A REVIEW ON DESIGN AND FABRICATION OF AUTOMATIC SMART DUSTBIN

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Abstract: The primary aim of this project is to design and develop an intelligent and fully automated smart dustbin system that can effectively segregate waste into three categories: dry, wet, and metal. This system is intended to offer a cost-efficient and practical solution for waste sorting, which can be used in a variety of environments for accurate waste detection. By integrating smart technologies, the system seeks to improve the speed and precision of waste identification, offering a more efficient alternative to traditional manual segregation methods. The project emphasizes innovation and automation to contribute to a cleaner and more sustainable waste management process. This smart segregation system is designed to reduce human effort and promote cleaner surroundings through automation. It can be installed in public spaces, households, or industrial areas to manage waste more responsibly. The use of sensors and control units allows the system to identify and sort waste quickly and accurately. Its affordability and ease of use make it suitable for widespread adoption. Overall, the system supports a smarter and greener approach to waste management in growing urban environments.

Keywords: Smart dustbin system, waste sorting, manual segregation methods

1. Introduction

India generates approximately 62 million metric tons of solid waste each year, but much of it remains poorly managed, especially in urban areas. This inefficiency in handling waste has led to severe environmental damage and health hazards across various cities. A common sight in many regions is the open and unregulated dumping of garbage into landfills, a practice that reflects the lack of structured disposal methods. Among the numerous challenges the country faces today, ineffective waste management stands out as a critical concern. One of the most pressing issues is the lack of proper waste segregation and the difficulty in converting waste into energy. The absence of organized collection, treatment, and transportation methods has further worsened the situation. As India continues to urbanize and industrialize, the volume of waste produced is increasing significantly. Key hurdles in effective waste management include the need for better waste separation, efficient door-to-door collection systems, sustainable recycling and reuse practices, advanced treatment technologies, land availability for waste processing, and improved disposal capabilities. Contemporary waste management practices emphasize the importance of source-level segregation and the need for tailored treatment solutions based on waste type. In line with this, the Indian government introduced the “Swachh Bharat Mission,” aiming to create a cleaner and more sustainable nation. Presently, there is a stronger emphasis on systematic collection and meaningful categorization of waste to maximize resource recovery. One promising solution to this issue is the development of an Automated Waste Segregation and Monitoring System (AWSMS). Such a system can independently sort waste into categories such as dry, wet, and metal without any manual involvement. The advantages of AWSMS are significant: it minimizes environmental pollution, decreases landfill usage, cuts down on manual labour, and offers a cost-effective, efficient, and time-saving approach to waste management. The goal of this project is to design and construct a smart waste management system that streamlines the segregation process and supports sustainable urban living.

II. Statement of the Problem

The current waste segregation methods are limited by its accuracy due to the human involvement which can make it difficult to detect the metal objects in the collected waste. There is a growing need to identify different types of waste and direct them to the correct section of a bin. Proper segregation at the source improves recycling efficiency, reduces environmental pollution, and minimizes manual effort. An automated system that detects and channels waste into wet, dry and metal waste categories can greatly enhance the overall waste management process.

The effectiveness of the object detection sensor is crucial in ensuring that the bin lid opens only when the segregation system is ready to receive waste. This helps in maintaining a smooth and automated workflow, preventing errors like mixing of waste types. By checking the sensor's response based on the system’s segregation status, we can ensure accurate waste disposal and enhance the system’s efficiency and reliability. Designing a

portable bin is essential for ensuring easy installation and flexibility in placement across various locations such as homes, offices, or public spaces. A compact and lightweight design allows for quick relocation and setup without requiring complex tools or infrastructure. This portability makes the waste segregation system more accessible and adaptable to different environments, promoting broader usage and better waste management practices.

III.REVIEW OF LITERATURE

1) Kapil Dev Sharma, Rishi Kumar Prajapati, al: This system minimizes human interference and shortens the time and cost of segregation. Powered by Arduino UNO and various sensors, this system easily separates solid waste into three main categories namely metal, dry, and wet.
2) Dr Kavitha Mani A, Suman R, Raswanth V, al: The main purpose of this project is to develop a sensible segregation system for the welfare of the environment. This model uses the Arduino Uno as a central hub to regulate all the sensors.
3) Myra G. Flores, Jose B. Tan Jr, al: Analysing and classifying the garbage using image processing can be a very productive way to process waste materials. This paper aims to analyse existing research presented studies around the globe. This will enable to determine the problems, the algorithm used and method of those cited studies.
4) Agha Muhammad Furqan Durrani1, Ateeq Ur Rehman, al: An Automated Control Management System (AWCMS) has been designed which includes an electronic waste detection device and a central control unit. All the information like latitude, longitude, the status being full or empty etc. are displayed in the GUI of the software in the event of a waste-bin getting full and then being emptied by municipal waste trucks or field workers.

IV. OBJECTIVES OF THE STUDY

1. To design and develop an automatic smart dustbin system that can be used for segregation of waste into three categories like dry, wet and metal waste.
2. To create an efficient and cost-effective waste segregation system that can be used for various waste detection purpose.
3. To provide innovative solution to waste detecting that is faster and more efficient than other waste segregation method.

V. RESEARCH METHODOLOGY

The project will be implemented in the following steps:

1. Preparation and Gathering of Materials.
2. Drafting the 3D model of the mechanical system of the bin for analyzing the design.
3. Design and development of waste segregation system:
   - Waste segregation system will be designed and developed using various component such as metal detecting sensor, temperature sensor, power adaptor, servo motor, I2C LCD display and ESP 32 module.
4. Integration of sensor with ESP32 node MCU:
   - An ultrasonic sensor is an electronic device that measures distance by using ultrasonic sound waves. It emits high-frequency sound pulses, which bounce off nearby objects and return to the sensor. By calculating the time, it takes for the echo to return, the sensor determines the distance to the object.
   - Dustbin bag detection is accomplished using ultrasonic sensor
   - MLX90614 is a non-contact infrared temperature sensor used to measure the temperature of an object or surface without physical contact. It works by detecting infrared radiation emitted by the object and converting it into a temperature reading.
   - The metal detector coil was designed and constructed using a copper wire coil and a ferrite core. The coil was wound around the ferrite core, and the ends were connected to a circuit board that was connected to the microcontroller.

5. Testing and validation:

- The system will be tested and validated in segregation of various type of waste to ensure its efficiency and accuracy.

VI. Overview of Smart Dustbin

The project aims to develop an automatic waste segregation system that can be used for various purposes such as wet waste, dry waste and metallic waste. Metallic zinc sheet is used to develop the body of the bin which leads to the robots design of the dustbin. A metallic structure for a dustbin offers several advantages, including high durability, strength, and resistance to damage. Metal bins are less likely to crack or deform compared to plastic ones, making them ideal for long-term use, especially in outdoor or industrial environments. They can withstand extreme weather conditions, are fire-resistant, and are easy to clean and sanitize. Additionally, metal is recyclable, making it an environmentally friendly choice for sustainable waste management solutions. The Smart bin is divided into three compartments. Each Compartment has their own function, the first compartment Consists of an IR sensor and a metal detector and the second Compartment consists of another IR sensor and moisture Sensor for detecting dry and wet waste, the last compartment is subdivided into three bins for collection of the segregated Waste respectively. The whole system is controlled by Micro controller. Each and every component is interfaced to the microcontroller board. The necessary code for controlling the sensors and the motors is coded using embedded-C language, in which the inputs and the output ports can be defined easily. In this project we have used IDE compiler to compile the code and upload it to the board using an A-B wire. To provide details of every decision we have used a Liquid Crystal Display device to display the decisions made by the Arduino processor.

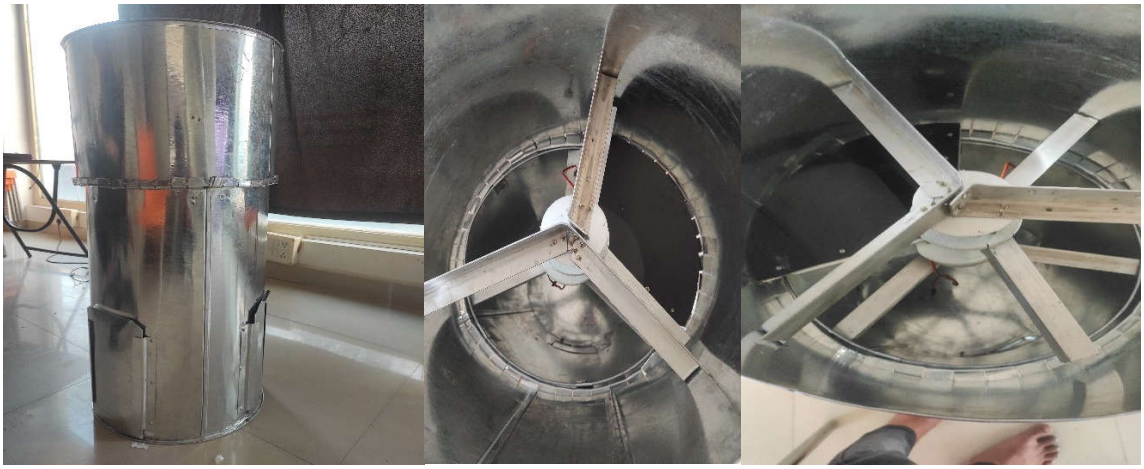

Figure 1: Automatic Smart Dustbin

1. Metal Sensor

An Inductive Proximity Sensor is a non-contact electronic proximity sensor used for the detection of metals. Sensing range of this sensor completely depends upon the metal being detected. Rise and fall of amplitudes are detected by a threshold circuit that causes a corresponding change in the output of the sensor. If a metal contains some percentage of ferrous, the sensing range is longer, while non-ferrous metals like copper reduce the sensing range by 60 percent. There are two possible outputs of this sensor, hence it is also called inductive proximity switch. Common applications of inductive sensors include metal detectors, traffic lights, etc. and a plethora of industrial automated processes.

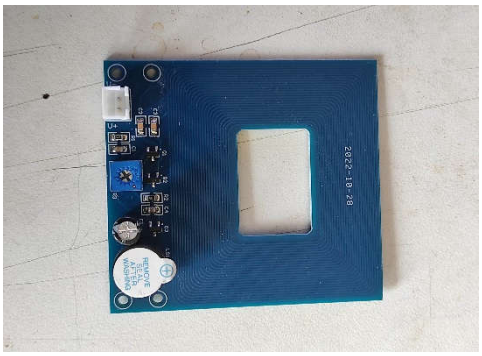

Figure 2: Metal detector

2. MLX90614 Temperature sensor

The MLX90614 is a non-contact infrared (IR) temperature sensor. This means it can measure the temperature of an object without physically touching it by detecting the infrared radiation emitted by the object. It's a popular choice for various applications due to its small size, low power consumption, and relatively high accuracy. The MLX90614 non-contact infrared (IR) temperature sensor presents a compelling avenue for enhancing the functionality and intelligence of an automatic smart dustbin, extending its capabilities beyond simple lid actuation and fill-level monitoring. By integrating this sensor, the smart dustbin can gain the ability to "sense" the thermal characteristics of the waste being deposited, opening up possibilities for more sophisticated waste management and user interaction. Unlike traditional sensors that focus on proximity or volume, the MLX90614 measures the infrared radiation emitted by objects, allowing for temperature readings without any physical contact.

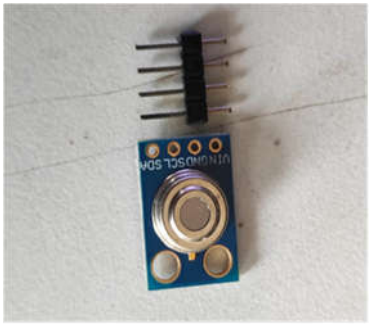

Figure 3: MLX90614 Temperature sensor

VII. Conclusions

The automated waste segregation system enhances efficiency, sustainability, and waste management by minimizing human intervention and improving sorting accuracy. By utilizing sensors to classify wet, dry, and metal waste, the system ensures proper disposal while reducing manual effort, its ability to detect bin capacity optimizes waste handling. With its adaptability for households, offices, colleges, and industries, this model presents a solution for effective and responsible waste segregation.

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