates all operations. It receives input from various sensors, processes this data according to programmed logic, and controls output devices. The Arduino can be programmed using C++ to define how it interprets sensor data and when to trigger alerts. It's versatile, cost-effective, and has a large community of developers, making it ideal for IoT projects like this smart garbage alert system.

**LCD Display:**The Liquid Crystal Display provides visual output for the system. It can show real-time information such as the current fill level of the bin, temperature readings, or system status messages. The LCD is typically controlled by the Arduino, which sends commands to update the display. This component is crucial for providing easily readable information to waste management personnel or anyone checking the bin status on-site.

**Ultrasonic Sensors:**Ultrasonic sensors use sound waves to measure distance. They emit high-frequency sound pulses and measure the time it takes for the echo to return. In this system, they're used to detect the fill level of the garbage bin by measuring the distance from the sensor (mounted at the top of the bin) to the surface of the garbage. Multiple sensors might be used for more accurate readings or to monitor different sections of the bin.

**LEDs:**Light Emitting Diodes serve as simple, effective visual indicators in the system. They can be programmed to show different alert levels - for example, green for empty, yellow for partially full, and red for full. LEDs are energy-efficient and can be easily seen from a distance, making them ideal for quick status checks. The Arduino controls when and which LEDs light up based on the data from the sensors.

**Buzzer:**The buzzer produces audio alerts, adding another dimension to the notification system. It can be programmed to sound when the bin reaches a certain fill level or if there's an issue with the system that requires immediate attention. The Arduino controls the buzzer, determining when it should activate and for how long. This audio alert is particularly useful for grabbing attention in noisy environments or when visual alerts might be missed.

**Soil Moisture Sensor:**While typically used for measuring soil moisture, in this context it might be adapted to detect liquid levels or humidity inside the garbage bin. This sensor can help monitor potentially hazardous or rapidly decomposing waste. It works by measuring the electrical resistance between two probes inserted into the medium being measured. The Arduino interprets this data to determine moisture levels in the bin.

**IR Sensor:**An Infrared (IR) sensor is an electronic device that detects IR radiation in its surrounding environment. It consists of an IR LED (emitter) and an IR photodiode (receiver) working together. The sensor emits IR radiation and detects the reflection from nearby objects. IR sensors are widely used in various applications, from obstacle detection in robotics to proximity sensing in smartphones, due to their simplicity, low cost, and effectiveness in short-range detection.

**Breadboard:**The breadboard is a construction base for prototyping electronics. It allows for easy connection of various components to the Arduino without soldering. This is particularly useful during the development and testing phase of the project. The breadboard has a grid of holes into which component leads and jumper wires can be inserted to create circuits. It facilitates quick modifications and experimentation with different circuit configurations.

**Power Supply:**While not explicitly shown in the image, a power supply is essential for the system. It provides the necessary electrical power to run all components. This could be a battery pack for portability, a solar panel for sustainable operation, or a mains-connected power adapter. The power supply needs to provide stable, appropriate voltage levels for the Arduino and other components to function reliably.

# CHAPTER 4

## CIRCUIT DIAGRAM

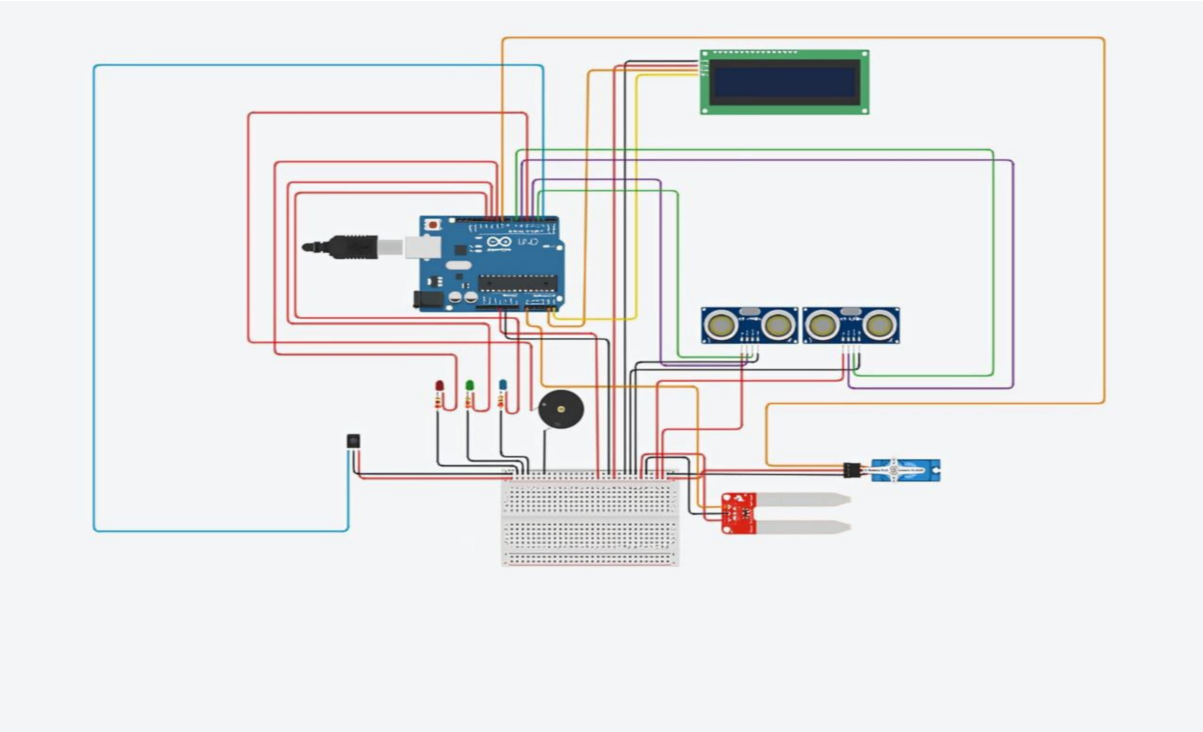


**Fig 4.1**

## 4.2 COMPONENTS , FEATURES

### Arduino Board


**Fig 4.2**

The Arduino Board is an open-source microcontroller platform designed for easy electronic prototyping. It's based on flexible, user-friendly hardware and software, making it accessible to hobbyists, artists, and professionals alike. The board typically features an Atmel AVR microcontroller, which acts as the brain of the system. It can be programmed using the Arduino Integrated Development Environment (IDE), which uses a simplified version of C++. Arduino boards come in various models with different capabilities, but all share a common philosophy of simplicity and ease of use. They can read inputs from sensors, process data, and control various output devices. Arduinos are widely used in IoT projects, robotics, home automation, and interactive art installations due to their versatility and robust community support.

**FEATURES :**

1. Open-source hardware and software for extensive customization and community support.

2. Cross-platform IDE compatible with Windows, macOS, and Linux.

3. User-friendly programming environment suitable for beginners and advanced users.

4. Expandable functionality through add-on shields (e.g., WiFi, Bluetooth, motor control).

5. Cost-effective microcontroller platform for hobbyists and educational purposes.

6. Real-time processing capabilities for time-sensitive applications.

7. Multiple analog and digital I/O pins for interfacing with various sensors and actuators.

8. Built-in serial communication interfaces, including USB for easy programming and debugging.

**Soil Moisture Sensor:**

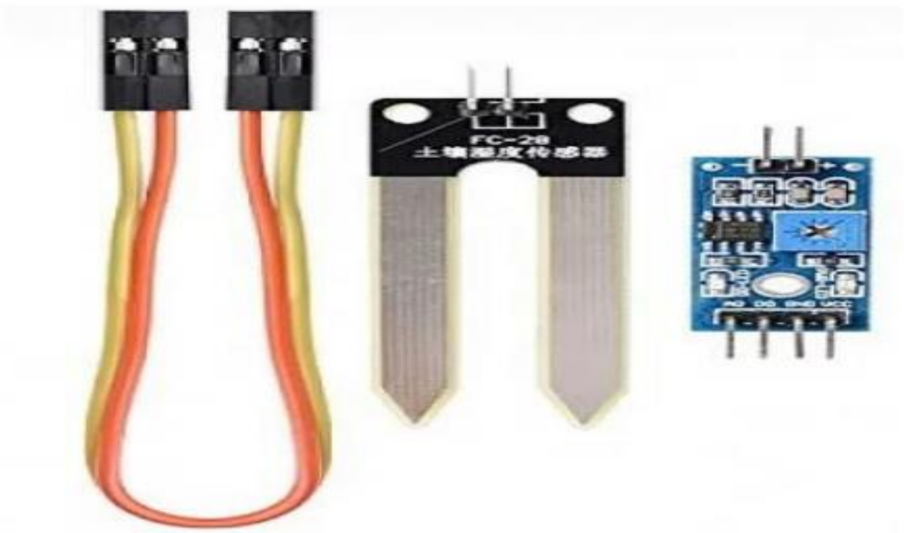



**Fig 4.3**

This is a simple water sensor that can be used to detect soil moisture when the soil moisture deficit

module plant waterer device, so that the plants in your garden without people to manage. It gives a digital

output of 5V when the moisture level is high and 0V when the moisture level is low in the soil.

Connection:

VCC ➟ 3.3V-5V

GND ➟ GND

DO ➟ Digital output interface(0 and 1)

AO ➟ Analog output interface

**Features:**

1. Measures volumetric water content in soil or similar mediums.
2. Uses electrical resistance or dielectric constant to detect moisture levels.
3. Available in both analog and digital output versions for versatile integration.
4. Corrosion-resistant probes for durability in harsh environments.
5. Low power consumption, suitable for battery-operated IoT devices.
6. Temperature compensation for accurate readings across various conditions.
7. Quick response time for real-time moisture monitoring.
8. Calibration options for different soil types and applications.

**Jumper Cables:**

**Fig 4.4**

**Features**

1. This is 10pcs of each (total 30 pcs) jumper cable Dual port wire for Arduino.
2. High quality and in good working condition.
3. Durable and reusable.
4. Easy to install and use.
5. A popular choice for construction or repair.
6. Be used for the electronic project and Genuine Arduino product.

**LCD Display:**

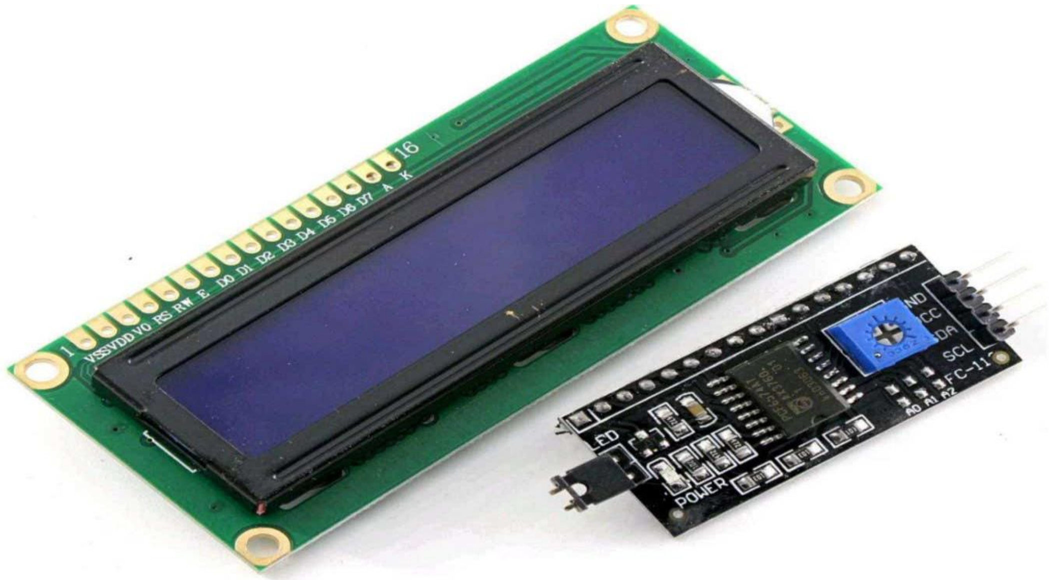


**Fig 4.5**

This is LCD 1602 Parallel LCD Display that provides a simple and cost-effective solution for adding a 16×2 White on Liquid Crystal Display into your project. The display is 16 character by 2 line display has a very clear and high contrast white text upon a blue background/backlight.

**Feature:**

1.Green backlight.

2. 4-bit or 8-bit MPU interface enabled.

3. 80 X 8-bit display RAM (80 characters max).

4. Working Voltage: 5V.

5. Standard Type.

6. Works with almost any Microcontroller.

7. Compact size, lightweight, and easy to interface.

**Ultrasonic Sensors:**

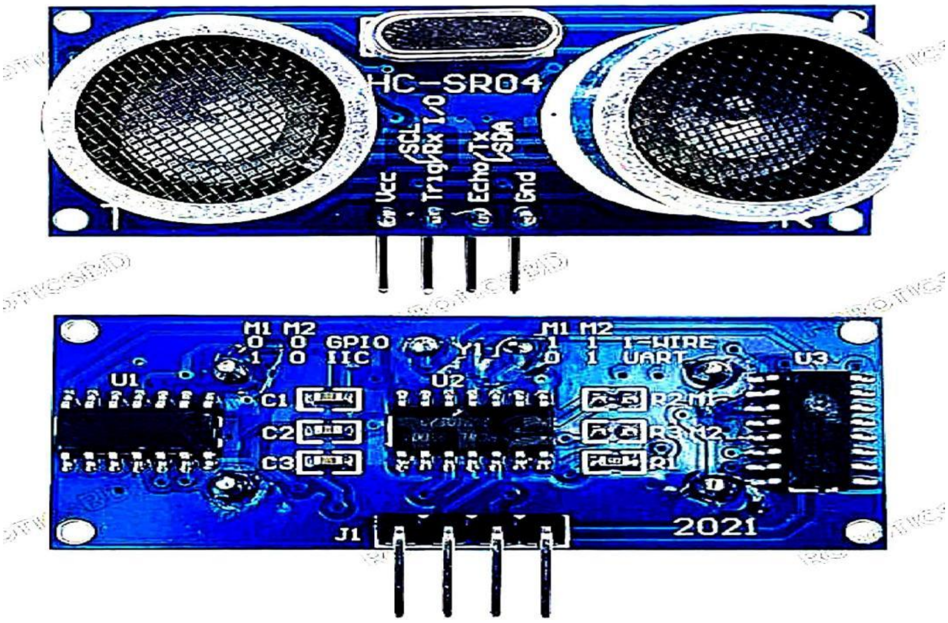



**Fig 4.6**

Ultrasonic sensors use sound waves to measure distance, making them valuable in robotics, automation, and security applications. They typically consist of a transmitter and receiver, measuring the time taken for sound waves to bounce back from an object. Most sensors used with Arduino have a range of 2cm to 400cm and are not affected by light conditions or object color. They provide accurate, non-contact distance measurements and are easy to interface with Arduino boards. Ultrasonic sensors are commonly used in obstacle avoidance systems, water level monitoring, and proximity detection.

**Feature:**

1. Non-contact distance measurement

2. Typical range of 2cm to 400cm

3. High accuracy and precision

4. Not affected by color or transparency of objects

5. Works well in various lighting conditions

6. Low power consumption

**LEDs:**

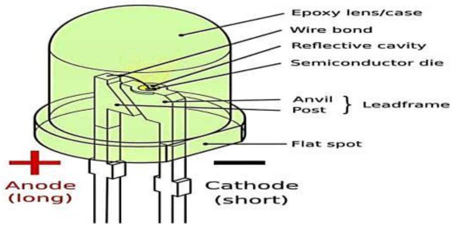



Fig 4.7

Light Emitting Diodes (LEDs) are simple yet versatile components in electronics projects. They come in various colors and sizes, providing visual indicators for system status, data transmission, or decorative lighting. LEDs are low-power devices with long lifespans and fast response times. They can be easily controlled using Arduino's digital pins, with options for brightness control through PWM. LEDs are fundamental in creating visual feedback in projects, from simple on/off indicators to complex lighting patterns and displays.

**Feature:**

1. Visual indicators for system status

2. Available in various colors

3. Low power consumption

4. Long lifespan

5. Fast response time

6. Can be used for data transmission (e.g., IR communication)

**Buzzer:**


Fig 4.8

Buzzers provide audio feedback in Arduino projects, useful for alarms, notifications, and simple music generation. They come in active (with built-in oscillators) and passive types, both easily controlled by Arduino's digital pins. Buzzers can produce various tones and frequencies, allowing for different audio signals. They are compact, low-power devices that add an auditory dimension to projects. Buzzers are commonly used in timers, doorbells, game projects, and alert systems, enhancing user interaction with Arduino-based devices.

**Feature:**

1. Audio feedback for alerts and notifications

2. Can produce various tones and frequencies

3. Active and passive types available

4. Low power consumption

5. Compact size

6. Simple to control with digital signals

**IR Sensor:**

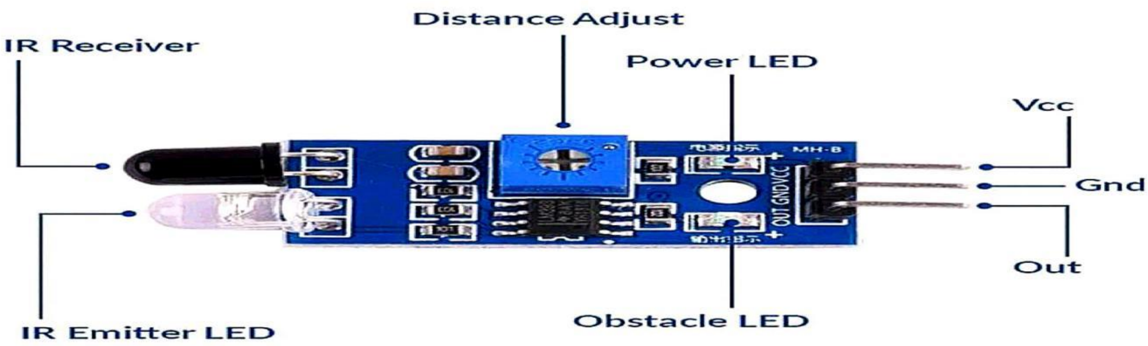



**Fig 4.9**

An Infrared (IR) sensor is an electronic device that detects IR radiation in its surrounding environment. It consists of an IR LED (emitter) and an IR photodiode (receiver) working together. The sensor emits IR radiation and detects the reflection from nearby objects. IR sensors are widely used in various applications, from obstacle detection in robotics to proximity sensing in smartphones, due to their simplicity, low cost, and effectiveness in short-range detection.

**Feature:**

1. Non-contact detection: Can sense objects without physical contact.

2. Adjustable range: Detection range can often be adjusted, typically from a few centimeters to several meters.

3. High response speed: Rapid detection capabilities make them suitable for real-time applications.

4. Low power consumption: Generally require minimal power to operate effectively.

5. Interference immunity: Less affected by ambient light compared to other optical sensors.

Versatility: Can be used for both object detection and distance measurement in various environments.

**Breadboard:**

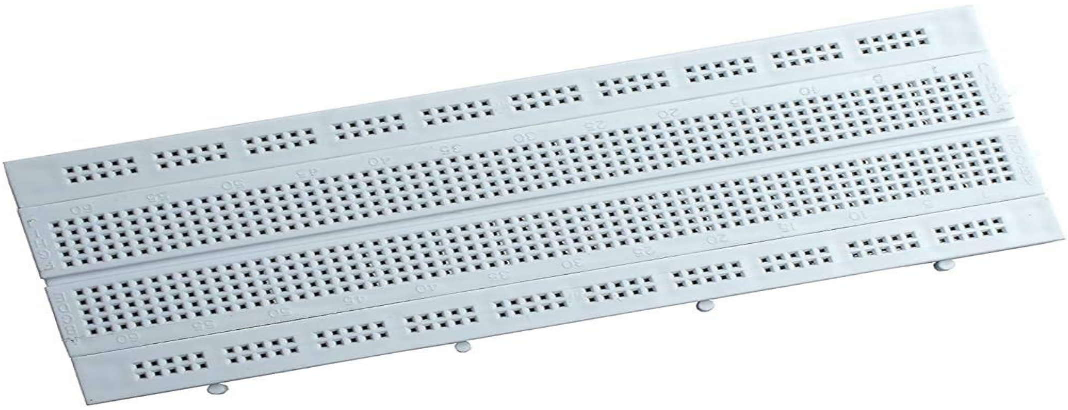


**Fig 4.10**

Breadboards are essential tools for prototyping electronic circuits without soldering. They feature a grid of holes where components and jumper wires can be easily inserted and removed. Breadboards typically have power rails running along the sides for convenient power distribution. They allow for quick circuit modifications and testing of different configurations. Some breadboards come with adhesive backing for secure mounting. Breadboards are invaluable for beginners learning electronics and for experienced makers prototyping new designs before final assembly.

**Feature:**

1. Allows for quick prototyping without soldering

2. Reusable for multiple projects

3. Organized layout with power rails

4. Accommodates various component sizes

5. Multiple tie points for each row

6. Some models have adhesive backing for secure mounting

**Power Supply Adapter:**

**Fig 4.11**

Power supplies provide the necessary electrical energy for Arduino projects. Options include batteries for portable applications, AC adapters for stationary setups, or USB power for computer-connected projects. Many power supplies offer voltage regulation to ensure stable output, crucial for sensitive electronics. Some models feature adjustable voltage output and protection against over-current and short-circuits. Choosing the right power supply depends on the project's power requirements, portability needs, and operating environment. Proper power management is essential for the reliability and longevity of Arduino-based systems.

**Feature:**

1. Provides necessary voltage and current for the system
2. Options include batteries, AC adapters, or USB power
3. Voltage regulation for stable output
4. Over-current and short-circuit protection
5. Some models offer adjustable voltage output
6. Portable options available for field use

**Components Required for SMART WASTE MANAGEMENT SYSTEM : AUTOMATED SEGREGATION AND REAL-TIME MONITORING :**

**Project Software Used**

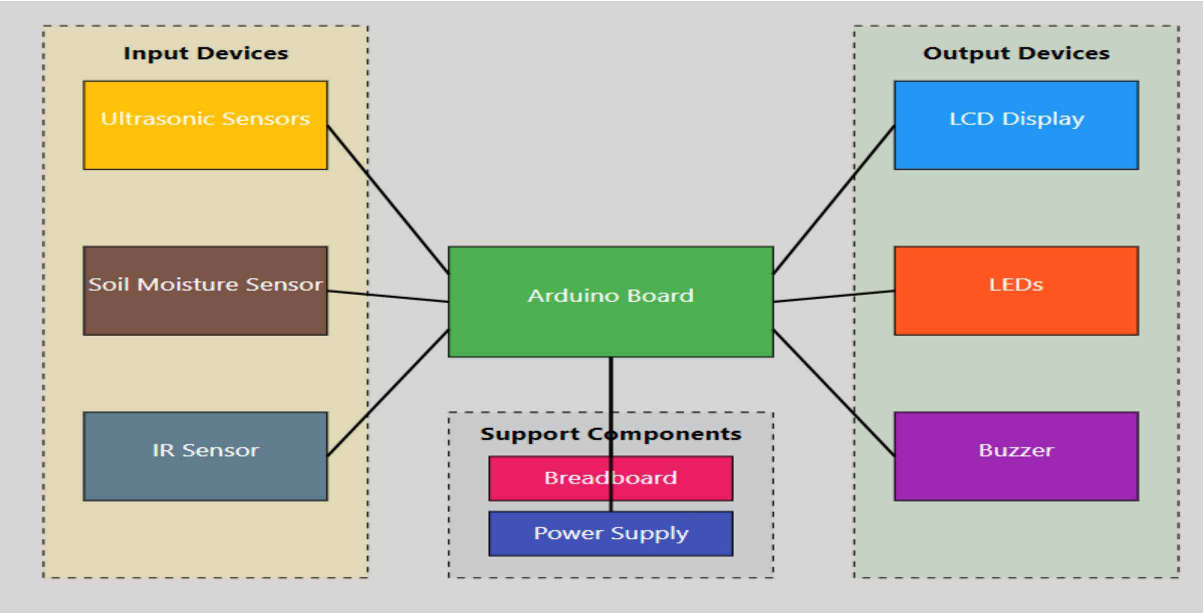
Arduino Software

**Project Hardware Used**

1. Arduino Board
2. LCD Display
3. Ultrasonic Sensors
4. LEDs
5. Buzzer
6. Soil Moisture Sensor
7. IR Sensor
8. Breadboard
9. Power Supply adapter

# CHAPTER 5

## METHODOLOGY




### 1. Identify requirements:

The first step involves defining the project's goals and specific functionalities. This includes determining what environmental factors to monitor (e.g., soil moisture, distance), the desired outputs (e.g., LCD display, LEDs, buzzer), and any specific performance criteria. It's crucial to consider the project's scope, budget constraints, and intended use environment during this phase.

### 2. Choose hardware:

Based on the requirements, select appropriate components for the project. This includes the Arduino board, sensors (ultrasonic and soil moisture), output devices (LCD, LEDs, buzzer), and any necessary supporting components like resistors or capacitors. Consider factors such as compatibility, accuracy, power consumption, and cost when choosing hardware.

### 3. Sensor data acquisition:

This stage focuses on implementing the code to read data from the sensors. It involves setting up communication protocols, calibrating sensors, and processing raw data into usable information. Ensure proper timing and sampling rates for each sensor to get accurate and timely readings. Consider implementing error checking and data validation to handle potential sensor malfunctions.

**4. Data visualization and control:**

Develop the logic to display sensor data on the LCD screen and control the LEDs. This involves formatting data for clear presentation, updating the display at appropriate intervals, and implementing any user interface elements. Create a logical system for using LEDs to indicate different states or conditions based on sensor readings.

**5. Notifications and alerts:**

Implement the system for triggering alerts based on sensor data. This includes setting thresholds for various conditions, programming the buzzer to sound different alerts, and ensuring timely notification of important events. Consider creating a hierarchy of alerts and a system for users to acknowledge or silence them.

**6. Testing and optimization:**

Conduct thorough testing of each component and the system as a whole. This involves checking sensor accuracy, verifying alert conditions, and ensuring smooth operation of all features. Optimize the code for efficiency, considering factors like power consumption and response time. Debug any issues and refine the system based on test results.

**7. Deployment:**

Prepare the system for its intended environment. This may involve creating a protective enclosure, setting up power supply solutions, and finalizing any user instructions or documentation. Consider factors like weatherproofing if the system will be used outdoors. Plan for ongoing maintenance and potential future upgrades to the system.

## 5.2 PROGRAM CODE

```
#include <LiquidCrystal.h>
#include <Servo.h>
#include <Wire.h> // Library for I2C communication
#include <LiquidCrystal_I2C.h> // Library for LCD
Servo myservo;  // create servo object to control a servo
// twelve servo objects can be created on most boards
int irsensor = 2;
int pos = 0;    // variable to store the servo position
int value = A0;
#define trigPin 4
#define echoPin 3
#define trigPin1 6
#define echoPin1 7
#define buzz 5
// Define pins for LEDs
#define RED_LED 10
#define GREEN_LED 11
#define BLUE_LED 12
const int buzzerPin = 5; // Buzzer connected to digital pin 5
LiquidCrystal_I2C lcd = LiquidCrystal_I2C(0x27, 16, 4);
void setup() {
  // Set pin modes for LEDs and Buzzer
  pinMode(RED_LED, OUTPUT);
  pinMode(GREEN_LED, OUTPUT);
  pinMode(BLUE_LED, OUTPUT);
  // Initialize the ultrasonic sensor
  pinMode(trigPin, OUTPUT);
  pinMode(echoPin, INPUT);
  pinMode(trigPin1, OUTPUT);
  pinMode(echoPin1, INPUT);
  pinMode(buzz, OUTPUT);
  lcd.init();
  lcd.backlight();
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("TRASH IN");
  lcd.setCursor(0, 1);
  lcd.print("CASH OUT");
  delay(3000);
  lcd.clear();
  Serial.begin(9600); // Initialize serial communication for debugging
  lcd.setCursor(0, 0);
  lcd.print("Distance:");
  myservo.attach(9);  // attaches the servo on pin 9 to the servo objec
  myservo.write(100);
```

```
  delay(1000);
  pinMode (irsensor, INPUT);
  pinMode (value, INPUT);
}

void loop() {
  value = analogRead(A0);
  if (digitalRead(2) == LOW && value > 950)
  {
    myservo.write(30);
    delay(1000);
    myservo.write(100);
    delay(1000);
    lcd.setCursor(0, 0);
    lcd.print("DRY Waste ");
    lcd.setCursor(3, 1);
    lcd.print("Detected");
    delay (1000);
    // Generate a tone at 440 Hz (A4 note) for 1 second
    tone(buzzerPin, 440, 1000);
    delay(1000); // Wait for 1 second
    digitalWrite(RED_LED, HIGH);
    digitalWrite(GREEN_LED, LOW);

    // Measure distance
  long duration, distance;
  digitalWrite(trigPin, LOW);
  delayMicroseconds(2);
  digitalWrite(trigPin, HIGH);
  delayMicroseconds(10);
  digitalWrite(trigPin, LOW);

  duration = pulseIn(echoPin, HIGH);
  distance = (duration / 2) / 29.1; // Convert duration to distance in cm

  // Display the distance on the LCD
  lcd.setCursor(0, 1);
  lcd.print("                "); // Clear previous value
  lcd.setCursor(0, 1);
  lcd.print(distance);
  lcd.print(" cm");

  // Print distance to Serial Monitor (optional)
  Serial.print("Distance: ");
  Serial.print(distance);
  Serial.println(" cm");

  // Small delay before next measurement
```

```
delay(500);

}
else
{



}
lcd.clear();
value = analogRead(A0);
if (value < 900) {
  Serial.println(value);
  myservo.write(170);
  delay(1000); // Wait for 1 second
  myservo.write(100);
  delay(1000);
  lcd.setCursor(0, 0);
  lcd.print("WET Waste ");
  lcd.setCursor(3, 1);
  lcd.print("Detected");
  delay (1000); // Wait for 1 second
  // Generate a tone at 880 Hz (A5 note) for 1 second
  tone(buzzerPin, 880, 1000);
  delay(1000); // Wait for 1 second
  digitalWrite(RED_LED, LOW);
  digitalWrite(GREEN_LED, HIGH);

   // Measure distance
long duration, distance;
digitalWrite(trigPin1, LOW);
delayMicroseconds(2);
digitalWrite(trigPin1, HIGH);
delayMicroseconds(10);
digitalWrite(trigPin1, LOW);

duration = pulseIn(echoPin1, HIGH);
distance = (duration / 2) / 29.1; // Convert duration to distance in cm

// Display the distance on the LCD
lcd.setCursor(0, 1);
lcd.print("                "); // Clear previous value
lcd.setCursor(0, 1);
lcd.print(distance);
lcd.print(" cm");

// Print distance to Serial Monitor (optional)
Serial.print("Distance: ");
Serial.print(distance);
```

```
Serial.println(" cm");

// Small delay before next measurement
delay(500);

}
else
{



}
lcd.clear();
long duration, inches, cm;
// The PING))) is triggered by a HIGH pulse of 2 or more microseconds.
// Give a short LOW pulse beforehand to ensure a clean HIGH pulse:
digitalWrite(trigPin, LOW);
delayMicroseconds(2);
digitalWrite(trigPin, HIGH);
delayMicroseconds(5);
digitalWrite(trigPin, LOW);
// Take reading on echo pin
duration = pulseIn(echoPin, HIGH);
// convert the time into a distance
inches = microsecondsToInches(duration);
cm = microsecondsToCentimeters(duration);

Serial.print(inches);
Serial.print("in, ");
Serial.print(cm);
Serial.print("cm");
Serial.println();

if (inches <3) {
  digitalWrite(buzz, HIGH);
  delay(500);
  lcd.setCursor(0,0);
  lcd.print("TRASH BIN ");
  lcd.setCursor(5,1);
  lcd.print("FULL");
  digitalWrite(RED_LED, LOW);
  digitalWrite(GREEN_LED, LOW);
  digitalWrite(BLUE_LED, HIGH);
  // Generate a tone at 523 Hz (C5 note) for 1 second
  tone(buzzerPin, 523, 1000);
  delay(1000); // Wait for 1 second

} else {
```

```
    Serial.println("no hand");
    digitalWrite(buzz, LOW);
    delay(500);
    digitalWrite(RED_LED, LOW);
    digitalWrite(GREEN_LED, LOW);
    digitalWrite(BLUE_LED, LOW);
  }

  delay(100);
}

long microsecondsToInches(long microseconds)
{

  return microseconds / 74 / 2;
}

long microsecondsToCentimeters(long microseconds)
{
  // The speed of sound is 340 m/s or 29 microseconds per centimeter.
  // The ping travels out and back, so to find the distance of the
  // object we take half of the distance travelled.
  return microseconds / 29 / 2;
}
```

### 5.3 Advantages:

**Versatility:** This project combines multiple sensors and outputs, enabling a wide range of applications. It can be adapted for environmental monitoring, home automation, or educational demonstrations. The diverse components allow for complex data collection and analysis.

**Educational value:** The setup provides hands-on experience with electronics, programming, and sensor integration. Users can learn about microcontroller basics, sensor interfacing, and data processing. It's an excellent platform for STEM education and hobbyist learning.

**Real-time monitoring:** The LCD display enables instant visualization of sensor data and system status. Users can see immediate results of their programming and sensor readings. This real-time feedback is valuable for debugging and dynamic applications.

**Cost-effectiveness:** Arduino boards and most components used are relatively inexpensive. This makes the project accessible to students, hobbyists, and small-scale researchers. The low cost encourages experimentation without significant financial risk.

**Open-source platform:** Arduino's open-source nature provides access to a vast community and resources. Users can find libraries, tutorials, and support forums easily. This ecosystem accelerates learning and problem-solving.

**Multiple feedback mechanisms:** The project incorporates visual (LCD, LEDs) and auditory (buzzer) outputs. This multi-modal feedback enhances user interaction and data representation. It allows for creating more intuitive and informative interfaces.

**Environmental sensing:** Inclusion of sensors like moisture sensors enables environmental monitoring. This opens up applications in agriculture, weather monitoring, and ecology. The project can be adapted for various environmental studies.

## 5.4 Disadvantages:

**Complexity:** Managing multiple sensors and outputs can be overwhelming for beginners. The project requires understanding of various sensor protocols and integration techniques. It may have a steep learning curve for those new to electronics.

**Power management:** Coordinating power requirements for various components can be challenging. Different sensors may have varying voltage needs and power consumption. Efficient power distribution and management are crucial for reliable operation.

**Connection reliability:** Breadboard connections can be prone to looseness and intermittent issues. This can lead to inconsistent readings or system failures. For long-term use, more permanent connection methods might be necessary.

**Processing limitations:** Arduino has limited processing power compared to more advanced platforms. This may constrain complex algorithms or real-time data processing. For demanding applications, a more powerful microcontroller might be needed.

**Calibration requirements:** Some sensors, particularly environmental ones, may need regular calibration. This ensures accurate readings but adds to maintenance overhead. Calibration processes can be time-consuming and may require specialized equipment.

# CHAPTER 6

## 6.1 CONCLUSION

In conclusion, this project successfully demonstrates the integration of multiple electronic components with an Arduino microcontroller to create a versatile and comprehensive monitoring and alert system. The system effectively incorporates ultrasonic sensors, an LCD display, LEDs, a buzzer, and a soil moisture sensor to achieve its objectives. The ultrasonic sensors provide accurate distance measurements, essential for applications such as obstacle detection and level monitoring. This capability ensures that the system can be used in diverse environments requiring precise spatial awareness.

The LCD display plays a crucial role in enhancing user interaction by presenting real-time data, making the system user-friendly and informative. Users can easily monitor the status of the system and receive timely updates on sensor readings. The inclusion of LEDs offers a straightforward yet effective method for indicating the system's operational status, providing immediate visual feedback. The buzzer adds another layer of alert functionality, delivering audible warnings in critical situations to ensure prompt responses.

A key feature of this project is the soil moisture sensor, which adds significant value, particularly for agricultural and gardening applications. This sensor ensures optimal soil conditions by continuously monitoring moisture levels, thus helping maintain healthy plant growth. The successful integration of these components showcases the Arduino's ability to handle diverse inputs and outputs simultaneously, proving its versatility and robustness.

Overall, this project highlights the flexibility and potential of Arduino-based systems in developing comprehensive monitoring solutions. It underscores the effectiveness of combining various sensors and output devices in a cohesive system. The successful implementation of this project not only demonstrates the technical feasibility but also lays a solid foundation for future enhancements and potential real-world applications. The project serves as a testament to the power of Arduino in creating innovative solutions that cater to a wide range of monitoring and alert needs, paving the way for further exploration and development in this field.

## 6.2 Future Scope:

1. Wireless Connectivity: Integrate Wi-Fi or Bluetooth modules to enable remote monitoring and control. This could allow data to be sent to a cloud platform or a mobile app for real-time access and analysis.

2. Expanded Sensor Array: Add more sensors to monitor additional environmental factors like temperature, humidity, light levels, or air quality. This would provide a more comprehensive environmental assessment.

3. Machine Learning Integration: Implement basic machine learning algorithms on the Arduino or a connected system to predict trends, detect anomalies, or optimize environmental conditions based on historical data.

4. Energy Efficiency: Explore solar power or other renewable energy sources to make the system self-sustainable, especially for outdoor applications.

5. Scalability: Develop a network of these devices that can communicate with each other, allowing for monitoring of larger areas or multiple locations simultaneously.

## 6.3 Limitations:

1. Limited Processing Power: Arduino boards have relatively low processing power compared to more advanced microcontrollers or single-board computers. This may limit the complexity of data analysis and the number of sensors that can be simultaneously managed.

2. Wired Connections: The current design relies on wired connections, which can limit placement flexibility and make it challenging to monitor large or dispersed areas.

3. Power Constraints: If running on batteries, the system may have limited operational time before requiring recharging or battery replacement, especially with continuous monitoring.

4. Limited Data Storage: Arduino boards typically have limited onboard memory, restricting the amount of historical data that can be stored locally.

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# CHAPTER - 7

# MODEL OF THE PROPOSED SYSTEM FOR SMART WASTE MANAGEMENT SYSTEM : AUTOMATED SEGREGATION AND REAL-TIME MONITORING