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

Priya Mane, Sanchita Kalbhor, Shahu Nikam, Prathamesh Rajwade, Sarthak Tambe, V.D.Deshmukh
Department of First Year Engineering Science
AISSMS'S Institute of Information Technology, Pune, India
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***Abstract*—Waste management has become an important environmental issue due to rapid urbanization and industrial growth. Improper segregation of wet and dry waste leads to environmental pollution, health hazards, and inefficient recycling. This paper presents a smart automated waste segregation system using Arduino-based sensor technology. The system uses an Arduino Uno microcontroller along with moisture sensors, IR sensors, ultrasonic sensors, and MG995 servo motors to classify waste into wet and dry categories automatically. The IR sensor detects the presence of waste, the moisture sensor determines the moisture content, and the servo motor directs the waste into the appropriate bin. Ultrasonic sensors monitor the fill level of bins. The proposed system reduces manual effort, improves hygiene, and increases segregation accuracy. Experimental analysis shows that the system achieves approximately 92–95% accuracy with low power consumption and response time of 1–2 seconds.**

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

I. INTRODUCTION

Proper waste management is one of the major challenges faced by modern cities and developing countries. Population growth and urbanization have increased the amount of waste generated daily. In most places, waste is disposed of without proper segregation, resulting in pollution, health risks, and poor recycling efficiency.

Traditional waste segregation methods depend on manual sorting, which is unhygienic and time-consuming. Workers handling waste are exposed to harmful substances and contaminated materials. To overcome these limitations, automated systems using embedded technologies and sensors are becoming increasingly popular.

This research paper proposes a smart automated wet and dry waste segregation system using Arduino Uno and sensor technology. The system automatically identifies and separates waste based on moisture content, improving waste processing efficiency and hygiene.

II. PROBLEM STATEMENT

Mixing wet and dry waste in a single bin creates major challenges in recycling and waste processing. Manual segregation methods are inefficient and unsafe. Existing automated systems are often expensive and unsuitable for household applications. Therefore, there is a need for a low-cost, reliable, and automated waste segregation system that can efficiently separate waste materials with minimal human intervention.

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

Several researchers have worked on smart waste management systems using sensors, IoT, and AI technologies.

Arduino-based waste management systems are widely used because of their low cost and simplicity. However, many systems only detect the presence of waste without classification capability.

AI-based segregation systems provide high accuracy using image processing techniques, but they require expensive hardware and complex programming.

IoT-based monitoring systems use ultrasonic sensors to monitor bin levels but focus mainly on monitoring rather than segregation.

The proposed system improves existing systems by integrating moisture-based classification with automatic segregation and level monitoring using cost-effective hardware.

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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