

# Waste Segregation using Deep Learning Algorithm

R.S.Sandhya Devi, Vijaykumar VR , M.Muthumeena

**Abstract:** In 2017, India is in 177th position of the Green ranking in World Economic Forum. Due to poor handling of air pollution and waste management, India has moved from 141st position to 177th position. With the emerging smart city development across the cities in India, Smart Garbage Management system is the need of the hour. It is estimated that the generated waste is more than 2.0 billion tones. The existing way of garbage management system in India involves waste collection from homes and industries and dumping into dump yards. The segregation of solid waste is completely done by manual laborers which is less efficient, time-consuming and not completely feasible due to large amount of waste. This paper proposes an automated waste classification system using Convolution Neural Network (CNN) algorithm, a Deep Learning based image classification model used to classify objects into bio and non-biodegradable, based on the object recognition accuracy in real-time. This algorithm is suitable for a large amount of waste segregation process. Python index package of spyder is used to identify and classify the waste material in real-time through webcam. In this paper, the first phase of the waste segregation process is carried out where initially the system is able to detect the object provides the relative match percentage of each object. Open source software libraries such as Tensor flow and Spyder is used for this process

**Key Words:** Convolution Neural Network, Tensorflow, waste segregation

## I. INTRODUCTION

Waste segregation process leads to recycling of waste, energy generation out of waste, reduction of waste and lessening of land fills. Many waste management strategy approaches are carried out to deal with the multifaceted challenges due to urbanization. Time, waste materials were greater than the production. The study involves understanding of the various kinds of waste, and the required focus to improve our systems to enable the sustainability of the waste management sector with participation from both the government and private agencies [1]. At present in India, there is no automated waste segregated approach at household level and a compact, low cost and user friendly segregation system for urban household to streamline the waste management process is the need of the hour [2]. To properly manage the waste it has to be handled, segregated, transported and disposed so as to reduce the risks to public lives and sustainable environmental. The economic value of waste is best comprehended when it is segregated. One of the big

problems is city waste consisting of industrial, daily useable waste, hotel, building waste, etc.

The waste becomes valuable if it is segregated and recycled using the recent advancements in technology thereby becomes a useful entity. This conversion method of waste can be employed to generate synthetic gas made up of carbon monoxide and hydrogen. The gas after burning can be used to produce steam and electricity, and for generation of bio fuels. Some industries do follow semi-automatic waste segregation process. Semi-automatic waste segregation process has some manual work, that leads to health hazards. In our proposed system, fully automatic waste segregation using deep learning algorithm is used. Deep learning is a class of machine learning algorithm that uses multiple layer of data representation and feature extraction. Using convolution neural network, a class of deep, feed-forward artificial neural network has successfully been applied to analyze the image. Thus, in waste segregation using deep learning involves acquiring images from camera with detection, object recognition, prediction and classification into categories as biodegradable and non-biodegradable [3].

## II. DEEP LEARNING ALGORITHM

The subset of Artificial Intelligence is Deep Learning algorithm. The various applications where deep learning algorithm plays a significant role are in tasks such as recognizing the images, converting speech to text, recognition of speech and visual object, drug discovery, face detection and recognition, weather forecast etc. With the dawn of High Performance Computing (HPC) , advanced techniques and technologies such as Big Data used for processing very large datasets results in giving the predicted output through effective recognition. Deep learning allows processing of multiple layers through the computational models in order to learn data representations with abstraction of many layers.

CNN is the most appropriate image classification method in the last years, where no handcrafted features are extracted from segmented objects [4]. However the training process is time consuming. On the implementation aspect, important python libraries used are Theano, Tensorflow, Numpy, Matplotlib, Pillow, opencv, etc. In that, libraries are helpful to detect and classify waste object. Further, the choice of image processing options depends factors like speed, code quality and correctness, community support, ecosystem, feature richness, and users' ability to contribute[5].

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## III. METHODOLOGY

The methodology [6] of waste segregation using deep learning algorithm are given below.

- a. Library Installation
- b. Model Preparation
- c. Frozen inference graph
- d. Process of displaying image
- e. Classify waste of image

### A. Library Installation

Collection of functions and methods are known as python library and it allows to perform lot of actions. The python index packages are helpful to add specific task to the application. The installation of python libraries are numpy, matplotlib, tensorflow, utils, opencv, tarfile, os.

Numpy is an array of multidimensional matrix and supports high level mathematical operation. The Numpy is an important python library helpful to realize convolution neural network algorithm. Using Numpy, image is converted into matrix. The matrix form of image using CNN is used for interpretation and analysis. The Numpy is one of the numerical mathematics extension of Matplotlib.

Matplotlib supports plotting functions for python programming language. In this proposed system, Matplotlib is used to draw bounding box. The bounding box is used to display object image name with score range. The Matplotlib provides object oriented application programming interface and it is one of the numerical mathematics extension Numpy.

OS is an import library of python. It uses a way of operating system dependent functionality. It is used for path manipulation Sys is one of the import library of python. It uses a particular task of system operation and it is same as os.path. Os.path is specifies the path to access and sys.path is uses the path defined for system operation. Tarfile is used to read and write large amount of data representation in specific task. In this, import file reduces size of code in read and write operation.

Tensorflow is one of the main concepts in this proposed system. The python library of tensorflow is an open source software library. Tensorflow is used to create frozen graph. The frozen graph is helpful to detect and segregate object in real-time using webcam. It supports graphical representation of data and includes lot of file libraries such as protobuf, util, framework, graph etc.

Utils is a collection of function and classes. The utils is one of python library file and its concept supports the implementation of CNN. In this proposed system, utils library is installed from Tensorflow library.

### B. Model Preparation

Model preparation is one of the main concept of training dataset in deep learning algorithm. The training dataset has multiple of image in form array. The model preparation process [7] is used to download SSD mobilenet COCO dataset. In that, mobilenet is one of the fastest RCNN and hence used in the training dataset for this proposed system. The library file utils with tarfile downloads dataset via os.path and then sys.path. Fig. 1 shows that SSD mobilenet is directly downloaded via goggle after running code.

Advantage of SSD mobilenet is the detection of object from an image at a faster rate.

```

...:
...: # Path to frozen detection graph. This is the
...: actual model that is used for the object detection.
...: PATH_TO_CKPT = MODEL_NAME + '/'
frozen_inference_graph.pb'
...:
...: # List of the strings that is used to add correct
Label for each box.
...: PATH_TO_LABELS = os.path.join('data',
'mscoco_label_map.pbtxt')
...:
...: NUM_CLASSES = 90

In [6]: opener = urllib.request.URLopener()
...: opener.retrieve(DOWNLOAD_BASE + MODEL_FILE,
MODEL_FILE)
Out[6]:
('ssd_mobilenet_v1_coco_2017_11_17.tar.gz',
<http.client.HTTPMessage at 0xdafc3eac88>)

In [7]:
    
```

**Fig. 1: SSD mobilenet download from google**

### C. Frozen inference graph

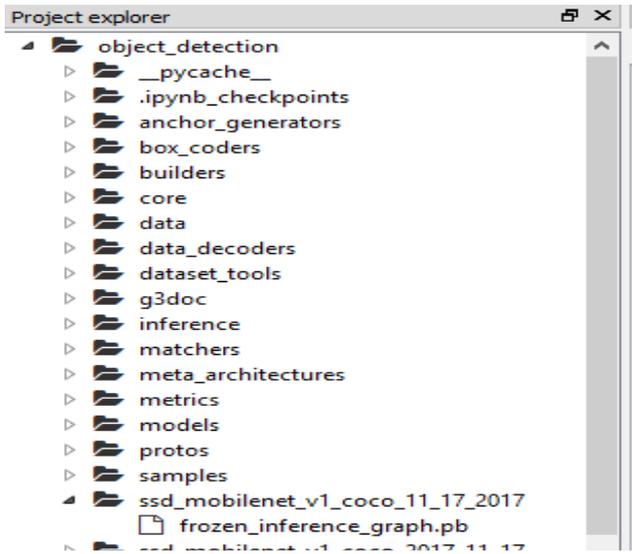
Protocol Buffer [8] is widely used by google for storing and interchanging all kinds of structured information. The protocol buffer is important in the frozen graph. The protocol buffer installation command is “protoc object\_detection/protos/\*.proto --python\_out”. The successful installation of protobuf is shown in Fig.2. After installation of protobuf, tensorflow library of pb2 file is automatically installed. The frozen detection graph of the pb file is through object path detection and then it’s convolution neural network concept. The command path\_to\_ckpt is used to predict a specific object detection from image or video. After running of the command path\_to\_ckpt, and automatically create frozen graph in SSD mobilenet. The creation of frozen graph in SSD mobilenet is shown in Fig. 3.

```

(C:\Users\ADMIN\Anaconda3) D:\>E:
(C:\Users\ADMIN\Anaconda3) E:\>cd Test
(C:\Users\ADMIN\Anaconda3) E:\Test>cd models
(C:\Users\ADMIN\Anaconda3) E:\Test\models>E:/Test/protoc-3.4.0-win32/bin/protoc
object_detection/protos/*.proto --python_out=
object_detection/protos/*.proto: No such file or directory
(C:\Users\ADMIN\Anaconda3) E:\Test\models>cd research
(C:\Users\ADMIN\Anaconda3) E:\Test\models\research>E:/Test/protoc-3.4.0-win32/bi
n/protoc object_detection/protos/*.proto --python_out=
(C:\Users\ADMIN\Anaconda3) E:\Test\models\research>
    
```

**Fig. 2: Installation proto buf**





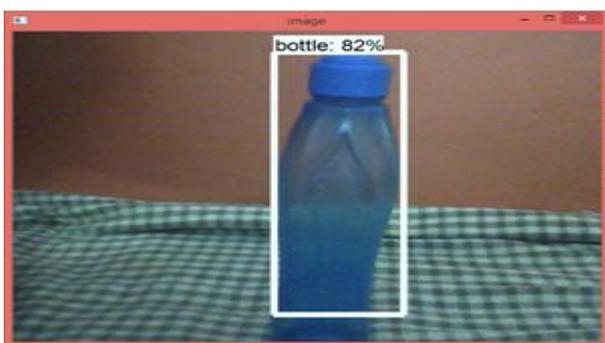
**Fig. 3: Frozen inference graph**

**D. Process of display image convert RGB**

Already the code for conversion of specific image to RGB base on the image size. The input of image size may or may not be of different size. Whatever is the size of object be, the detected image will be converted to the specific size (32X32). The python index library of numpy is used to create the array information of the image. Os.path and Sys.path is used to detect images and are identified as biodegradable or not. The steps in the identification of images is similar to that in image processing and edge detection and matching method are used along with image classification. The object detection using the proposed methodology is shown in Fig. 4 & Fig. 5.



**Fig. 4. Waste object detection-1**



**Fig. 5. Waste object detection-2**

**IV. CONCLUSION**

With the advent of deep network architectures that deals with Big Data, provides the best – in-class performance in terms of accuracy, scalability, adaptability without any feature engineering. The paper proposes the idea of fully automated waste segregation using deep learning without involving manual work. Hence to implement it, the system works with a huge data set, pattern predictions for object detection and training algorithms. Further work includes, optimization of the results and prediction accuracies for various discrete inputs in real- time. Thus this approach, aids in reducing pollution levels and in the long run focuses on the development of universal waste segregation framework. Thus, the work is an important asset to the society.

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