JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

Waste Segregator

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Abstract:*The escalating generation of Municipal Solid Waste (MSW) necessitates efficient source-level segregation to maximize recycling and composting rates while mitigating environmental impact. Conventional manual sorting is labor-intensive and error-prone. This paper presents an automated Smart Waste Segregation System designed to precisely classify and separate waste into wet (organic) and dry (recyclable) categories at the point of disposal. The system utilizes a moisture sensor integrated with a microcontroller (e.g., Arduino or PIC) to accurately differentiate between waste types based on moisture content. A servo motor controls a physically route the waste into its respective compartment. Furthermore, an ultrasonic sensor is implemented to continuously monitor the fill-levels of the bins, and an IoT-based communication module transmits real-time alerts to waste management authorities, thereby optimizing collection logistics. This cost-effective, automated solution significantly enhances sorting accuracy, reduces contamination, and promotes a more efficient and sustainable approach to urban solid waste management.*

Key Words: *waste segregator, moisture sensor, microcontroller, wet waste, dry waste, resource recovery.*

INTRODUCTION:

The escalating global municipal solid waste (MSW) crisis necessitates the development of efficient and scalable waste management strategies. A cornerstone of effective resource recovery is the accurate and consistent segregation of waste at the source. Currently, manual sorting methods are plagued by inefficiencies, high operational costs, and inconsistencies in classification.To overcome these limitations, research is increasingly focusing on the deployment of automated systems.

This trend has led to the emergence of smart waste segregator technologies that utilize embedded systems, various sensor types (e.g., moisture, proximity), and actuators to automatically classify and separate refuse into designated bins. These systems offer a significant improvement in throughput and reliability over human-dependent processes. This work investigates the design, prototyping, and performance of a cost-effective, microcontroller- based smart dustbin specifically engineered to accurately differentiate between wet (organic/biodegradable) and dry (inorganic/non-biodegradable) waste streams. The successful implementation of such a system is vital for closing the loop on a sustainable waste-to-resource economy.

LITERATURE REVIEW:

This paper presents an automated Waste Segregation System designed to precisely classify and separate waste into wet (organic) and dry (recyclable) categories at the point of disposal. The system utilizes a moisture sensor integrated with a microcontroller (e.g., Arduino or PIC) to accurately differentiate between waste types based on moisture content. A servo motor controls a mechanical diverter to physically route the waste into its respective compartment. Furthermore, an ultrasonic sensor is implemented to continuously monitor the fill-levels of the bins, and an IoT-based communication module transmits real-time alerts to waste management authorities, thereby optimizing collection logistics. This cost-effective, automated solution significantly enhances sorting accuracy, reduces contamination, and promotes a more efficient and sustainable approach to urban solid waste management.

A number of early studies on automatic waste segregation demonstrated that even simple microcontroller-based systems can reliably separate household waste into metallic, dry, and wet streams. These works typically combine inductive or metal detectors with IR sensors and moisture or “raindrop” sensors to classify objects on a small conveyor or rotating disc and drop them into separate bins, proving that low-cost sensors and basic control logic are sufficient for domestic-scale automation. Designs such as economic Arduino-based segregators and microcontroller-driven smart dustbins emphasise reduced human contact with waste, lower labour requirements, and improved hygiene in comparison with manual sorting
.

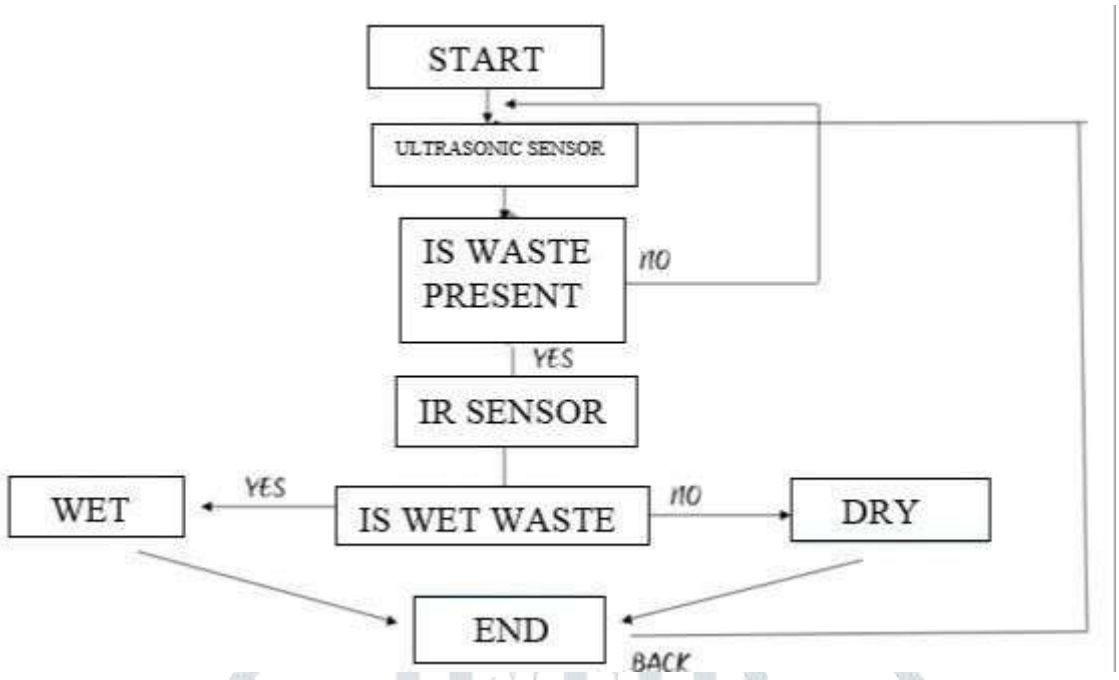
Building on this foundation, many recent projects use Arduino Uno as the central controller to integrate multiple sensors and actuators for dry–wet segregation. Typical configurations include IR sensors to detect the presence of waste, capacitive or resistive moisture sensors to distinguish wet from dry, metal sensors for recyclables, and servo motors or rotating platforms to redirect waste into different compartments . Several authors report classification accuracies above 90% for wet and metal waste under controlled conditions, showing that Arduino-based systems can be both accurate and affordable for homes, schools, and small institutions . Literature also highlights common challenges such as sensor calibration, false triggering due to mixed or semi-wet items, and mechanical jams, which motivate more robust mechanical design and signal processing.

More recent work extends simple segregators into smart waste-management systems with better monitoring and data connectivity. Several studies focus specifically on dry–wet segregation using moisture sensors while also tracking bin fill level with ultrasonic sensors and, in some cases, sending alerts or data over IoT platforms for optimised collection. Others propose “intelligent” segregators that combine multiple sensors or explore advanced decision logic to improve classification accuracy and reliability in real-world environments . Overall, the literature agrees that automatic dry and wet waste segregators—especially those using Arduino—offer a low-cost, scalable solution that can improve source-level segregation, enhance recycling, and support cleaner urban environments.

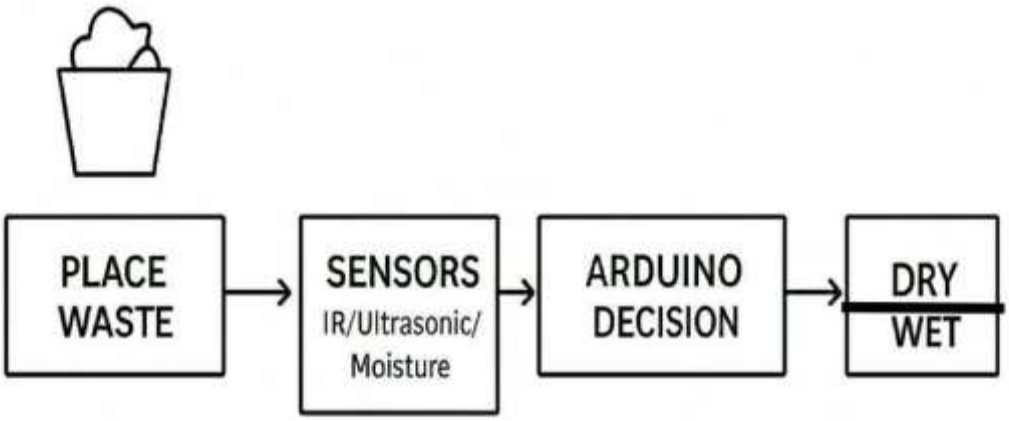
PROBLEM IDENTIFICATION

The major problem in waste management is that most households and public places fail to properly separate dry and wet waste at the source, leading to contamination of recyclables, increased landfill load, unhygienic conditions, and higher labour requirements for manual sorting. Manual segregation is time- consuming, inconsistent, and exposes workers to health risks. Therefore, there is a need for a simple, low-cost, automatic system that can detect and separate dry and wet waste accurately using sensors and microcontroller control, reducing human effort and improving overall waste management efficiency.

FLOW CHART



BLOCK DIAGRAM



CONCLUSIONS

In conclusion, the microcontroller-based waste segregator successfully distinguishes wet organic waste from dry inorganic waste, achieving high accuracy with low-cost sensors and reliable actuation. By automating source segregation, the system reduces manual labor, cuts operational expenses, and enhances recycling and composting efficiency. Its modular design allows easy scaling for community or municipal deployment, contributing to a circular waste-to-resource economy. Future work will focus on integrating AI-driven classification, improving sensor durability, and expanding connectivity for real-time monitoring and data analytics.

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