Smart Waste Segregation using ML Techniques

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Abstract:- **The rapid increase in amount and types of solid and hazardous waste due to constant economic growth, industrialisation and urbanisation, is becoming a growing problem for local and national governments to ensure effective and sustainable management of waste. We have come up with a solution to tackle this problem from a local level. We have focused our efforts to build a smart bin exclusively for household purposes The system has a plethora of sensors and machine learning model for an easier segregation of waste. Segregation on a large scale is difficult to manage with the minimum resources available. Therefore we chose to approach this problem from a local level to help solve it more efficiently. In the smart bin, we have a process of identifying non- biodegradable and biodegradable material with the help of sensors and ML models built for identifying based on this data. The biodegradable material is stored in its section of storage and the non-biodegradable material is further divided into landfill waste and recyclable waste.**

Keywords:- Smart Bin, IoT, Machine Learning.

I. INTRODUCTION

Increase in population, progress in technological advancement, urbanisation and development have resulted in an increase growth in consumer product. And with this progress comes a price; generation of waste. In a recent survey conducted by the World Bank, about 1.3 billion tons of waste is generated each year. The number is expected to reach 2.2 billion by 2025. Waste management is a problem faced by a lot of societies and communities. The amount of waste generated is far more than the waste recycled. Improper waste management has led to increase in cost of recycling and more working hours. This leads to overcapacity of dumping grounds and landfills, littered waste around the city. These environments act as a breeding ground for diseases.

To solve the problem of segregation of waste at the grass- root level, our project can be implemented at home and office. The waste can be segregated based on whether it is biodegradable or non-biodegradable. Furthermore, it segregates recyclable waste from non recyclable waste. The product enables a touch-free interaction with the dustbin, which increase the hygiene of the household. The equipment and sensors used in the bin ensures that the waste is properly segregated.

A camera is installed at the top of the bin that detects a human presence and opens the lid.The image processing algorithm used in the bin can detect and process the waste and carefully signal the bins to open the compartment where the waste belong. The dataset used for the model is mostly of all the generic waste produced in the household. This grass-root segregation of waste will enable faster way to recycle the waste and save time and resources.

II. DESIGN AND ARCHITECTURE OF OUR SYSTEM

A. Design Components

The idea is to have smart bins, exclusively for household purposes. The system which we are planning to propose has a plethora of sensors and machine learning model for an easier segregation of waste. The sensors which we are planning to utilise are -

➢ Raspberry Pi Board - The Raspberry Pi board is a series of single-board computers having a System On Chip (SoC). It has a multicore processor, GPU, ROM, I/O Peripherals, DDR RAM memory, Ethernet port, USB host and micro HDMI on it. The Raspberry Pi board is very efficient as it can help in various automation projects, smart agriculture and we will be using it in our system for smart segregation of waste. We will be using the Raspberry Pi 4 board for the smart bin.

➢ Ultrasonic Sensor - The feature of the ultrasonic sensor is to detect any object nearing the dustbin. This will, in turn, open the lid of the bin and the trash can be discarded. We are planning to use the HC-SR04 module which is quite streamlined.

➢ Raspberry Pi camera module - This Raspberry Pi camera module V2 is the apt camera module for this purpose of waste segregation. It has a fixed focus lens on board with an 8 megapixel native resolution sensor-capable of 3280 x 2464 pixel static images. These images will be used as input for the machine learning model which will determine the type of waste.

➢ Capacitive Plates - These plates will be used for finding if the disposed waste is a wet waste or dry waste. This sensor will be connected to the collapsible flap, which in turn is controlled by a servo motor. These plates measure the moisture by finding out the dielectric constant of the water, which is unique to every substance.

➢ Servo Motors - These motors are small devices with the shaft attached and controlled by the Raspberry Pi board. It receives a certain amount of pulse, with which it turns clockwise or anticlockwise. It can turn from 0 to 180 degrees, as it has a gearbox and potentiometer, with which we can position the shaft. We might as well use the stepper motor for efficient output. The servo motor Tower Pro SG90 will be used for this project.

➢ Infrared Sensors - These sensors emit infrared light, which is absorbed by the body to which is projected, and is later received by the receiver. The amount of absorptivity is measured or calculated and can be used to segregate waste like plastic, which might be a challenge for the machine learning model. This, however, is an alternative in case the plastic doesn't get identified and segregated in the apt bin.
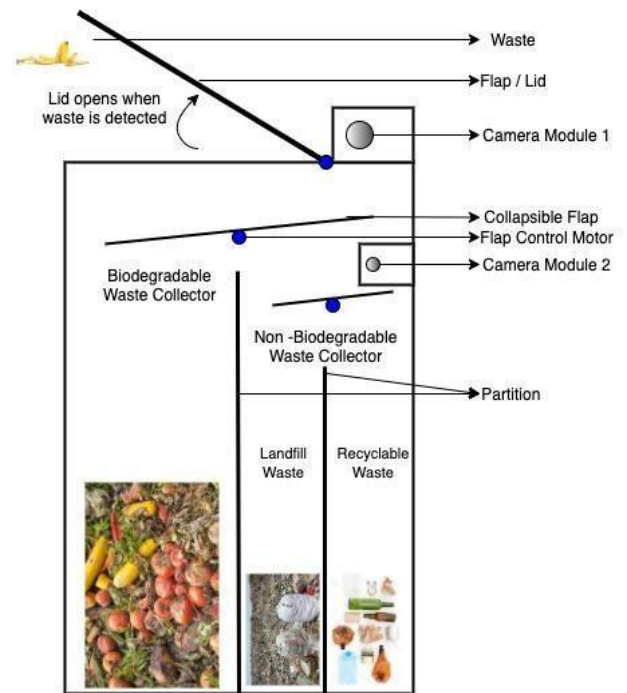
B. Architecture of our System

The rough design of the smart bin is as shown in Fig. 1.The system works as follows.

When trash is brought near the lid of the smart bin, an ultrasonic sensor detects the trash and opens the lid so that it can be placed on the first collapsible flap below the lid. The user is only expected to place the trash on the first collapsible flap of the smart bin, all segregation is taken care of by the bin. No other user interaction is necessary. The trash is then segregated into biodegradable or non-biodegradable trash with the help of the Raspberry Pi camera module, infrared sensor, and moisture sensor. This segregation is done using object detection and convolutional neural network algorithms(?). To further increase the accuracy of the classification, moisture sensor or capacitive plates are used to distinguish between wet and dry trash. When the classification is done, a pulse is then sent to the servo motors which control the first collapsible flap. Depending on the pulse, the first collapsible flap tilts clockwise or anticlockwise accordingly so that the trash falls into its correct category. If the trash is classified as biodegradable there is no more classification and segregation is complete. On the other hand, if the trash is classified as non- biodegradable, it then falls onto the second collapsible flap. This trash on the second collapsible flap is then further classified into landfill or recyclable trash. This is done by using object detection on the non-biodegradable trash. When the classification is done, a pulse is sent to the servo motors controlling the second collapsible flap. Again depending on the pulse, the servo motors tilt the flap clockwise or anticlockwise. The trash then falls into its rightful category and then segregation is complete.

Fig 1:- Design of the Proposed System

III.   CONCLUSION

The waste segregator has been successfully implemented for segregation of waste into biodegradable and non- biodegradable waste at a domestic level. However, the noise can be eliminated from the sensor modules to increase the accuracy and efficiency of the system. This system has its own limitations. It can segregate only one type of waste at a time since having different types of wastes at once can create problems in effectively segregating. Thus, improvements can be made to segregate mixed type of waste by the use of buffer spaces.

IV.   FUTURE WORK

Our future aspiration is to improve the segregation process to support more waste to added to it. This would make the smart bin more usable for household by dumping all wastes rather than adding the waste one by one. We would also like to reduce the cost of the sensors which would effectively reduce the cost of the smart bin, making it more affordable for the people.

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