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The Smart Dry and Wet Waste Segregation

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Abstract: ***Rapid population growth and urban development have increased the amount of solid waste generated in cities and educational institutions. Improper disposal of mixed waste creates environmental pollution and reduces recycling efficiency. To solve this problem, a smart dustbin system is proposed that automatically separates wet and dry waste at the source level. The system uses sensors and a microcontroller to identify the type of waste and direct it into the appropriate container. Automatic segregation improves recycling efficiency and reduces manual handling of garbage. The proposed model is simple, low-cost, and suitable for use in homes, colleges, and public places.***

I. INTRODUCTION

Waste management has become an important environmental issue due to rapid population growth, urbanization, and increased consumption of products. Large quantities of waste are produced every day from households, educational institutions, industries, and public areas. In many places, different types of waste are thrown into the same dustbin without proper segregation. This mixing of waste creates environmental problems and makes recycling more difficult.Improper waste disposal can cause soil pollution, water contamination, unpleasant odors, and unhealthy surroundings. Therefore, proper waste management practices are necessary for maintaining a clean and sustainable environment.

Solid waste can generally be divided into two main categories: wet waste and dry waste. Wet waste mainly includes biodegradable materials such as food leftovers, vegetable peels, fruit waste, and other organic substances. These materials cannaturally decompose and can be used for composting. Dry waste includes materials such as plastic, paper, glass, and metal. These materials do not decompose easily but can be recycled and reused if they are separated properly.

One effective way to improve waste management is source-level segregation. Source segregation means separating waste at the place where it is generated. This makes recycling and composting processes easier and more efficient. However, many people do not follow proper segregation practices because of lack of awareness or convenience. Manual segregation can also be unhygienic and may expose workers to health risks.

With the development of technology, automation can help improve waste management systems Smart waste management solutions use sensors microcontrollers, and automated mechanisms to detect and separate waste materials. These systems reduce human effort and improve the efficiency of waste handling.

II. LITERATURE REVIEW

Many researchers have worked on smart waste management systems using sensors and automation technologies. Bharadwaj et al. proposed an IoT-based solid waste management system that monitors garbage levels in dustbins using sensors. The system sends real-time alerts when the bin becomes full, which helps improve waste collection efficiency. Sinha et al. developed a smart dustbin that performs automatic operations using sensors. Their system helps reduce manual effort and improves hygiene in public environments. Pushpa et al. designed a microcontroller-based automatic waste segregator that separates waste materials into different categories using sensors and control mechanisms.

Sharma and Singh proposed a smart waste management system using IoT technology for monitoring waste bins in smart cities. Although these systems provide useful solutions, many designs are expensive or complicated for small-scale applications. Therefore, there is a need for a simple and cost-effective automatic waste segregation system that can be used in homes, colleges, and public places.

III. PROBLEM STATEMENT

In many public places and institutions, traditional dustbins are still used where all types of waste are mixed together. This leads to several problems such as:

1) Difficulty in recycling materials
2) Increase in landfill waste

3) Bad odor and unhygienic surroundings
4) Additional labour required for manual segregation

Therefore, an automatic system that separates wet and dry waste at the source level is required.

IV. PROPOSED SYSTEM

The proposed system is a sensor-based automatic waste segregation dustbin. It detects the type of waste using moisture sensing and directs the waste into the appropriate container.

Main components used in the system:

1) Arduino UNO microcontroller
2) Moisture sensor
3) Ultrasonic sensor
4) Servo motor
5) Dual waste container (wet and dry)

The Arduino microcontroller acts as the control unit of the system. It receives signals from sensors, processes the data, and controls the movement of the servo motor.

V. METHODOLOGY

The working process of the system follows several steps. First, when waste is placed inside the dustbin, the ultrasonic sensor detects the presence of the object. The sensor sends a signal to the microcontroller indicating that waste has been deposited.

Next, the moisture sensor measures the moisture level of the waste material. Wet waste such as food leftovers usually contains higher moisture, while dry materials like plastic or paper contain lower moisture levels.

The microcontroller compares the detected moisture value with a predefined threshold value.

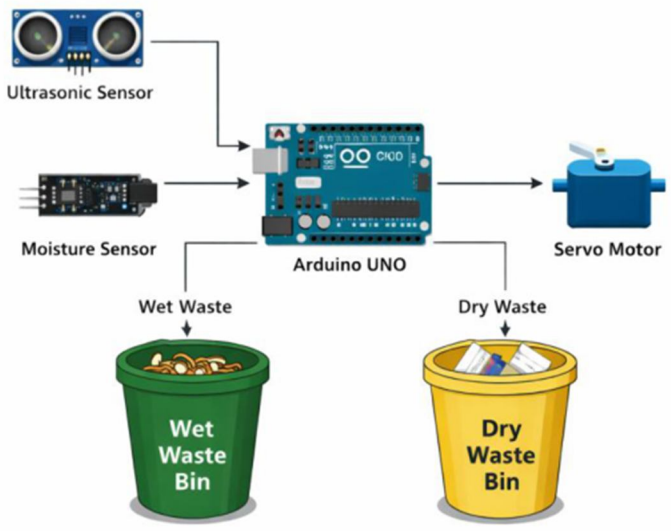
If the moisture value is high, the waste is classified as wet waste.

If the moisture value is low, the waste is classified as dry waste.

After classification, the microcontroller sends a signal to the servo motor. The servo motor rotates a flap mechanism that directs the waste into the correct container.

This entire process occurs automatically within a few seconds without human intervention.

VI. BLOCK DIAGRAM



Smart Dry and Wet Waste Segregation System

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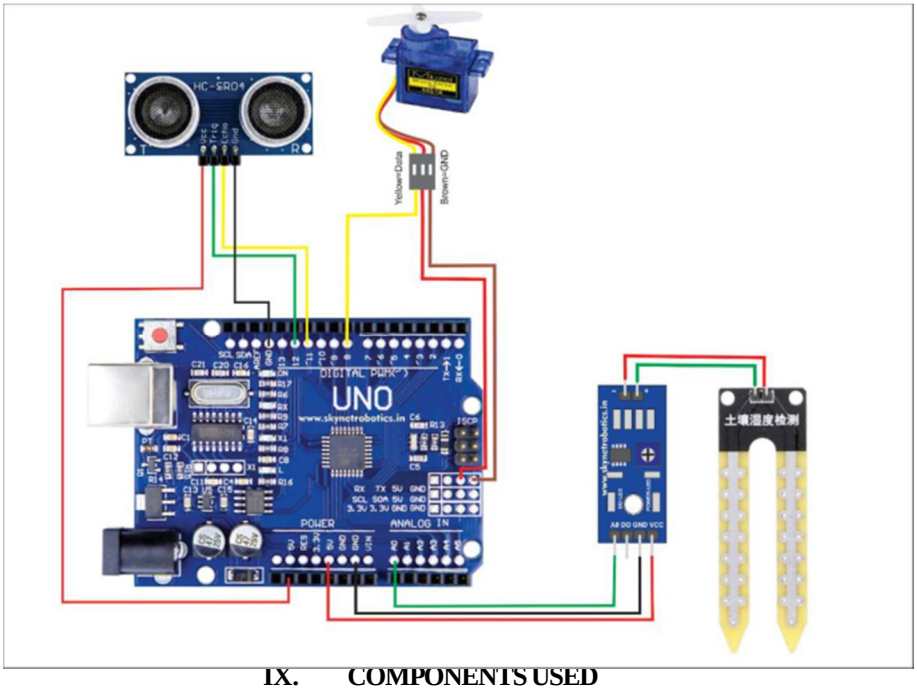
VII. BLOCK DIAGRAM EXPLANATION

The block diagram shows the main functional units of the system, which include the sensor unit, microcontroller unit, motor control mechanism, and waste containers. When waste is placed inside the dustbin, the sensors detect the characteristics of the waste material. The information collected by the sensors is sent to the microcontroller. The microcontroller processes the data and determines whether the waste is wet or dry. Based on this decision, the microcontroller activates the servo motor mechanism. The motor then moves a flap that directs the waste into the appropriate container. Finally, the waste is separated into two bins: one for wet waste and one for dry waste.

VIII. CIRCUIT DIAGRAM



IX. COMPONENTS USED

1) Arduino UNO: Acts as the main controller of the system. It processes the sensor data and controls the servo motor.
2) Ultrasonic Sensor: Detects the presence of waste when an object is placed in the dustbin.
3) Moisture Sensor: Measures the moisture level of the waste and helps determine whether it is wet or dry.
4) Servo Motor: Controls the movement of the flap that directs waste into the correct container.
5) Jumper Wires and Breadboard: Used to create electrical connections between different components in the circuit.

X. EXPERIMENTAL OBSERVATION

The system was tested using different types of waste materials.

Sample	Waste Type	Sensor Output	Expected Result	Actual Result	Status
1	Paper	Low moisture	Dry	Dry	Correct
2	Plastic	Low moisture	Dry	Dry	Correct
3	Banana peel	High moisture	Wet	Wet	Correct
4	Food waste	High moisture	Wet	Wet	Correct
5	Newspaper	Low moisture	Dry	Dry	Correct
6	Biscuit packet	Low moisture	Dry	Dry	Correct

7	Vegetable peel	High moisture	Wet	Wet	Correct
8	Cardboard	Low moisture	Dry	Dry	Correct
9	Rice waste	High moisture	Wet	Wet	Correct
10	Chips packet	Low moisture	Dry	Dry	Correct
11	Apple peel	High moisture	Wet	Wet	Correct
12	Tissue paper	Medium moisture	Dry	Wet	Incorrect
13	Plastic bottle	Low moisture	Dry	Dry	Correct
14	Tea leaves	High moisture	Wet	Wet	Correct
15	Bread	Medium moisture	Wet	Dry	Incorrect
16	Paper cup	Low moisture	Dry	Dry	Correct
17	Orange peel	High moisture	Wet	Wet	Correct
18	Chocolate	Low moisture	Dry	Dry	Correct
19	Onion peel	High moisture	Wet	Wet	Correct
20	Thermocol	Low moisture	Dry	Dry	Correct

During testing, the system correctly identified and separated the waste materials based on moisture content.

XI. PERFORMANCE ANALYSIS

The performance of the system can be evaluated using classification accuracy.

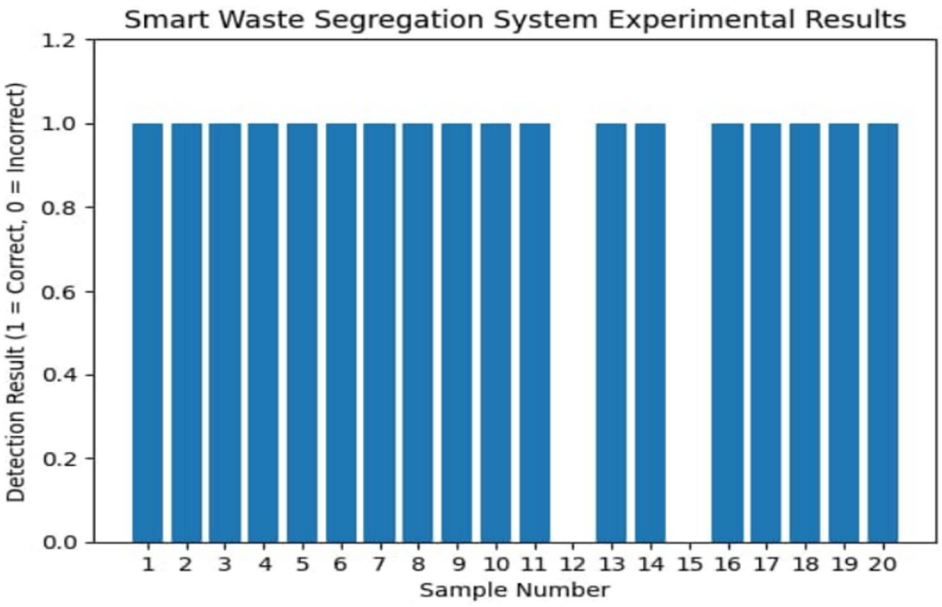
Accuracy Formula:

Accuracy = (Correct Detection / Total Samples) × 100

Accuracy = (18/20) × 100

Accuracy = 90%

XII. RESULT GRAPH



XIII. RESULTS AND DISCUSSION

The experimental results show that the proposed smart dustbin can successfully separate wet and dry waste using moisture detection. The sensor-based approach is simple and reliable for basic waste classification.The use of an Arduino microcontroller allows fast processing and control of the system. The design also reduces manual sorting of waste and improves hygiene in waste handling. Since the system uses low-cost components, it can be easily implemented in homes, colleges, and public places.

XIV. CONCLUSION

The Smart Dry and Wet Waste Segregation Dustbin provides a simple and effective solution for waste management. By using sensors and a microcontroller, the system automatically identifies and separates wet and dry waste. This approach reduces manual effort, improves hygiene, and supports recycling and composting processes. The system can contribute to cleaner surroundings and better waste management practices.

XV. FUTURE SCOPE

The proposed system can be further improved using advanced technologies.
In the future, Internet of Things (IoT) technology can be integrated so that the dustbin can send notifications when it becomes full.
Camera-based image processing techniques can also be used to identify different types of waste materials more accurately.
The system can also be powered using solar energy to make it suitable for outdoor installations.
Additionally, multiple smart dustbins can be connected to a central monitoring system for smart city waste management.

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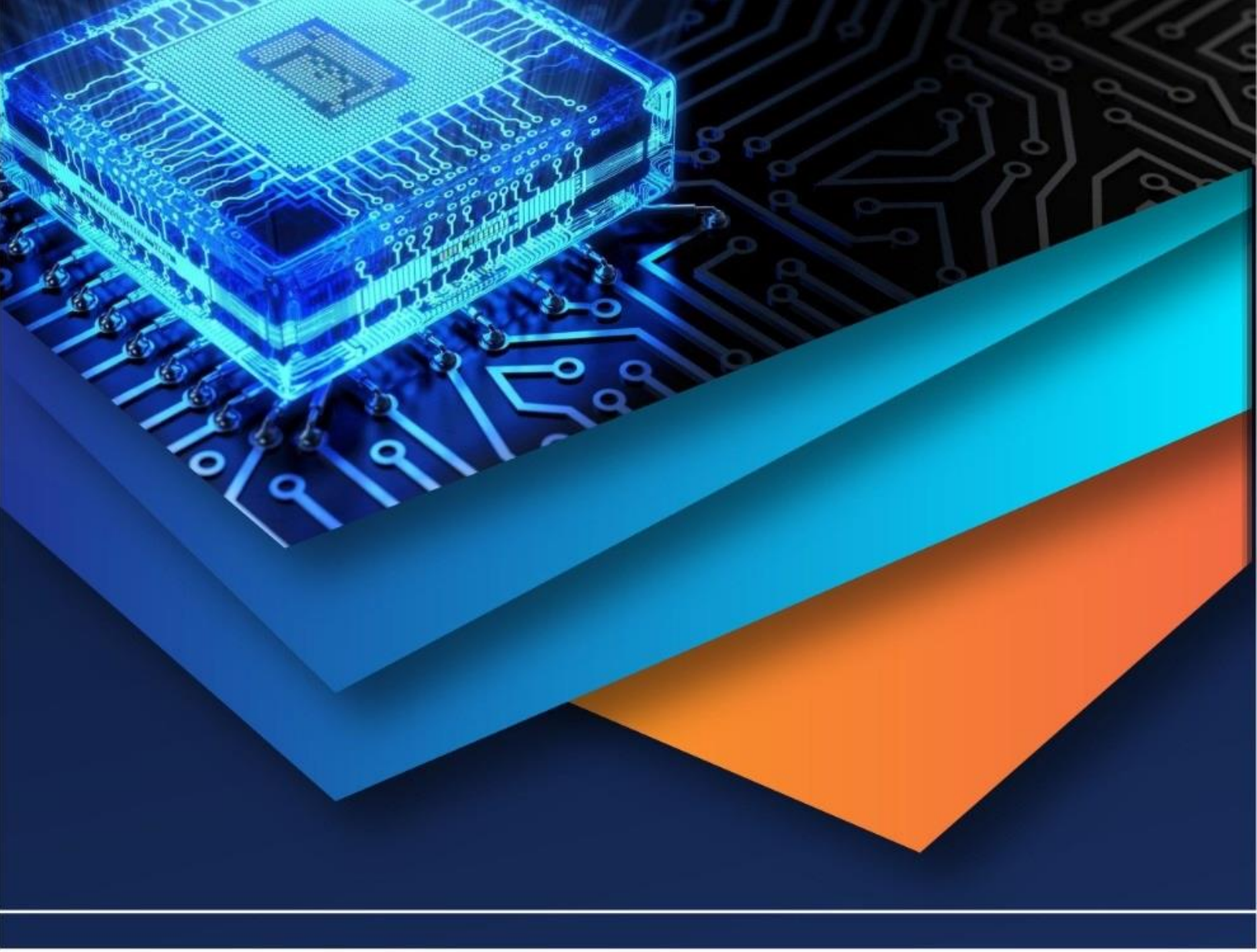

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