WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Development and Fabrication of Solar powered Smart Waste Segregation Machine

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DOI: https://doi.org/10.55248/gengpi.5.0524.1263

ABSTRACT—

India demands an effective system for handling waste due to rapid urbanization and an ever-increasing population. Only one-fifth of the rubbish produced gets processed, with the rest dumped in landfills. Household waste segregation contributes to the decrease of complexity in waste management plants. Workers who collect home waste typically classify it into dry and moist categories. So the purpose of this research is to create an automatic trash segregation system for families and small communities that uses a conveyer belt. The project's major result is to minimize the amount of individual effort and time required for waste segregation. To accomplish so, we need a robotic trash segregator. This approach for categorizing garbage into three distinct groups: dry waste and moist waste by automation is easy and straightforward, thanks to the Arduino Uno. The automated method saves time and effort for waste management plants, increasing their efficiency. We have a trash system of classification that we use for all types of waste. An electronic sensor is employed for detection, while shorter mechanical arms are employed for separation. This study will benefit society in a variety of ways. garbage management aims to recycle as much garbage as feasible.

Keywords—Automation, Environment, Waste Segregation, Sensors, Arduino Uno, Conveyer belt etc.

Introduction

India is currently confronting a number of environmental difficulties as a result of garbage generation, including inappropriate trash collection, treatment, transportation, and disposal. The most challenging obstacle is from invention to disposal. Because of the growing urban population, the nation cannot sustain the present structure, which causes both health and environmental degradation.

TThe economic worth of garbage created is not realised until it is totally recycled. When garbage is separated into fundamental flows such as wet, dry, and metallic, it has a better chance of being recovered, repurposed, and reused. The moist waste percentage is commonly turned into compost, methane gas, or both. Metallic trash can be reused or repurposed. Even if large-scale industrial waste segregators exist, it is always preferable to separate the trash at the source. The benefits associated with doing so include retaining a greater grade of the material for recycling, which implies more value may be recovered form the trash. The occupational risk to trash workers is lowered. In addition, the segregated garbage might be transferred directly into a recycling and processing facility rather than first to the separation plant and then to a recycling plant. The goal of this project is to develop a small, low-cost, and user-friendly segregation device for urban households to expedite the waste management process..

As we progress towards an increasingly digitalized future, there is a strong correlation between increased urbanisation and industry. This is the primary cause of a considerable quantity of garbage. According to a World Bank research, roughly 1.3 billion tonnes of municipal garbage are created each year, with this figure anticipated to climb to almost 2.2 billion tonnes by 2025. As a result, garbage is scattered in the surrounding area and thrown on open lands, posing a significant problem for many sorts of disease-causing germs and viruses, which is why waste control is critical. Segregation allows for more effective reuse and recycling of trash. As a result, waste management has emerged as a critical problem for societal health and well-being. Currently, garbage is segregated manually by placing several bins for collecting various types of waste, such as wet, dry, and metal. However, this system has several discrepancies, one of which being the lack of awareness of most individuals regarding trash management.

Problem Identification

The management of waste is a major problem in today's globe. The disposal technique for a large volume of produced garbage has had a negative impact on the environment. Municipal trash disposal methods commonly include unplanned dumps at landfill sites.

This strategy has an effect on human health, as well as plant and animal life. In India, the conventional way of garbage segregation is by rag pickers, which is time-consuming and can be harmful to the health of those exposed to these wastes.

The economic worth of garbage created is not realised until it is totally recycled. There's a need for an inexpensive and easy-to-use system for the separation of domestic garbage.

Objectives

This project aims to simplify garbage management for urban families by designing and implementing a solar-powered, user-friendly segregation system.

• Design a method to separate garbage into dry and wet categories, retaining higher quality materials for recycling and maximizing value recovery.

• Minimize occupational hazards for garbage collectors and handlers.

• Design and build a low-cost automated waste segregator.

• Conveyor belt mechanism for efficient garbage transfer.

• Use a solar-powered system providing uninterrupted power supply.

Literature survey

Azeez, 2020[1] proposes "IoT-based waste management for Intelligent Cities" to address environmental concerns such as insufficient trash collection, treatment, and disposal. Because flooding of the trashcan creates unsanitary circumstances, the dustbin is spread across the city and is provided at a low cost. The "Blynk app" is used to receive an instant SMS as soon as the rubbish bin reaches its maximum capacity. As a result, when the state of a bin is reported over the internet, the alert authorities will take immediate action. The suggested system is developed using an ultrasonic sensor, a node MCU, the Blynk software, and a servo motor.

Nikolaos Baras, Dimitris Ziouzios, 2020[2] offers "A cloud-based smart recycling container for in-house waste classification" as urban waste rises in tandem with modern lifestyles. Recycling is the most effective approach to build a sustainable environment, but it also requires waste material sorting, which is a time-consuming and tiresome operation. It is a low-cost yet efficient smart recycling container that employs cloud technology to classify garbage for personal in-home use. A centralised information system receives data from smart dustbins, and the rubbish in each bin can be categorised using machine learning and neural networks. It can classify different forms of garbage with a precision of 93.4%.

Shashank Shetty, Sanket Salvi, 2020[3] This presents the SAF-Sutra: "A Prototype of Remote Intelligent Waste Segregation and Garbage Level Monitoring System," which can be remotely monitored and manufactured at a very low cost. The given system's design prioritises component portability and simplicity of assembly during implementation. The demonstration displays the implemented system, its interaction to the user via the mobile and the online application.

Clude-Noel Tamakloe, Dr. Elena v. Rosca, Introduces the Smart Network and the Internet of Things (IoT) in trash management to enable efficient and effective garbage disposal, hence enhancing city waste management. The suggested system is designed as a prototype of a solar-powered, small smart waste bin that is monitored via server-side apps. The smart trash bin can monitor internal rubbish levels, compress them, and liberate about 25% of room with each compaction. The bin measures and tracks the overall weight and may communicate the data to a secure server-side application.

Rania Rizki Arinta, Dominikus Boli Watomakin, 2020[5] Introduces the "Improves smart disposal to preserve tourist attractions." Yogyakarta in IoT Environment", the major aim is to make trash recycled; if it is not recycled, the breakdown process will be more difficult. As a result, the dustbin is coupled with the smartphone to determine rubbish capacity using an ultrasonic sensor. The wi-fi module, when connected with the dustbin, allows the sensor to be able to relay data via smartphone.

Chethan Kaushal, Anshu Singha, 2020[6] introduce the Architecture for garbage tracking systems using integrated technology, proposed a novel waste management architecture that utilises the concept of IoT and the processing of digital images, the architecture acts as a surveillance system that tracks the overflow of garbage and delivers an alert to the concerned authorities for taking the necessary and immediate action.

Block Diagram

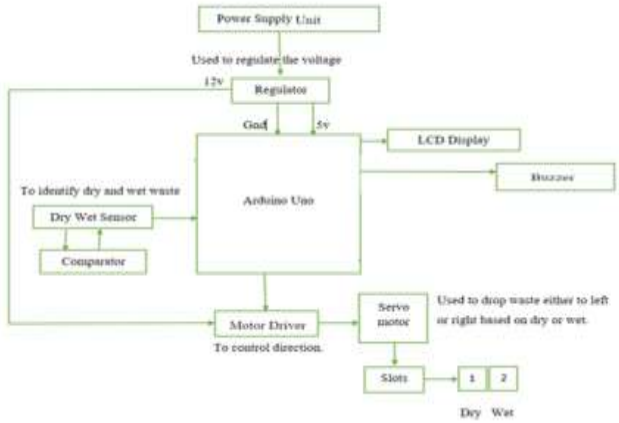

Fig. 1. Block Diagram

Working Principle

A solar panel serves to convert solar energy into electrical energy, powering the entire segregation machine. The primary goal of utilizing solar energy is to ensure uninterrupted power supply for the smart segregation machine. An external power supply unit transforms AC power into DC power through a step-down transformer, providing 12V DC power to operate all control boards and components.

To power sensors, the buzzer, and the display unit, a voltage regulator is employed to convert 12V DC to 5V DC supply. The diagram comprises three sections to execute the project: the Input section, utilizing sensors to detect signals; the Processing unit, employing an Arduino Uno controller to process input signals and relay them to the output; and the Output unit, utilizing a buzzer, motor, and display.

The proposed system involves two bins for storing dry and wet waste, designed to be replaceable for cleaning purposes. Waste is placed on the dry-wet sensor, which is set with a moisture threshold value. Upon sensing moisture content, the motor driver facilitates the rotation of the servo motor in both clockwise and anticlockwise directions, directing waste into their respective bins. The entire waste transportation process is executed using a conveyor belt mechanism.

Arduino UNO collects sensed data via sensors and transmits it to the display through the MCU. Messages are displayed on the LCD, and the buzzer notifies authorized individuals of the bin status based on the obtained data. This comprehensive system aims to streamline waste segregation with the use of renewable energy and efficient automation.

Components

- Power supply unit
- 7805 voltage regulator
- Arduino Uno Controller
- Moisture sensor
- LCD Display
- Adapter
- Conveyer Belt
- DC MOTOR
- Servo Motor
- Motor Driver Circuit
- Soal panel
- Battery
- Buzzer

- Frame
- Dustbin
- Others.

Result and Discussion

The proposed system "Solar powered automatic waste segregator and monitoring system" sorts wastes into three different categories, namely metal, dry and the wet (organic) waste. Wet waste refers to organic waste such as vegetable peels, left-over food etc. Separating our waste is essential as the amount of waste being generated today causes immense problem. Here, we will be testing the household wastes which are generated in every home today and we will be having following expected result. Tables below show the tested results of the waste when exposed to our automatic waste segregator and monitoring system. The proposed system would be able to monitor the solid waste collection process and management of the overall collection process. It would provide in time solid waste collection.

Table 1: Expected Result of Metallic Waste Separation

SL NO	TYPE OF METAL WASTE	DISCARDED OR NOT
1	SAFETY PIN	YES
2	PAPER CLIP	YES
3	BATTERY	YES
4	NAIL	YES

Table 2: Result of Wet Waste Separation

SL NO	TYPE OF WET WASTE	DISCARDED OR NOT
1	KITCHEN WASTE	YES
2	LEFTOVER FOOD	YES
3	VEGETABLE PEEL/FRUIT PEEL	YES
4	ROTTEN FRUITS AND VEGETABLES	YES

Table 3:. Result of Dry Waste Separation

SL NO	TYPE OF DRY WASTE	DISCARDED OR NOT
1	PAPER	YES
2	SMALL BOTTLES	YES
3	HEAVY CARTONS	NO
4	MILK COVER	YES
5	DRY LEAVES	YES
6	CLOTHES	YES
7	TETRA PACK	NO

Rapid increase in population has led to improper waste management in metro cities and urban areas which has resulted in spreading of diseases. This hectic problem all over in the society has led us to do this project for the proper segregation and monitoring of waste in every households and surrounding areas where it need most. The waste segregator as the name suggests, segregates the waste into three major classes: plastic, organic, metallic. The proposed system would be able to monitor the solid waste collection process and management of the overall collection process. Automatic Waste Segregator has been successfully implemented for the segregation of waste into metallic, dry and wet waste at a domestic level. The system can segregate only one type of waste at a time with an assigned priority for metal, wet, dry waste. Sensors are added for monitoring waste collection process. Sensors such as Inductive proximity sensor, IR Sensors and Moisture sensor are used. The Infrared sensor would be placed in the garbage bins. Inductive proximity sensor for the metal waste detection and moisture sensor for wet waste detection.

The experiment has been conducted for wet, dry, glass and metallic wastes. It is found that the change of capacitive count value is greater for wet waste and very less for dry waste. Other objects like glass and wood have intermediate relative dielectric constant and thus are detected as dry waste. Servo motor and a DC motor is used here. Servo motor for rotating the bin and DC Motor for the robotic arm having electromagnet in it. A LCD module is there and the status of the dry, wet, metal waste bin is given in the webpage created. Experimental result shows that the waste has been successfully monitored and segregated into metallic, wet and dry waste using the Automatic Waste Segregator and Monitoring system.

Project Image

Advantage

- Sorting of waste at the primary stage will make the waste management more effective and fruitful.
- Use of solar energy provide uninterrupted power to the machine.
- The dustbins are cleared as and when they are filled, thus giving way to a cleaner environment.
- Eco friendly system.
- Lower initial investment including lower cost of installation.

Applications

- Hospitals
- Colleges
- Railway station
- Auditoriums & Malls
- Cinema Halls
- Public places
- Apartments and colonies.

Conclusion

Research has uncovered several shortcomings in the current practices of municipal solid waste management, including insufficient segregation systems and low public awareness. To address these deficiencies, there is a need to emphasize machinery-based segregation and design innovative devices for this purpose. The waste sorting machine, capable of segregating wastes into lightweight and heavy materials, achieves an average overall efficiency of 55.60%. This approach has the potential to boost recycling rates and reduce the volume of waste sent to landfills. Simple in design, such waste sorting machines could provide a viable solution for municipalities grappling with waste management challenges nationwide.

At the societal level, an Automated Waste Segregator can be implemented to separate waste into dry and wet categories, handling one type of garbage at a time, including metal, wet, and dry waste. This method offers benefits such as cost reduction and resource optimization, making it a valuable solution for municipalities striving to enhance waste management practices throughout the country.

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