

Smart Automated Waste Management System with Touchless Operation, Solid-Liquid Separation and Compressed Waste Removal

Shantanu Mangesh Shinde, Samarth Ankush Tad, Rushikesh Vijay Tad, Sanket Vilas Sawant, Rohan Shivaji Nagare, Krushna Shirish Lamgunde, Mrunali Mohan Sawant, Manish Shankar Matre, Digvijay Devendra Gaikwad, Vijay Ananda Abhivant, Meghnath Lahu Khatal.

U.G. Student, SVERI's College of Engineering, Pandharpur, Maharashtra, India
U.G. Student, SVERI's College of Engineering, Pandharpur, Maharashtra, India
U.G. Student, SVERI's College of Engineering, Pandharpur, Maharashtra, India
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U.G. Student, SVERI's College of Engineering, Pandharpur, Maharashtra, India
U.G. Student, SVERI's College of Engineering, Pandharpur, Maharashtra, India

ABSTRACT: Efficient waste management is essential for ensuring environmental cleanliness and minimizing pollution in both urban and rural regions. The proposed Intelligent Automated Waste Management System presents an integrated approach that combines automation, moisture reduction, wastewater purification, and real-time monitoring to overcome the limitations of traditional waste disposal methods. The system consists of a fine mesh separator that isolates solid waste from liquid components, followed by a thermal drying unit that reduces moisture and volume, enhancing waste processing efficiency. A sensor-driven actuator system monitors bin levels, compresses waste to extract excess water, and automatically sends alerts through a connected mobile application when collection is required. The touchless lid mechanism, activated by a human presence sensor, ensures hygienic operation and minimizes contact-based contamination. The companion IoT-enabled mobile application provides real-time insights such as bin status, fill levels, malfunction alerts, and waste collection analytics—empowering authorities to plan efficient collection routes and reducing manual supervision. The filtration system purifies separated liquid through multi-layer filters, reducing odor and bacterial contamination. Powered by an energy-efficient electrical source, the proposed system offers a sustainable, automated, and hygienic waste management solution suited for domestic, institutional, and agricultural applications. By integrating smart hardware and a digital monitoring interface, the system supports global efforts toward smarter, cleaner, and more sustainable waste management.

KEY WORDS: Smart Waste Management, IoT, Automation, Moisture Reduction, Wastewater Purification, Real-Time Monitoring, Touchless Operation

I.INTRODUCTION

Effective waste management is one of the most essential aspects of maintaining environmental cleanliness, public health, and sustainability. With the continuous growth of population, industrial activities, and urbanization, the amount of waste generated has increased significantly. In most regions, traditional waste disposal methods such as manual collection and dumping are still practiced, which often lead to unhygienic surroundings, unpleasant odors, overflow of bins, and pollution of nearby water bodies. These practices not only affect the environment but also pose serious health risks to waste handlers and the community.

To overcome these challenges, the integration of technology in waste management has become a necessity. The development of intelligent systems using automation, sensors, and Internet of Things (IoT) technology provides a more efficient, cleaner, and safer alternative to traditional methods. The proposed intelligent automated waste management system introduces a compact and smart design that combines solid-liquid separation, moisture reduction, and wastewater purification processes. The system incorporates a fine mesh separator to isolate solid particles from liquid waste, a thermal drying unit to minimize moisture, and a touchless lid mechanism operated by a human presence sensor to maintain hygiene.

In addition, a sensor-based actuator continuously monitors the level of waste in the bin and automatically compresses it to reduce volume. The integration of a mobile application further enhances system performance by displaying real-time waste status, sending alerts when the bin is full, and providing maintenance notifications. The separated liquid waste passes through multiple filtration layers to remove odor and bacterial impurities, producing cleaner water for possible reuse.

This intelligent waste management system offers an efficient, eco-friendly, and automated approach suitable for domestic, institutional, and agricultural environments. By combining mechanical design with IoT-based monitoring, the project aims to reduce human intervention, improve waste handling efficiency, and contribute to the vision of sustainable and smart cities.

II. SIGNIFICANCE OF THE SYSTEM

The intelligent automated waste management system holds great significance in addressing the limitations of conventional waste disposal methods and promoting a sustainable, hygienic, and efficient waste-handling approach. Traditional systems depend largely on manual collection and segregation, which often result in unhygienic conditions, delayed disposal, and environmental pollution. In contrast, the proposed system integrates automation, IoT technology, and moisture reduction mechanisms to ensure continuous monitoring and smart operation with minimal human involvement.

The system's touchless operation minimizes physical contact, thereby reducing the risk of infection and contamination—an especially important feature in public and institutional areas. Its ability to separate solid and liquid waste helps in reducing the total waste volume, making collection and disposal more efficient. The drying and compression processes not only decrease moisture content but also optimize storage capacity, resulting in reduced collection frequency and operational costs.

The integrated mobile application adds further value by enabling real-time monitoring, notifications, and data analytics related to waste generation patterns. This helps municipal authorities, institutions, and households plan waste collection and management more effectively. Additionally, the filtration of separated liquid waste reduces odor, bacterial growth, and environmental contamination, supporting cleaner surroundings.

Overall, the system provides a technologically advanced and environmentally responsible solution that aligns with the objectives of smart city development. It ensures cleaner environments, improved resource utilization, and promotes sustainable living through automation, efficiency, and innovation.

III. LITERATURE SURVEY

Efficient waste management has become a global priority due to the increasing volume of waste generated from domestic, commercial, and industrial activities. Earlier waste disposal systems primarily relied on manual collection and segregation, which often resulted in unhygienic conditions, delayed processing, and health hazards for workers. With technological progress, researchers have focused on the development of automated and intelligent systems to improve efficiency, minimize human involvement, and enhance environmental hygiene.

Recent studies have introduced smart bins equipped with ultrasonic or infrared sensors to detect waste levels and notify collection authorities when bins are full. Such systems help prevent overflow and allow better planning of waste collection routes. Some designs incorporate wireless communication technologies like GSM, Wi-Fi, or LoRa to transmit real-time data to centralized monitoring platforms, enabling data-driven waste management decisions. Other researchers have explored RFID-based waste tracking for urban applications to enhance accountability and optimize collection schedules.

Several works have also focused on automated segregation systems using sensors to distinguish between dry and wet waste, moisture sensors for classification, and mechanical separators for improved processing. However, most of these models are limited to monitoring and alerting functions and do not address issues related to moisture reduction, liquid treatment, or odor control.

The proposed intelligent automated waste management system bridges these gaps by integrating solid-liquid separation, thermal drying, compression, and wastewater purification within a single compact unit. It also employs sensor-based operation, a touchless lid mechanism, and an IoT-enabled mobile application for real-time monitoring and notifications. Furthermore, a multi-layer filtration process is incorporated to treat the separated liquid, reducing odor and bacterial contamination.

This review indicates that while significant progress has been made in the development of smart monitoring systems, there remains a need for multifunctional, self-sustaining waste management solutions. The proposed system addresses this need by combining automation, real-time monitoring, and waste treatment capabilities to create a more hygienic, efficient, and sustainable approach suitable for domestic, institutional, and agricultural applications.

IV. METHODOLOGY

The intelligent automated waste management system is designed to combine automation, solid-liquid separation, moisture reduction, and wastewater purification into a single efficient setup. The methodology focuses on the sequential functioning of each subsystem to achieve efficient waste handling, minimal human contact, and real-time monitoring through IoT technology.

The process begins with the waste collection stage. The system uses a touchless lid mechanism operated by an infrared or ultrasonic human presence sensor. When motion is detected near the bin, the lid opens automatically, allowing users to dispose of waste without any physical contact. This mechanism ensures hygiene, prevents cross-contamination, and is particularly useful in public and institutional environments.

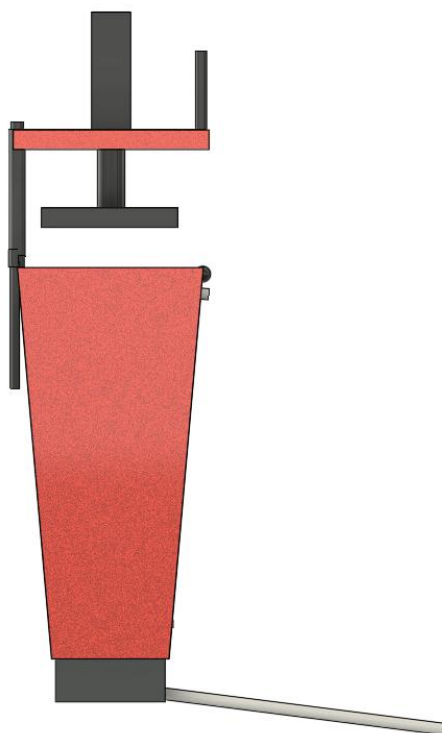


Figure 1: Front View of the Intelligent Automated Waste Management System

This image displays the front view of design of the system, highlighting the automated lid section, sensor placement, and waste inlet area. It provides a clear overview of the user interface and external housing of the bin. Once the waste enters the bin, it passes through a fine mesh separator that divides solid materials from liquid waste. The liquid portion flows towards the filtration unit, while the solid portion remains for further treatment. The solid waste is then directed into a thermal drying chamber, where a controlled heating element reduces the

moisture content. A sensor-based actuator compresses the waste slightly to extract remaining liquid and reduce its overall volume, improving storage efficiency and extending the time between waste collections.



Figure 2: Isometric Layout of the Automated Waste Management Unit

This figure illustrates the internal structure and working arrangement of the system, including the drying chamber, compression mechanism, actuator setup, and filtration section. It shows how each part is interconnected to achieve automatic separation, drying, and purification.

After separation, the liquid waste moves through a multi-layer filtration system composed of fine mesh, activated carbon, and sand filters, which remove odor, impurities, and bacteria. The filtered water is cleaner, reducing environmental contamination and promoting hygienic waste treatment.

The system is connected to an IoT-based mobile application that continuously monitors the waste level, operational status, and system health. The sensors inside the bin measure the fill level, and once it reaches a certain threshold, the app sends automatic notifications to the user or authority responsible for collection. The mobile application interface displays key information such as waste level, type of waste, and real-time maintenance alerts, ensuring efficiency and timely action.



Figure 3: IoT-Based Mobile Application Interface for Waste Monitoring

This image shows the design of the mobile application used for monitoring the system. It displays parameters such as bin status, waste level indicator, and alert notifications, allowing users to track and manage waste collection remotely.

The entire system operates through an external power supply optimized for low energy consumption. The control circuitry coordinates sensors, actuators, and IoT modules to maintain reliable and synchronized operation. This methodology ensures a hygienic, automated, and sustainable waste management approach that reduces manual effort, prevents overflow, and supports smart city waste management initiatives.

V. EXPERIMENTAL RESULTS

The proposed intelligent automated waste management system is expected to provide an efficient, hygienic, and sustainable solution for waste handling through automation and real-time monitoring. It aims to overcome the limitations of manual collection by integrating touchless operation, solid-liquid separation, moisture reduction, and wastewater purification in a single unit.

The touchless lid mechanism is expected to ensure complete hands-free operation, reducing infection risks and improving hygiene. The sensor-based actuator will detect human presence and operate the lid automatically, while the waste level sensor will monitor bin capacity and send timely alerts through the connected mobile application, preventing overflow and enabling scheduled collection.

The fine mesh separator is anticipated to effectively separate solid waste from liquid components, directing the liquid to the filtration unit for further treatment. The thermal drying and compression process should reduce moisture and overall waste volume, improving space utilization and reducing disposal frequency. The filtration system is expected to remove impurities and odor, producing cleaner and safer liquid discharge.

The IoT-enabled mobile application will display real-time system data, including bin status and notifications, allowing users or authorities to monitor operations remotely. Overall, the system is expected to be energy-



efficient, low-maintenance, and suitable for domestic, institutional, and agricultural applications, contributing to smart and eco-friendly waste management practices.

VI. CONCLUSION AND FUTURE WORK

The proposed intelligent automated waste management system offers an efficient and hygienic solution for handling waste through automation, moisture reduction, solid-liquid separation, and wastewater purification. It minimizes human effort, prevents overflow, and ensures real-time monitoring via an IoT-based mobile application. The system promotes clean surroundings and supports the vision of smart and sustainable waste management suitable for domestic, institutional, and agricultural use.

In the future, the system can be enhanced by adding renewable energy sources like solar power for self-sustained operation and integrating AI-based waste classification for improved efficiency. Further developments such as predictive data analysis and GPS-based collection tracking can make the system smarter, more energy-efficient, and adaptable for large-scale urban applications.

REFERENCES

- [1] A. K. Sharma, R. Gupta, and S. Kumar, "IoT-Based Smart Waste Management System for Efficient Resource Utilization," *International Journal of Engineering Research & Technology (IJERT)*, vol. 9, no. 6, pp. 1125–1129, 2020.
- [2] M. Patel and P. Deshmukh, "Automation in Waste Segregation and Management Using Sensor-Based Technology," *International Research Journal of Engineering and Technology (IRJET)*, vol. 7, no. 5, pp. 4102–4106, 2020.
- [3] S. G. Nallusamy and K. Saravanan, "IoT Enabled Smart Waste Bin for Smart Cities," *International Journal of Recent Technology and Engineering (IJRTE)*, vol. 8, no. 5, pp. 2714–2718, 2021.
- [4] R. Singh, A. Kumar, and T. K. Das, "Design and Implementation of an Intelligent Waste Management System Using IoT and Cloud Computing," *IEEE Access*, vol. 8, pp. 108–115, 2020.
- [5] P. Verma and M. Mishra, "Solid-Liquid Waste Separation and Moisture Reduction Techniques in Smart Waste Systems," *International Journal of Mechanical and Production Engineering Research and Development (IJMPERD)*, vol. 10, no. 3, pp. 567–573, 2021.
- [6] N. R. Prasad and V. R. Pawar, "A Review on Smart Waste Management Systems with IoT Integration," *International Journal of Innovative Science and Research Technology (IJISRT)*, vol. 6, no. 9, pp. 950–954, 2021.
- [7] M. L. Chavan and R. Jadhav, "Development of Automated Waste Collection System Using IoT for Smart Cities," *International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering (IJAREEIE)*, vol. 10, no. 8, pp. 2345–2350, 2021.