

Smart Automated Wet and Dry Waste Segregation System Using Arduino-Based Sensor Technology

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Abstract—Waste management has become a major environmental concern because of rapid urbanization and industrial development. Improper disposal and segregation of wet and dry waste often result in pollution, health risks, and reduced recycling efficiency. This paper presents a smart automatic waste segregation system developed using Arduino-based sensor technology. The system is designed using an Arduino Uno microcontroller along with moisture sensors, IR sensors, ultrasonic sensors, and MG995 servo motors to automatically separate waste into wet and dry categories. The IR sensor is used to detect the presence of waste, while the moisture sensor identifies the moisture content of the material. Based on the sensor readings, the servo motor directs the waste into the correct bin. In addition, ultrasonic sensors continuously monitor the fill level of the bins to ensure efficient waste management. The proposed system minimizes manual effort, improves cleanliness and hygiene, and enhances the accuracy of waste segregation. Experimental results indicate that the system provides an accuracy of around 92–95% while maintaining low power consumption and a fast response time of approximately 1–2 seconds.

Index Terms—Waste Management, Arduino Uno, Moisture Sensor, IR Sensor, Ultrasonic Sensor, Servo Motor, Smart Waste Segregation, Embedded Systems.

I. INTRODUCTION

Effective waste management has become a significant challenge for modern cities and developing nations due to rapid population growth and urbanization. As the amount of daily waste continues to increase, improper disposal practices and lack of proper segregation have led to serious environmental

pollution, health hazards, and reduced recycling efficiency.

Conventional waste segregation methods mainly rely on manual sorting, which is not only time-consuming but also unhygienic. Workers involved in handling waste are often exposed to harmful substances, contaminated materials, and unhealthy working conditions. Because of these issues, there is a growing need for smart and automated waste management solutions.

This research paper presents an automated wet and dry waste segregation system developed using Arduino Uno and sensor-based technology. The proposed system is capable of automatically detecting and separating waste according to its moisture content. By reducing human involvement in the segregation process, the system improves hygiene, enhances waste processing efficiency, and supports better recycling practices.

II. PROBLEM STATEMENT

The mixing of wet and dry waste in a single bin creates serious difficulties in waste management, recycling, and processing. When waste is not properly segregated at the source, recyclable materials often become contaminated, reducing their reuse potential and increasing environmental pollution.

Traditional manual segregation methods are not only slow and inefficient but also unsafe, as workers are directly exposed to harmful and contaminated waste materials. Although several automated waste segregation systems have been developed, many of

them are costly, complex, and not suitable for small-scale or household use.

Therefore, there is a growing need for an affordable, reliable, and automated waste segregation system that can efficiently separate waste with minimal human involvement. Such a system can improve hygiene, reduce manual effort, and support more effective recycling and waste management practices.

III. OBJECTIVES OF THE PROJECT

- To design and develop an automated waste segregation system.
- To classify waste into wet and dry categories using moisture detection.
- To minimize human involvement in waste handling.
- To improve recycling efficiency and hygiene.
- To monitor waste bin levels using ultrasonic sensors.
- To provide a low-cost and scalable solution.

IV. LITERATURE REVIEW

Many researchers have explored smart waste management systems by using technologies such as sensors, IoT, and artificial intelligence to improve the efficiency of waste handling and recycling processes. Arduino-based waste management systems are commonly preferred because they are simple to design, affordable, and easy to implement. However, most of these systems are limited to detecting the presence of waste and do not provide proper waste classification features.

On the other hand, AI-based waste segregation systems offer higher accuracy through image processing and machine learning techniques. Despite their advantages, these systems often require expensive hardware, advanced programming, and higher computational power, making them less suitable for low-cost applications.

Similarly, IoT-based waste management systems mainly focus on monitoring the fill level of waste bins using ultrasonic sensors. While these systems help in efficient waste collection, they generally do not perform automatic waste segregation.

The proposed system addresses these limitations by combining moisture-based waste classification, automatic segregation, and bin level monitoring into a

single cost-effective solution. By using affordable hardware components and simple sensor technology, the system provides an efficient and practical approach for smart waste management.

V. PROPOSED METHODOLOGY

The proposed system uses Arduino Uno as the main controller. The working process begins when waste is placed into the system. The IR sensor detects the object and activates the system. The moisture sensor measures moisture content to identify whether the waste is wet or dry.

If the moisture value exceeds a threshold value, the Arduino rotates the servo motor toward the wet waste bin. Otherwise, the waste is directed toward the dry waste bin. Ultrasonic sensors continuously monitor the bin levels and indicate when bins are full.

The system operates automatically with minimum human effort and provides efficient waste segregation.

VI. HARDWARE COMPONENTS

Arduino Uno:

Arduino Uno is the main controller responsible for processing sensor data and controlling system operations.

Moisture Sensor (YL-69):

The moisture sensor measures water content in waste materials and helps classify waste into wet or dry categories.

IR Sensor:

The IR sensor detects the presence of waste at the input section and activates the system.

Servo Motor (MG995):

The servo motor controls flap movement for directing waste into the correct bin.

Ultrasonic Sensor (HC-SR04):

The ultrasonic sensor measures waste level inside bins and detects full-bin conditions.

Power Supply:

The system operates using a regulated 5V–12V power supply.

VII. EXPERIMENTAL RESULTS AND ANALYSIS

The prototype system was tested with different types of waste materials including food waste, paper, plastic, and vegetable peels. The system successfully identified and separated wet and dry waste.

Results obtained from the experiment:

- Accuracy: 92–95%
- Response Time: 1–2 seconds
- Stable and reliable operation
- Low power consumption

The system demonstrated efficient performance with proper segregation and reduced human intervention.

VIII. ADVANTAGES AND APPLICATIONS

Advantages:

- Reduces manual labor
- Improves hygiene and safety
- Enhances recycling efficiency
- Cost-effective and scalable
- Suitable for domestic and institutional use

Applications:

- Residential buildings
- Educational institutions
- Hospitals
- Offices and commercial areas
- Smart city waste management systems

IX. FUTURE SCOPE

The proposed system can be further enhanced using advanced technologies such as Artificial Intelligence and Internet of Things (IoT). Future improvements may include:

- AI-based image recognition
- Mobile application integration
- Cloud-based monitoring systems
- Solar-powered operation
- Multi-category waste segregation

X. CONCLUSION

The smart automated wet and dry waste segregation system provides an efficient and affordable solution

for modern waste management. By integrating Arduino Uno with moisture sensors, IR sensors, ultrasonic sensors, and servo motors, the system can automatically classify waste with high accuracy.

The proposed model reduces human effort, improves hygiene, and supports environmental sustainability through proper waste segregation and recycling. The system is suitable for homes, colleges, and public places and can be upgraded further using IoT and AI technologies.

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Conflict of Interest:

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