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IoT Based Garbage Segregator Using Image Processing

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Abstract:

The waste generation has been increasing due topopulation explosion and urbanization.The waste products include kitchen or gardening waste and recyclableproducts. This can be brought to use by segregating the waste into dry and wet waste. As tons of waste is produced this segregation process becomes time consuming. With the help of IoT based systems segregation process can be automated. This process can be accelerated with the help of pre-trained models which assists in object detection. This paper provides detailed information about our prototype of garbage segregator.

Keywords **—Waste Generation, Garbage Segregator, IoT, pre-trained models, Object detection.**

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I. INTRODUCTION

Incities, the overflowed bin creates an unhygienicenvironment. This causes various types of diseases andbadly affects the species and the ecosystem. Poor waste management leads to exploitation of natural resources and environmental degradation. Inefficient waste segregation system has multiple consequences. Biodegradable waste needs to be separated for producing manure. On the other hand, non-biodegradable waste such as plastic,paper, etc must be separated from wet waste in order to avoid leaching.This dry waste after recycling can be used again to develop new products.WasteSegregation system helpsin classifying the waste according to itscategory i.e.,wet or dry.The detection isdone basedontheshape, size, colour

and texture of the item with the help of object detection API. The segregation is done with the help of microcontroller and servo motor on the basis of the results acquired from the detection.

The major goal of the prototype proposed in thispaper is to improve the user experience by providing automated waste segregation by classifying the waste material according to its category.Thus,reducing the labour and conserving the resources by following the principle of reduce, reuse and recycle.

II. LITERATURE SURVEY

There are various models are available for objectdetection and feature extraction.The models are distinguished based on their speed (in ms),accuracyofdetection and form of output(i.e., boxes,keypoints,masks).The models available include CenterNet HourGlass104 512x512, Faster R-CNN ResNet50 V1 1024x1024, etc. But we have usedSSD MobileNet V2 FPNLite 320x320 as the speed of this model is better and it meets our system requirement. The architecture of the model is given below in Fig.1.

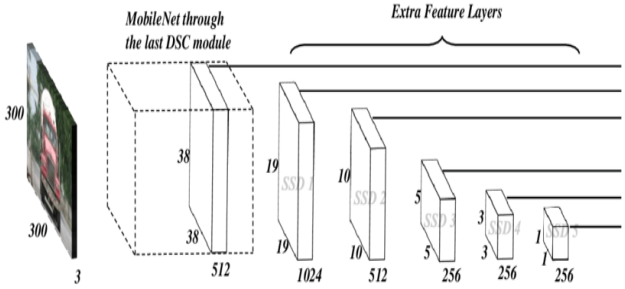


Fig. 1 SSD MobileNet-SSD Network Architecture(from [8])

SSD MobileNet V2 FPNLite 320x320 is a lightweight model. It achieves competitive accuracy with significantly fewer parameters.

The performance accuracy of this model is very high. It takes an image as input and bounding boxes for the objects in the image. The model is pretrained on COCO.

SSD is Single Shot Detector which is a technique to detect the characteristic features of the captured imaged in assistance with the manually labelled dataset. MobileNet Version 2 is the backbone of our model. It provides good accuracy with lowlatency with low power models. The algorithm used for object detection is R-CNN based on deep convolution neural network. FPN lite stands forFeature Pyramid Network and is usedfor feature extraction.

React and Node Jsframework is used for creatinguser interface in order to display the image and it's waste category. React Js supports the API used for interfacing the Raspbian OS with the local operating system.There are several microcontrollers like Arduino UNO, Raspberry Pi available in the market. We have chosen

Raspberry Pi Zero Wasit is compact microcontroller. Unlike some other devices, itcontains integrated Wi-Fimodule, power supply port,USB port and is cost effective too. Raspberry Pi Zero W Camera Module is used to captureimages. It is compatible with RPi Zero W and has a 5MP resolution.

Ngrokfunctions as a proxy server in our prototype. It exposes a local web server to the internet via a secure tunnel. The free version of Ngrok is utilized and it generates a random URL hostname that is connected to the internet and can route requests from third party apps to our local machine.

III. IMPLEMENTATION

A. Datasets

The dataset consists of around 800 images. Majority of the images are captured by us and some are collected from the internet. We have labelled our captured images so that our model can identify the waste. Each image is associated with the category of the waste i.e., Dry or Wet. With the help of these of these labelled images we have trained our model. Dry Waste include images of paper ball, Cardboard, Crushed bottles, Metal can, Tetra pack. Wet Waste include images of banana peel, half eaten apple, egg shell, potato.Fig.2 displays the image dataset.

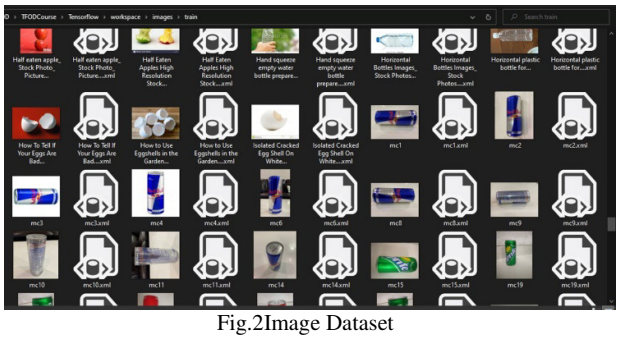


Fig.2Image Dataset

B. Methodology

IOT based garbage segregator is used to identify waste category(dry or wet waste) using

image processing,segregates the waste product accordingly with the help of microcontroller and servo motor and the output(captured image of the waste product and waste category tag) gets displayed on the user interface. The flow chart of the system is given below in Fig.3.

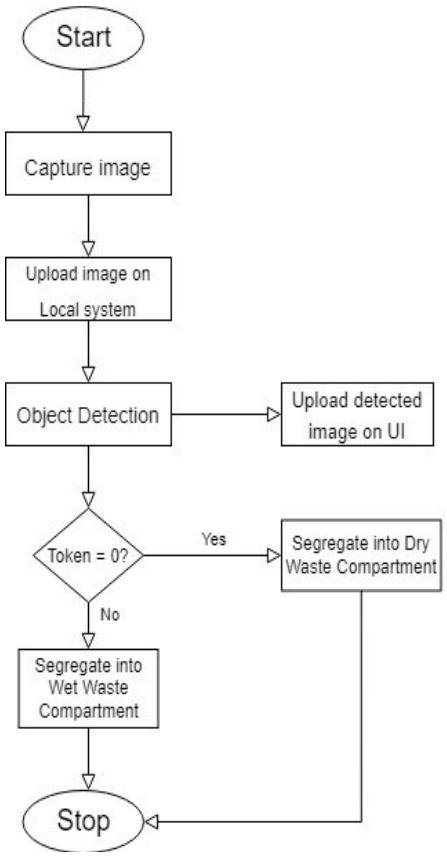


Fig.3 Flow Diagram

Steps involved in our project are explained below:

1) ***Data collection:***This phase is concerned with gathering the appropriate dataset for model training and object detections. The datasets were curated as mentioned in the above section.

2) ***DataPre-processing:***This step is responsible for processing of images collected in the dataset. The objects in the images are labelled and thus the lablemap is created for training purpose. An XML file is generated for each image in the dataset which contains the characteristic features of the particular image. This XML file gets further utilized by pretrained model.

3) ***Training:***After pre-processing of the images, the model is trained with the help of dataset. For training purpose, we have selected SSD MobnetV2 FPNLite 320x320 due to itshigh performance and accuracy. This trained model is further used for object detection.

4) ***Detection***: The image is captured with the help of Raspberry Pi zero W camera module. Raspberry Pi zero W uploads this image on the local system by hitting UploadImage API. UploadImage API is used to create an interface between local system and Raspbian Operating System i.e., Operating system of Raspberry Pi zero W. The object i.e., waste product in this image gets detected by using R-CNN algorithm for object detection. The captured image along with its waste category tag is displayed on the user interface with the help of DetectImage API.

5) ***Segregation***: Raspberry Pi zero W fetches the data of detected image and passes it to the servo motor by hitting DetectImage API. The detection data consists of a token variable i.e., 0 or 1. Token 0 and token 1 represents dry waste category and wet waste category respectively. With the help of this token the waste product is segregated into the dry or wet compartment of the dustbin.

IV. RESULTS

We have detected the waste product categoriesfor the captured images with an accuracy of 87%. The accuracy is determined with the help of TensorBoard, which providesthevisualization and tooling needed for machinelearning experimentation. The waste productgets segregated into the dustbin compartments according to its category i.e., dry or wet waste with the help of the flap, controlled by servomotor.

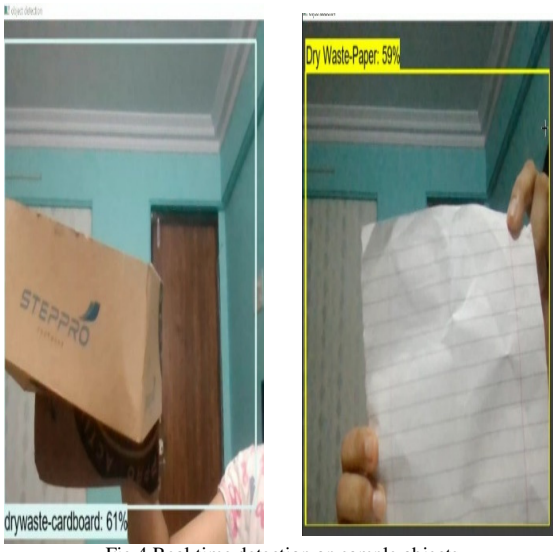
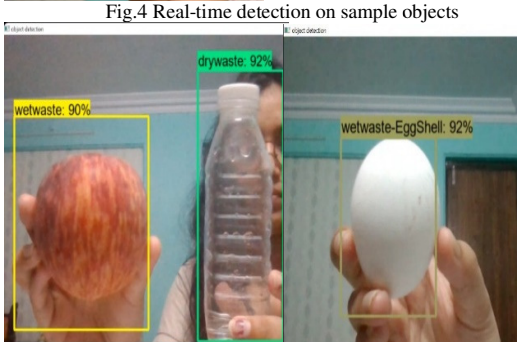


Fig.4 Real-time detection on sample objects



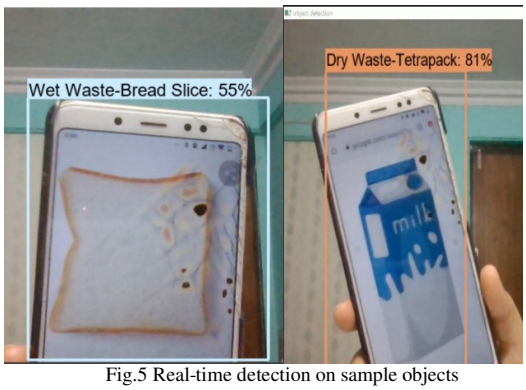


Fig.5 Real-time detection on sample objects

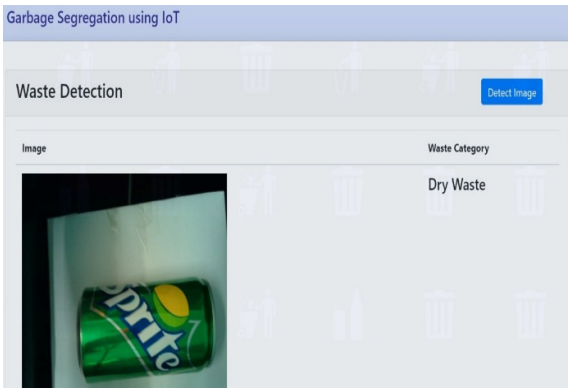


Fig.6 Display of detection data on user interface (Dry Waste)

Fig.7 Display of detection data on user interface (Wet Waste)

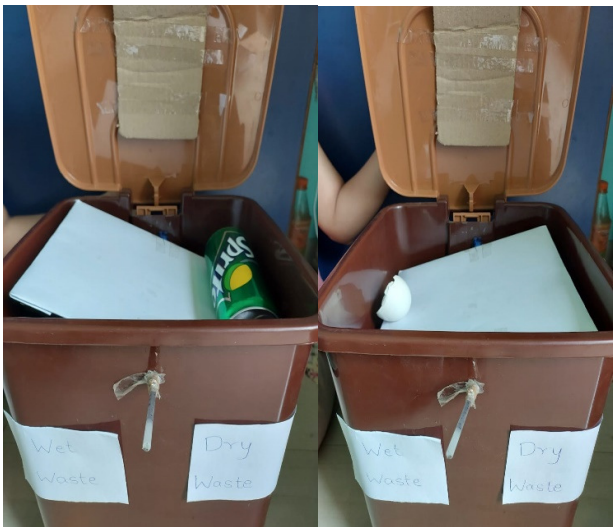


Fig.8 Result of segregation of waste into their respective compartments.

V. CONCLUSIONS

In this paper, we have provided a detailed description of our prototype which will help in automating the garbage segregation process. The segregation is 87% accurate.

With more advancements, this prototype can be made more efficient and marketable.Also, the dataset can be expanded to increase the accuracy rate of the model.

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