

GARBAGE CLASSIFICATION

Using Convolution Neural Networks

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SMART BRIDGE -REMOTE SUMMER INTERNSHIP PROGRAM

1.INTRODUCTION:

Garbage is defined as the items or materials that need to be discarded because they no longer serve any purpose for us or are of no use to us. The classification is needed to know and apply reuse methods that could bring benefits and reduce the environmental problems. Now-a-days the existence of techniques or models that help people to sort garbage has become essential in the correct disposal of those materials. Although there are different types of recycling categories, people still can be confused or do not properly recognize about how to determine the correct trash bin can to dispose of each garbage.

The objective of this project is to take images of a single piece of recycling or garbage and classify it into four classes consisting of glass, metal, paper, plastic. We create a dataset that contains around 250 images for each class, which was hand collected. The huge amount of garbage and complex diversity of the contained ingredients in the garbage not only bring serious environmental pollution problems, but also bring a wide range of social problems as well as the waste of resources. How to classify garbage and make the garbage achieve harmless, reduction, resource and socialization has become the common goal all over the world.

Image segmentation and classification is more and more being of interest for hand picking. Systems on the rise need accurate and efficient segmentation and recognition mechanisms. This demand coincides with the increase of computational capabilities of modern computer architectures and more effective algorithms for image recognition. The use of convolutional neural networks for the image classification and recognition allows building systems that enable automation in many industries. This article presents a system for classifying garbage, using convolutional neural networks.

The problem of segregation of renewable waste is a big challenge for many countries around the world. Apart from segregating waste using human hands, there are several methods for automatic segregation. The article proposes a system for classifying waste with the following classes: glass,metal,paper,plastic. The obtained results show that automatic waste classification, using image processing and deep learningmethods, allows building effective systems that operate in the real world.

An important Element of the whole process is the preliminary division of waste into various groups of materials followed,by detailed segregation.the dispoal of waste is more important in evironmental protection.

The convolution neural network was used to classify images with garbage most popular in household waste,in paricular glass,metal,paper,plastic. The obtained results show that automatic garbage classification, using image processing and deep learning methods, allows building effective systems that operate in the real World Waste management (or waste disposal) include the activities and actions required to manage garbage from its inception to its final disposal. This includes the collection, transport, treatment and disposal of waste, together with monitoring and regulation of the garbage management process.

The accumulation of solid waste in the urban area is becoming a great concern, and it would result in environmental pollution and may be hazardous to human health if it is not properly managed. It is important to have an advanced/intelligent garbage management system to manage a variety of waste materials. One of the most important steps of garbage management is the separation of the waste into the different components and this process is normally done manually by hand-picking. To simplify the process, we propose an intelligent garbage material classification system, which is developed by using the 50-layer residual net pre-train Convolutional Neural Network model which is a machine learning tool and serves as the extractor, which is used to classify the garbage into different groups/types such as glass, metal, paper, and plastic etc. The separation process of the waste will be faster and intelligent using the proposed waste material classification system without or reducing human involvement.

1.1 Overview-

Garbage became the major source in our world .The accessibility of garbage datasets and data analysis promote the researchers to apply study in extracting unknown pattern from garbage datasets. The intention of this study is to design a prediction system that can predict the incidence of the garbage classification at early stage by analyzing through the set of training and testing images that has been selected datasets .Data Mining is one of the most motivating and vital area of research with the aim of extracting information from tremendous amount of accumulated data sets.Here a new model for classifying type of garbage by using deep learning concepts and as alternative machine learning concepts can also be used for classifying the garbage . The model has been built using data from imaging test and to predict the type of garbage. By using the neural networks a Flask model has been implemented and tested.The potential of the proposed method is obtained using Imagedata generator class which was obtained by preprocessing the training and testing images to predict the image by a series of random translations. The outcome confirms that the maximum classification accuracy (85%) and configures the learning process by optimizing and saving the model ,is achieved for this study.

1.2 Purpose-

Our aim from the project is to make `numpy`,`keras`,`tensorflow`,`Imagedatagenerator` libraries from python to extract the libraries for deep learning for the prediction of garbage classification .Secondly, to learn how to hyper tune the parameters using image search cross validation for the convolution neural networks algorithm. In the end, to predict whether the type of grabage techniques of combining the predictions from deep learning algorithms and with drawing the conclusions.

2. LITERATURE SURVEY:

The authors did well to take advantage of a pretrained model to improve generalization. Other recycling based classification problems used physical features of an object. In a project from Lulea University of Technology worked on recycling

metal scraps using a mechanical shape identifier. They used chemical and mechanical methods such as probing to identify the chemical contents and current separation. This paper's mechanical approach provides interesting advancement strategies for our project. Another more image based classification of materials was performed on the image Database. The team used features such as color, microtexture and outline shape in a Bayesian computational framework. This project is similar to ours in that it attempts to classify images based on material classes. However, the dataset used is different than ours in that the images are untarnished materials with no logos or deformation.

The present way of separating waste/garbage is the hand-picking method, whereby someone is employed to separate out the different objects/materials. The person, who separate waste, is prone to diseases due to the harmful substances in the garbage. With this in mind, it motivated us to develop an automated system which is able to sort the waste and this system can take short time to sort the waste, and it will be more accurate in sorting than the manual way. With the system in place, the beneficial separated waste can still be recycled and converted to energy and fuel for the growth of the economy.

Deep Learning is the process of analyzing data from different perspectives and extracting useful knowledge from it. It is the core of knowledge discovery process. Convolution neural network is the most applied deep learning technique, which detects predictions based on image classification and uses object detection code to predict image through video analysis. Identifying type of garbage and identifying the object based on images are particularly well suited to deep learning techniques. In CNN, training set is used to build the model as the Image data generator class which can classify the data items into its images into appropriate classes. A test set is used to validate the model

2.1 Existing problem-

In most of the world, including india, we do one of two things with our ordinary garbage: burn it or bury it. Neither one is good for us or for the environment. Burning garbage in incinerators releases dangerous gases and dust (particulate matter) which contribute to global warming and pollute lakes, forests, oceans and cities half a world

away from where they originated. Most incinerators in industrialized countries now remove large quantities of particles and pollutants, thus ensuring cleaner air. But the bulk of what they remove ends up in a landfill. Burying garbage also causes both air and water pollution, and simply transporting it to the sites consumes an increasing amount of valuable fossil fuels, which produces more pollution and other problems. The current waste management practice in India involves collecting waste from sources through a community collective bin system, after which it gets transported to a low-lying landfill system with intermediate processing of Municipal Solid Waste. The open dumping practice is leading to various problems like pollution and health hazards. Both surface and groundwater are affected by this; in fact, groundwater is in a critical state. Current procedures are not ideal, hence, the solid waste management crisis.

2.2 Proposed solution-

Deep Learning (Convolutional Neural Networks): In vision of the problem statement described in the introduction section, CNN model is proposed with boosted accuracy to predict the garbage classification.

The framework is composed of the following important phases:

- Dataset Collection (creating training and testing folders)
- Data Preprocessing.
- Model Building.
- Achieving trained model with highest accuracy
- Using trained model for prediction
- Application Building

The recyclability of a material depends on its ability to reacquire the properties it had in its virgin or original state. It is an alternative to "conventional" waste disposal that can save material and help lower greenhouse gas emissions. Recycling can prevent the waste of potentially useful materials and reduce the consumption of fresh

raw materials.

Recyclable materials include many kinds of glass, paper, cardboard, metal, plastic, tires, textiles, batteries, and electronics. The composting or other reuse of biodegradable waste such as food or garden waste is also a form of recycling. Materials to be recycled are either delivered to a household recycling center or picked up from curbside bins, then sorted, cleaned, and reprocessed into new materials destined for manufacturing new products. We use CNN to classify the image into four categories of garbage classes. By using model and obtained a mean accuracy of 87.69%.

3. THEROTICAL ANALYSIS:

While selecting the algorithm that gives an accurate prediction we done through lot of algorithms which gives the results abruptly accurate and from them we selcted only one algorithm for the prediction problem that is convolution neural networks ,it assumes that the presence of a particular feature detector in a imagedatagenerator class detects the image and transforms the image in the batch by a series of random translations and these translations are based on arguments and replaces original batch with new data.and also performs data augmentation. Thats how the prediction work great the prediction work great

The peculiarity of this problem is collecting the data of garabge classification details real time and working with the prediction at the same time, so we developed an user interface for the people who'll be accesssing for the type of garbage prediction.

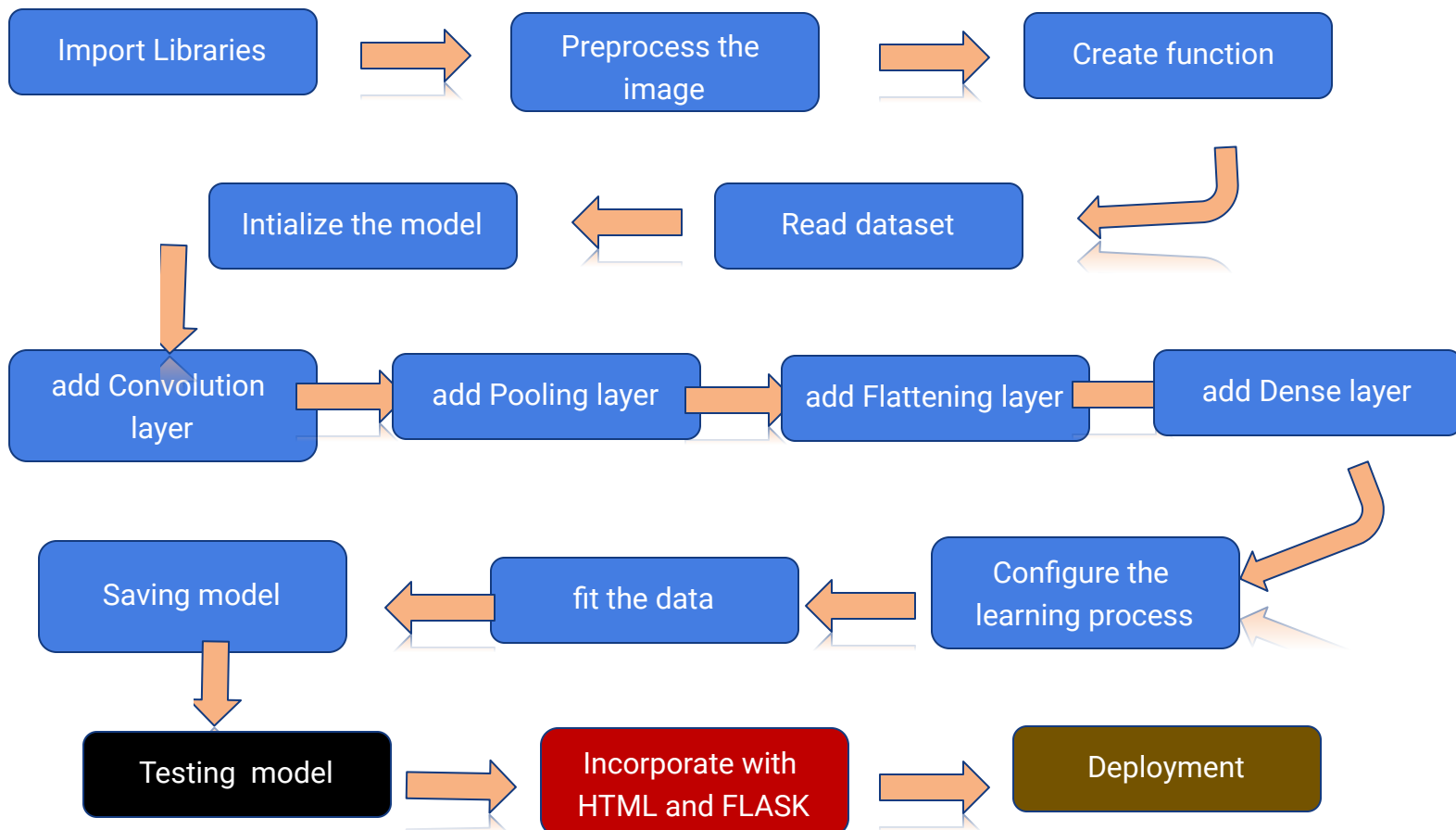
Accuracy is defined as the ratio of the numbercorrectly classified by the classifier to the total number of samples for a given test data set. The classified by the classifier to the total number of samples for a given test data.The formula ia as follows

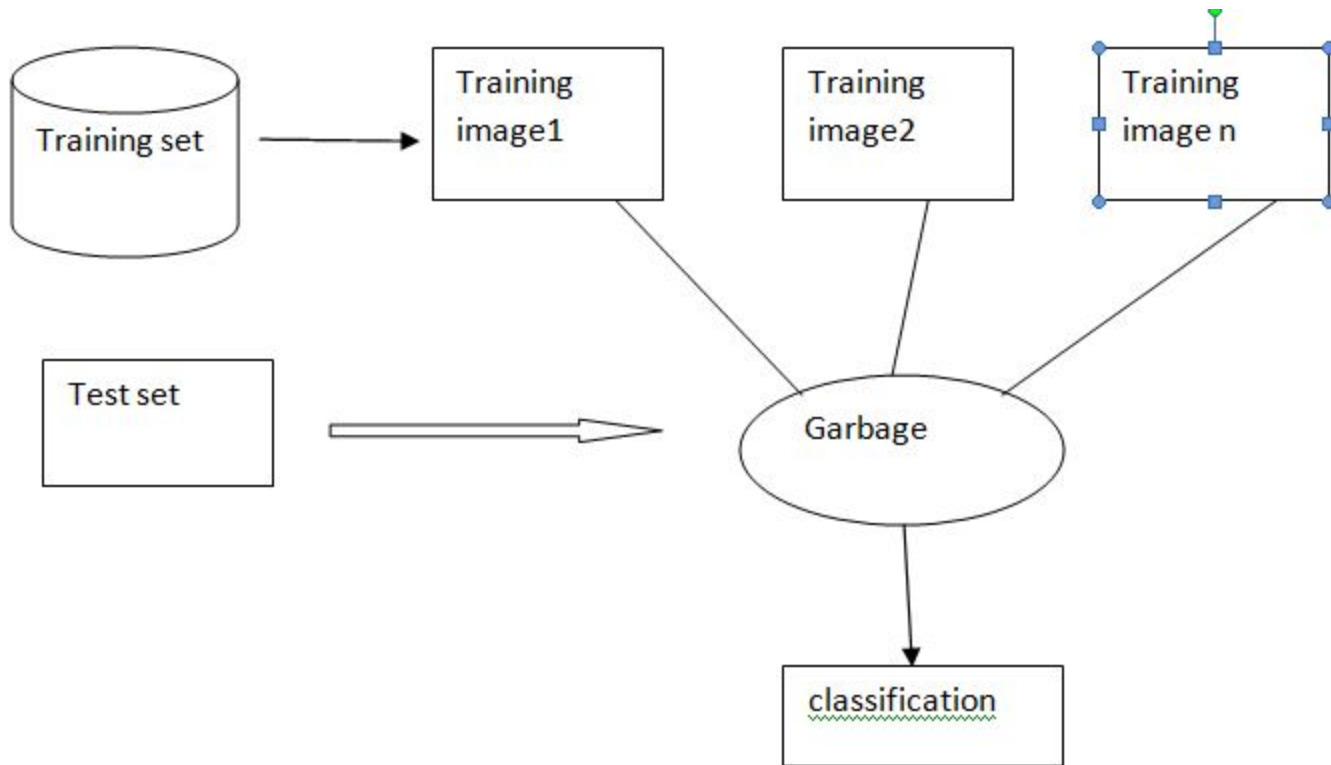
$$\text{Accuracy} = \frac{TP+TN}{TP+TN+FT+FN}$$

At first we got like lot of worst accuracies because we tried lot of trained images by giving more number of epochs for the best accurate algorithm , finally after all of that

we tried the best suitable algorithm which gives the prediction accurately is convolution neural networks. And developed it to use as a real time prediction problem for the garbage classification prediction. Import Libraries

3.1 Block diagram-





3.2 Software designing-

- Jupyter Notebook Environment
- Spyder Ide
- Deep learning Algorithm
- Python (numpy, tensorflow , keras)
- HTML
- Flask

We developed this garbage classification by using the Python language which is a interpreted and high level programming language and using the cnn. For coding we used the Jupyter Notebook environment of the Anaconda distributions and the Spyder. It is an integrated scientific programming in the python language. For creating an user interface for the prediction we used the Flask. It is a micro web fr amework written in Python. It is classified as a microframework because it does not require particular tools or libraries. It has no database abstraction layer, form validation, or any other

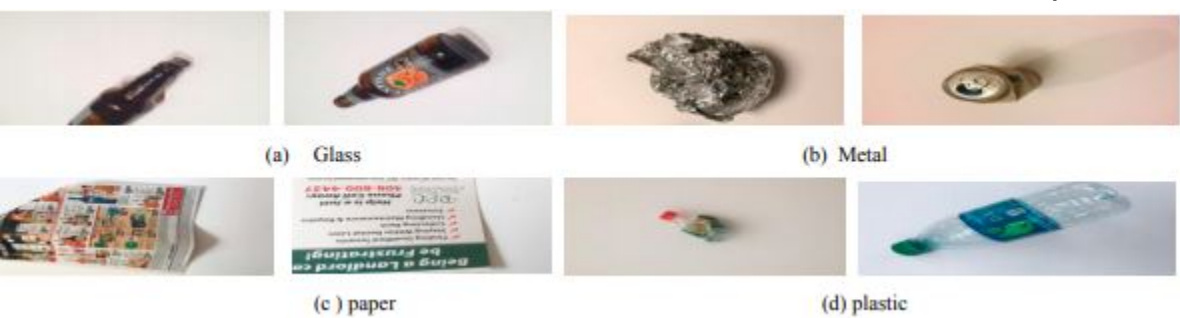
components where pre-existing third-party libraries provide common functions, and a scripting language to create a webpage is HTML by creating the templates to use in the functions of the Flask and Html.

4. EXPERIMENTAL INVESTIGATION:

The first dataset namely Trashnet dataset was collected by mobile devices, which contains images with four

NO	CLASSES	NO. OF IMAGES
1	Glass	300
2	Metal	430
3	Paper	501
4	Plastic	520

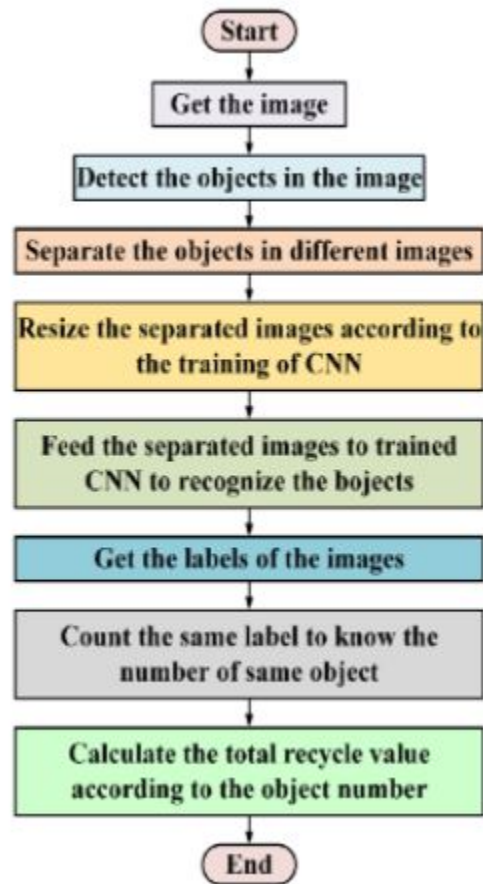
classes such as glass, paper, cardboard, plastic, metal, and trash. The object of images was placed on a white background and using sunlight and/or room lighting. The statistic of images for each class was presented in Table 1 while Figure shows several samples in each class of this dataset. In addition, this study also collects another dataset named VN-trash dataset for the trash classification problem.



The data acquisition process was done by hand by us because there are no publicly available datasets pertaining to garbage materials. However, these images do not accurately represent the state of recycled goods after more research on recycling plants and the state of recycled goods. For example, the images in the Flickr Material Database present materials in a pristine and undamaged state. This is unlikely in recycled materials treated as waste because they are dirty, ruffled, crumpled, etc. Therefore, we hand collected our own dataset of images, which we plan on making a public dataset. The dataset contains images of recycled objects across four classes

with about 250 images each ; totaling about 1000images. The data acquisition process involved using a white posterboard as a background and taking pictures of trash and recycling around Stanford, our homes, and our relatives' homes. The lighting and pose for each photo is not the same, which introduces variation in the dataset.

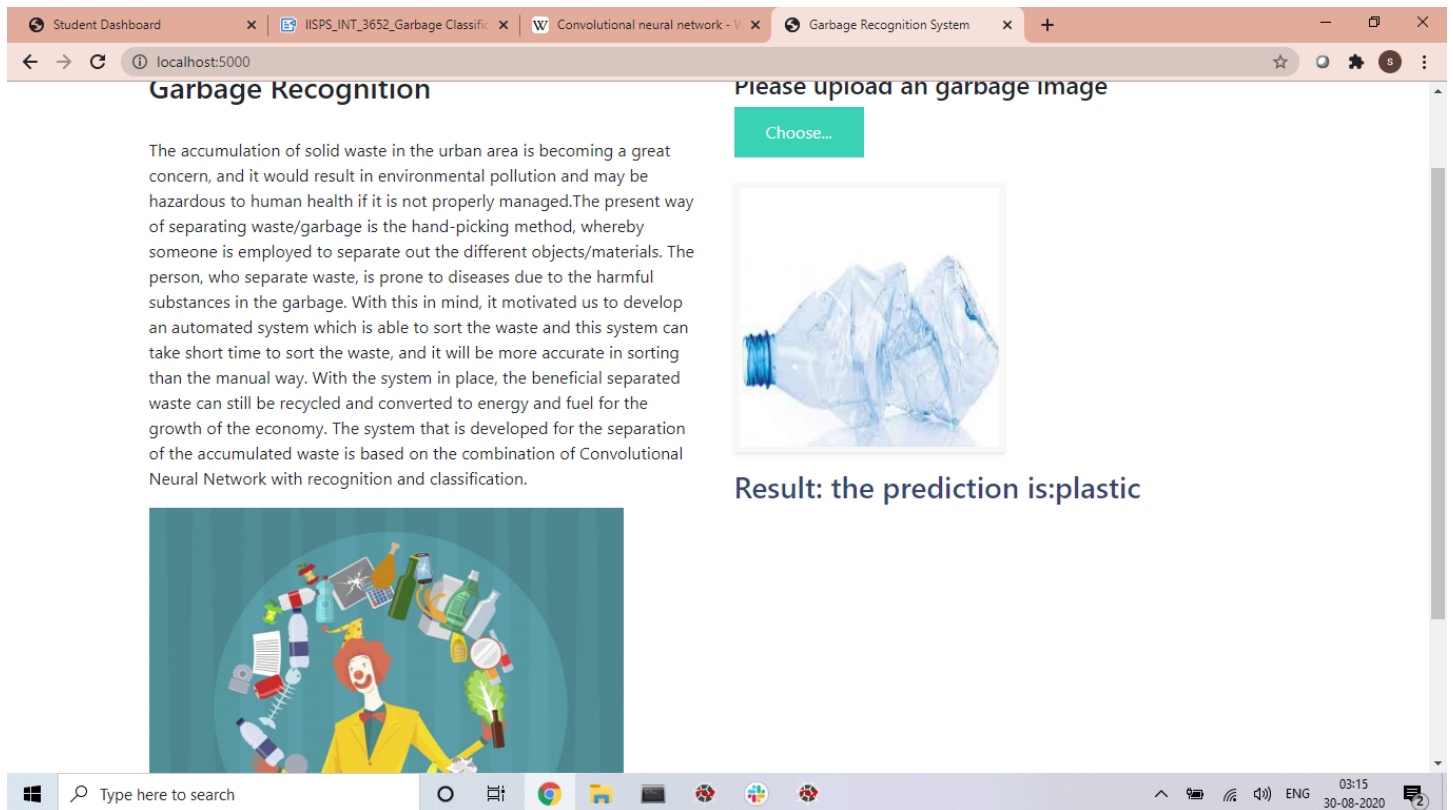
5.FLOW CHART:



6.RESULT:

The convolution neural networks is used to predict the outcome based on image analysis by giving an object detection code. There are many algorithms in machine learning techniques which are used to predict the garbage classification, but the technique we have used in this project is deep learning technique. The convolution neural networks using Image DataGenerator class and feature detectors it predicts an

image whether it is a metal,paper,glass or plastic .By having good amount of training images for training and testing images for testing our model has predicted good accuracy with 85% and validation accuracy as 61%... firstly we have saved our model and predicted the type garbage whether it is or benign.secondly after getting correct predictions I have built an web application using flask and html.The screenshots below shows the model building and application building in the UI.



7.ADVANTAGES AND DISADVANTAGES:

Advantages:

- ❄ CNN represent current state of art techniques in image classification.
- ❄ This program helps to reduce the exposure of harmful germs and chemicals to garbage pickers.
- ❄ It provides better control over odour and noise.

❄ It is effective for recycling of glass,metal,paper and plastic.

❄ It helps in reduction of pollution.

Disadvantages:

❄ The runtime of convolution operations are computationally high.

❄ Large number of training data and annotations are needed ; which maynot be practical in some problems.

❄ From a memory and capacity standpoint the CNN is not much bigger than regular two layer network.

8.APPLICATIONS:

★ It mainly applies for image recognition of garbage and helps to classify garbage into glass, metal, paper and plastic.

★ This garbage classification system can take short time to sort the garbage .

★ It will be more accurate than sorting of garbage products by manual way.

★ Open source libraries for deploying application in CNN is very fast.

★ This application improves the functioning of corporations which are involved in garbage collection.

9.CONCLUSION:

Through this research, we obtained the accuracy above 87% and made the comparative analysis on the model we adapted to train our data. For this, we have been putting a continuous effort for getting better result for each evaluation metrics. Furthermore, we still have things to work on dataset and increase its number. Also, the performance of model can be improved further by increasing the number of images and fine tuning the model properly. The idea of garbage classification can be used in recycling process of waste if the mode is reliable and more accuracte

10. FUTURE SCOPE:

We have successfully implemented the project where it detects the waste object and classifies it into categories namely glass, paper, metal, plastic. After classifying the object it also opens the respective bin of that category. The project has a wider scope in future considering the idea behind the project is very practical and is in dire need of such applications in garbage segregation. There are various ways in which the project can be further improvised at a large scale level.

The garbage collected in the bin will be near full at a certain time. Using wifi module or an application and sensors, this data can be sent to the janitor or concerned authority who will be intimidated to come and clear the bin.

Another application can be to convert the bin into a robot and train it to dump itself after the bin is full. This could be implemented on single floor basis where collecting garbage from every room becomes a hassle. The robot can be programmed accordingly.

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APPENDIX :

HTML:

```
<html lang="en">
<head>
  <meta charset="UTF-8">
  <meta name="viewport" content="width=device-width, initial-scale=1.0">
  <meta http-equiv="X-UA-Compatible" content="ie=edge">
  <title>Garbage Recognition System</title>
  <link href="https://cdn.bootcss.com/bootstrap/4.0.0/css/bootstrap.min.css" rel="stylesheet">
  <script src="https://cdn.bootcss.com/popper.js/1.12.9/umd/popper.min.js"></script>
  <script src="https://cdn.bootcss.com/jquery/3.3.1/jquery.min.js"></script>
  <script src="https://cdn.bootcss.com/bootstrap/4.0.0/js/bootstrap.min.js"></script>
  <link href="{{ url_for('static', filename='css/main.css') }}" rel="stylesheet">
  <style>
    .bg-dark {
      background-color: #42678c!important;
    }
    #result {
      color: #0a1c4ed1;
    }
  </style>
</head>
<body>
  <nav class="navbar navbar-dark bg-dark">
    <div class="container">
      <a class="navbar-brand" href="#">Garbage Recognition Using CNN</a>
    </div>
  </nav>
  <div class="container">
    <div id="content" style="margin-top:2em">
      <div class="container">
        <div class="row">
          <div class="col-sm-6 bd" >
            <h3>Garbage Recognition </h3>
            <br>
            <p> The accumulation of solid waste in the urban area is becoming a great
```

concern, and it would result in environmental pollution and may be hazardous to human health if it is not properly managed. The present way of separating waste/garbage is the hand-picking method, whereby someone is employed to separate out the different objects/materials. The person, who separate waste, is prone to diseases due to the harmful substances in the garbage. With this in mind, it motivated us to develop an automated system which is able to sort the waste and this system can take short time to sort the waste, and it will be more accurate in sorting than the manual way. With the system in place, the beneficial separated waste can still be recycled and converted to energy and fuel for the growth of the economy. The system that is developed for the separation of the accumulated waste is based on

the combination of Convolutional Neural Network with recognition and classification.</p>

```

```

```
</div>
```

```
<div class="col-sm-6">
```

```
<div>
```

```
<h4>Please upload an garbage image</h4>
```

```
<form action = "http://localhost:5000/predict" id="upload-file" method="post"
enctype="multipart/form-data">
```

```
<label for="imageUpload" class="upload-label">
```

```
Choose...
```

```
</label>
```

```
<input type="file" name="image" id="imageUpload" accept=".png, .jpg,
.jpeg, .jif">
```

```
</form>
```

```
<div class="image-section" style="display:none;">
```

```
<div class="img-preview">
```

```
<div id="imagePreview">
```

```
</div>
```

```
</div>
```

```
<div>
```

```
<button type="button" class="btn btn-info btn-lg "
```

```
id="btn-predict">Click on this to see what object it is!</button>
```

```
</div>
```

```
</div>
```

```
<div class="loader" style="display:none;"></div>
```

```

        <h3>
            <span id="result"> </span>
        </h3>
    </div>
</div>

</div>
</div>
</div>

</div>
</body>
<footer>
    <script src="{{ url_for('static', filename='js/main.js') }}" type="text/javascript"></script>
</footer>
</html>

```

APP.PY

```

from flask import Flask ,render_template ,request
import os
from keras.preprocessing import image
from werkzeug.utils import secure_filename
from keras.models import load_model
model = load_model("garbage.h5")
import numpy as np
app = Flask(__name__)

import tensorflow as tf
sess = tf.compat.v1.Session(graph=tf.compat.v1.get_default_graph())

tf.compat.v1.keras.backend.set_session(sess)
@app.route("/")
def index():
    return render_template("base.html", methods = ['GET'])

@app.route('/predict',methods = ['GET','POST'])
def pred():
    if request.method == "POST":

```



```
print("hi")
f = request.files["image"]
basepath = os.path.dirname(__file__)
print(basepath)
file_path = os.path.join(basepath,"uploads",secure_filename(f.filename))
print(file_path)
f.save(file_path)
img = image.load_img(file_path,target_size=(64,64))
x = image.img_to_array(img)
x = np.expand_dims(x,axis=0)
```

```
with sess.as_default():
    p=model.predict_classes(x)
    print(p)
index=['glass','metal','paper','plastic']
text ="the prediction is:" +index[p[0]]
return text
```

```
if __name__ == '__main__':
    app.run(debug = False)
```