AUTOMATED TRASH SEPARATOR

LaukikaSankpal
Arizona State University
lsankpal@asu.edu

Saipriya Vrindavan Kunnath
Arizona State University
svrindav@asu.edu

Rajeshwari Sivasubramanian
Arizona State University
rsivasu2@asu.edu

***Abstract*—Waste management is a significant issue to be considered throughout the world. The responsible authorities face numerous challenges due to the rapid increase in the amount of waste with time. Improper management can lead to soil pollution. There is a chance of recycling 80% of the things buried in the landfills. This paper proposes a model that uses a Convolutional Neural Network to classify the waste items into two categories, plastic, and non-plastic. Further, we indicate the user to throw the trash in the correct bin. Based on the predicted category of the trash, the respective bin opens with the help of the servo motors attached to the bins.**

***Keywords*— Waste management, Convolutional Neural Network, servo motors.**

I. INTRODUCTION

Recycling of waste is a crucial part of waste management. The first step in recycling is segregating waste into different categories. The governments of most countries worldwide are taking great efforts in this step. Not only does this step require a lot of energy, but also a significant amount of time is lost in segregating all the garbage. All this time can be saved if this process is carried out at a much lower level. People can be informed to separate the trash at their homes, schools, offices, etc.

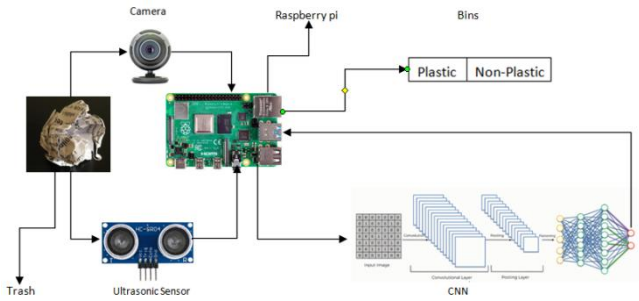

Figure 1.: Architecture of the automated trash separator

We have implemented the classification of objects into plastic and non-plastic with the help of MobileNet-v2, which is a deep CNN and transfer learning in which we add two more layers to the model.

With the help of OpenCV, an image of the object in front of the camera is captured. This image is given as an input to the CNN, which predicts the class of the object in the image, i.e., either non-plastic, which is class 0 or plastic, which is class 1. The output of the CNN is given as an input to the raspberry pi. The raspberry pi will, in turn, provide a signal to the respective servo motor to open the bin. After this, the camera is again ready to capture when the proximity sensor detects an object.

II. DATA PROCESSING

We collected 461 sample images of non-plastic objects and 482 sample images of plastic objects. Then we used the augmentor package to generate more pictures for the data set. This package takes a small data set and aids in augmentation and artificial generation of more images [2]. By applying the flip, skew, rotate, zoom, and black and white functions of the Augmentor package on our small dataset, we created a dataset of 10000 total images.

III. CONVOLUTIONAL NEURAL NETWORK

Convolutional Neural Networks or CNN have proven to be continually improving with the significant innovations in the field of computer vision.

These are mainly used for image processing, image classification, and segmentation. A CNN has one or more layers, and each layer has various filters called convolutional kernels. These filters are used on the subsets of the input images having the same size as that of the kernel. The output results in a single value per pixel of the image [3].

The CNN that we used for this project is the MobileNet-v2. Initially, we considered using models like VGG, Inception, and MobileNet. We chose MobileNet-v2 because of its smaller size and faster performance as compared to other models like VGG16. The MobileNet-v2 is 53 layers deep. It has various pretrained versions on more numerous images from the ImageNet database [1]. This model requires the input images to be of the size 224 x 224.

IV. TRANSFER LEARNING

In transfer learning, a pre-trained model is applied to a similar problem. The weights that the network learns in one task can be transferred to another task using transfer learning. This technique can be used when we already have a trained model on a large data set. If we want to train another model but only have a small data set, we can use the previous models and add new layers to it to give correct predictions for the new task [4].

We added a global average pooling layer and a prediction layer to one of the pre-trained models known as Mobilenet Version 2. The top layers of this model were made non-trainable. The global pooling layer minimizes overfitting by reducing the number of parameters or the features to be extracted, and the prediction layer maps the output of the GAP layer into two classes. The learning rate was set to 0.0001. We used RMSprop algorithm for optimizing the model. The model is trained for 20 epochs

with 156 steps in each epoch and the batch size for training and validation was set to 64.

V. OPENCV

OpenCV is an open-source computer vision library. It is suitable for real-time computer vision problems. As our project needs real-time object detection and image capturing, we made use of OpenCV-Python. Once an image is captured with the help of a camera, it is then converted to the 224x224 dimension to match with the requirements of the CNN. This image is stored in a .jpg format.

Figure 2: The images taken by the camera

VI. SENSORS AND ACTUATORS

The input to the system is given in the form of an image which is captured by the camera when the Ultrasonic Distance Sensor HC-SRO4 senses an object in front of the camera. When the object to be thrown is brought in the range of the ultrasonic sensor, the input is given to the pins 12 and 16 of the raspberry pi, which, in turn, instructs the camera to capture an image.

Once the input is classified either as plastic or non-plastic, the raspberry pi gives output through the SG90 Micro servo motor actuators. The output pins 11 and 13 of the raspberry pi are used to provide output pulses to the servo motors in the bin for plastic objects and in the bin for non-plastic objects, respectively. The motor that receives a high pulse will result in the opening of the respective bin. The trash can then be thrown in the open bin.

VII. RESULTS

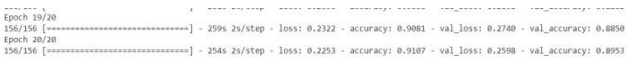

Figure 3: Number of epochs taken to train the model

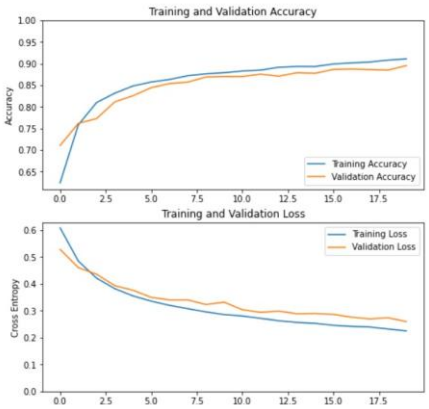

Figure 4: Training and Validation Accuracy and loss

Figure 3 and Figure 4 show that the model was trained for 20 epochs and got a validation accuracy of 89.5% and 0.2598% validation loss. The loss function here indicates the Binary Cross Entropy function.

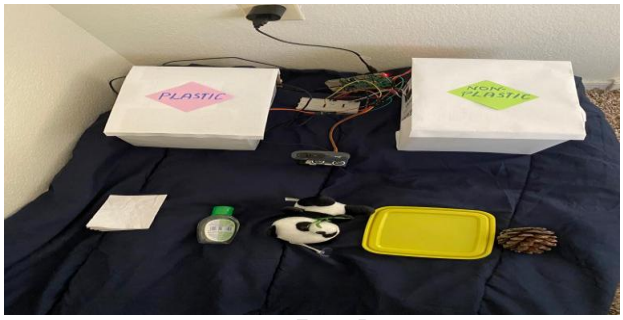

Figure 5.

Following is the image of our working model. There is an ultrasonic sensor, a camera, a raspberry pi, and two bins for segregation of plastic and non-plastic objects. We tested our system on a 5 sample objects. 4 out of the 5 objects gave us a correct prediction by opening the respective bins.

VIII. CONCLUSION

Recycling the plastic objects can do really good to reduce the soil pollution and it will also minimize the need of producing more plastic. For instance, a single bench can be made out of 4100 used plastic bottles and one plastic bottle can be used to make one plastic pen. It also has a lot of positive impact on the environment like less combustion of plastic waste, less CO_2 emission and saving raw materials.

IX. REFERENCES

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