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Dry and Waste Management System Using Arduino Uno

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Abstract: *Rapid urbanization and population growth have significantly increased the generation of solid waste, creating serious environmental and public health challenges. Improper segregation of dry and wet waste at the source leads to inefficient recycling, increased landfill burden, and environmental pollution. This research paper presents the design and implementation of an automated dry and wet waste management system using Arduino Uno, aimed at improving waste segregation efficiency at the initial collection stage.*

The proposed system utilizes various sensors such as moisture sensorsand infrared (IR) sensors to identify and classify waste as dry or wet. Based on the sensor readings, the Arduino Uno processes the data and controls actuators to automatically direct the waste into the appropriate bins. The system reduces human intervention, minimizes health risks for sanitation workers, and ensures accurate waste separation. Additionally, the project promotes environmentally sustainable practices by facilitating effective recycling and composting processes.

Experimental results demonstrate that the system is reliable, cost effective, and suitable for small-scale implementation in households, educational institutions, and public areas. The proposed solution offers a practical approach toward smart waste management and contributes to the development of cleaner and greener urban environments.

Keywords: Arduino Uno, Ultrasonic Sensor, Moisture Sensor

I. INTRODUCTION

Nowadays, waste management is a big problem in many cities and villages due to increasing population and daily human activities. A large amount of waste is produced every day from homes, offices, schools, and public places. This waste is generally divided into ***dry waste*** and ***wet waste***. Dry waste includes materials like plastic, paper, metal, and glass, while wet waste includes food waste and other organic materials. When both types of waste are mixed together, it becomes very difficult to recycle or reuse them properly.

In most places, waste segregation is done manually, which is not hygienic and also risky for sanitation workers. People often do not separate dry and wet waste at home, which increases pollution and fills landfills quickly. To solve this problem, an automatic waste segregation system is required.

This project focuses on developing a ***dry and wet waste management system using Arduino Uno***. The system uses sensors to identify the type of waste. A moisture sensor is used to detect wet waste, and an IR sensor is used to sense the presence of waste. The Arduino Uno processes the sensor data and controls the system to place the waste into the correct bin automatically.

The proposed system helps in reducing human effort, improving cleanliness, and promoting proper waste segregation. It is simple, low-cost, and can be used in homes, schools, and public places. This project encourages eco-friendly waste management and supports a clean and healthy environment.

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II. LITERATURE SURVEY

S. N0	Title of Paper	Authors	Year	Technology Used	Key Findings
1	Design and Implementation of Automated Waste Segregator with Smart Compression	John Paul S. Endaya, Ferdinand S. Mabitasan Jr., Jonela Cyrel Mae Gonzales	2020	Arduino Uno, push buttons, LEDs, ultrasonic sensors, stepper motor, linear actuators	Automated waste segregation with smart compression; improves storage efficiency but increases mechanical complexity
2	Automatic Waste Segregator using Arduino	Undisclosed	2019	Arduino, sensors, servo motors	Reduces manual effort; improves recycling efficiency through automated classification
3	Automated Waste Segregation System Using Arduino Uno R3	C. E. Tan, V. J. M. C. Samson, P. A. P. Palomo	2024	Arduino Uno R3, infrared sensors, moisture sensors	Detects dry and wet waste; improves segregation accuracy using sensors
4	Automatic Waste Segregation System Using Arduino	A. A. Ibarra	2024	Optical sensors, material detection sensors, machine learning, servo motors	High accuracy waste classification using ML; but increases cost and system complexity
5	Automatic Waste Segregation and Management	G. S. Salibio	2020	Arduino Uno, basic sensors	Low-cost system; reduces human involvement and suitable for small-scale use

III. METHODOLOGY

The proposed ***Dry and Wet Waste Management System using Arduino Uno***follows a systematic approach to achieve automated and efficient waste segregation. The methodology is designed to minimize human involvement while improving accuracy in separating waste at the source level.

The system is based on a modular design in which Arduino Uno acts as the central control unit. It receives input data from different sensors and processes the information to make segregation decisions. An infrared (IR) sensor is used to detect the presence of waste on the input platform and initiate the segregation process. Once waste is detected, a moisture sensor measures the moisture content of the waste material.

Based on the moisture sensor readings, the Arduino Uno classifies the waste as either dry or wet. If the measured moisture level exceeds a predefined threshold value, the waste is identified as wet waste; otherwise, it is considered dry waste. This decision-making logic is implemented through conditional programming within the Arduino environment.

After classification, the Arduino Uno sends control signals to a servo motor. The servo motor rotates in a specific direction to guide the waste into the appropriate bin. Dry waste is directed into the dry waste container, while wet waste is directed into the wet waste container. The entire process occurs automatically without manual intervention.

The software for the system is developed using the Arduino Integrated Development Environment (IDE). The program continuously monitors sensor inputs and controls the actuators accordingly. Proper calibration of sensors is carried out to ensure accurate readings and reliable system performance.

To validate the system, various waste samples such as paper, plastic, food waste, and vegetable peels are tested. Multiple trials are conducted to evaluate the system's accuracy, response time, and reliability. The results confirm that

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the proposed methodology provides an effective, low-cost, and practical solution for automated dry and wet waste segregation suitable for small-scale applications such as homes, institutions, and public places.

IV. BLOCK DIAGRAM

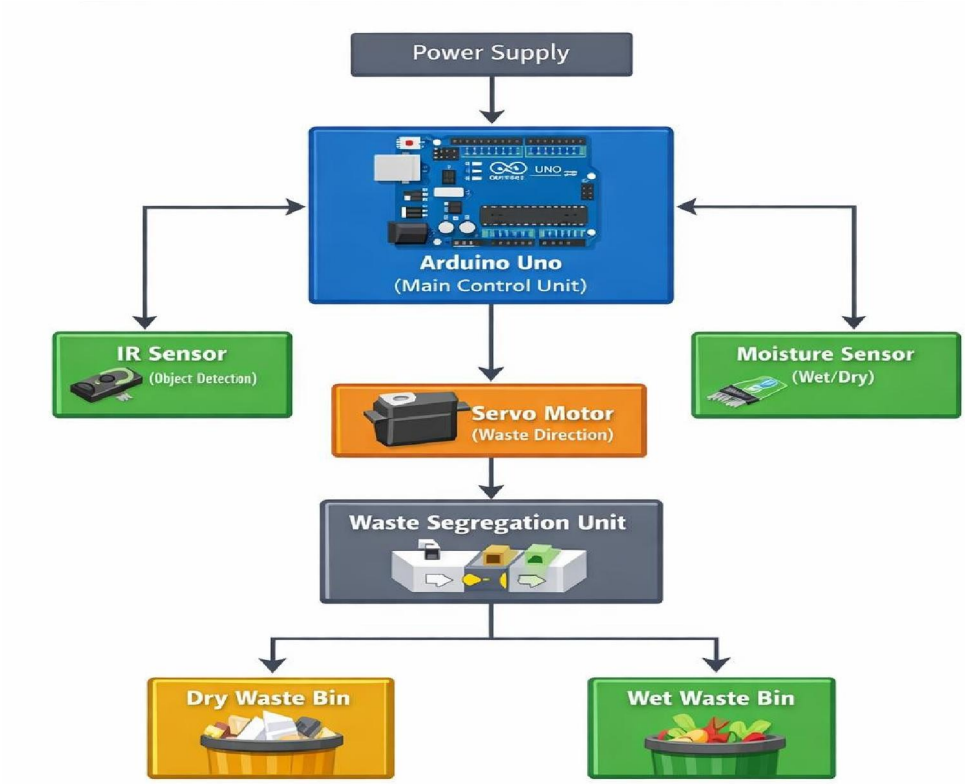

Fig. 1. Dry and waste management system using Arduino UNO

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V. CIRCUIT DIAGRAM

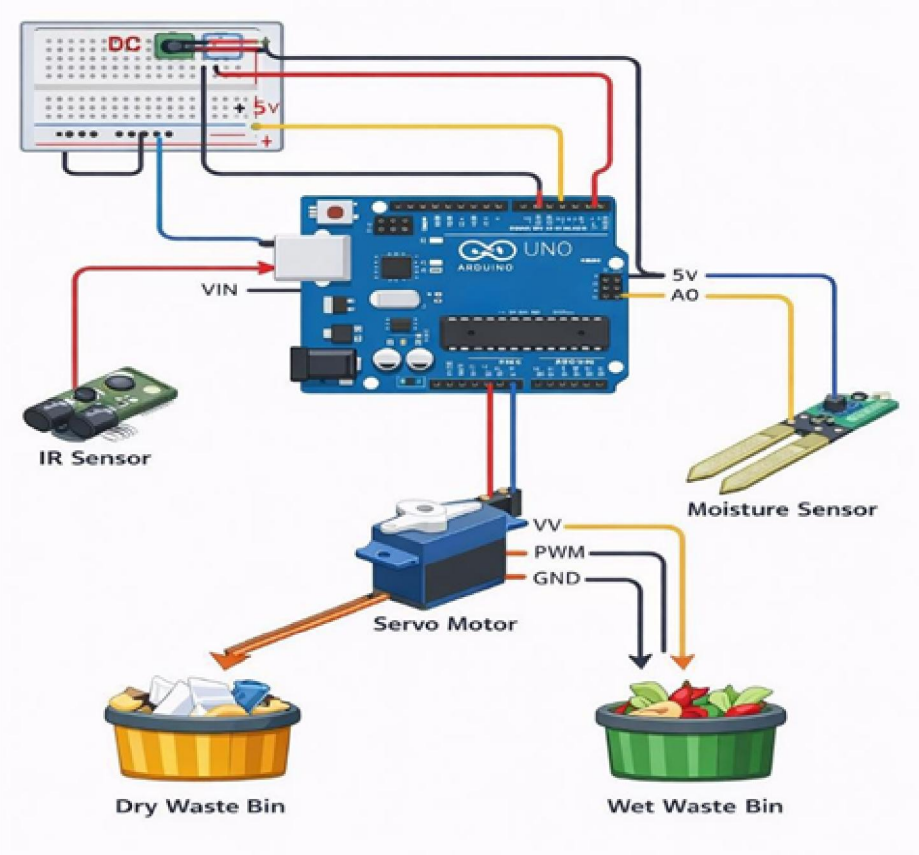

Fig. 2. Circuit diagram of Dry and waste management system using Arduino UNO

Components Required

Arduino Uno
Ultrasonic Sensor (HC-SR04) – for detecting trash
Moisture Sensor – to detect wet/dry waste
Servo Motor – to rotate bin
LEDs (optional) – indication
Buzzer (optional)
Jumper wires + Breadboard

Circuit Connections

1. Ultrasonic Sensor (HC-SR04): -
VCC → 5V (Arduino)
GND → GND
TRIG → Pin 9
ECHO → Pin 10
2. Moisture Sensor: -
VCC → 5V

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GND → GND
AO (Analog Output) → A0 (Arduino)
3. Servo Motor: -
Red wire → 5V
Brown/Black → GND
Yellow/Orange (Signal) → Pin 6
4. LED Indicators (Optional): -
Green LED (Dry Waste) → Pin 3 (via resistor)
Blue LED (Wet Waste) → Pin 4 (via resistor)
5. Buzzer (Optional): -
Positive → Pin 7
Negative → GND

Working Logic: -
Ultrasonic sensor detects when waste is placed.
Moisture sensor checks if waste is **wet or dry**.
Arduino processes the value:
If moisture HIGH → Wet Waste
If moisture LOW → Dry Waste
Servo motor rotates bin accordingly:
0° → Dry bin
90° → Wet bin
LED/Buzzer gives indication.

VI. HARDWARE IMPLEMENTATION

The hardware implementation of a dry and wet waste management system using an Arduino Uno is based on integrating sensors, a control unit, and a mechanical segregation mechanism within a compact bin structure.

The system consists of a single waste inlet at the top and two separate compartments for dry and wet waste. An ultrasonic sensor is mounted near the inlet to detect the presence of waste, while a moisture sensor is placed just below it to determine whether the waste is dry or wet based on its moisture content.

A servo motor is installed beneath the sensing area with an attached flap or divider. Based on the sensor input, the Arduino processes the data and rotates the servo to direct the waste into the appropriate compartment. The controller is enclosed in a protected casing, and a stable power supply is provided for reliable operation.

Overall, the system operates by detecting waste, classifying it using moisture sensing, and mechanically diverting it into the correct bin, ensuring efficient and automated waste segregation.

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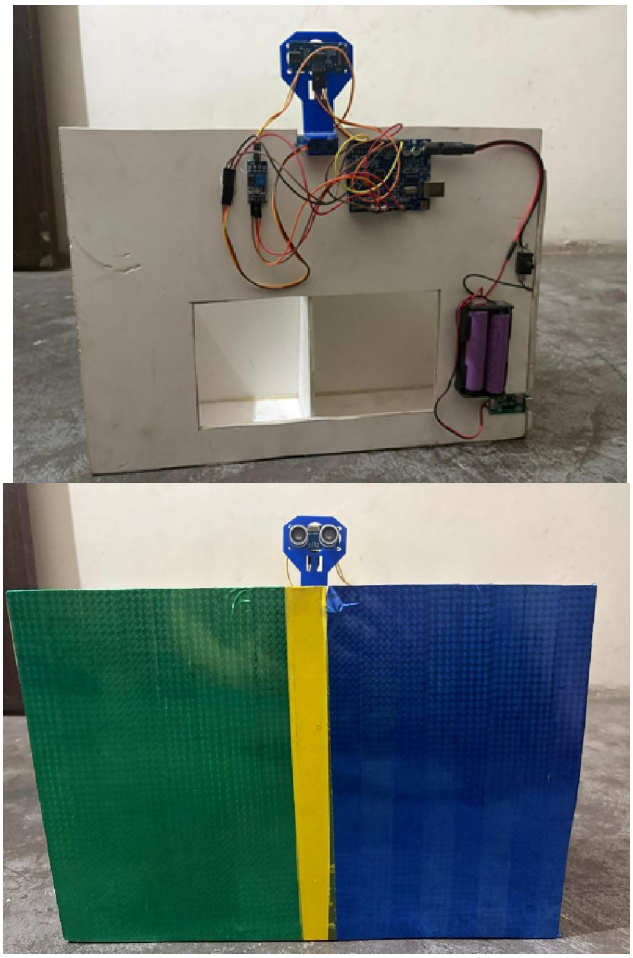

Fig. 2. Prototype model of the automatic dry and wet waste segregation system using Arduino Uno

VII. TABLE FOR OBSERVATION

Observation Table					
S. No	Type of Waste	Moisture Sensor Reading	Classification (Dry/Wet)	Servo Motor Direction	Correct Segregation (Yes/No)
1	*Paper*	*120*	*Dry*	*Dry Bin*	*Yes*
2	*Plastic Bottle*	*80*	*Dry*	*Dry Bin*	*Yes*
3	*Vegetable Peel*	*450*	*Wet*	*Wet Bin*	*Yes*
4	*Food Waste*	*500*	*Wet*	*Wet Bin*	*Yes*
5	*Cardboard*	*110*	*Dry*	*Dry Bin*	*Yes*
6	*Fruit Pulp*	*480*	*Wet*	*Wet Bin*	*Yes*
7	*Aluminium Can*	*90*	*Dry*	*Dry Bin*	*Yes*

Table I. Experimental Observation Table for Moisture-Based Waste Classification and Segregation Using Arduino Uno

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VIII. RESULTS AND DISCUSSION

The developed waste management system using the **Arduino Uno** successfully demonstrated automatic segregation of dry and wet waste based on moisture content. The system utilized a moisture sensor to detect the presence of water in the waste material and accordingly classified it as dry or wet. A servo motor mechanism was employed to direct the waste into the appropriate bin.

Results: -

During testing, different types of waste materials such as paper, plastic bottles, and vegetable peels were used. The moisture sensor readings clearly distinguished between dry and wet waste:

Dry waste (paper, plastic) showed low moisture values and were directed to the dry bin.

Wet waste (vegetable peels, food waste) showed higher moisture values and were directed to the wet bin.

The system achieved a high level of accuracy in waste segregation under controlled conditions. The servo motor responded correctly to sensor input, ensuring proper bin selection. The response time of the system was fast, typically within a few seconds of waste detection.

An observation table confirmed that most of the waste items were correctly classified, indicating reliable performance of the system.

Discussion: -

The results indicate that the Arduino-based system is effective for small-scale automated waste segregation. The use of a moisture sensor is a simple yet efficient method for distinguishing between dry and wet waste. However, certain limitations were observed:

Some semi-dry waste materials (e.g., damp paper) may lead to incorrect classification.

Sensor sensitivity can vary depending on environmental conditions such as humidity.

The system works best in controlled environments and may require calibration for real-world applications.

Despite these limitations, the system significantly reduces manual effort and promotes proper waste segregation, which is essential for efficient recycling and environmental sustainability.

Future improvements can include:

Integration of additional sensors (e.g., gas sensors, weight sensors)

Use of machine learning for more accurate classification

IoT-based monitoring for smart waste management systems

VIII. CONCLUSION

The ***Dry and Wet Waste Management System using Arduino Uno*** successfully demonstrates a simple, cost-effective, and efficient approach to automated waste segregation. By integrating an IR sensor and a moisture sensor with Arduino Uno, the system can accurately detect the presence of waste and classify it as dry or wet. The servo motor effectively directs the waste into the corresponding bin, minimizing human intervention and reducing health risks for sanitation workers.

Through multiple trials, the system showed high accuracy in segregating different types of waste such as paper, plastic, vegetable peels, and food waste. The implementation confirms that Arduinobased automation is practical for small-scale applications like households, schools, and public areas.

Overall, this project contributes to better waste management practices, promotes recycling and composting, and supports environmental sustainability. With minor improvements, such as adding IoT monitoring or scalability for larger applications, the system has the potential to be implemented on a wider scale.

A. Future Scope: -

The current system based on **Arduino Uno** provides a simple and effective solution for basic waste segregation. However, there is significant potential for further improvement and expansion to make the system more efficient,

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intelligent, and suitable for real-world applications. In the future, the system can be enhanced by integrating multiple sensors such as gas sensors, metal detectors, and infrared sensors to classify waste more accurately into categories like biodegradable, non-biodegradable, and recyclable waste. This would overcome the limitation of relying only on moisture detection. The implementation of Internet of Things (IoT) technology can make the system smarter by enabling real-time monitoring of waste levels in bins. Data can be sent to a mobile app or cloud platform, allowing authorities to track bin status, optimize collection routes, and reduce operational costs.

Machine learning and artificial intelligence can also be introduced to improve waste identification. By using image processing and trained models, the system can recognize different types of waste more precisely, even in complex scenarios where moisture-based detection fails. Another important future scope is scaling the system for use in public places such as smart cities, railway stations, malls, and residential societies. The system can be integrated with automated conveyor belts for continuous waste segregation in large-scale waste management facilities.

Additionally, solar power integration can make the system energy-efficient and suitable for outdoor use, especially in remote or rural areas. This would reduce dependency on conventional power sources and promote sustainable development. User awareness and interaction can also be improved by adding display units or voice alerts to guide people in disposing of waste correctly. This will encourage proper waste management practices among users.Overall, with advancements in IoT, AI, and automation, the system can evolve into a fully smart waste management solution that contributes significantly to environmental protection and efficient resource utilization.

IX. ACKNOWLEDGMENT

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