International Journal of Advances in Engineering and Management (IJAEM)
Volume 3, Issue 6 June 2021, pp: 981-984 www.ijaem.net ISSN: 2395-5252

Waste Managementand Classification using Deep Learning CNN

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Submitted: 25-05-2021 Revised: 01-06-2021 Accepted: 05-06-2021

ABSTRACT:India is currently working through a phase of health crises with the way the waste is being treated becoming a major concern for the majority of the population. A significant amount of people are forced to work closely with the waste due to the pretense of earning a living to support their families, working closely or even living close to waste dumps, exposed sewage systems can have a very major impact on one's health-giving rise to diseases like asthma, tuberculosis, etc.

One of the major factors leading to the ever-increasing amount of waste is the malfunctioning of the waste management system, if we can increase the robustness of how the waste products are managed this can lead to a significant decrease in problems related to improper waste disposal plus it also provides concerned parties with time to further develop policies for proper disposal and recycling of waste products.

This project focuses on the second part of making the waste management system more robust with the help of deep learning more precisely using image recognition and object recognition.

The current system of waste management in practice is not up to the industry standards which has led to the increase in the dumping of waste products without proper treatment or proper pre-processing. We have numerous amounts of active non authorized land-fills which give rise to so many diseases and lead to not only cause harm to human health but also our natural environment.

This paper presents a Waste Management system based on the concept of the identifying a given waste product into different categories using the concept of Deep Learning. The paper focuses on both concepts of Image classification as well as object detection.

KEYWORDS: Inception,classifier,TrashNet

I. INTRODUCTION

With the increase of the amount of waste being generated with every passing year, it has become a major concern for a country like India with such a high population density. One of the major factors for the increase in waste is due to the current waste management system in place which has not been up to the industry standards. If we can create a system that segregates waste according to different categories for disposal at the lowest level then this can solve a huge part of the problem. This change can make the process of disposal and recycling easier for the authorities as well as make the people more aware of the whole process.

The system this paper presents is a prototype for a waste management system, which mainly focuses on classifying the category of a waste product which in turn will help in deciding how to recycle a given waste product following a given set of guidelines issued by the concerned authorities. This waste classification system uses two approaches for classification, that are image classification and object detection. The paper discusses the approaches taken for both as well the results achieved while testing.

For Image Classification, the paper focuses on the InceptionV3 model whose first version was launched by Google in 2014. For Object detection, the paper mainly focuses on Detectron and Mask RCNN models. Image classification mainly focuses on detecting what is the category for a given input mainly using Convolution Neural Networks. Object Detection is a more detailed version in the sense that it not only detects the category for a given input image it also detects where the object is present in the given input. The main difference which gives Object detection an edge over Image classification is the fact that in a given input if we have multiple objects belonging to different categories then image classification will only be able to classify it into a single category whereas Object detection can classify all the object in the given input provided the model was trained on a vast dataset

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II. MOTIVATION

This paper presents a Waste Management system based on the concept of the identifying a given waste product into different categories using the concept of Deep Learning. The paper focuses on both concepts of Image classification as well as object detection.

Image Classification

Image classification is the technique based on Convolution Neural Network where the main objective is to classify a given input into a particular category (category here denotes the different categories on which the model was trained). This paper focuses on the InceptionV3 model trained using the concept of Transfer Learning.

Transfer Learning is the process of using pre-trained weights from a heavily trained model to save time and energy for inference, in transfer learning the first stage is to freeze the initial layers as the model during the initial stages focuses on discovering features like edges which is most common. So we can use the weights for these layers from different models, now as the layers get deeper the model starts to find specific features related to the input, this is where we need to add our custom layer to satisfy the requirements for our input categories.

Object Detection

Object detection is the process of classifying the given input into different categories along with classifying where a particular object is present in the input. The exact location of the object can be represented using a bounding box (used in the Yolo network) or by a mask (used in Mask RCNN models).

Object Detection surpasses image classification due to the fact that it can classify different objects present in the same input whereas image classification can classify one category per image only. But this comes with a drawback as we need to precisely determine the location of an object the amount of data that is needed while training is higher in comparison to the image classification process

III. EXPERIMENTATION

The base model (with the highest accuracy shown during testing) was built using the InceptionV3 architecture and based on the concept of transfer learning. Inception-v3 is based on the convolutional neural network whose first version was launched by Google in 2014 for the ImageNet competition, this network was only 48 layers deep which made the training process much faster as compared to its predecessors. The Inception network can easily classify a given image into 1000 different categories ranging from a car to a fish to an airplane, etc. For our purposes, we need to classify a given waste product into different categories ranging from organic waste to plastic, glass, etc.

The first stage for training the model using transfer learning is to freeze the initial layers and train some of the final layers. As the original inception model was trained on the ImageNet dataset it has 1000 nodes at the output layer. As here we are working with only 20 classes, we replace the last SoftMax layer with a SoftMax unit with 20 nodes only.

The initial model achieved an overall accuracy of around 86%. The next stage was to unfreeze some more layers and retrain the model. Following this, the model's accuracy was increased to 90% but the model started to overfit.

To overcome this a dropout layer was added with a dropout probability of 0.3 which means out of every 10 nodes 3 will be dropped this helps the model to generalize rather than overfit on the training data.

The accuracy was increased to 94% and further changes and iterations to the model did not have a significant effect on the accuracy.

Some of the images from the original dataset used while training can be seen in the figure below along with their categories:

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IV. CONCLUSION

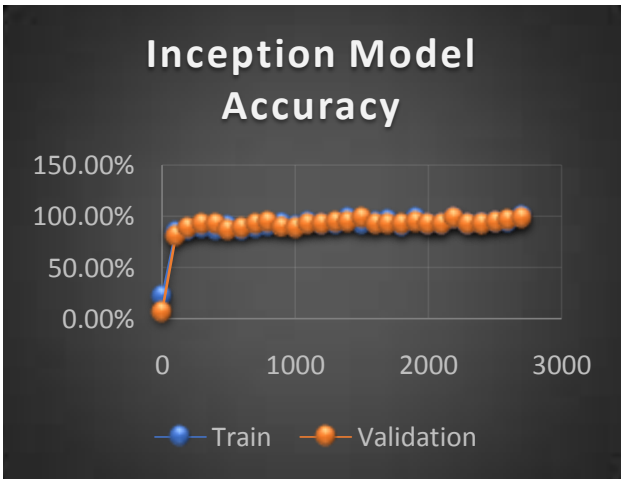
The model achieved an overall accuracy of 94.6% in training phase on the testing data. The model was trained for around3000 iterations in the test set The Mask RCNN model did not perform up to the requirements and only yielded a mAP = 52%.

•The model presented in a paper can be used as a prototype to build upon a system which can be sustainable and provides a better way of how we dispose of waste products.

•We can use data augmentation to increase the amount of training data from a few thousands to millions.

•Building a platform where the user will be presented with the choice of uploading the images and then he will also be given the proper guidelines for complete recycling of the product.

Here is a graph representing the overall training phase percentages:



V. PREDICTIONS:

Here are some of the Sample predictions from the model:

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