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Development of a Solar-Powered Smart Dustbin for Odor-Free, Pathogen-Controlled, and Health-Centrist Waste Management

Rushikesh Vijay Tad[1], Vishvjit Ranganath Dighe[2], Suyash Yashwant Atpadkar[3], Sanket Arun Wagh[4], Sanskar Bibhishan Karpe[5], Prathmesh Gajanan Waghmare[6], Pranav Hanumant Shinde[7]

[1]Department of Mechanical Engineering, SVERI's College of Engineering, Pandharpur
[2]Department of Mechanical Engineering, SVERI's College of Engineering, Pandharpur
[3]Department of Civil Engineering, SVERI's College of Engineering, Pandharpur
[4]Department of Computer Engineering, SVERI's College of Engineering, Pandharpur
[5]Department of Mechanical Engineering, SVERI's College of Engineering, Pandharpur
[6]Department of Mechanical Engineering, SVERI's College of Engineering, Pandharpur
[7]Department of Mechanical Engineering, SVERI's College of Engineering, Pandharpur

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Abstract - This study presents an eco-friendly, dual-compartment smart dustbin designed to improve waste management by reducing odor, preventing contamination, and enhancing hygiene. The upper chamber (80%) collects solid waste and dries it using a solar-powered dryer to reduce volume, moisture, and bacterial growth. The lower chamber (20%) collects liquid waste, which is passed through a filtration system to remove harmful contaminants. A touchless infrared sensor enables automatic lid opening, ensuring hygienic and contact-free waste disposal. By separating wet and dry waste at the source, the system reduces odor, minimizes the release of gases such as methane and ammonia, and helps prevent the spread of bacteria like E. coli and Salmonella. With India recording nearly 1.7–2.1 million deaths annually due to pollution-related causes, this solar-powered smart dustbin offers a clean, sustainable, and health-focused solution for modern waste management. It supports better hygiene, protects public health, and promotes a cleaner environment.

Key Words: Smart DustbinSolar-Powered Waste Management Dual-Compartment SystemWaste Drying and Filtration Touchless Infrared Sensor

I. INTRODUCTION

In today's world, managing the wastage is properly. it becomes a big challenge. On a day-to-day basis, a large amount of waste is generated from homes, offices, and public places. Mostly waste is a mixture of the wet and dry wastage, which is leads to many problems. it will not separate correctly. When wet and dry waste are mixed, it produce a bad smell, attracts insects, and becomes a source of harmful bacteria and viruses. Over time, the waste starts releasing toxic gases from the waste as methane, ammonia, and hydrogen sulfide. It is polluted by the air, harmful gases generated, which will be effected of human health and the environment.

The proper wastage is disposal does not create an unhygienic environment, but also increases the risk of diseases. There will be many areas that suffer from air and water pollution because of poor waste handling. Studies have shown that millions of deaths occur every year due to air pollution and related health issues. This clearly shows the need for a smart and sustainable system that can handle waste safely and improve efficiency.

It overcome these issues, this project presents the design and development of a solar-powered dual-compartment smart dustbin. The main aim of this system is to separate solid and liquid waste and process them in a hygienic and eco-friendly manner. The upper compartment of the dustbin is used to collect solid waste and includes a solar-powered dryer it is removes moisture content, reduces odor, and prevents bacterial growth. The lower compartment collects liquid waste and passes it through a simple filtration system to remove harmful bacteria and impurities in the liquid waste.

The dustbin also uses an infrared sensor, allowing it to open and close automatically when anyone passes by. This is the touchless operation that helps maintain cleanliness and reduces the spread of germs since users do not need to touch the dustbin. The system is runs completely on solar energy, it is an energy-efficient and environmentally friendly solution.

By combining solar energy with smart sensing technology, this project promotes cleanliness, supports sustainable living, and helps reduce pollution and human disease. the step is toward creating a cleaner, safer, and greener environment for everyone.

II. RESEARCH GAP

Although several smart dustbin systems have been developed in recent years, most existing models focus only on waste segregation, automatic lid operation, or basic sensor-based monitoring. However, there is a significant lack of solutions that address the combined challenges of odor control, bacterial growth prevention, and liquid waste filtration within a single system. Current designs rarely include mechanisms for drying solid waste, which is essential for reducing moisture, preventing foul smells, and minimizing harmful gas emissions such as methane and ammonia. Moreover, very few studies explore the use of solar energy to power drying units and filtration systems in smart dustbins, which is necessary for achieving long-term sustainability and energy efficiency. Additionally, existing research often overlooks the health risks associated with untreated liquid waste, including contamination by bacteria like *E. coli* and *Salmonella*. These shortcomings highlight the need for a comprehensive, eco-friendly, and touchless smart dustbin that integrates waste drying, liquid filtration, odor reduction, and solar-based operation to improve public hygiene and environmental safety.

III. PROBLEM STATEMENT

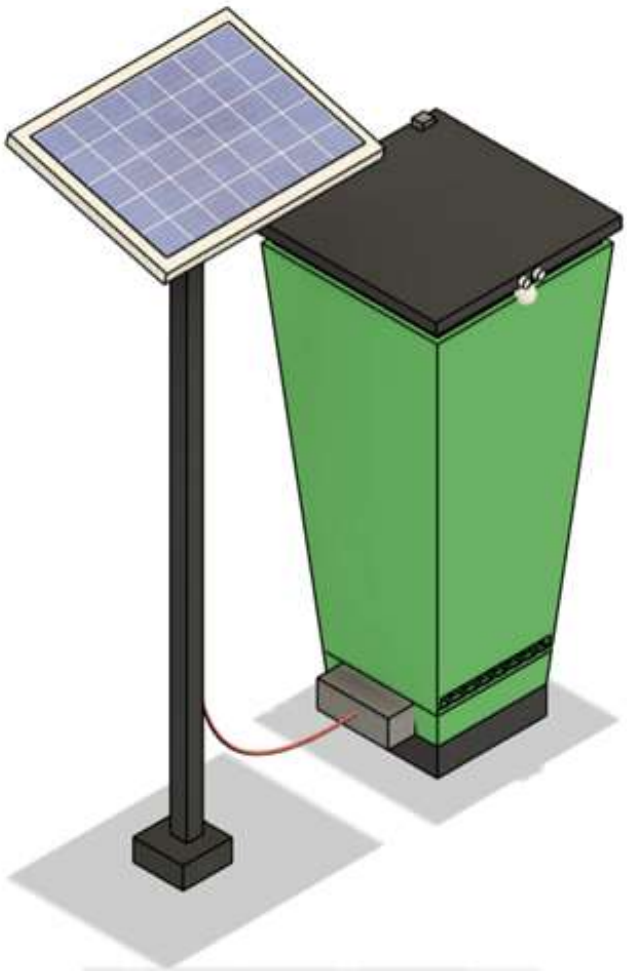
Improper waste disposal and the mixing of wet and dry waste in conventional dustbins lead to foul odors, rapid bacterial growth, harmful gas emissions, and increased health risks. Traditional dustbins do not provide separation of solid and liquid waste, nor do they include mechanisms to dry waste or filter contaminated wastewater. This results in the spread of diseases, environmental pollution, and unhygienic surroundings. Additionally, most dustbins require physical contact, increasing the chances of infection transmission. Therefore, there is a need for an eco-friendly, touchless, solar-powered smart dustbin that can efficiently separate waste, dry solid waste, filter liquid waste, reduce odor and harmful gases, and sustainably improve hygiene.

IV. OBJECTIVES

The main aim of this project is to design and develop a solar-powered dual-compartment smart dustbin that can make waste management cleaner, safer, and more efficient. The project focuses on solving problems like odor, unhygienic surroundings, and pollution caused by poor waste disposal.

1. To improve hygiene and cleanliness
2. To separate wet and dry waste properly
3. To make use of solar energy
4. To reduce odor and bacterial growth
5. To promote sustainability and public health

V. DESIGN



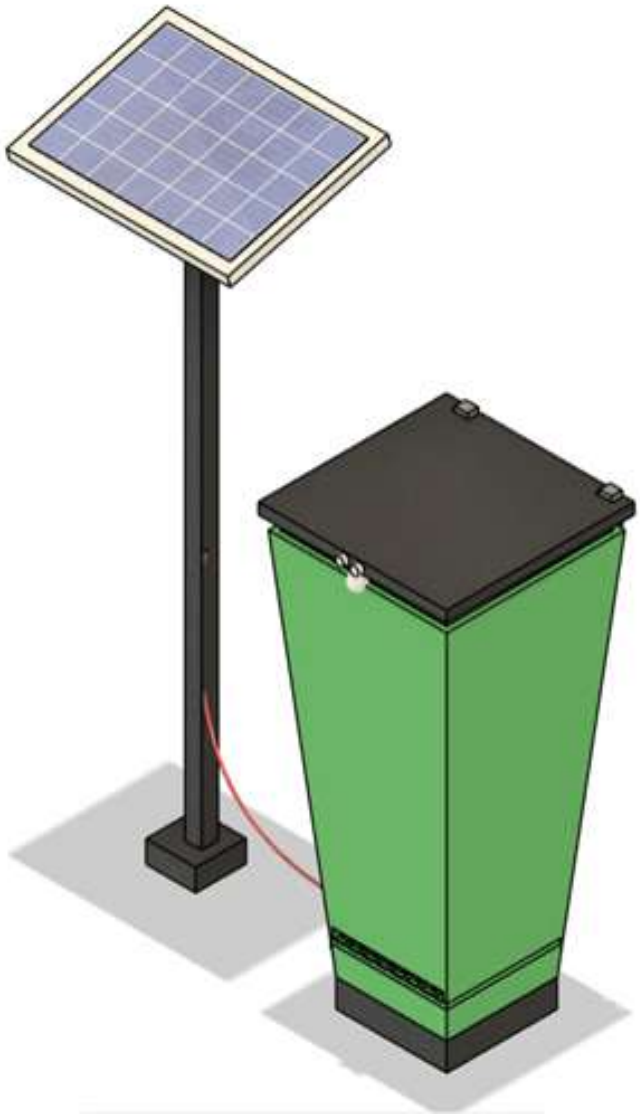


Fig. Solar-Powered Smart Dustbin

VI. WORKING

The working is simple, and the eco-friendly dual-compartment solar-powered dustbin is a simple and sustainable mechanism designed to improve hygiene and waste management efficiency and to reduce pollution. The system mainly consists of two parts, the upper and lower chambers. The upper chamber is 80% for the collection of the solid waste of the total space, food remains, and plastic. This section includes a solar-powered dryer in the middle after the net. Net separates the liquid and solid waste to the waste, it helps to reduce bad Odor, control bacteria growth, and decrease the overall waste volume. By drying the waste, it also reduces the release of harmful gases such as methane, ammonia, and hydrogen sulfide, which are commonly produced in traditional bins and can cause air pollution and breathing problems. The lower chamber, which occupies the remaining 20% space, is used for collecting liquid waste. The liquid dripping from to the lower chamber passes through the filter. West is the purification and separation of harmful particles and preventing the spread of bacteria like *E. coli* and *Salmonella* that can contaminate water and cause diseases. The dustbin also has a touchless infrared sensor system that automatically opens the lid when someone comes near it. allowing the user to throw waste without touching the bin and then closing it automatically after 5 seconds. This maintains hygiene and convenience. The entire system operates using solar energy stored through the solar panel fitted to the side of the dustbin, which powers the dryer and sensor efficiently even when sunlight is low. This eco-friendly system not only separates solid and liquid waste but also reduces odor, bacterial growth, and environmental pollution, promoting a cleaner and healthier environment.

VII. ADVANTAGES

1. Touchless infrared sensing prevents direct contact, reducing the risk of infection and maintaining cleaner surroundings.
2. Separate chambers for solid and liquid waste ensure proper disposal and prevent mixing, which commonly causes odor and contamination.
3. The drying system removes moisture from solid waste, significantly decreasing foul smells and preventing unpleasant environments.
4. Drying and filtration help reduce harmful bacteria such as *E. coli* and *Salmonella*, improving public health safety.
5. Reduced moisture and proper separation minimize gases like methane, ammonia, and hydrogen sulphide, which are harmful to human health and the environment.

VIII. APPLICATIONS

1. Suitable for homes, apartments, and housing societies to maintain hygiene and reduce bad odor from daily household waste.
2. Helps in safe waste disposal, reduces contamination risks, and supports infection control.
3. Useful in schools, colleges, and universities for promoting clean campuses and proper waste management practices.
4. Ideal for parks, bus stands, railway stations, and streets where large amounts of mixed waste are generated.
5. Offices, malls, restaurants, and supermarkets can use the system to maintain clean and odor-free environments.

IX. CONCLUSION

The solar-powered dual-compartment smart dustbin provides an effective and eco-friendly solution for modern waste management challenges. By separating solid and liquid waste, drying the solid waste, and filtering the liquid waste, the system significantly reduces odor, bacterial growth, and harmful gas emissions. The touchless infrared sensor enhances hygiene by allowing users to dispose of waste without physical contact. Using solar energy makes the system sustainable, energy-efficient, and suitable for both urban and rural areas. Overall, this smart dustbin design improves public health, supports a cleaner environment, and promotes responsible waste handling for a safer and more hygienic society.

X. FUTURE SCOPE

1. Integration of IoT sensors for monitoring waste levels and sending alerts for timely collection.
2. Addition of AI-based waste identification to automatically recognize and sort waste types.
3. Improved filtration systems to treat liquid waste more efficiently and make it reusable.
4. Incorporation of composting units to convert organic waste into compost directly inside the system.
5. Use of biogas conversion modules to generate renewable energy from decomposable waste.
6. Connectivity to smart city networks for real-time waste tracking and optimized collection routes.

XI. AKNOWLEDGE

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