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SMART TRASH CAN

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Abstract— Waste poses a significant challenge globally, with estimates from the World Bank indicating an annual production of approximately 2.01 billion tonnes of solid waste. Regrettably, at least 33% of this waste is not managed in an environmentally sound manner. The imperative of waste segregation is one we can no longer afford to overlook. To meet recycling targets, both households and commercial organizations must contribute by accurately sorting their waste. Our solution addresses this challenge by segregating biodegradable and non-biodegradable waste. Implemented with Raspberry Pi and a USB camera, the system provides real-time waste analysis. The model, trained on a predefined dataset, classifies the waste types and opens the respective sections of the trash can.

I. INTRODUCTION

The segregation of waste and recycling is essential for effective waste management. Due to the busy schedule most of the people do not have a time to separate their waste. However, there is a significant issue with the segregation of the collected garbage. The implementation of an intelligent trash-management architecture is essential for the removal or reduction of waste and the maintenance of a clean, corporate environment. To detect the presence of garbage, an ultrasonic sensor is used. All garbage entered will be caught by the USB web camera and processed by the machine learning module once it has been processed. Using the model, we can identify the many forms of waste, such as paper, plastic, bottle, fruits peels, vegetable peels and glass, which account for most of the garbage materials found in a home area. This aids in removing the trash from the trash can in the most efficient and effective manner possible. This research presents an IoT, and Machine Learning based completely intelligent trash segregation and management System that recognizes the dustbins' wastes using sensor systems. This project aims to develop an automated waste segregation system using a CNN algorithm that will capture waste images from a camera with object detection and classify waste materials such as paper, plastic, and glass so that the waste can be recycled appropriately. The proposed architecture with CNN gives an accuracy of 80.23%. This system will help in garbage disposal by categorizing it, contributing to a cleaner environment.

II. Equipments Required

In order to implement this whole idea into a real-world IOT-based project, we need several electronic boards, sensors, and various devices.

So, these are the following equipments we have used to implement this project :

* ARDUINO UNO R3 BOARD
* ULTRASONIC SENSOR(HC-SR04)
* SG90 MICRO SERVO MOTOR
* RASPBERRY PI 3B
* USB WEB CAMERA
* JUMPER WIRE

Now we are going to see and discuss all the equipments in details with their explanation.

1 - ARDUINO UNO R3 BOARD

Arduino UNO is based on an ATmega328P microcontroller. It is easy to use compared to other boards, such as the Arduino Mega board, etc. The board consists of digital and analog Input/Output pins (I/O), shields, and other circuits. The Arduino UNO includes 6 analog pin inputs, 14 digital pins, a USB connector, a power jack, and an ICSP (In-Circuit Serial Programming) header. It is programmed based on IDE, which stands for Integrated Development Environment. It can run on both online and offline platforms.

2 - ULTRASONIC SENSOR(HC-SR04)

HC-SR04 is an ultrasonic distance sensor used for measuring the distance at which an object is located.The principle used by this sensor is called SONAR. It has two parts,one emits the ultrasound sonar to measure the distance to an object.The other part is the receiver which listens for the echo.As soon as the ultrasound hits the object it bounces back and is detected by the receiver.The time taken for the wave to come back decides the distance of the object being measured.

3 - SG90 MICRO SERVO MOTOR

A servo motor is a small device that has an output shaft.This shaft can be positioned to specific angular positions by sending the servo a coded signal. A standard servo has 42 Oz/inches of torque.

The micro servo 9G is a light, good quality and very fast servo motor. This servo is designed to work with most radio control systems. It is perfect for small robotics projects.

4 - RASPBERRY PI 3B

Raspberry pi is the name of the "credit card-sized computer board" developed by the Raspberry pi foundation, based in the U.K. It gets plugged in a TV or monitor and provides a fully functional computer capability. The original device had a single-core Processor speed of device ranges from 700 MHz to 1.2 GHz and a memory range from 256 MB to 1 GB RAM. To store the operating system and program memory Secure Digital (SD) cards are used. Raspbian OS which is a Linux operating system is recommended OS by Raspberry Pi Foundation.

There have been many generations of raspberry Pi from Pi 1 to Pi 4. There is generally a model A and model B. Model A is a less expensive variant and it trends to have reduce RAM and dual cores such as USB and Ethernet.

5- USB WEB CAMERA

A webcam is a digital camera that's connected to a computer to stream live video in real time. It's the camera that's connected to your computer, either as an integrated piece of equipment, via USB cable, or wirelessly. Internal webcams are those that are built-into the computer you're using.

5- JUMPER WIRE

A jumper is a tiny metal connector that is used to close or open part of an electrical circuit.It may be used as an alternative to a dual in-line package(DIP) switch.A jumper has two or more connecting points,which regulate an electrical circuit board.

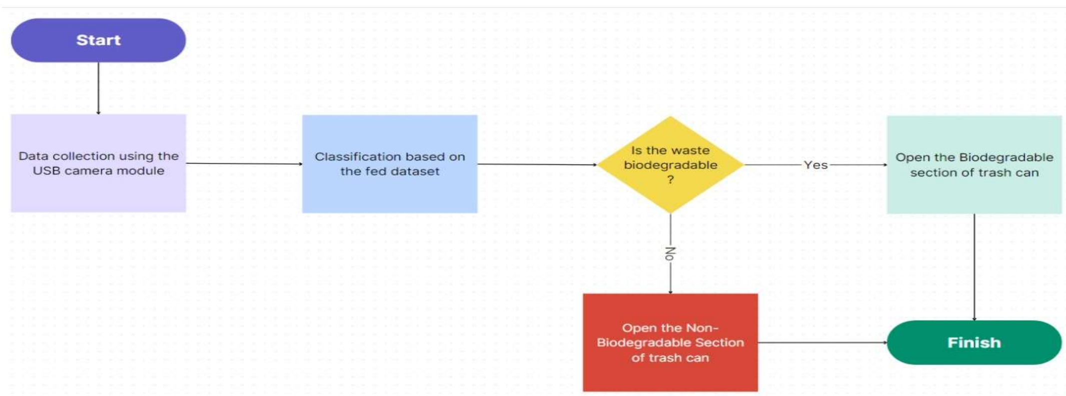

Fig. 1. Flowchart of Working Model of Smart Trash Can

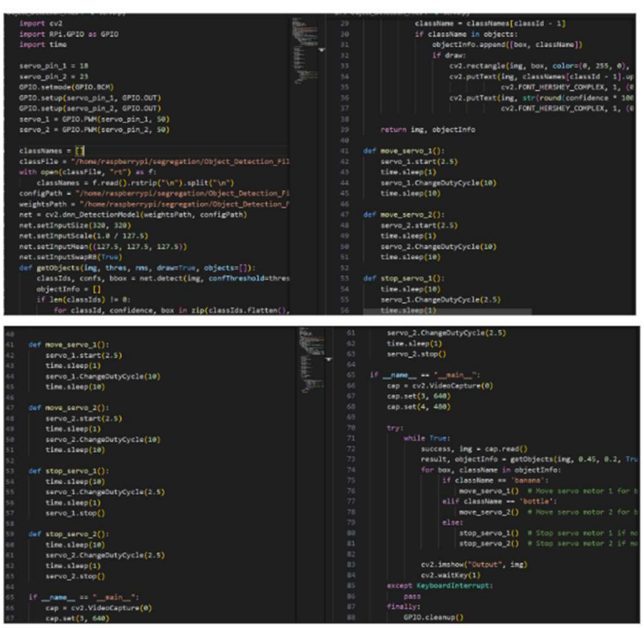

Fig.2.Python code of the project.

The above figure 2 shows the python code to control the servo motors used for opening the sections of the dustbin. The motors open based upon the type of the waste object detected. The motors are connected on the GPIO pins 18 and 23 of the raspberry pi.

Fig. 3 Different types of Wastes that the model can classify

III. Experimental Setup

The earlier stage of our project uses an Ultrasonic sensor HC-SR04 to detect objects in front. It then sends the signals to Arduino Uno.

The Arduino understands the signal and sends a signal to the Servomotor which opens the flap on top of the dustbin. Here we have program it to open the race for only 3 seconds after 3 seconds the flap automatically closes. We can change that time just by making minor changes to the code in Arduino IDE**.**

But in this concept the waste segregation was not possible. So we modified our project and added Raspberry PI(with the means of Open-CV) and USB camera in order to differentiate the wastes.

Data Collection using OpenCV: OpenCV is used to extract every frame in real-time from a video feed obtained from a USB camera. The camera is aimed at the waste object, and OpenCV is employed to identify the type of waste using a Haar cascade transformation.

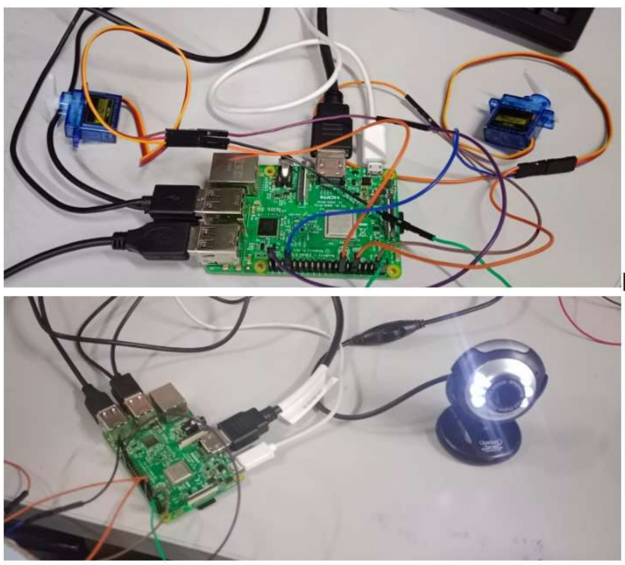

Fig. 4. Working Model

Implementation on Raspberry Pi: The developed model, constructed using a Convolutional Neural Network (CNN) architecture, is deployed on a Raspberry Pi 3B model. The testing of the model in various environments with different subjects is mentioned, highlighting its deployment on the Raspberry Pi platform.

Object Recognition and Region of Interest (ROI): Once an waste object is identified, a region of interest (ROI) is drawn around the waste using OpenCV. This ROI is then used for further analysis, particularly for detecting the type of waste.

Fig. 5. Demonstration of the working of the Smart Trash Can

Figure 5 depicts a various test circumstances used to train and validate the model using subject photographs. The OpenCV package already has all of the necessary capabilities to extract every frame in real time from a video feed. The developed model starts in a frozen state, attempting to access the videos only when a waste object is identified in the camera. The driver's face is extracted using a har cascade transformation then a region of interest (ROI) is drawn around it.

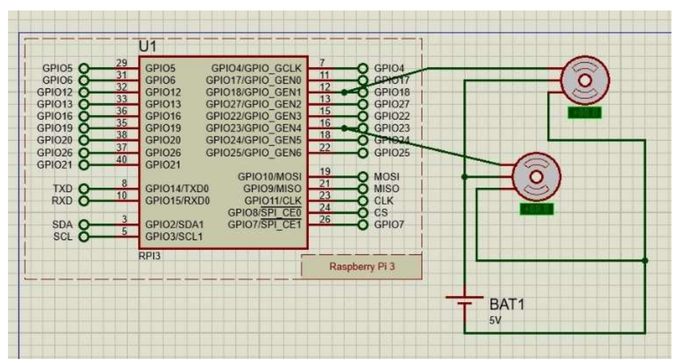

Fig. 5 Circuit Diagram

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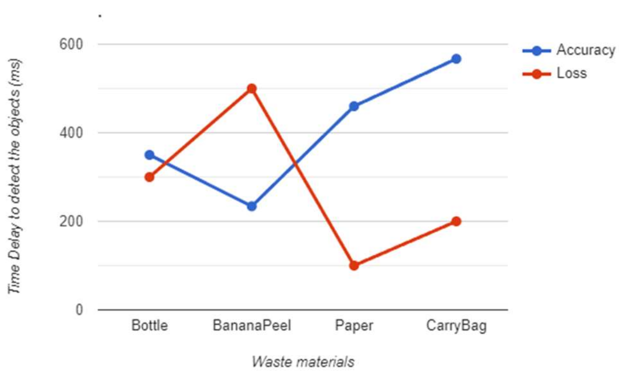

Fig. 6. Curve of the model to show the time delay to detect the waste

IV. CONCLUSION

The efficient segregation and management of waste are imperative for a sustainable and clean environment. Recognizing the challenges posed by busy schedules hindering manual segregation, our project introduces an intelligent trash-management architecture. Leveraging ultrasonic sensors and a USB web camera, our system detects the presence of garbage, subsequently employing a machine learning module to identify various forms of waste, including paper, plastic, glass, and organic materials.

This innovative approach combines the power of Machine Learning, culminating in a comprehensive waste segregation system. The implemented Convolutional Neural Network (CNN) algorithm achieves an impressive accuracy of 80.23%, showcasing the system's effectiveness in identifying and categorizing waste materials. By automating the segregation process, our project not only streamlines waste disposal but also contributes significantly to recycling efforts.

In essence, our intelligent trash segregation and management system offer a practical solution to the challenges of contemporary waste management. By facilitating the proper categorization of waste, we aim to enhance recycling practices, promote a cleaner corporate environment, and ultimately contribute to the broader goal of achieving a sustainable and eco-friendly future.

V. ACKNOWLEDGEMENT

We would like to express our deepest gratitude to the individuals and organizations who played a significant role in the realization of Our Smart Trash Can project. Firstly, we extend our heartfelt thanks to our dedicated team members whose unwavering commitment and collaborative spirit were instrumental in bringing this project to fruition. Their innovative ideas and relentless efforts greatly contributed to the success of our endeavor.

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Our sincere appreciation goes to the institution and laboratory that provided us with the necessary resources, equipment, and infrastructure essential for the development and testing of our project.

Furthermore, we express our gratitude to the open-source community for the wealth of knowledge, libraries, and tools they have generously shared.

In conclusion, it is the collective effort of these individuals and groups that made our Smart Trash Can project possible. We are profoundly grateful for their support, and we acknowledge their indispensable roles in our academic and technical journey.

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