Waste Not, Want Not: A Sustainable Approach to Living

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Publication Date: 2025/03/24

Abstract: The growing population has contributed to a noticeable decline in the standards of waste management systems. As a result, current disposal methods have become increasingly detrimental to the environment. The accumulation of waste in public spaces leads to the contamination of surrounding areas, creating additional environmental and health risks. This situation could worsen various health problems for individuals living nearby. Furthermore, the overall condition of the affected areas is likely to degrade over time. To address this issue and ensure cleaner environments, it is crucial to implement an intelligent waste management system. This research proposes a sophisticated system capable of distinguishing between different types of waste, such as plastics, metals, and non-metallic materials. Given the urgency of the problem, the need for an automated waste management system has never been greater. Without effective segregation, proper waste disposal becomes virtually impossible.

Keywords: *Waste Management, ARDUINO, GSM, Tinkercad, Distance Sensors, Passive Infrared Sensors (PIR).*

How to Cite: Rupkatha Goswami, Sayandip Dutta; Surajit Basak; Kaushik Roy; Koushik Pal. (2025). Waste Not, Want Not: A Sustainable Approach to Living. *International Journal of Innovative Science and Research Technology*, 10(2), 2396-2404. https://doi.org/10.38124/ijisrt/25feb1505.

I. INTRODUCTION

This Improper waste management is a critical issue with serious consequences for both public health and the environment. When waste is not correctly sorted or disposed of, it can lead to significant pollution, which endangers ecosystems, contaminates water sources, and degrades air quality. Hazardous materials within waste, if mishandled, pose a particular risk, potentially leading to toxic contamination of land and water systems [1]. This improper disposal also contributes to an increase in harmful greenhouse gas emissions, which further accelerates global climate change.

Waste management remains one of the most challenging tasks for urban areas worldwide, where large amounts of waste are generated daily. Effective strategies for segregating biodegradable and non-biodegradable materials are vital to mitigating these environmental risks. Our model draws on established waste management strategies and integrates innovative systems for waste sorting [2]. By utilizing insights from previous models, we have developed a streamlined digital framework that enhances waste separation and ensures more efficient disposal practices.

II. RELATED WORKS

The authors in [3] proposed an approach that focused on efficient waste categorization and disposal by effectively distinguishing between metallic and non-metallic waste. The proposed system offers significant environmental and economic benefits. The authors meticulously detailed their concepts through comprehensive descriptions and illustrative diagrams. Furthermore, the paper clearly illustrated and explained the utilization of sensors, integrated with relevant logic, to facilitate the efficient implementation of this waste management system. The accumulation of waste in public spaces leads to unclean surroundings. This can pose various health risks to the local community. Additionally, it diminishes the area's overall value. The authors proposed in [4] aims to mitigate these issues and improve cleanliness. This setup utilizes sensor technology to assess the level of waste in bins, and a GSM system to relay that information to an authorized control room.

Waste management is a critical issue globally, and numerous studies have been conducted to explore sustainable methods for managing waste across various stages, including collection, recycling, treatment, and disposal. Below are some key areas and works that have

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25feb1505

contributed to the development of waste management practices:

A. *Waste Sorting and Recycling*

The Various technologies for waste sorting and recycling, including hybrid manual-automated systems, have been shown in figure1 to improve material recovery rates.

Fig 1: Waste Sorting and Recycling

B. *Biological Treatment Methods*

Studies on composting and anaerobic digestion highlight their potential for efficient organic waste treatment, with biogas production offering a renewable energy source as shown in figure 2 following [5].

C. *Circular Economy*

The circular economy approach promotes product design for recycling and reuse, encouraging businesses to adopt eco-design principles to reduce waste as shown in figure 3.

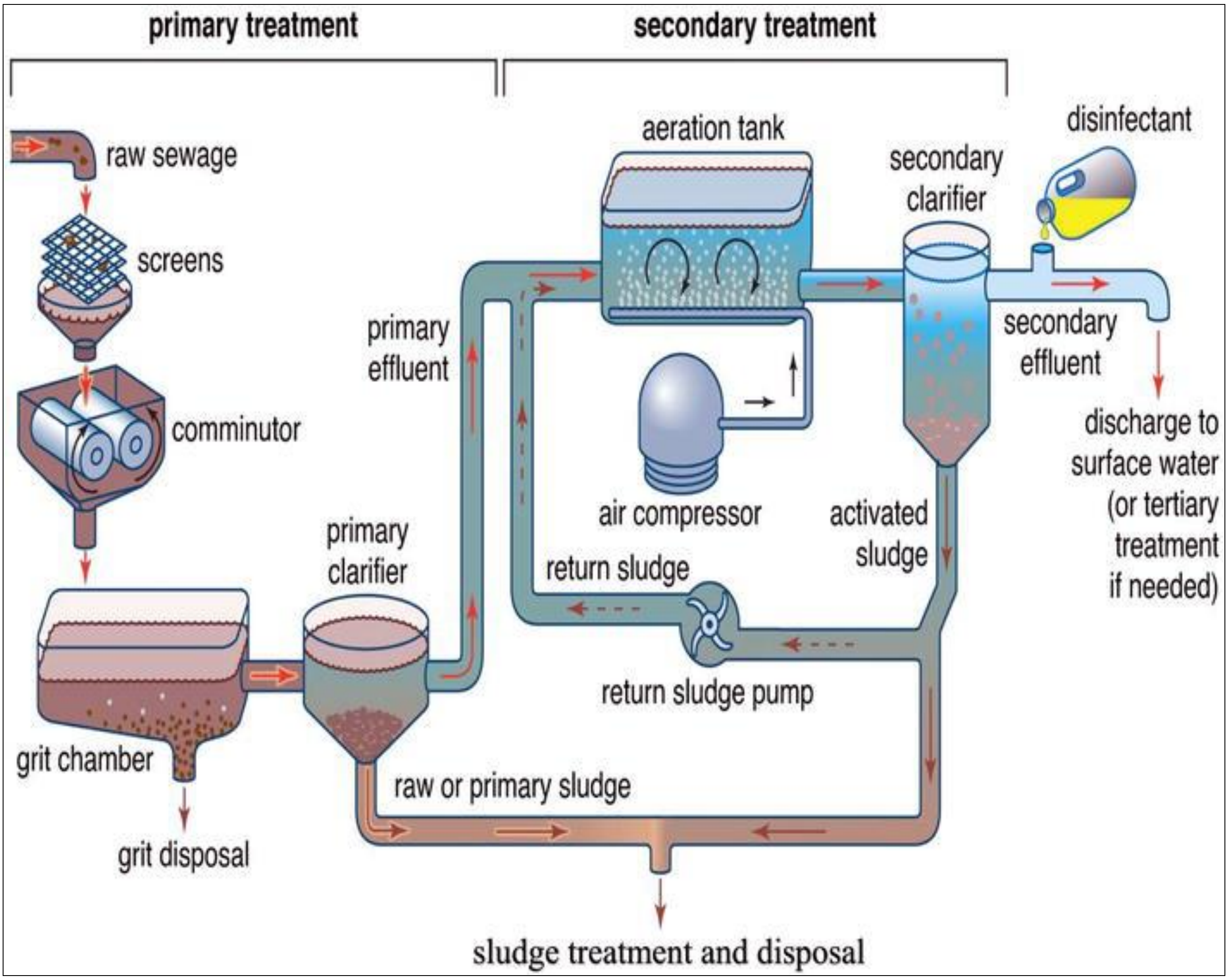

Fig 2: Biological Treatment Methods

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25feb1505

Fig 3: Circular Economy

D. Waste-To-Energy (WTE)

Waste-to-energy technologies like incineration and pyrolysis help reduce waste volume while generating energy as shown in figure 4. Newer methods like pyrolysis show promise for better efficiency and lower emissions.

Fig 4: WTE

E. Integrated Waste Management (IWM)

IWM systems combine various strategies to optimize waste reduction, collection, and disposal, with public-private partnerships playing a key role as shown in figure 5.

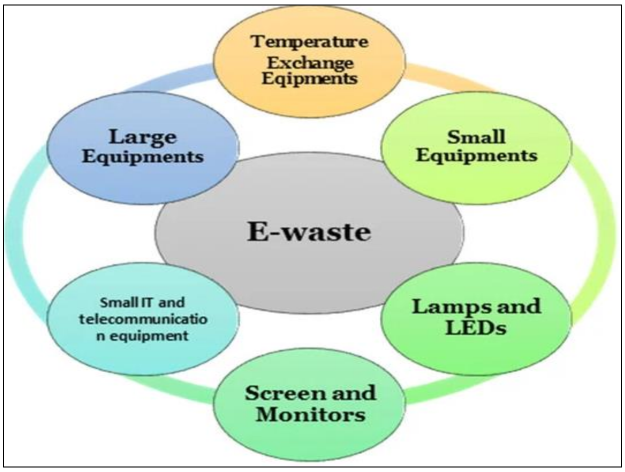

Fig 5: IWM

Fig 6: Smart Waste Solutions

F. Smart Waste Solutions

IoT sensors and machine learning are being used to optimize waste collection and predict generation patterns, improving efficiency and reducing costs as shown in figure 6.

G. Behavioral Aspects

Public participation in waste management is critical; educational campaigns and community engagement influence waste reduction behaviours [6] as shown in figure 7.

Fig 7: Behavioral Aspects

H. E-Waste Management

With the rise in electronic waste, studies emphasize the need for better recycling infrastructure and regulations to manage e-waste effectively as shown in figure 8.

I. Policy and Regulation

Effective policies and regulations are the key to reducing landfill use and promoting recycling, as demonstrated by

Fig 8: E-Waste Management

Fig 9: Policy and Regulations

Studies on waste management frameworks in different countries as shown in figure 9.

J. Sustainable Landfills

Innovations in landfill management aim to reduce environmental impacts, focusing on minimizing leachate and methane emissions through better design and operation [7] as shown in figure 10.

Fig 10: Sustainable Landfills

These studies highlight various approaches in waste management, from technological innovations to policy frameworks, aiming for more sustainable and efficient systems.

III. IMPORTANCE OF WASTE MANAGEMENT

Waste management has become increasingly significant on a global level in recent years. Waste is commonly generated in various settings, including households, factories, construction sites, refineries, and nuclear energy facilities. With arising population and shifting consumption habits, serious environmental challenges have surfaced alongside changing lifestyles. Ineffective waste management can adversely affect both the environment and public health [8]. Therefore, it is crucial for individuals and organizations to recognize the importance of proper management.

Recycling the materials generated by businesses can lead to cost savings. This would ultimately lower their waste disposal expenses. Furthermore, by understanding the different types of waste their operations produce, companies can choose waste management services tailored to their specific needs, which can also help minimize transportation costs. Moreover, waste management plays a role in promoting environmental sustainability by lowering greenhouse gas emissions and conserving natural resources, which enhances the company’s public image. Instead of discarding perishable items and harming the environment, restaurants have the option to donate them to those needs.

IV. CIRCUIT IMPLEMENTATION

A. Components Used

For the modelling purpose, we are using Tinkercad (shown in figure 11). It is a web browser used for free 3D modelling and circuit stimulation. It has become well-liked since its 2011 release as a tool for creating 3D printed models and as a teaching introduction to constructive solid geometry.

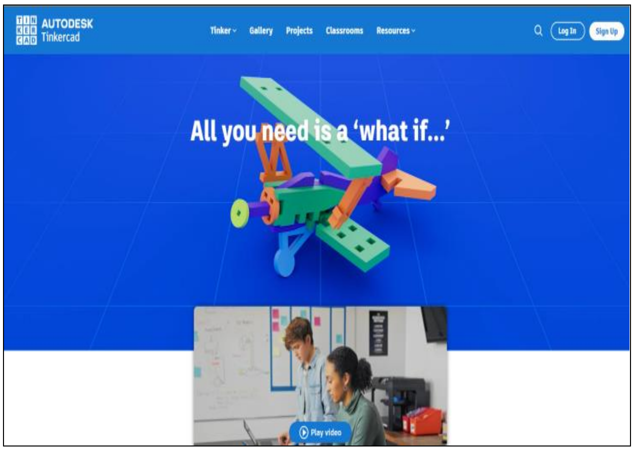

Fig 11: Tinkercad

- **Breadboard:** It's common practise to construct temporary circuits on a breadboard. Its utility allows designers to swiftly remove and alter components. We built the circuit on a bread board to demonstrate how it functions (shown in figure 12).

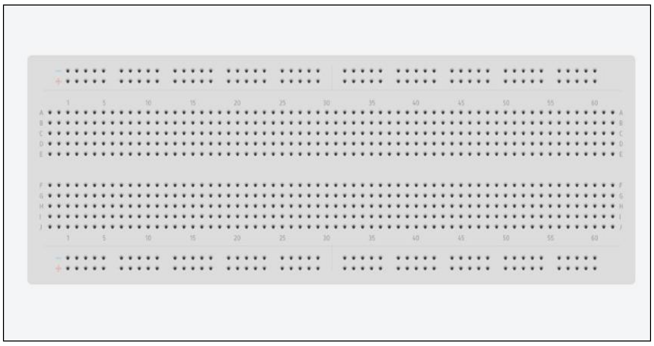

Fig 12: Breadboard

- **ARDUINO:** Various microcontrollers and CPUs are incorporated into the designs of Arduino boards. As seen in figure 13, the boards' sets of digital and analogue input/output (I/O) pins can connect to a wide range of expansion boards, breadboards (for prototyping), and other circuits.

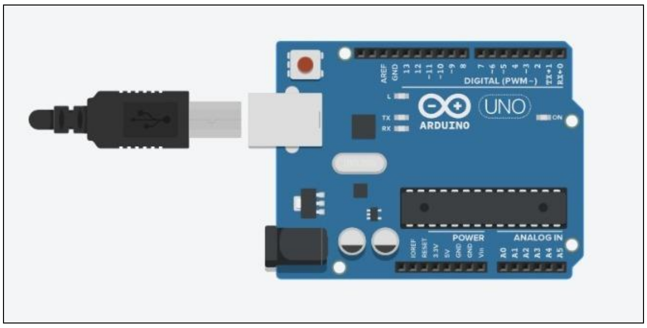

Fig 13: ARDUINO

- **Distance sensors**: These are used for precise positioning, rapid measurement, and a variety of material identification (shown in figure 14).

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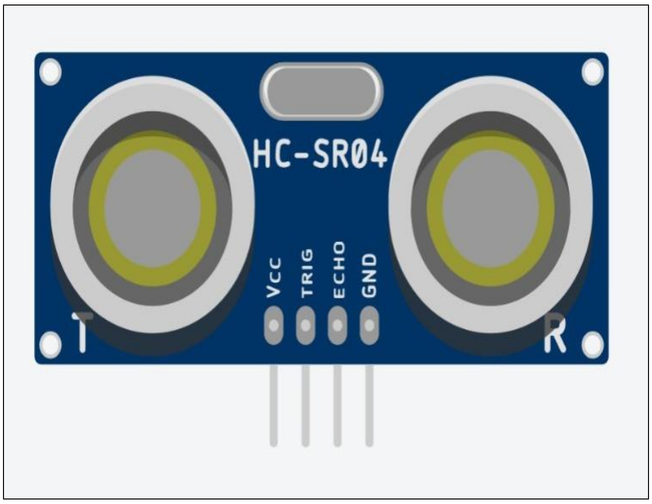

Fig 14: Distance Sensor

- **Passive infrared (PIR) sensor:** These devices are used to track locations for security and motion detection systems. They are designed to detect infrared radiation only. In thermal sensing applications like motion detection, security alarms, and smart lighting, PIR sensors are consequently widely used. A PIR sensor that recognises motion is a part of our model (shown in figure 15).

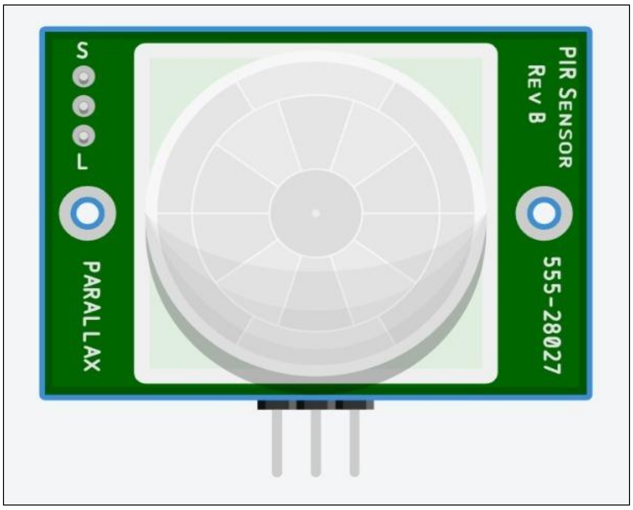

Fig 15: Passive Infrared (PIR) Sensor

B. Working Principle with Circuit Diagram

The image shown in figure 16 presents a flowchart illustrating the logic behind a system that detects human presence and motion using a PIR sensor. The flow chart may be breakdown as follows:

➢ *The System is Activated when the Circuit is Turned on.*

- **Distance Check:** The PIR sensor assesses the distance of the person from the sensor. If the person is at a distance greater than 150 cm, the system displays "out of range. If the person is within 150 cm, the PIR sensor monitors the person's movement.
- **Motion Detection:** If the person moves within the 150 cm range, the system displays "Motion detected". If the person remains stationary within the 150 cm range, the system displays "0".
- In essence, the system utilizes a PIR sensor to determine the presence and movement of a person within a specific distance range. The circuit diagram for our proposed system is shown in figure 17.

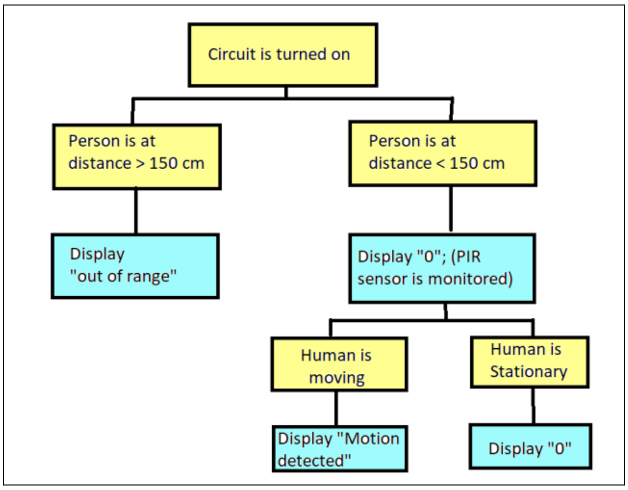

Fig 16: Flowchart of Circuit Approach

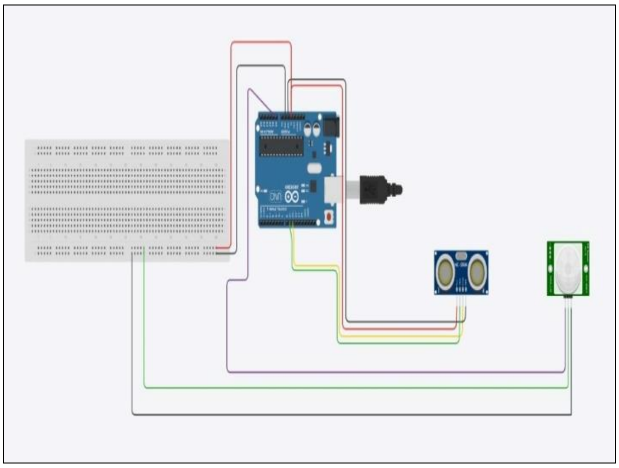
Fig 17: Circuit Diagram

V. SIMULATION RESULTS

The figure 18 shows that the circuit is turned on and serial monitor display “0”. The figure 19 represents display of serial monitor is “out of range” when distance is altered. The figure 20 depicts that the serial monitor display “motion detected” when distance is altered.

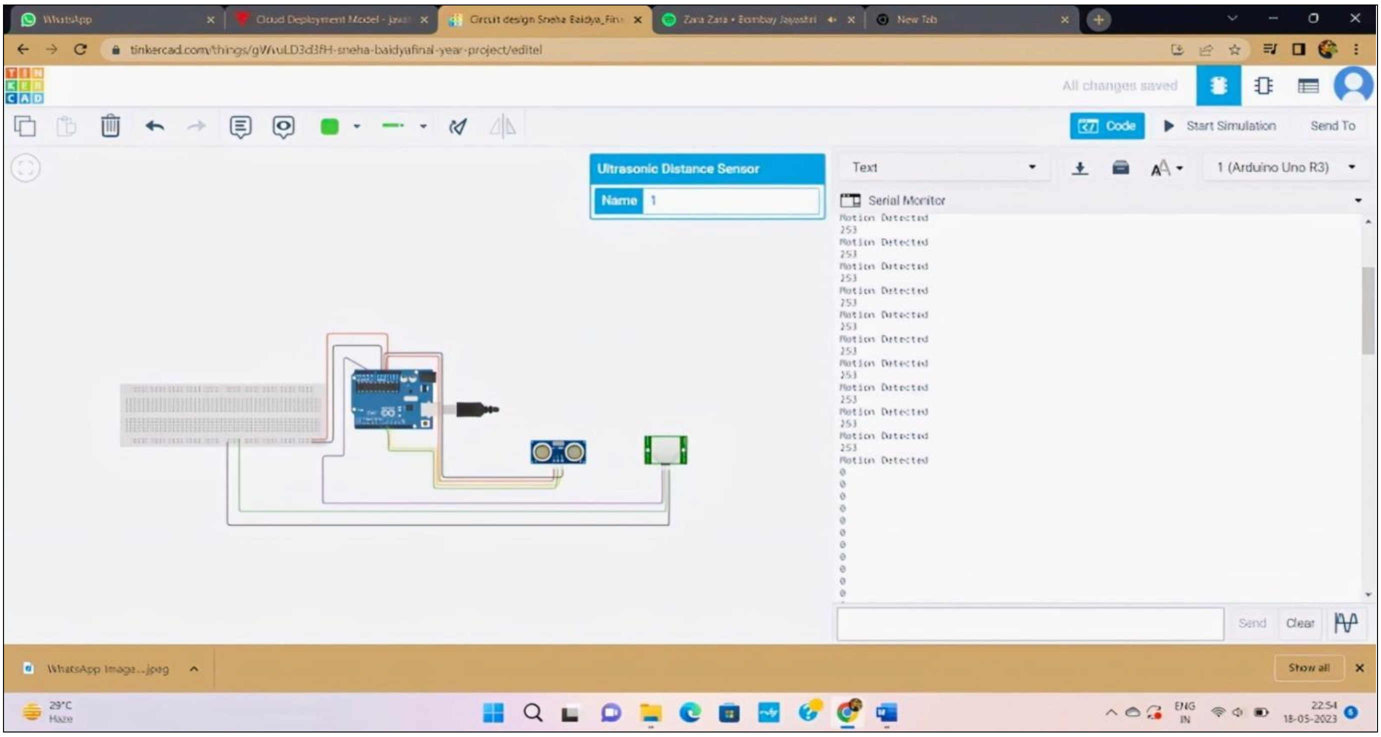

Fig 18: Simulation 1

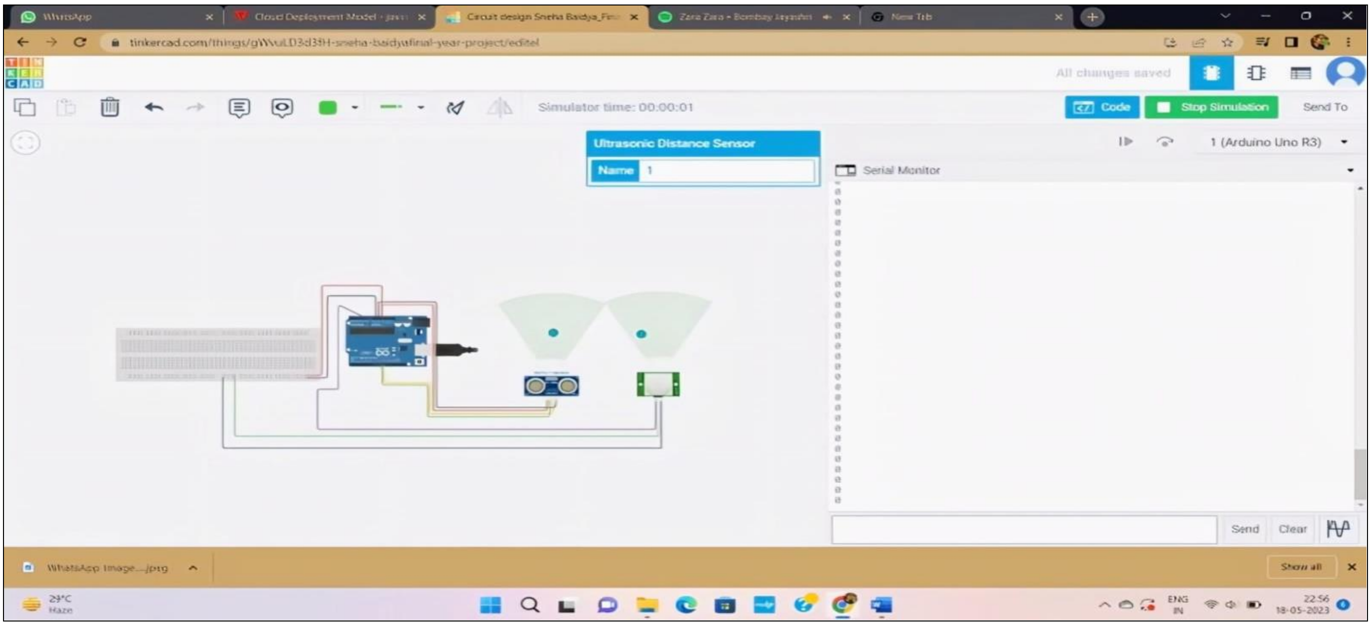

Fig 19: Simulation 2

VI. CODE IMPLEMENTATION APPROACH

To demonstrate how our proposed dustbin for waste management is to be built on the basis of motion detection and range, we develop a demo model.

A human is considered to be "out of range" when they are within 150 cm of the distance sensor, at which point the trash can lid does not open and the PIR sensor is not activated. The serial monitor shows "0" when a human enters the detection area and the PIR sensor is activated, which happens when they are within 150 cm of the distance sensor. Additionally, the dustbin lid opens for garbage disposal when the motion is continued, as indicated by the serial monitor's "Motion detected" display.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25feb1505

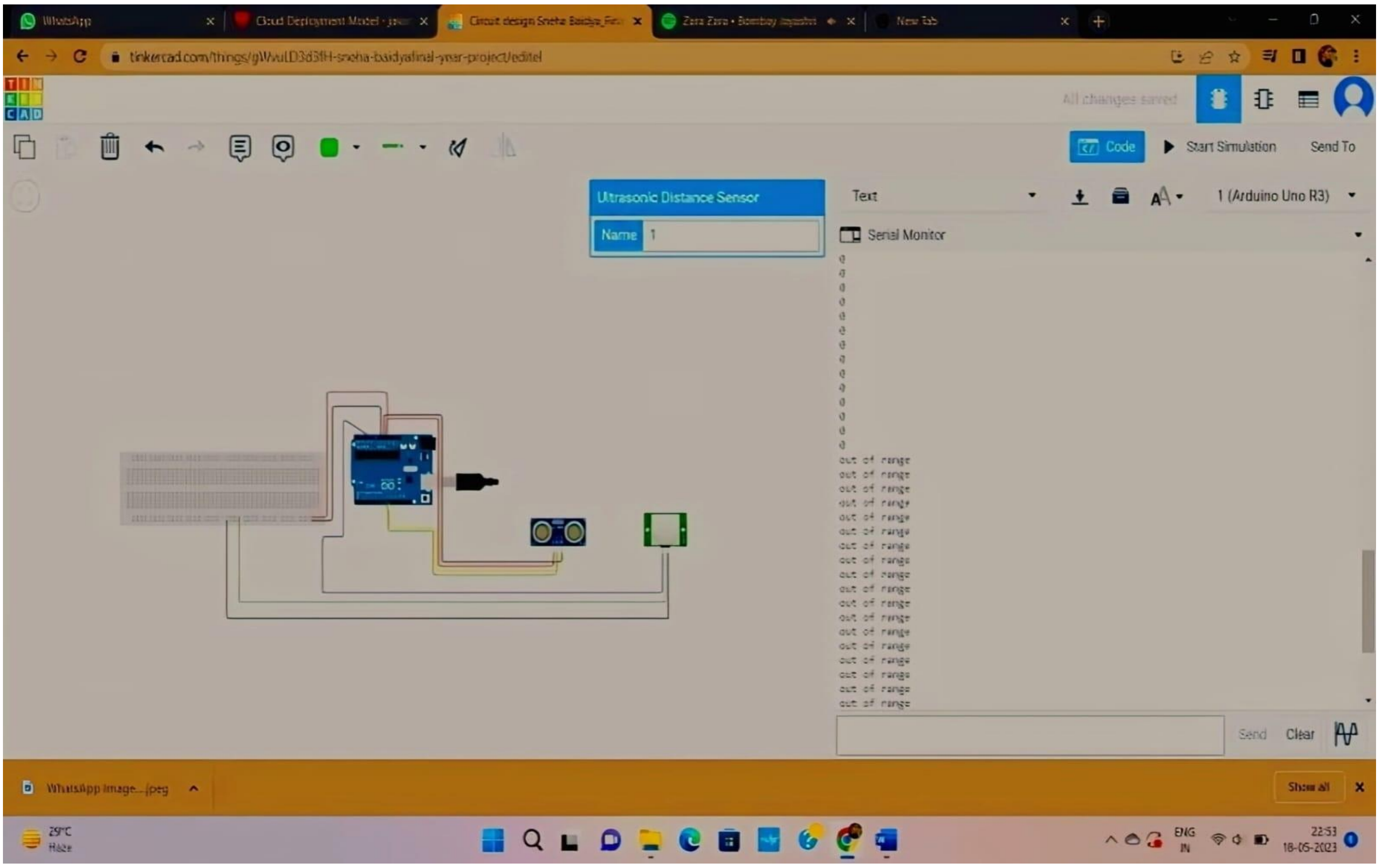

Fig 20: Simulation 3

➢ *CODE:*

```
const int trigPin = 9;
const int echoPin = 10;
int a=0;
int distanceCm;
int b=0;
long duration;
void setup() {
pinMode(trigPin, OUTPUT);
pinMode(echoPin, INPUT);
Serial.begin(9600);
}
void loop() {
digitalWrite(trigPin, LOW);
delayMicroseconds(2);
digitalWrite(trigPin, HIGH);
delayMicroseconds(10);
digitalWrite(trigPin, LOW);
duration = pulseIn(echoPin, HIGH);
distanceCm= duration*0.034/2;

if (distanceCm<150)
{
a=analogRead(A0);
b=map(a,0,1023,0,255);
Serial.println (b);
if (b>100)
{
Serial.println ("Motion Detected");
delay (100);
}

}
if (distanceCm>150)
{
Serial.println ("out of range");
delay (10);
}

delay(10);
}
```

VII. CONCLUSION AND FUTURE PLAN

Text Effective waste management plays a crucial role in maintaining clean, sustainable environments in both urban and rural areas. By implementing innovative and practical solutions, such as user-friendly waste disposal systems, we can significantly reduce waste-related challenges in public spaces. The proposed trash can design offers a reliable, cost-effective approach to waste management, ensuring ease of use, durability, and long-term functionality with minimal maintenance.

Looking ahead, there is a need to continue advancing waste management strategies to address growing urbanization and environmental concerns. Future efforts could focus on integrating smart technologies, such as sensors and automated systems, to improve waste

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25feb1505

collection efficiency. Additionally, the development of more eco-friendly materials and recycling solutions will play a key role in minimizing environmental impact. Collaboration between governments, businesses, and communities will be essential in creating sustainable waste management practices for a cleaner, greener future.

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