AUTOMATA BIN

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2023 Intelligent Computing and Control for Engineering and Business Systems (ICCEBS) | 979-8-3503-9458-0/23/$31.00 ©2023 IEEE | DOI: 10.1109/ICCEBS58601.2023.10448985

***Abstract*-Waste management and segregation is one of the most essential components of the sanitary process but the people are still unaware about the types of wastes and its method of disposal. To ensure the masses gets awareness as well as the garbage gets segregated and disposed correctly. This work focuses on designing a smart IoT based dustbin which scans the image of the garbage in real-time and compare it with the pre-defined data on the system. Then, it is classified into different categories by utilizing a combination of computer vision and an image classification machine learning algorithm based on Tensor Flow library together. The real time image of the trash is compiled by the ML model using OpenCV library. This model works by cross referencing the given data to the labelled dataset of the model. Since this model utilizes labelled data for classification the results produced will be more accurate compared to other such methods. The model is trained using 100 epochs and hence results in more accurate results. The segregation of waste at the initial step can reduce the burden on the garbage collectors, improves the recycling rate and promotes sustainability.**

KEYWORDS- Computer Vision, Tensor Flow, Deep Learning model, Open CV, labelled dataset, epochs, Arduino UNO,S90 Micro Servo, Camera Module OV 5647.

I. INTRODUCTION

The exponential growth in global population has prompted a push towards urbanization on a grand scale, which has boosted trash generation. The waste generated is not being segregated into their respective categories which causes the waste to be dumped in landfills or incinerators which causes environmental problems like increased pollution and also leads to various health problem. These landfills take up lots of space and money to function which puts a strain in the government's budget. At present, India ranks as one the largest garbage generators in the world, producing about 62 million tonnes of waste every year. Only about 82% of it is collected and only 28% of that is treated and processed. Most goes into landfills, open dump sites or is just left on the ground, often clogging rivers and drains. This lack of proper segregation leads to increased costs for waste management and reduces the potential for resource recovery and recycling. This also results in the inefficient use of resources and negative environmental impact. This is caused due to lack of appropriate bins, collection systems, and disposal facilities for different types of waste can impede the segregation process. In many areas, waste collection and disposal systems are not designed to accommodate separate streams of waste, which discourages people from segregating waste at the source.

Many solutions have been proposed throughout the years, but none have had a positive impact on society as of yet. Our solution can take a step towards sustainability by designing an automated bin which segregates waste without human intervention by utilizing machine learning technique and image classification.

Literature survey reveals that a domestic friendly framework to segregate waste into biodegradable and non-biodegradable using a rotating terminal connected to an Arduino board [1]. In another literature the IoT sensors are used to detect whether the given material is biodegradable or non-biodegradable using the predefined parameters and rotating the terminal based on the result generated to place it in their respective destination. Also the literature employed a model to detect explosives and other undesirable material to be put in the dustbin. The system monitors the waste by using a RFID tag, RFID reader, ultrasonic sensors by checking the type of waste the users put in the bin and verifying each user using their Aadhar card [2]. This model helps in monitoring the users and helps in the prevention of illegal activities at the public places. Another literature proposes a waste monitoring system which detects the status of the dustbin to the local authorities and the users by using a node MCU ESP8266 platform to transmit the status of the bin wirelessly to the authorities via email and it's detects the status by using an ultrasonic sensor [3]. The dustbin also has an LED interface that tells us the status of the bin to the users while using it shrike. The literature

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shows a model to classify the waste into dry or waste using a moisture sensor [4]. This model also detects whether the dustbin is full or not by utilizing a ultrasonic sensor and the information to the Arduino and it sends it to the user's mobile via an Wi-Fi module.

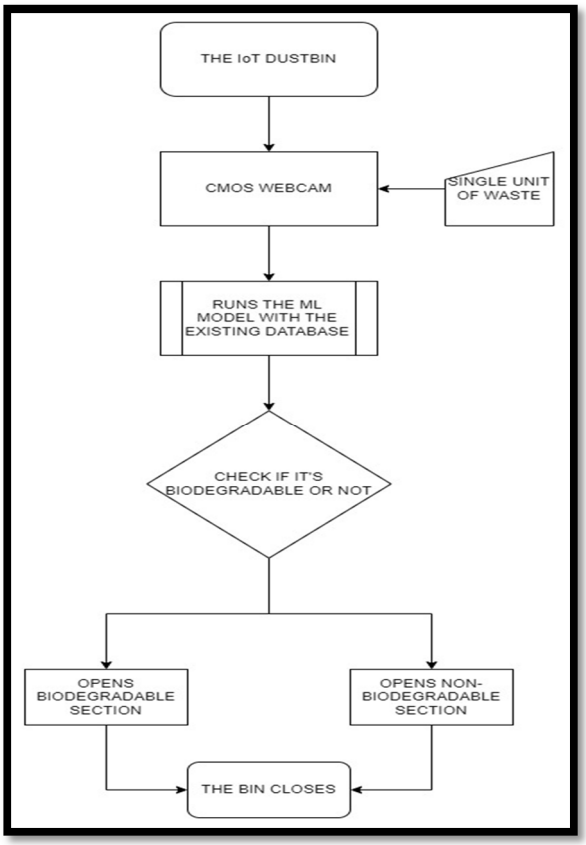
II. METHODOLOGY

The proposed system utilizes Tensor Flow classification model to segregate the waste into biodegradable and non-biodegradable by processing the image of the trash using the predefined data uploaded in the model. The model uses a camera module to take the live images of the trash and process the image to classify the image into their respective category.

The dustbin records the image of the trash through the Camera Module OV 5647. Computer Vision and Open CV is used to recognise the trash and the Tensor Flow ML algorithm classifies the image into biodegradable and non-biodegradable waste using the uploaded labelled datasets as the parameter for classification [5]. The appropriate section of the bin opens for the user to throw the trash using a servo motor module. The bin remains

Figure .1 Flowchart of working process

Open for the duration of 10 seconds and closes automatically afterwards. The program is looped so that it can classify the trashes continuously [6].



DATA SET CREATION

The Dataset was created by taking images from our surrounding and it was separated into two folders namely biodegradable and non-biodegradable. Each of the folders contains exactly 400 images of different waste according to their category [7].

This 800-image dataset will be uploaded for training the DL model as data for the waste classification process.

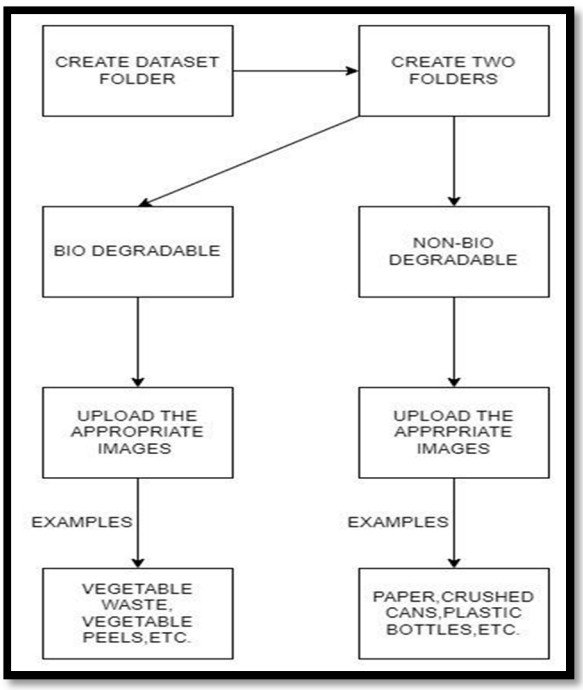


Figure .2 working process

ALGORITHM FOR IMAGE CLASSIFICATION

The following steps were performed to develop an image classification model in Python. Initially, libraries such as Keras, PIL, and NumPy were imported [8]. Then, to avoid recompilation, a pre-trained model (keras_model.h5) was loaded. 'class_names' was used to hold class labels read from 'labels.txt'. To match the model's input form (1, 224, 224, 3), an empty NumPy array was generated. After opening them using PIL, images were loaded, scaled, and turned into NumPy arrays [9]. Image normalisation was used to put pixel values into the range of -1 to 1. The normalised picture was fed into the array of inputs. To get class probabilities, inference were performed by utilising the models predict function. The predicted class was established, as well as its confidence score, and the results were printed to the console [10]. This method allows for picture categorization using a pre-trained deep learning model.

III. RESULT AND DISCUSSIONS

When the users show the trash in front of the camera the programs notify whether the object is biodegradable or not instantly.

Figure .3 Result displays biodegradable

The result shows that the object (banana) is accurately classified into biodegradable.

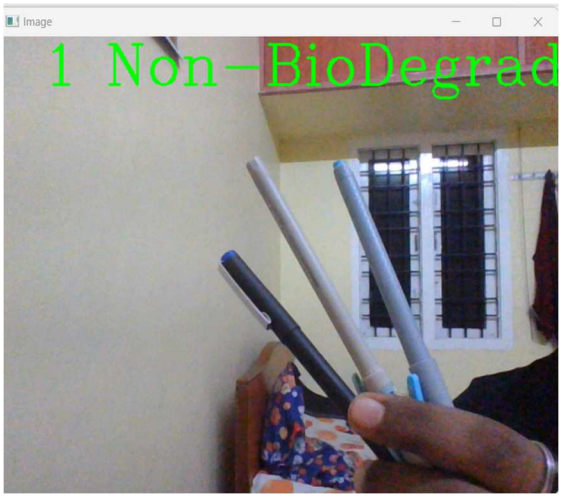


Figure .4 Results displays Non-Biodegradable

The result shows that multiple objects (pens) are accurately classified into non-biodegradable.

The following figure shows that results obtained using simulation is embedded to hardware Arduino UNO. The hardware functions based on interfacing with sensors, Motor control, Data logging, The hardware responds according to the control elements integrated in it. The device functions to classify image as bio-degradable or non- biodegradable.

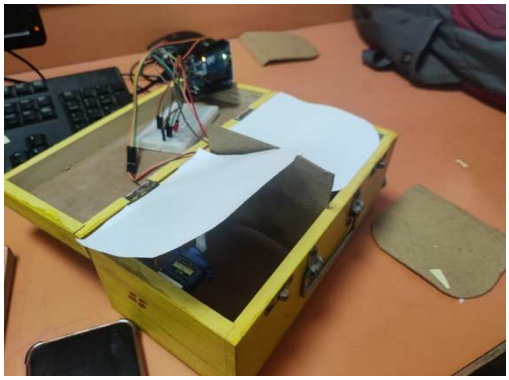


Figure .5 Results from Arduino UNO

The above figure shows simulated results using software model. This model is embedded to hardware using Arduino UNO. The result from pycharm code is binary value i.e. '1' for non-biodegradable items and '0' for biodegradable items, based on the value the Arduino UNO responds accordingly to control the servo motor integrated with it.

The above figure shows that the object (banana) is accurately classified into biodegradable and corresponding lid of dustbin opens automatically.

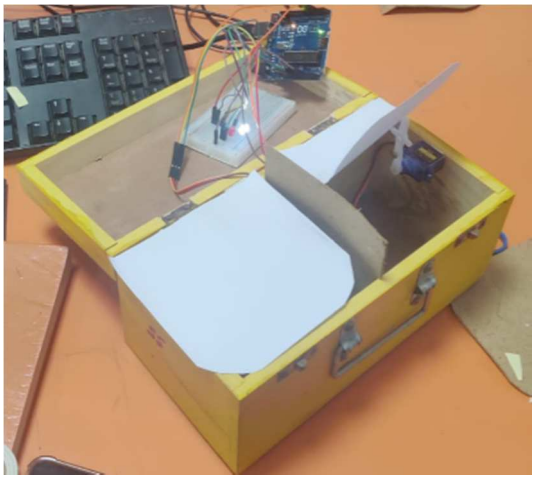


Figure .6 Results from Arduino UNO

The above figure shows that the object (pens) is accurately classified into non-biodegradable and the lid of dustbin opens accordingly.

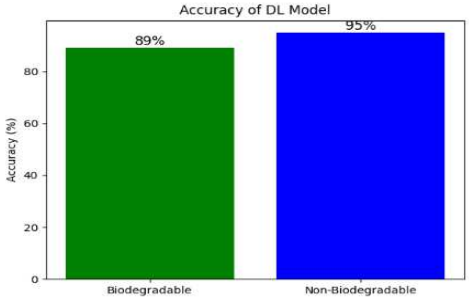


Figure .7 Results of accuracy model

Figure.7 shows bar chart which displays the accuracy of segregation of a biodegradable and non-biodegradable of images. Accuracy of DL model gives 89% of biodegradable and 95% as non-biodegradable.

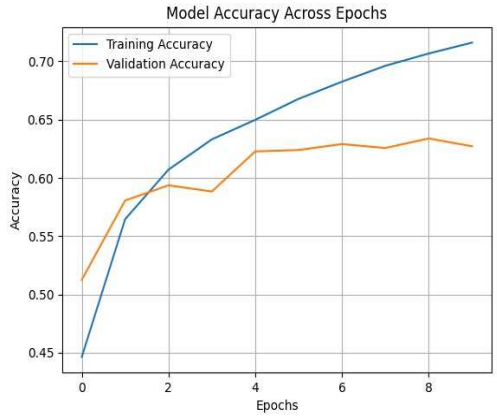


Figure .8 Model accuracy across epochs

The above results show accuracy versus model accuracy across epochs. The blue line shows the training accuracy level across epochs and the orange line indicates the validation accuracy of a model.

IV. Conclusion

The work obtained a segregation of waste at the initial stage which reduces the burden of a garbage collector, which also improves the recycling rate of wastes. The model trained using 100 epochs gives more accurate results. These progress in waste management improves the sustainability.

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