IoT-enabled dustbin for trash segregation and collection

Purnima Bansal[1], Aditi Ananya[2]and Shilpa Jindal[3]

[1,2,3] *Chandigarh College of Engineering & Technology, Sector 26, Chandigarh, India.*

Abstract

India is confronted with significant environmental problems as a result of waste generation and insufficient waste collection, segregation, and disposal. India's current waste management systems are incapable of dealing with the amount of waste created by an expanding population. To address this issue, a sophisticated waste management system is needed. It is important to properly segregate collected waste. This manuscript proposes an IoT based smart dustbin for garbage segregation that detects wastes in the dustbin via sensor devices and immediately segregates them into different chambers. The microcontroller serves as a connection between the sensors and the IoT module. Numerous sensors are used, including ultrasonic sensors, moisture sensors, and metal sensors which distinguishes the nearness of waste material, analyse the waste's moisture content, and put metal items in a separate chamber. The plastic and biodegradable objects are identified using an image processing algorithm and are divided into separate segments. This aids in the effective segregation of waste.

Keywords

Segregation, Sensor technology, Waste management, IoT device, Image processing.

1. INTRODUCTION

In recent years collection and isolation of waste is the main problem faced by all metropolitan cities worldwide. This is attributed to the rapid growth in population, industrialization, and urbanization. According to the Indian government's central pollution control board (CPCB), waste generation has risen exponentially (0.26 kg/day to 0.85 kg/day) per capita [1]. Around 80% to 90% of urban waste is disposed of in landfills without appropriate management methods or open burning, resulting in contamination of our natural resources. People are generally unaware of waste management problems, and the carelessness of their waste causes difficulties for municipalities. By sensing garbage flow and segregating it into different necessary parts, IoT-based smart dustbin can assist people in managing waste more efficiently and effectively. Segregation of several types of waste, such as metal, plastic, and biodegradable waste, can be achieved by the dustbin itself at the same time during garbage collection, saving both money and time.

While waste collection and segregation are critical city services, current waste management programs are resource-intensive, costly, and out of date.

The key to effective waste management is to ensure proper waste segregation at the source (domestic level) and to ensure that waste is recycled and recovered in multiple streams. The Internet of Things (IoT) can significantly improve waste management and segregation systems while lowering city operating costs[2]. Through connecting physical or virtual devices to the Internet, the current IoT performs sensing, actuation, data collection, storage, and processing. This paper discusses IoT-related trash segregation and management frameworks that verify garbage in dustbins using sensors and, once recognized, segregate waste materials in them using sensors into different sections as required. Additionally, an image processing algorithm [3] is used to identify plastic and biodegradable items, and the framework can be quickly adjusted. The microcontroller serves as a connection between the

International Conference on Emerging Technologies: AI, IoT, and CPS for Science & Technology Applications, September 06–07, 2021, NITTTR Chandigarh, India

EMAIL: bansalpurnima75@gmail.com (A. 1); aditiananya8@gmail.com (A. 2); shilpajindal@ccet.ac.in (A. 3)

ORCID: 0000-0002-9296-4776 (A. 1); 0000-0001-5505-803X (A. 2)

sensor and the IoT module. The main aim of this project is to segregate waste by defining the content of the garbage using a few sensors and image processing so that after segregation the useful substances can be used for different purposes including recycling, power generation, manures, etc.

2. LITERATURE SURVEY

The municipality has three different types of trash cans, including red, green, and blue. The public is required to deposit waste in the appropriate dustbin, which cannot be monitored. The algorithm will be trained with a variety of waste materials, and when the waste is thrown into the dustbin, it will be estimated, and the corresponding chamber will open to absorb the waste based on the prediction. The ideals of "sustainable growth," "precaution," and "polluter pay" guide waste management in India.The MS COCO dataset (Common Object in Context) will be used to train the API, which will then be compared to the captured image to predict the amount of waste medium. The data and its coordinate information are trained using the Train Object Detector. The paper concluded that the waste images as a whole are educated and compiled into a dataset. The camera opens to capture the file, which is then compared to the dataset to determine the waste form. Biodegradable waste can be used to create methane gas, which is used to generate electricity.[4]

A recycle bot was created that utilizes image processing to sort waste into recyclable and nonrecyclable components. Additionally, ZigBee is used. The waste collected in the dustbin is separated at the panel using various sensors, and an STM32 controller is used to monitor all dustbin operations. The Wi-Fi module will be linked to the data service to track the dustbin's waste threshold level. Each part of the dustbin can be opened independently to facilitate trash disposal. [5]. The suggested method for this smart dustbin is to use a Wi-Fi module instead of a GSM module, which is more beneficial. Arduino UNO, NODEMCU, Ultrasonic sensor, and Servo Motor are the hardware components used in this process. Following the dumping of the code, the sensors begin to operate in accordance with the written code. When the sensors fail to function as intended, the reset button should be pressed to restart the code and the microcontroller, allowing the sensors to function again [6]

3. EXISTING MODELS

Waste management systems here are predominantly control systems rather than handling systems. It just senses the presence of waste and the quantity of waste in the garbage bins. Once detected, the information is sent to the authorities using GSM [7] which is a slow communication compared to the current ones. Separation is only accomplished for metallic and non-metallic wastes, wet and dry wastes. The key concerns are the information is not transmitted in real-time, only metallic wastes are differentiated, which means both plastic and biowastes type in the category of non-metallic wastes, Moisture sensors will offer efficiency as wet wastes if there is a very tiny presence of water.

4. PROPOSED MODEL

This paper proposes an IoT-based completely intelligent waste segregation and management machine that evaluates wastes in dustbins using sensor systems, and if it detects waste substances outside of the dustbin using ultrasonic sensors, it will be captured using a camera module connected to the microcontroller, and the garbage will be put into chambers using sensors. The MS COCO [8] dataset will be used to identify recyclable and non-recyclable materials. For metallic and wet waste, however, sensors will be used. A four-way lid is intended for the dustbin. Recyclable, non-recyclable, metallic, and wet waste are separated into four chambers. Non-metallic waste, on the other hand, is divided into two chambers in this project. This project is heavily reliant on the processing of wet waste. If wet recyclable, non-recyclable, or metallic waste is discovered, it will be put in the wet chamber instead of the others.

5. BLOCK DIAGRAM

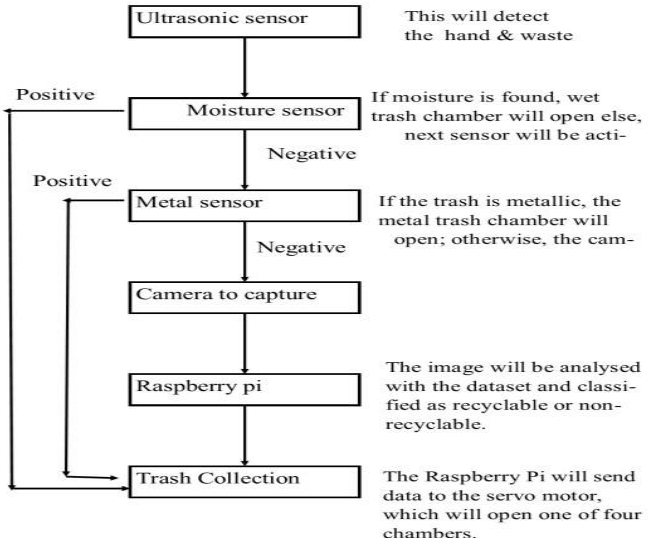

Figure 1: Block Diagram

6. IMPLEMENTATION

Garbage spilling over from dustbins into streets is a common sight, and it is a problem that needs urgent attention. In addition, some birds, dogs, and rats try to pull out garbage in search of food, resulting in trash spilling on the streets, polluting the atmosphere, and making it an unsanitary place to live in. To address this problem, the dustbin is fitted with an automatic lid to prevent physical contact, thus protecting the body from germs that cause diseases through waste. The automatic lid only opens when the plastics, moisture, metal, and biodegradable compositions are detected using various sensors and image processing, otherwise, it remains closed to prevent the spread of foul odour that cause pollution and disease. The project will be realized using the following hardware.

6.1. Ultrasonic Sensor

The ultrasonic sensor, like the bats, uses SONAR to determine particle separation. It proposes a fantastic contactless go ID with high accuracy and consistent comprehension in an easy-to-use pack with a range of 2 cm - 400 cm/1" - 13 feet. Sunshine and dull material have little effect on the action, while sensitive constituents like texture can be difficult to perceive acoustically. It comes from a collection of sources through an ultrasonic transmitter and a beneficiary unit [9].

Figure 2: Ultrasonic Sensor

6.2. Moisture Sensor

The Moisture Sensor is used to determine whether or not there is moisture in the waste material. When this is done, the sensor will detect the presence of moisture in the object, and if it does, the wet waste chamber will open and the waste will be collected.

6.3. Camera Module

The picture will be captured by the camera, which is attached to the microcontroller and compared to the training dataset. The image sensor is the most important of the camera module's key components since it is the most important for image quality. The sensor transforms light from the lens into an electrical signal, which is then converted to a digital signal. The new version of the Raspbian Operating System supports all applications.
Applicability: Motion recognition, CCTV surveillance camera, time-lapse photography [10]

Figure 3: Camera Module

6.4. Metal Sensor

Although there is no physical contact with the object, an inductive closeness detecting component can set up metal targets moving toward the sensor. The high-recurrence wavering sort uses attractive power enlistment, the attractive kind uses a magnet, and the typecast uses the change in capacitance. Inductive Proximity Sensor is widely requested into the accidental to three forms conform to the working standard opened.[11]

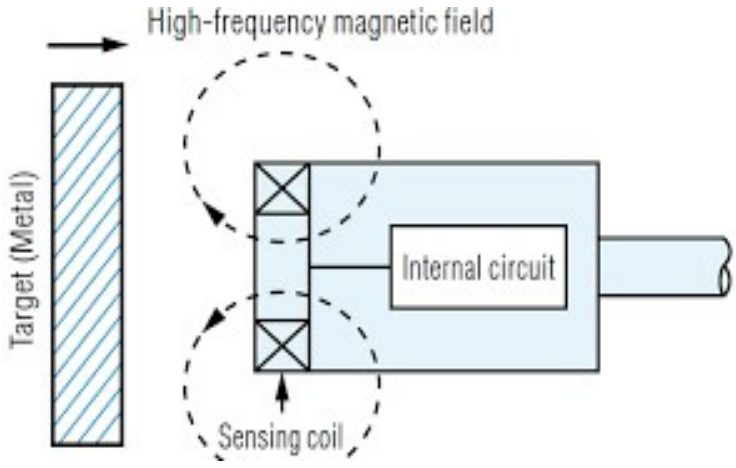

Figure 4: Metal Sensor

6.5 Servo motor

Servo motors are still small devices with yield shafts. This pole can be held in place to express daring spots by transferring a coded banner to the servo. The precise location of the shaft will be maintained for however long the coded banner is present on the data line. The exact location of the shaft changes if the coded banner changes. In radio-controlled aircraft, it's used to position control surfaces like lifts and rudders. Radio-controlled cars, puppets, and unmistakably robots all use them [12].

Figure 5: Servo Motor

7. HARDWARE IMPLEMENTATION CHAIN

To understand the hardware implementation, we must first understand how this system operates. The above diagram demonstrates the smart dustbin's capabilities. Rubbish collected from homes and streets is first recognized using ultrasonic sensors mounted on the trashcan; when hand-held waste is detected by the ultrasonic sensors, the dustbin chamberbecomes accessible. Because ultrasonic sensors detect sound waves emitted at frequencies above the human hearing threshold. The moisture sensor will detect the presence of moisture in the trash. If moisture is detected in waste, the wet waste chamber is opened; if not, the next sensor is engaged. As the image processing and capturing unit [13] can only assist in separating recycled and non-recyclable plastics, the metal sensor will determine whether the rubbish is metallic or not, opening the metal waste chamber in the case of metallic substance. Finally, this database is analysed in a trash collection area that has been configured for computing with Raspberry Pi. It will communicate with a servo motor, which will open one of the fourchambers as needed.

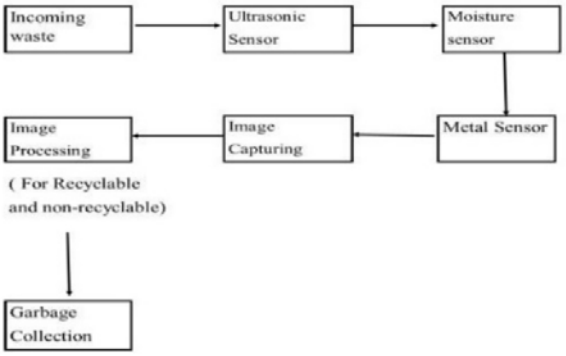

Figure 6: Hardware Implementation Chain

8. LIMITATIONS& FUTURE SCOPE

The fact that just one waste item can be disposed of at a time and that the dustbin is not moveable are two constraints that can be overcome by adding a bot mechanism and mechanical arms to pick up rubbish. It has no overflow protection. Another significant limitation is the camera's need for adequate light to record and process photographs. We truly hope that future candidates will be able to address these issues in their ideas. The proposed paper is merely a first step toward implementing IoT

for waste management. Many improvements to this framework can be done in the future to produce something that will aid in keeping the environment clean, sanitary, and a better place to live in. A few prospective enhancements could be made: The current study looks at a stationary trashcan that can be transformed into a moving trash-bot utilizing AI and robotics.[14] More bins can be added to separate and collect different types of rubbish from waste stuff. GPS trackers can also be placed in this trash can for a specific region, allowing them to be readily identified and unfilled.

9. CONCLUSION

A smart trash can that is connected to the internet of things is a useful tool for garbage management. It is installed to reduce the amount of time and effort required for rubbish collection and separation. This dustbin's automated lid keeps the environment and living things from coming into direct touch with the rubbish inside, resulting in cleaner surroundings and less contaminated land to live in. This technique encourages the easy completion of the clean India aim by using trash segregation at both the personal and communal levels.

10. REFERENCES

[1] Akhilesh Kumar, Avlokita Agrawal, Recent trends in solid waste management status, challenges, and potential for the future Indian cities, Volume 2, 2020, 100011, ISSN 2666-0490, https://doi.org/10.1016/j.crsust.2020.10001.

[2] Sejdiu, Besmir & Ismaili, Florie & Ahmedi, Lule. (2020). Integration of Semantics Into Sensor Data for the IoT: A Systematic Literature Review. International Journal on Semantic Web and Information Systems. 16. 1-25. 10.4018/IJSWIS.2020100101.

[3] Razali, Zol & Madasamy, Gunasegaran. (2012). An Application of Image Processing for Automated Mixed Household Waste Sorting System.

[4] Artificial Intelligence-Based Smart Dustbin Collector for Sustainable Environment by Dr. K. Haridas*, Mr. P. Ganesh**

[5] Kumar, B. S., Varalakshmi, N., Lokeshwari, S. S., Rohit, K., & Sahana, D. N. (2017, December). Eco-friendly IOT based waste segregation and management. In 2017 International Conference on Electrical, Electronics, Communication, Computer, and Optimization Techniques (ICEECCOT) (pp. 297299). IEEE.

[6] Maddileti, Telugu & Kurakula, Harish. (2020). IoT Based Smart Dustbin. International Journal of Scientific & Technology Research. 9. 1297-1302.

[7] T. S. Vasagade, S. S. Tamboli, and A. D. Shinde, "Dynamic solid waste collection and management system based on sensors, elevator, and GSM," 2017 International Conference on Inventive Communication and Computational Technologies (ICICCT), 2017, pp. 263-267, DOI: 10.1109/ICICCT.2017.7975200.

[8] Baihaqi, Muhammad & Wijaya, Wilbert & Widyoko, M. & Wikaningrum, Temmy. The Prospect of using smart dustbin for reducing garbage pick-up time. Journal of Environmental Engineering & Waste Management. 3.10.33021/jenv.v3i2.439.

[9] Internet Source https://osoyoo.com/2018/09/18/micro-bitlesson-using-the-ultrasonicmodule/

[10] Internet Source https://www.antratek.com/raspberry-pi-8mpcamera-module-v2

[11] Internet Source https://www.keyence.co.in/ss/products/sensor/sensorbasics/proximity/info/

[12] Internet Source https://www.electronicscomp.com/mg90s-metalgear-servo-motor

[13] Salhi, Dhai Eddine & Tari, Abdelkamel & Kechadi, Tahar. (2021). Using Clustering for Forensics Analysis on Internet of Things. International Journal of Software Science and Computational Intelligence. 13. 56-71. 10.4018/IJSSCI.2021010104.

[14] H. Hiraishi, "Experience-based analysis and modelling for cognitive vehicle data," 2019 IEEE 18th International Conference on Cognitive Informatics & Cognitive Computing (ICCI*CC), 2019, pp. 103-108, DOI: 10.1109/ICCICC46617.2019.9146043