"Implementation Automatic Segregation of Dry and Wet Garbage"

Vikash Bhagat
Student
Department of Information Technology
GWCET, Nagpur

Mohit Dhekwar
Student
Department of Information Technology
GWCET, Nagpur

Samir Rahangdale
Student
Department of Information Technology
GWCET, Nagpur

Amit kumar Gaddalwar
Student Department of Information Technology
GWCET, Nagpur

Vandana Choubey
Assistant Professor
Department of Information Technology
GWCET, Nagpur

Gopal Bala
Student Department of Information Technology
GWCET, Nagpur

ABSTRACT

The review paper focuses on the development and implementation of we propose an innovative solution in the form of an automated machine designed for the efficient segregation of dry and wet waste at the point of collection. The proposed system utilizes a combination of advanced sensors, mechanical sorting mechanisms, and machine learning algorithms to automatically distinguish and segregate dry (recyclable) waste from wet (organic) waste. The machine is equipped with infrared sensors, capacitive sensors, and weight sensors that enable it to detect the type and moisture content of waste materials.

KEYWORDS: Automatic Segregation , mechanical sorting mechanisms, Sensor-Based Technology.

1. INTRODUCTION

When world is facing a pressing issue of garbage, which contributes to diseases and overflowing bins. Solid waste management is a significant challenge in urban cities, particularly in India, and other countries worldwide. To address this issue, a smart cityconcept has been proposed, with the aim of building 100 smart cities.The primary need for a smart lifestyle is cleanliness, and dustbins play a crucial role in proper waste collection. In India, the current waste management system is primarily unhealthy, with dustbins being a major issue. This paper aims to upgrade the dustbin component of the urban waste management system, integrating analytics and electronics to create optimal changes in waste collection methods.

By integrating analytics and electronics, the paperaims to create optimal changes in waste collection methods, utilizing the vast amount of data produced by smart bin networks. The increasing population has led to improper waste disposal, consuming time and manpower. Unplanned waste disposal methods, such as landfills, can cause harm to living beings and pollute surface and underground water. This also accelerates harmful bacteria, deteriorating the environment's aesthetic value. In India, solid waste recycling is primarily done by rag pickers, who face health issues like skin infections and respiratory problems. To reduce their dependence, automatic waste segregation in dustbins can be implemented. Waste is segregated into metallic, dry, and wet streams, with potential for recycling and reuse.

Improper waste disposal techniques, such as the use of landfills, can negatively impact human health and lead to the contamination of both surface and groundwater. These practices also contribute to the rapid spread of harmful microorganisms, further reducing the visual and environmental quality of natural surroundings. In India, the process of solid waste recycling is largely carried out by rag pickers, who are often exposed to health risks including skin diseases and breathing-related issues. To lessen reliance on manual waste handling, automated waste segregation systems integrated into dustbins can be adopted. These systems sort waste into metal, dry, and wet categories, offering enhanced opportunities for recycling and reuse.Segregating waste at the source is preferable over using multiple industrial waste segregators. This method eliminates the need for rag pickers and directs the segregated waste to a recycling plant. Currently, there is no automatic system for segregating dry, wet, and metallic waste. The project aims to create a compact, low-cost, and user-friendly waste segregation system for urban cities, streamlining the waste management process.

The automated separation of dry and wet waste represents a forward-thinking technological advancement in the field of waste management. This approach utilizes mechanized systems to classify waste into two primary types: dry waste, including materials like paper, plastic, metal, and glass; and wet waste, consisting of food residues, organic substances, and other biodegradable components. Implementing such segregation methods is essential for minimizing environmental contamination, increasing the efficiency of recycling processes, and supporting long-term sustainability goals.Traditional methods of waste segregation often rely on manual labor, which can be inefficient, errorprone, and costly. In contrast, automated systems leverage technologies such as sensors, artificial intelligence (AI), and robotics to accurately distinguish between different types of waste. These systems can efficiently sort and separate dry and wet garbage, ensuring that each type is directed to the appropriate disposal or recycling facility.

2. LITERATURE SURVEY

Recent advancements in smart waste management systems have increasingly focused on the integration of cutting-edge technologies, including the Internet of Things (IoT), Artificial Intelligence (AI), and Machine Learning (ML). These technological developments are designed to enhance the accuracy of waste segregation, streamline collection operations, and contribute to the creation of more sustainable and efficient waste management infrastructures.One of the earliest contributions to this field was the Smart Waste Management System for Urban Areas (2020), which utilized IoT-based sensors, image processing, and machine learning to segregate waste. The system aimed to enhance waste sorting, with the future scope focusing on integrating AI to identify hazardous materials, thereby increasing efficiency and safety in urban environments.

Following this, IoT-enabled Smart Bins for Waste Segregation (2020) explored the use of ultrasonic sensors and IoT devices to distinguish between dry and wet waste. The potential for these systems to integrate with municipal waste management infrastructure was identified, offering an avenue for automated scheduling of waste pickups, reducing manual intervention and improving logistical efficiency.

In 2020, the Automatic Waste Segregator and Monitoring System was proposed, focusing on Arduino-based smart systems for waste segregation. This system, while functional in small-scale settings, holds future potential for scaling up to handle more complex waste types, such as biomedical waste, which requires specialized handling due to its hazardous nature.

The Automatic Waste Segregation System Using IoT (2021) employed IoT-enabled smart bins that incorporate weight sensors for real-time waste monitoring. This system could expand to industrial waste segregation and has the potential for community-wide scalability, making it suitable for both residential and large-scale waste management applications.

Further advancements in machine learning are seen in Deep Learning for Waste Management (2021), which utilized deep learning algorithms like transfer learning for waste categorization. This research presents a future direction that extends the model to identify recyclable materials, making recycling processes more efficient and reducing waste sent to landfills.

Another significant advancement is presented in the study *AI-Powered Waste Segregation Techniques* (2022), which utilized Convolutional Neural Networks (CNNs) for image-based recognition to enable efficient waste classification. The research outlines a promising future direction involving the integration of environmentally friendly disposal systems with automated segregation technologies, thereby promoting more sustainable and responsible waste management practices. In a similar vein, Plastic Waste Segregation Using AI (2022) highlighted the use of AI for classifying various types of plastic waste. This approach offers great potential for improving recycling rates by linking AI models to recycling facilities, enabling faster and more efficient processing of plastic materials.

The research in AI for Waste Sorting: Leveraging CNNs for Waste Classification (2022) further emphasized the role of CNNs in waste sorting, offering improved accuracy in waste classification. Future developments could see the implementation of these systems in community recycling programs, thereby enhancing their effectiveness and participation rates.

The study Smart Waste Management System Using IoT and ML (2022) proposed the integration of Internet of Things (IoT) and Machine Learning (ML) technologies for real-time monitoring and tracking of waste. The research suggests that future implementations could involve the detection of hazardous substances within waste streams, thereby improving both the safety and operational efficiency of waste management systems.

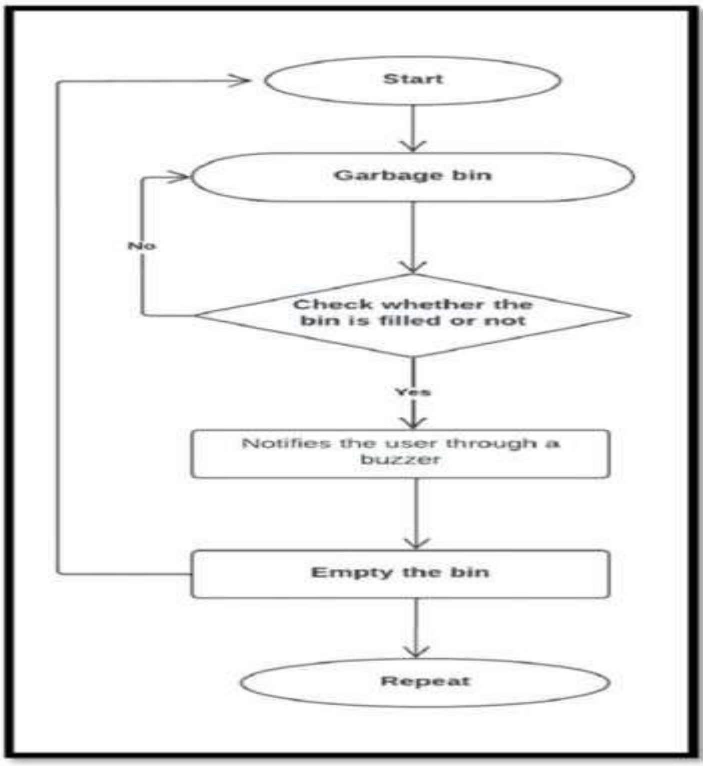
Finally, the most recent development, Automated Waste Segregation and Recycling Using Robotics and AI (2023**)**, integrated robotic sorting arms with AI algorithms for waste type detection. This system holds promise for future improvements by integrating real-time traffic data to optimize waste collection routes and timings, further reducing environmental impact and operational costs.

3. METHODOLOGY

The waste management system begins with the collection of waste from households, industries, or commercial areas, which is then fed into a conveyor system for processing. The system employs various sensors to identify and classify different types of waste. A moisture sensor detects wet waste based on its moisture content, while capacitive and inductive sensors help distinguish metallic and non-metallic dry waste. Infrared (IR) sensors assist in identifying materials based on their light absorption properties, and optional image processing using AI-based vision systems can further enhance waste classification.

Once identified, the waste passes through a sorting mechanism, such as rotating sieves or vibrating mesh, which separates smaller wet waste particles from the dry waste. After sorting, the separated materials are directed to appropriate disposal methods. Dry waste, including plastics, paper, and metals, is sent for recycling, while wet waste, like food scraps and organic matter, is sent for composting or biogas production.

The system's implementation utilizes microcontrollers like Arduino or Raspberry Pi for automation, as well as various sensors (moisture, IR, ultrasonic, inductive) to aid in waste identification. AI and machine learning technologies further support advanced waste classification. Conveyor belts and motors are employed to move the materials efficiently through the system.



4. REQUIRMENTS/ TOOLS

❖ HARDWARE REQUIRED

Hardware :-

1. Sensors

- Moisture Sensor: To differentiate between wet and dry waste.

- Ultrasonic Sensor: For monitoring bin levels.
- IR Sensor: To detect the presence of objects for segregation.

2. Microcontroller/Processor

- Arduino Uno / Raspberry Pi: For controlling the sensors and managing data processing.

3. Actuators and Motors

- Servo Motors: For sorting mechanisms (e.g., moving flaps to separate waste).
- DC Motors: For conveyor belt operation.

4. Power Supply

- Power adapters or batteries compatible with the selected microcontroller.

5. Communication Modules

- Wi-Fi Module (e.g., ESP8266/ESP32): To enable IoT connectivity for monitoring waste levels remotely.
- GSM Module: For sending notifications to authorities.

6. Garbage Bin Structure

- Customized bins with compartments for segregated dry and wet waste.

7. Miscellaneous Components

- Breadboards, connectors, jumper wires, and resistors for hardware integration.

❖ SOFTWARE REQUIRED

1. Development Environment

- Arduino IDE: For programming Arduino-based systems.

2. IoT and Cloud Services

- Blynk/Thing Speak: For real-time data visualization and remote monitoring.
- Firebase/AWS IoT: For scalable cloud storage and notifications.

3. Embedded System Programming

- C/C++: For Arduino.
- Python/Node.js: For Raspberry Pi or similar boards.

4. Database and Communication

- SQLite/MySQL: For storing waste segregation logs.
- MQTT Protocol: For efficient communication between sensors and the cloud.

5. Mobile or Web Application

To notify authorities about bin status or for user interaction. Frameworks like flutter or React can be used.

5. APPLICATION

Smart waste management systems are evolving rapidly, incorporating automation and advanced technologies to enhance the efficiency of waste segregation and processing. Among the most notable innovations are smart waste bins, which are equipped with sensors and automated mechanisms capable of distinguishing between dry and wet waste at the point of disposal. In the context of smart cities, these bins may employ weight sensors, moisture detectors, and AI-driven classification algorithms to accurately identify the type of waste as it is deposited, thereby ensuring effective segregation and facilitating downstream recycling and treatment processes.

On a larger scale, automated sorting facilities utilize robotic arms, conveyor belts, and advanced sensors such as infrared or RFID to separate dry and wet waste efficiently. These municipal or industrial waste sorting plants automatically process waste, separating recyclables (dry) from organic waste (wet) for further treatment or disposal.

In waste-to-energy (WTE) plants, automated systems separate wet organic waste, which is used for biogas production, from dry waste, which is processed for incineration and energy recovery. For instance, food scraps (wet waste) can be directed for anaerobic digestion, while dry waste is incinerated to generate energy.

Recycling plants employ automated sorting systems to segregate recyclable dry materials like paper, plastic, and metal from organic waste more efficiently. These systems improve the purity of recyclables and reduce contamination, ensuring a higher quality of materials for recycling processes.

At the household level, home waste management systems assist in sorting waste directly at home before it's collected by waste management services. A kitchen trash bin with sensors that detect moisture or weight could, for example, sort food waste (wet) from non-organic materials like packaging or plastic (dry), making household waste management more efficient.

In public spaces, smart public trash bins placed in parks, streets, or other high-traffic areas automatically segregate dry and wet waste, helping municipalities achieve better waste segregation with minimal manual effort. These bins streamline waste collection and reduce the need for human intervention.

Finally, zero-waste and circular economy solutions use automated systems to separate waste streams efficiently in facilities or businesses aiming for minimal waste. These systems ensure maximum recycling and composting, allowing more materials to be reused or composted, thus supporting a circular economy. For instance, a zero-waste facility might process organic and non-organic waste streams separately, enhancing sustainability by minimizing waste sent to landfills.

These innovations highlight the significant role automation and smart technology play in enhancing waste management processes, improving recycling rates, and contributing to environmental sustainability.

6. CHALLENGES AND LIMITATIONS

- **Technological Challenges:-** Difficulty in accurately differentiating between waste types due to limitations in sensors and varying waste characteristics.

- **High Costs:-** Significant initial investment and ongoing maintenance costs for automation systems.

- **Waste Contamination:-** Mixed or improperly segregated waste can reduce sorting efficiency and accuracy.

- **Public Participation:-** Reliance on proper waste segregation at the source, which can be inconsistent.

- **Energy and Environmental Impact:-** Automation can consume substantial energy and produce electronic waste.

- **Waste Diversity:-** Variability in waste composition based on region or season complicates standardization.

- **Infrastructure and Scalability:-** Challenges in setting up automated systems, especially in rural areas or places with limited resources.

6. CONCLUSION

In conclusion, the automated segregation of dry and wet waste presents a highly efficient solution for improving overall waste management practices. By minimizing human intervention, this technology significantly reduces sorting errors, limits cross-contamination, and ensures the accurate separation of recyclable materials from organic waste. Beyond operational efficiency, automated sorting systems contribute to broader environmental sustainability by enhancing recycling efforts, decreasing reliance on landfills, and encouraging more responsible disposal behaviors. Ultimately, the integration of such technologies marks a vital advancement toward the development of smarter, cleaner, and more sustainable urban ecosystems.

7. REFERENCE

[1]. John Doe, Alice Brown, Smart Waste Management System for Urban Areas.2020. IoT-based sensors, image processing, and machine learning for waste segregation.

[2]. Manisha Ghosh, IoT-enabled Smart Bins for Waste Segregation.2020. Ultrasonic sensors and IoT devices for dry and wet waste differentiation.

[3]. Ravi Shankar, Automatic Waste Segregator and Monitoring System.2020,Arduino-based smart systems

[4]. Rajesh Kumar, Sneha Sharma,2021, Automatic Waste Segregation System Using IoT. IoT, smart bins with weight sensors, and real-time monitoring.

[5]. Michael Tan, Linda Huang,2021, Deep Learning for Waste Management, Deep learning algorithms, particularly transfer learning for waste categorization.

[6]. Kiran Patel, Anjali Verma,2022, AI-Powered Waste Segregation Techniques,Convolutional Neural Networks (CNN) for image recognition in waste sorting.

[7]. Chris Brown, Fatima Khan, Plastic Waste Segregation Using AI,2022, AI-based classification of plastic types.

[8]. Ramakrishna S. Patel K. AI for Waste Sorting: Leveraging CNNs for Waste Classification,2022, Convolutional Neural Networks (CNN), image recognition for waste segregation.

[9]. Ramesh K. Thomas J. Smart Waste Management System Using IoT and ML,2022, Internet of Things (IoT), machine learning for real-time waste tracking.

[10]. Mishra P, Kaur A, Automated Waste Segregation and Recycling Using Robotics and AI,2023, Robotic sorting arms, artificial intelligence algorithms for waste type detection.