PROFESSIONAL READINESS FOR INNOVATION, EMPLOYABILITY AND ENTREPRENEURSHIP

IBM PROJECT REPORT

Team ID	NM2023TMID01947
Project Name	Intelligent garbage classification using deep learning

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1. INTRODUCTION

1.1 PROJECT OVERVIEW:

The goal of this project is to develop an intelligent garbage classification system that utilizes deep learning techniques to accurately classify different types of waste. The system aims to automate and improve the waste management process by efficiently sorting and segregating garbage based on its type, such as non-recyclable, organic, and hazardous waste. With the increase in the number of industries in the urban area, the disposal of solid waste is really becoming a big problem, and solid waste includes paper, wood, plastic, metal, glass, The present way of separating waste/garbage is the hand-picking method, whereby someone separates the different objects/materials. The person who separates 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 that is able to sort the waste in an accurate manual way. And recycle the waste, converted to energy fuel for the growth of the economy.

1.2 PURPOSE:

The primary purpose is to automate the process of garbage classification. Deep learning models can be trained to accurately identify and categorize different types of waste, reducing the need for manual sorting. This automation enhances the efficiency of waste management operations, saving time, resources, and labor, and identification and separation of recyclable materials from non-recyclable ones.

2. IDEATION &PROPOSED SOLUTION

2.1 PROBLEM SOLUTION DEFINITION:

- The amount of waste then the world almost generates at least 5 million tons of waste per day and this number is still increasing day by day why do we need to be aware ofwaste?

- This model helps us to classify waste with waste materials and it will show you the details of that particular waste material.

- This will help to raise awareness for people to reduce and enter recycling waste.

- Problem is pretty much straightforward, we all are familiarwith Garbage and waste material which is very harmful to our society.

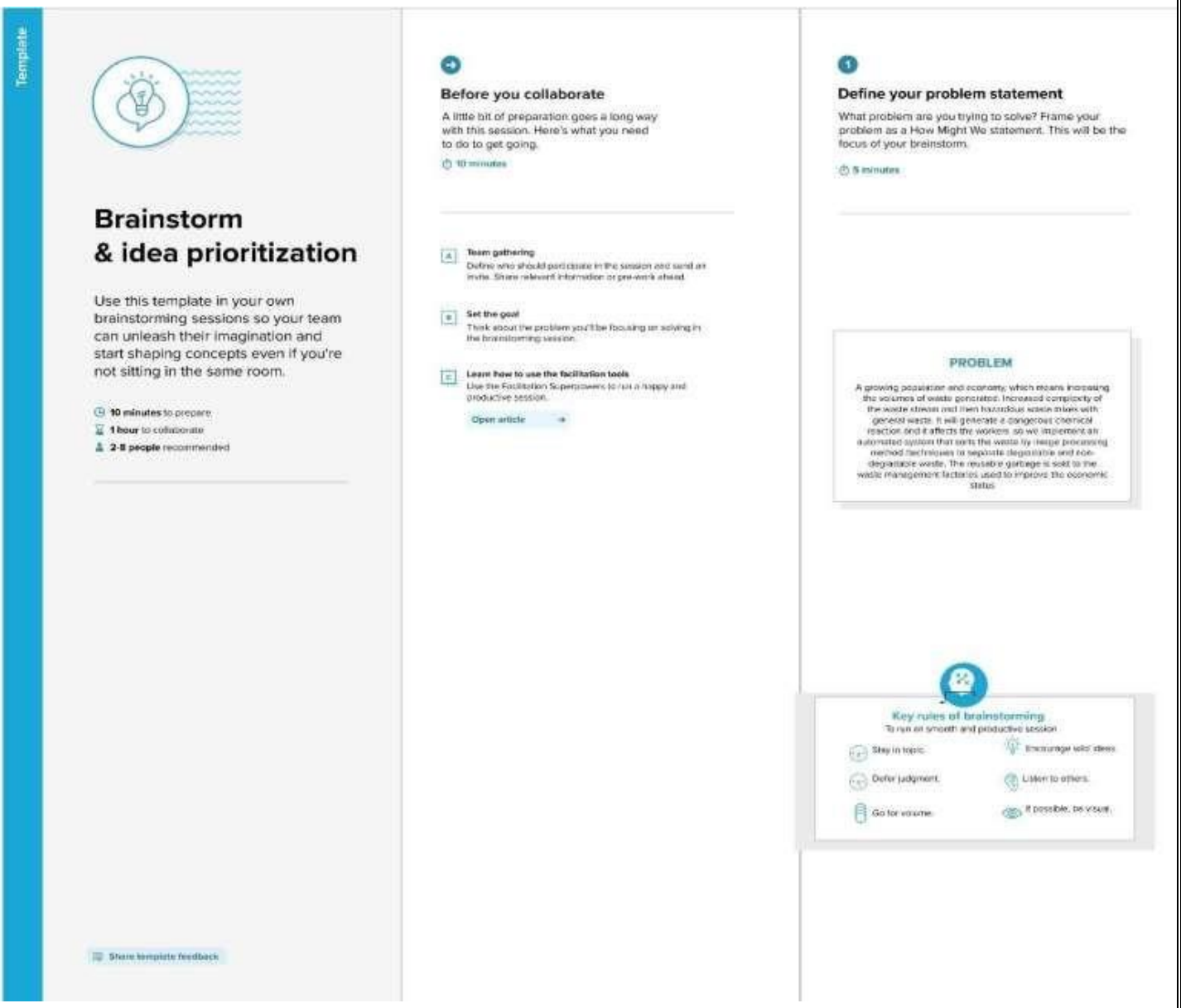
Example:

Problem Statement (PS)	Iam (Customer)	I'm trying to	But	Because	Which makes mefeel
PS-1	Municipality workers	Be healthy	I am Prone to disease	I am a municipal Garbage collector	Sad
PS-2	Entrepreneur	To increase my production	Not Efficient so complete My production	Not accuracy of segregation	Frustration

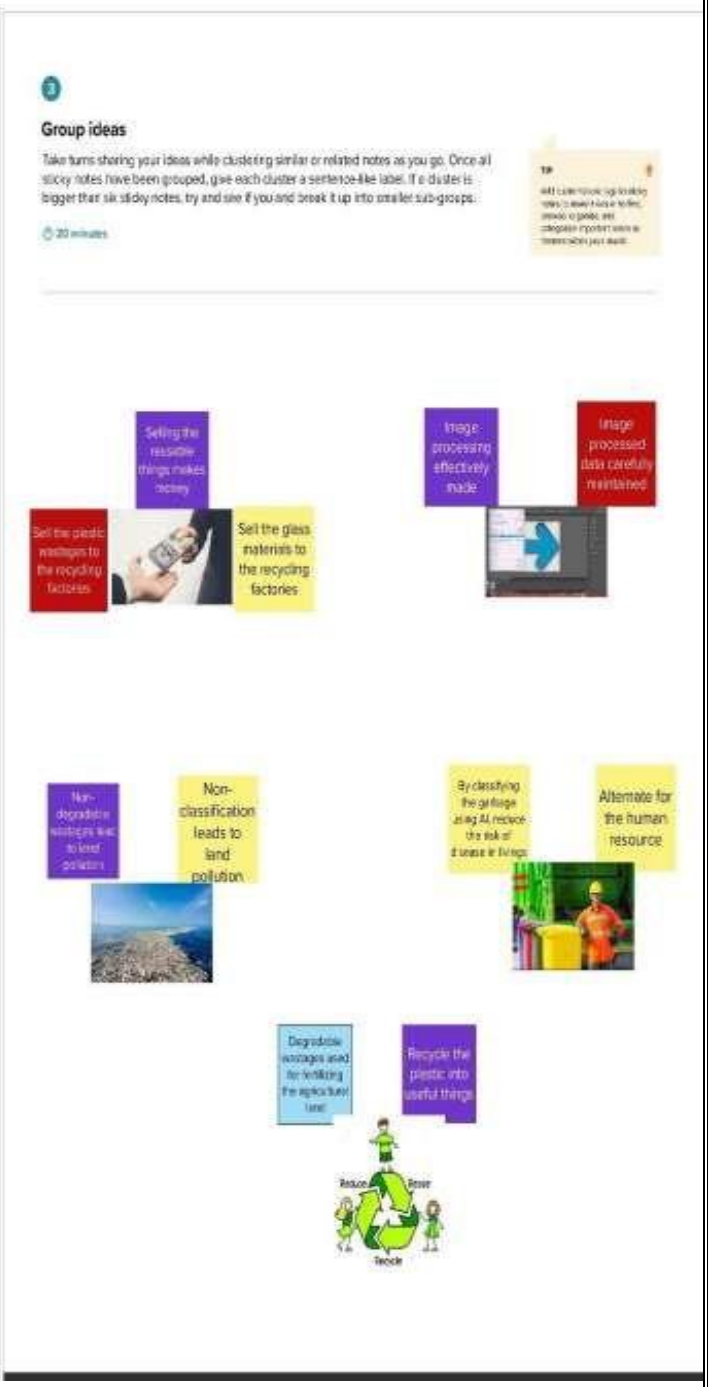
2.2 EMPATHY MAP CANVAS:

2.3 IDEATION & BRAINSTORMING:

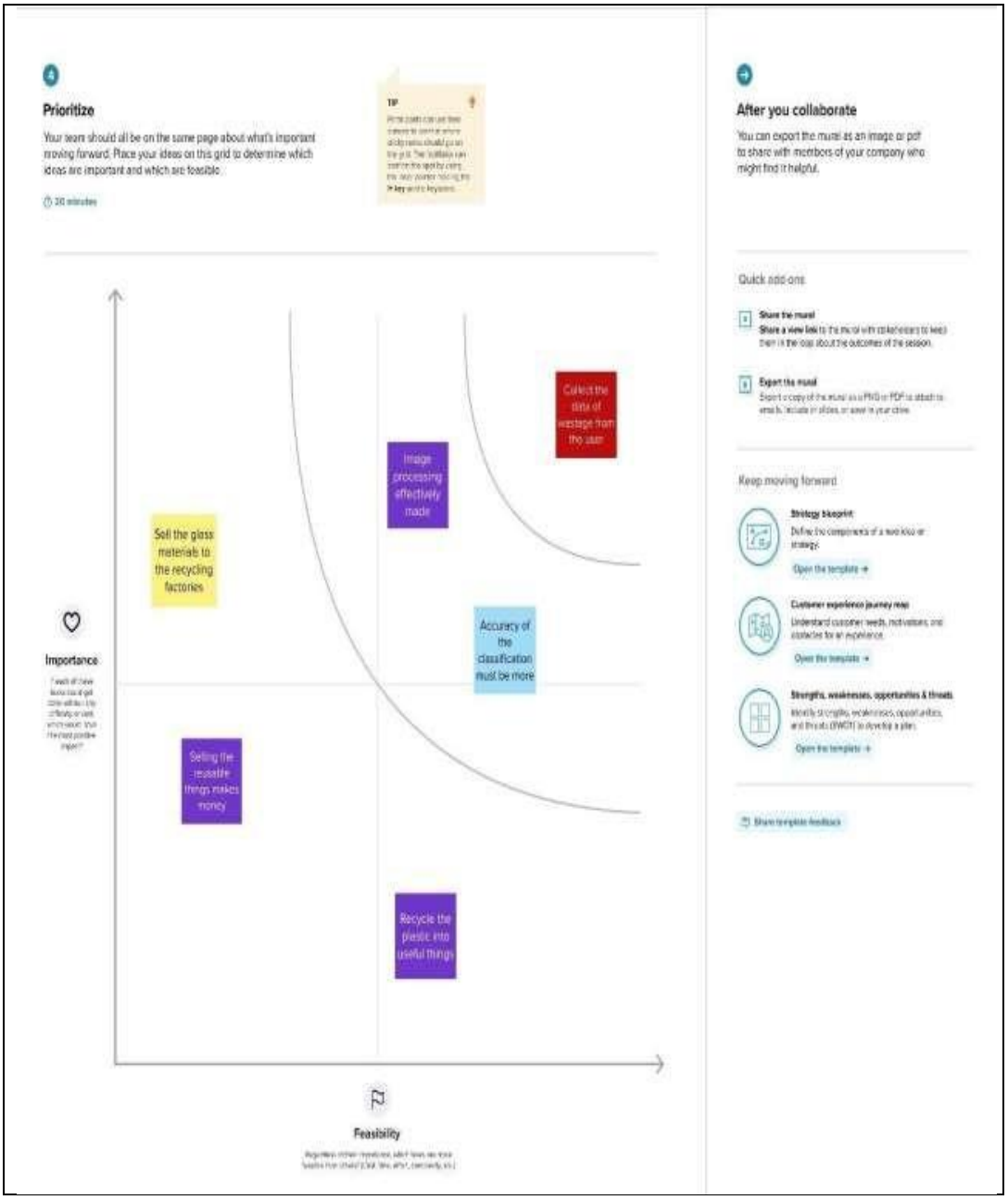
Step-1: Team Gathering, Collaboration, and Select the Problem Statement



Step-2: Brainstorm, Idea Listing and Grouping



Step-3: Idea Prioritization



2.4 PROPOSED SOLUTION:

1.	Problem Statement (Problem to be solved)	• As increase in population and the volume of waste increases, it generates a dangerous chemical reaction when mixed with hazardous waste and affects workers' health.
2.	Idea / Solution description	• We proposed the solution as an intelligent garbage classification that uses deep learning algorithms to classify various garbage. The system will utilize various sensors and cameras to classify the garbage such as recyclable, organic, etc..., • Convolutional neural networks (CNNs) and other deep learning techniques will be used by the system to identify garbage based on its properties and attributes.
3.	Novelty / Uniqueness	• The suggested system is unique in that it uses deep learning algorithms to effectively classify various sorts of rubbish, making it more efficient and accurate than typical garbage classification methods. • In addition, the system can adapt to new waste types by training it and making it scalable for future waste management.
4.	Social Impact / Customer Satisfaction	• The Intelligent garbage classification has a social impact by reducing pollution and improving environmental sustainability. • customer satisfaction can be provided by the accurate method of classification and by reducing the time for classification.
5.	Business Model (Revenue Model)	• The intelligent classification could involve the income by selling the model to the organizations for fee for waste classification. • In addition, we can gain revenue by data analytics, providing valuable information to the organization.
6.	Scalability of the Solution	• The proposed solution is scalable because it can be adapted to different waste management systems and adapt to new waste types by training it. • It can be easily integrated with the existing waste management and scale up the organisations.

3 . REQUIREMENT ANALYSIS

3.1 FUNCTIONAL REQUIREMENT :

Following are the functional requirements of the proposed solution

FR No	Functional Requirement(Epic)	Sub Requirements
FR-1	Image Recognization	➢ The system should be capable of recognizing and classifying different types of garbage from images such as plastic bottles, cardboard, metals, glass, etc...
FR-2	Time Management	➢ It should reduce human timeand power.
FR-3	Real-time Processing	➢ The system should be capable ofprocessing image streams in real-time, allowing for efficient garbage classification at high speeds.
FR-4	User-friendly interface	➢ The system should have a user-friendly interface that allows operators to interact with and monitor the classification process.

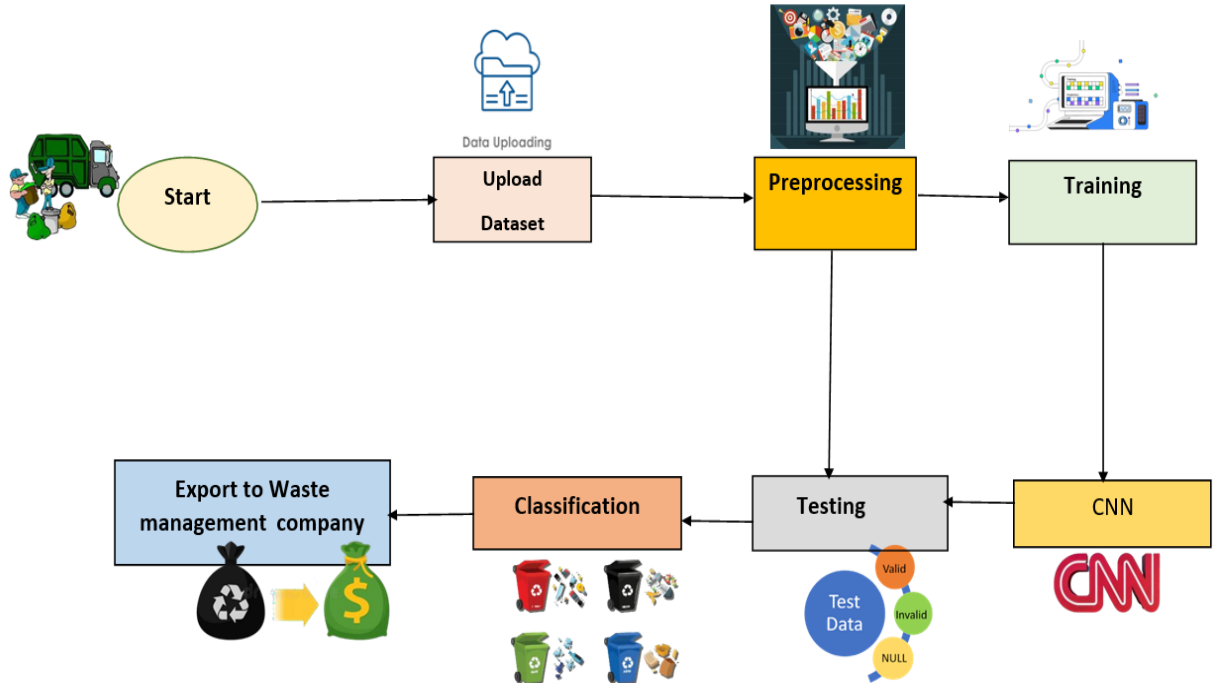
3.2 NON -FUNCTIONAL REQUIREMENT :

FR No.	Non-Functional Requirement	Description
NFR-1	Usability	➢ The intelligent garbage classification system can be designed to be user-friendly,efficient, and accessible ➢ to a wide range of users, ultimatelyimproving the overall user experience and adoption of the system.
NFR-2	Security	➢ The present way of separating waste/garbage is the hand-pickingmethod, whereby someone separates the different materials. ➢ The person who separates waste,is prone to diseases due to harmful substances in the garbage motivated us to develop an automated system that is able to sort the waste.
NFR-3	Reliability	➢ The garbage classification is mainly concentrated in fixed placesin the public environment. ➢ There are problems such as highlabor intensity,low sorting efficiency,and poor working environment. ➢ In fact, garbage classification inthe home environment can really solve the problem from the source.
NFR-4	Performance	➢ The mechanical structure of the system can operate normally andcorrectly. ➢ The system has good performanceand can complete garbage classification.
NFR-5	Availability	➢ The garbage classification should be available,with the ability to handle an huge amount of wastes .

NFR-6	Scalability	➢ The system should be scalable tohandle the waste materials.

4 . PROJECT DESIGN

4.1 DATA FLOW DIAGRAMS:



4.2 SOLUTION & TECHNICAL ARCHITECTURE

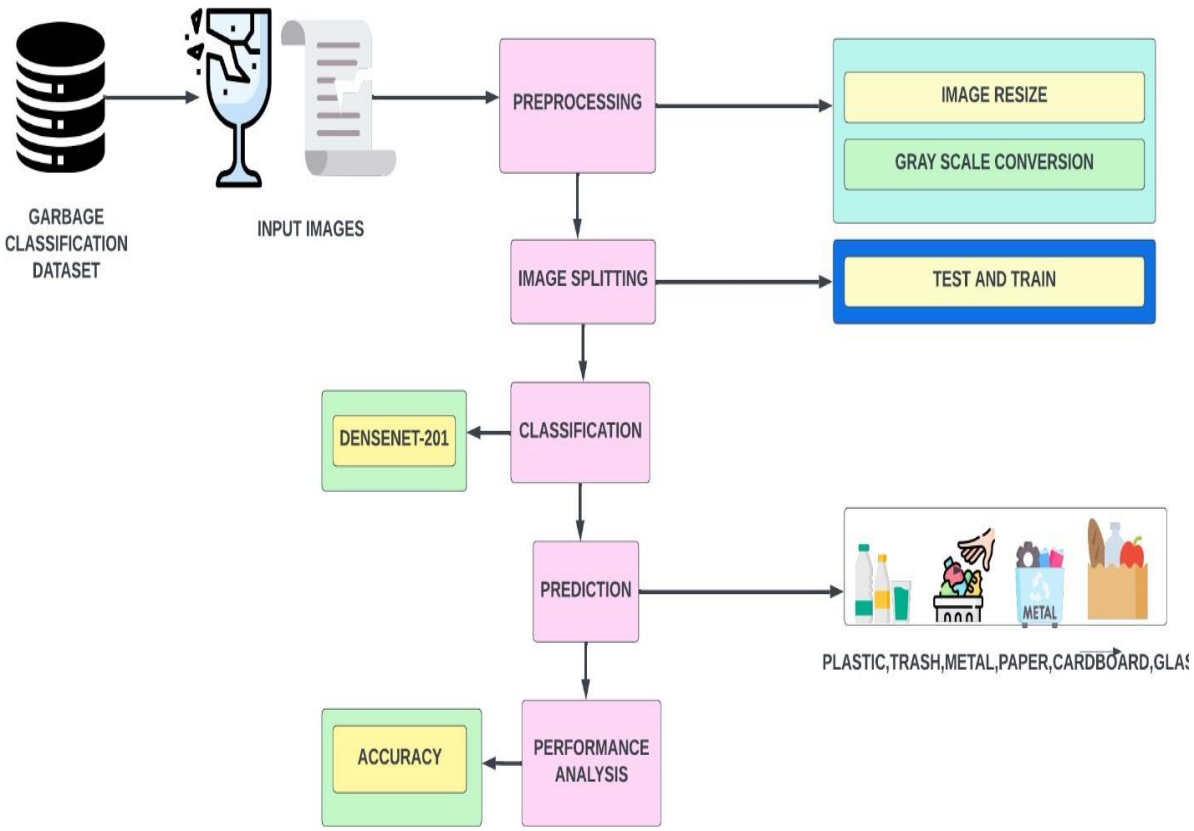
Solution architecture is a complex process – with many sub-processes – thatbridges the gap between business problems and technology solutions.

Its goal is to:

To establish an Intelligent Garbage classification using Deep learning with the necessary architecture

- The designed methods sort the waste into different categories with higher accuracy
- To segregate the garbage into different types.
- This method works in different phrases:
  Capturing of images, Collection of a database, Pre-processing of images, Training data, Testing data, Evaluation of model.

Example - Solution Architecture Diagram



4.3 USER STORIES:

User Type	Functional Requirements	User Story Number	User Story/Task	Acceptance Criteria	Priority	Team member
Residential users	Dataset creation	USN:01	I want to be able to easily identify and separate different types of waste sothat I can contribute to sustainable waste management practices.	The dataset should be relevant to the problem being addressed. The data is useful for the intended purpose.	High	Madumitha
		USN:02	I want to store the waste in appropriate containers or bags and keep them in a clean and safe place.	The dataset should beof high quality and meet the standards for data quality in the field.	Medium	Karthiga
Commercial user	Image Preprocessing	USN:03	I want to be able to easily identify different types of waste generated in my business operations so that I can sort them properly	The system should be able to extract features from the garbage images	High	Aruna

		USN:04	I want to collaborate with waste management companies to ensure that waste is collected and disposed of efficiently.	The image processing algorithm is accurate in identify andclassifying wastes..	Medium	Rajalakshmi
Waste management company	User Interface	USN:05	I want to provide easy-to-use and accurate garbage classification tools so that they can properly segregate their waste.	user-friendly and easy to navigate, and understand the functions, and features of the interface quickly.	High	Madumitha
Municipal authorities	Maintenance	USN:06	I want to provide regular waste collection and disposal services to households and commercial users, to ensure cleanliness and safety of the city.	The system should be monitored the performance over time, including accuracy and processing speed	High	Karthiga

5. CODING & SOLUTIONS

5.1 FEATURES :

Python Flask :

Python Flask is used to develop Intelligent garbage classification using Deep learning. Flask is used to rent the garbage classification in the browser by providing API. By running the Python application, the suitable server domain link is obtained and run in the browser.

HTML :

The HTML and CSS, JS image we stored in the static folder. JavaScript-main.js and CSS-main.css to enhance our functionality and view of the HTML page.

Build PYTHON FLASK CODE:

app.py

```
import re

import  numpy  as np

import os

from flask import Flask, app, request,render_template
```

```
from TensorFlow.keras import models

from tensorflow. Keras.models import load_model

from tensorflow. Keras. preprocessing import image

from tensorflow.python.ops.gen_array_ops import concat

#Loading the model

model=load_model(r"C:\Users\91630\Desktop\garbage_classification\Garbage Classification Using CNN\Flask\garbage_new.h5")



app=Flask(__name__)



#default home page or route

@app.route('/')

def index():

    return render_template('index.HTML)


@app.route('/prediction.html')

def prediction():

    return render_template('prediction.html')


@app.route('/index.html')

def home():

    return render_template("index.html")
```

```
@app.route('/result',methods=["GET","POST"])

def res():

    if request.method=="POST":

        f=request.files['image']

        basepath=os.path.dirname(__file__) #getting the current path i.e where app.py is present

        #print("current path",basepath)

        filepath=os.path.join(basepath, 'uploads',f.filename) #from anywhere in the system we can give an image but we want that image later  to process so we are saving it to the uploads folder for reusing

        #print("upload folder is",file-path)

        f.save(file path)



        img=image.load_img(file path,target_size=(128,128))

        x=image.img_to_array(img)#img to array

        x=np.expand_dims(x,axis=0)#used for adding one more dimension

        #print(x)

        prediction=np.argmax(model.predict(x), axis =1) #instead of predict_classes(x) we can use predict(X) ---->predict_classes(x) gave error

        #print("prediction is ",prediction)

        index=["cardboard", "glass", "metal", "paper", "plastic", "trash"]

        result=str(index[prediction])

        result

        return render_template('prediction.HTML,prediction=result)

""" Running our application """
```

```
if __name__ == "__main__":
    app.run(debug=False,port=8000)
```

Index.html

```
<!DOCTYPE html>
<html lang="en">
<head>
    <meta charset="UTF-8">
    <meta http-equiv="X-UA-Compatible" content="IE=edge">
    <meta name="viewport" content="width=device-width, initial-scale=1.0">

    <!--Bootstrap -->
    <link rel="stylesheet" href="https://maxcdn.bootstrapcdn.com/bootstrap/4.0.0/css/bootstrap.min.css" integrity="sha384-Gn5384xqQ1aoWXA+058RXPxPg6fy4IWvTNh0E263XmFcJlSAwiGgFAW/dAiS6JXm" crossorigin="anonymous">
    <script src="https://code.jquery.com/jquery-3.2.1.slim.min.js" integrity="sha384-KJ3o2DKtIkvYIK3UENzmM7KCkRr/rE9/Qpg6aAZGJwFDMVNA/GpGFF93hXpG5KkN" crossorigin="anonymous"></script>
    <script src="https://cdnjs.cloudflare.com/ajax/libs/popper.js/1.12.9/umd/popper.min.js" integrity="sha384-ApNbgh9B+Y1QKtv3Rn7W3mgPxhU9K/ScQsAP7hUibX39j7fakFPskvXusvfa0b4Q" crossorigin="anonymous"></script>
    <script src="https://maxcdn.bootstrapcdn.com/bootstrap/4.0.0/js/bootstrap.min.js"
```

```
integrity="sha384-
JZR6Spejh4U02d8jOt6vLEHfe/JQGiRRSQQxSfFWpi1MquVdAyjUar5+76PV
CmYl" crossorigin="anonymous"></script>



   <script src="https://kit.fontawesome.com/8b9cdc2059.js"
crossorigin="anonymous"></script>

   <link
href="https://fonts.googleapis.com/css2?family=Akronim&family=Roboto&dis
play=swap" rel="stylesheet">

   <link rel="stylesheet" href="C:\Users\ELCOT\Desktop\styles.css">

   <!-- <script defer src="../static/js/main.js"></script> -->

   <title>Garbage Classification</title>

</head>

<body>

   <header id="head" class="header">

  <section  id="navbar">

        <h1 class="nav-heading"><i class="fas fa-recycle m2"></i>Garbage
Classification</h1>

      <div class="nav--items">

         <ul>

            <li><a href="#about">About</a></li>

            <li><a href="#services">Services</a></li>

            <li><a href="#contact">Contact</a></li>

            <li><a href="prediction.html">Prediction</a></li>

         </ul>
```

```
    </div>
  </section>
  <section id="slider">
   <div id="carouselExampleIndicators" class="carousel" data-ride="carousel">
      <ol class="carousel-indicators ">
         <li data-target="#carouselExampleIndicators" data-slide-to="0" class="active "></li>
         <li data-target="#carouselExampleIndicators" data-slide-to="1"></li>
         <li data-target="#carouselExampleIndicators" data-slide-to="2"></li>
         <li data-target="#carouselExampleIndicators" data-slide-to="3"></li>
         <li data-target="#carouselExampleIndicators" data-slide-to="4"></li>
      </ol>
      <div class="carousel-inner">
         <div class="carousel-caption d-none d-md-block">
            <h2 class="font">We Help You To Classify Garbage</h2>
            <p class="text-light">Reuse the past, Recycle the present, Save the future.</p>
         </div>
         <div class="carousel-item active">
            <img class="d-block w-100" src="C:/Users/ELCOT/Downloads/first.jpg" alt="First slide">
         </div>
         <div class="carousel-item">
            <img class="d-block w-100" src="C:/Users/ELCOT/Downloads/second.jpg" alt="Second slide">
```

```
        </div>
        <div class="carousel-item">
          <img class="d-block w-100" src="C:/Users/ELCOT/Downloads/third.jpg" alt="Third slide">
        </div>
        <div class="carousel-item">
          <img class="d-block w-100" src="C:/Users/ELCOT/Downloads/fourth.jpg" alt="fourth slide">
        </div>
        <div class="carousel-item">
          <img class="d-block w-100" src="C:/Users/ELCOT/Downloads/fifth.jpg" alt="fifth slide">
        </div>
      </div>
      <a class="carousel-control-prev" href="#carouselExampleIndicators" role="button" data-slide="prev">
        <span class="carousel-control-prev-icon" aria-hidden="true"></span>
        <span class="sr-only">Previous</span>
      </a>
      <a class="carousel-control-next" href="#carouselExampleIndicators" role="button" data-slide="next">
        <span class="carousel-control-next-icon" aria-hidden="true"></span>
        <span class="sr-only">Next</span>
      </a>
    </div>
```

```
  </section>
</header>
<section id="about">
   <div class="top">
      <h3 class="title text-muted">
         ABOUT PROJECT
      </h3>
      <div class="line"></div>
   </div>
<div class="body">
<div class="left">
   <h2>Problem</h2>
   <p>
```

With the increase in the number of industries in the urban area, the disposal of solid waste is really becoming a big problem, and solid waste includes paper, wood, plastic, metal, glass, etc. The common way of managing waste is burning waste and this method can cause air pollution and some hazardous materials from the waste spread into the air which can cause cancer. Hence it is necessary to recycle the waste to protect the environment and human beings' health, and we need to separate the waste into different components which can be recycled using different ways. 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 separates waste is prone to diseases due to the harmful substances in the garbage. This problem can be overcome by automating the garbage classification process.

```
   </p>
</div>
```

<h2>Solution</h2>

In this project, we will be building a deep learning model that can detect and classify types of garbage. A web application is integrated with the model, from where the user can upload a garbage image like paper waste, plastic waste, etc., and see the analyzed results on UserInterface.

</section>

<section id="services">

<h3 class="title text-muted">WE CLASSIFY</h3>

<img src="C:/Users/ELCOT/Downloads/cardboard.jpg" class="card-img-top" alt="cardboard">

<h5 class="card-title text-muted">CardBoard</h5>

Cardboard, also referred to as corrugated cardboard, is a recyclable material that is recycled by small and large scale businesses to save money on waste disposal costs.

```
<img src="C:/Users/ELCOT/Downloads/bottle.png" class="card-img-top" alt="bottle">

<div class="card-body">

<h5 class="card-title text-muted">Glass</h5>

<p class="card-text">Glass is found in municipal solid waste (MSW), primarily in the form of containers such as beer and soft drink bottles; wine and liquor bottles; and bottles and jars for food, cosmetics and other products.</p>

</div>

</div>

<div class="card" style="width: 25rem;">

<img src="C:/Users/ELCOT/Downloads/metal.jpg" class="card-img-top" alt="metal">

<div class="card-body text-muted">

<h5 class="card-title">Metal</h5>

<p class="card-text">Metal waste/scrap waste can be subjected to the recycling process over and over again without changing its properties. Steel, for example, is one of the most recycled metals on the planet. Lorem ipsum dolor sit amet.</p>

</div>

</div>

<div class="card" style="width: 25rem;">

<img src="C:/Users/ELCOT/Downloads/page.jpg" class="card-img-top" alt="page">

<div class="card-body text-muted">

<h5 class="card-title">Paper</h5>
```

```
        <p class="card-text">Paper Waste is a severe problem in many industries and offices. Because of printing mistakes, junk mails, billings, and packaging. Lorem ipsum dolor sit amet consectetur, adipisicing elit.</p>



      </div>

    </div>

  <div class="card" style="width: 25rem;">

      <img src="C:/Users/ELCOT/Downloads/plastic.jpg" class="card-img-top" alt="plastic">

      <div class="card-body text-muted">

        <h5 class="card-title">Plastic</h5>

        <p class="card-text">Plastic waste, or plastic pollution, is the accumulation of plastic objects  in the Earth's environment that adversely affects wildlife, wildlife habitat, and humans.</p>



      </div>

    </div>

  <div class="card" style="width: 25rem;">

      <img src="C:/Users/ELCOT/Downloads/trash.jp" class="card-img-top" alt="trash">

      <div class="card-body text-muted">

        <h5 class="card-title">Trash</h5>

        <p class="card-text">Trash, rubbish, or refuse is waste material that is discarded by humans, usually due to a perceived lack of utility. Lorem ipsum dolor sit amet.</p>



      </div>
```

```
    </div>
</div>
</section>

<!-- Contact  -->
<setion id="contact">
   <h3 class=" text-muted title">CONTACT US</h3>
   <div class="line"></div>
   <div class="contact-container">
   <div class="conatct-left">
      <div class="items">
         <i class="fas fa-map-pin fa-2x"></i>
         <h3 class=" text-muted">
            Address
         </h3>
         <p>Lorem ipsum dolor sit amet consectetur adipisicing elit. Molestias, quae.</p>
      </div>
      <div class="items">
         <i class="fas fa-envelope fa-2x"></i>
         <h3 class="text-muted">
            Enquiries
         </h3>
         <p>websupport@xyz.com</p>
```

```
        </div>
        <div class="items">
            <i class="fas fa-phone fa-2x"></i>
            <h3 class=" text-muted">
                Call Us
            </h3>
            <p>+911234567890</p>
        </div>

    </div>
    <div class="contact-right">
        <h3 class=" text-muted">ENROLL TO OUR SERVICES</h3>
        <form>
            <input type="text"  placeholder="Your Name"
              name="name">
              <input type="email"  placeholder="Email Adress"
              name="email">
              <input type="text"  placeholder="Phone Number"
              name="phone">
            <button type="submit" class="btn-warning btn">Submit</button>
        </form>
    </div>
</div>
```

```
</setion>
<section id="footer">
    <p>Copyright © 2021. All Rights Reserved</p>
    <div class="social">
      <a href="#" target="_blank"><i class="fab fa-2x fa-twitter-square"></i></a>
       <a href="#" target="_blank">
        <i class="fab fa-2x  fa-linkedin"></i></a>
        <a href="#">
           <i class="#"></i>
        </a>
    </div>
</section>
</body>
</html>
```

Prediction.html

```
<!DOCTYPE html>
<html lang="en">
<head>
    <meta charset="UTF-8">
    <meta http-equiv="X-UA-Compatible" content="IE=edge">
    <meta name="viewport" content="width=device-width, initial-scale=1.0">
```

```
    <!--Bootstrap -->

    <link rel="stylesheet"
href="https://maxcdn.bootstrapcdn.com/bootstrap/4.0.0/css/bootstrap.min.css"
integrity="sha384-
Gn5384xqQ1aoWXA+058RXPxPg6fy4IWvTNh0E263XmFcJlSAwiGgFAW/d
AiS6JXm" crossorigin="anonymous">

    <script src="https://code.jquery.com/jquery-3.2.1.slim.min.js"
integrity="sha384-
KJ3o2DKtIkvYIK3UENzmM7KCkRr/rE9/Qpg6aAZGJwFDMVNA/GpGFF93
hXpG5KkN" crossorigin="anonymous"></script>

    <script
src="https://cdnjs.cloudflare.com/ajax/libs/popper.js/1.12.9/umd/popper.min.js"
integrity="sha384-
ApNbgh9B+Y1QKtv3Rn7W3mgPxhU9K/ScQsAP7hUibX39j7fakFPskvXusvf
a0b4Q" crossorigin="anonymous"></script>

    <script
src="https://maxcdn.bootstrapcdn.com/bootstrap/4.0.0/js/bootstrap.min.js"
integrity="sha384-
JZR6Spejh4U02d8jOt6vLEHfe/JQGiRRSQQxSfFWpi1MquVdAyjUar5+76PV
CmYl" crossorigin="anonymous"></script>




    <script src="https://kit.fontawesome.com/8b9cdc2059.js"
crossorigin="anonymous"></script>

    <link
href="https://fonts.googleapis.com/css2?family=Akronim&family=Roboto&dis
play=swap" rel="stylesheet">

    <link rel="stylesheet" href="C:/Users/ELCOT/Desktop/styles.cs">



    <script defer src="C:/Users/ELCOT/Desktop/ibm/static-20230520T042555Z-
001/static/js/JScript.js"></script>

    <title>Prediction</title>
```

```
</head>

<body>

   <header id="head" class="header">

      <section  id="navbar">

         <h1 class="nav-heading"><i class="fas fa-recycle m2"></i>Garbage Classification</h1>

         <div class="nav--items">

            <ul>

               <li><a href="index.html#about">About</a></li>

               <li><a href="index.html#services">Services</a></li>

               <li><a href="index.html#contact">Contact</a></li>

               <li><a href="prediction.html">Prediction</a></li>

            </ul>

         </div>

      </section>

   </header>

   <!-- dataset/Training/metal/metal326.jpg -->

   <section id="prediction">

      <div class="prediction-input">

      <div class="circle">

         <img src="C:/Users/ELCOT/Downloads/metal326.jpg" alt="Demo" id="demo" class="circle">

      </div>

         <form id="form" action="/result" method="post" enctype="multipart/form-data">
```

```
            <input type="file" id="imageupload" name="image" accept="image/*" class="input-image">

            <input type="submit" class="submitbtn">

          </form>

        </div>

        <h3 class="title text-muted">

        THE PREDICTION IS

      </h3>

      <div class="line"></div>

        <div class="output-container">

          <div data-type="cardboard" class="output img1">

            <img src="C:/Users/ELCOT/Downloads/cardboard.jpg" alt="" class="circle">

            <h3 class="text-muted">CARDBOARD</h3>

          </div>

          <div data-type="glass" class="output img2">

            <img src="C:/Users/ELCOT/Downloads/bottle.png" alt="" class="circle">

            <h3 class="text-muted">GLASS</h3>

          </div>

          <div data-type="metal" class="output img3">

            <img src="C:/Users/ELCOT/Downloads/metal.jpg" alt="" class="circle">

            <h3 class="text-muted">METAL</h3>

          </div>
```

```
            <div data-type="paper" class="output img4">
              <img src="C:/Users/ELCOT/Downloads/page.jpg" alt="" class="circle">
              <h3 class="text-muted">PAPER</h3>
            </div>
            <div data-type="plastic" class="output img5">
              <img src="C:/Users/ELCOT/Downloads/plastic.jpg" alt="" class="circle">
              <h3 class="text-muted">PLASTIC</h3>
            </div>
            <div data-type="trash" class="output img6">
              <img src="C:/Users/ELCOT/Downloads/trash.jpg" alt="" class="circle">
              <h3 class="text-muted">TRASH</h3>
            </div>

          </div>

          <div class="hide" id="result">
            {{prediction}}
          </div>
    </section>
    <section id="footer">
        <p>Copyright © 2021. All Rights Reserved</p>
        <div class="social">
```

```
        <a href="#"_blank"><i class="fab fa-2x fa-twitter-square"></i></a>
         <a href="#" target="_blank">
          <i class="fab fa-2x  fa-linkedin"></i></a>
          <a href="#">
             <i class="fab fa-instagram-square fa-2x "></i>
          </a>
       </div>
    </section>
</body>


</html>
```

app.py

```
import re
import numpy as np
import os
import tensorflow
import keras
from flask import Flask, app,request,render_template
from flask import Flask, render_template, request
from keras.models import load_model
from keras.preprocessing import image
```

```
from tensorflow.python.ops.gen_array_ops import concat
#Loading the model
model=load_model(r"C:/Users/ELCOT/Downloads/Garbage(3).h5")


app=Flask(__name__)



#default home page or route
@app.route('/')
def index():
    return render_template("index.html")

@app.route('/prediction.html')
def prediction():
    return render_template("prediction.html")

@app.route('/index.html')
def home():
    return render_template("index.html")

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

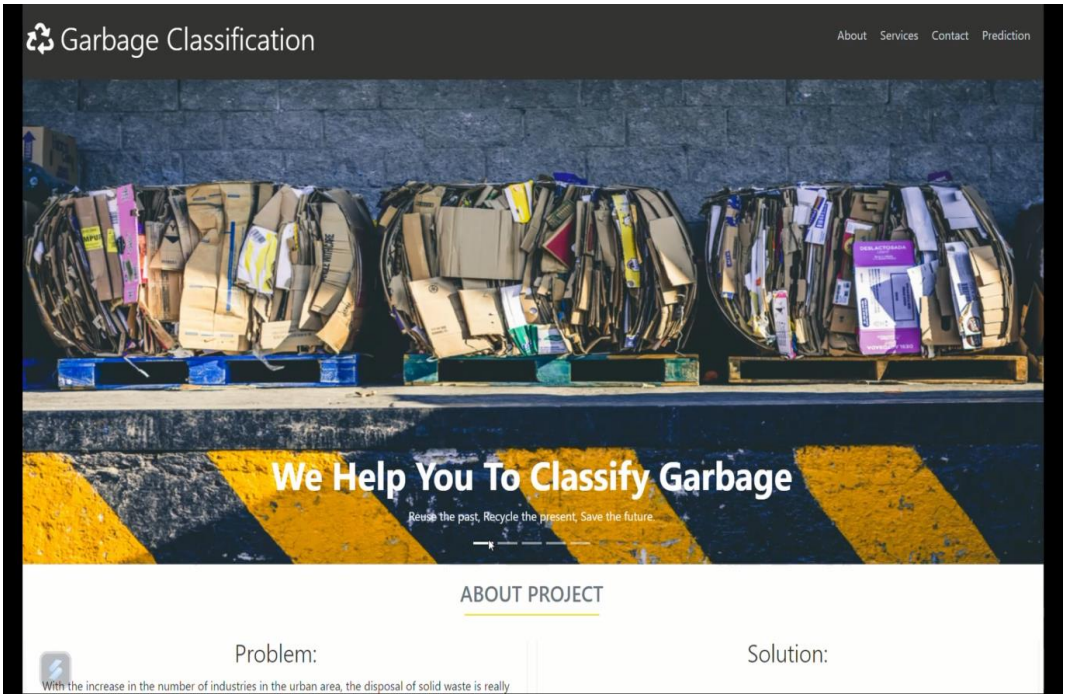
```
f=request.files['image']

basepath=os.path.dirname(__file__) #getting the current path i.e where app.py is present

#print("current path",basepath)

filepath=os.path.join(basepath,'uploads',f.filename) #from anywhere in the system we can give image but we want that image later  to process so we are saving it to uploads folder for reusing

#print("upload folder is",filepath)

f.save(filepath)



img=image.load_img(filepath,target_size=(128,128))

x=image.img_to_array(img)#img to array

x=np.expand_dims(x,axis=0)#used for adding one more dimension

#print(x)

prediction=np.argmax(model.predict(x), axis =1) #instead of predict_classes(x) we can use predict(X) ---->predict_classes(x) gave error

#print("prediction is ",prediction)

index=["cardboard","glass","metal","paper","plastic","trash"]

result=str(index[prediction])

result

return render_template('prediction.html',prediction=result)
```

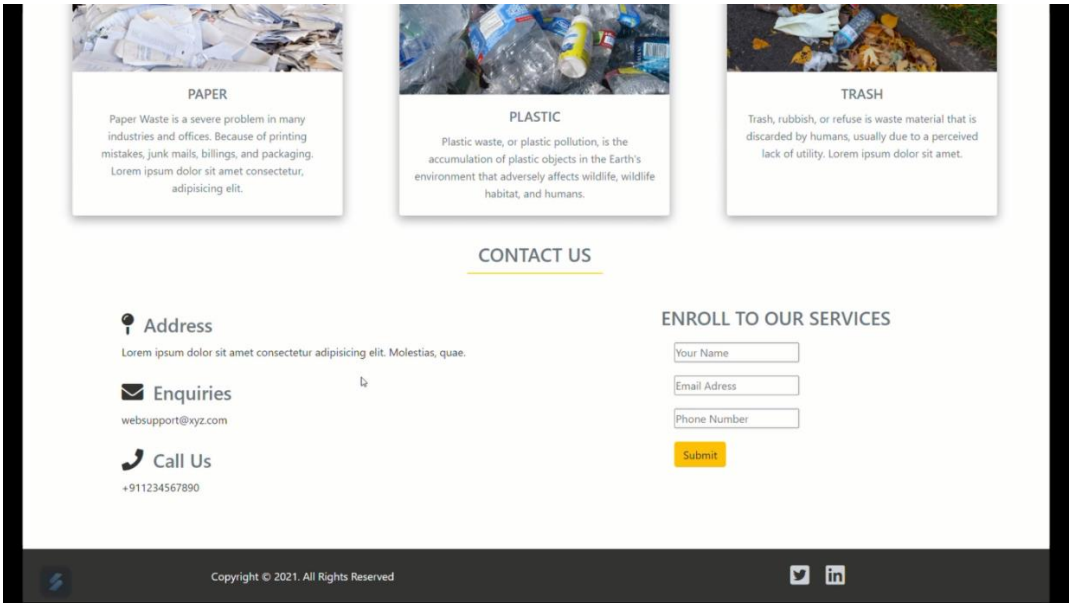
""" Running our application """

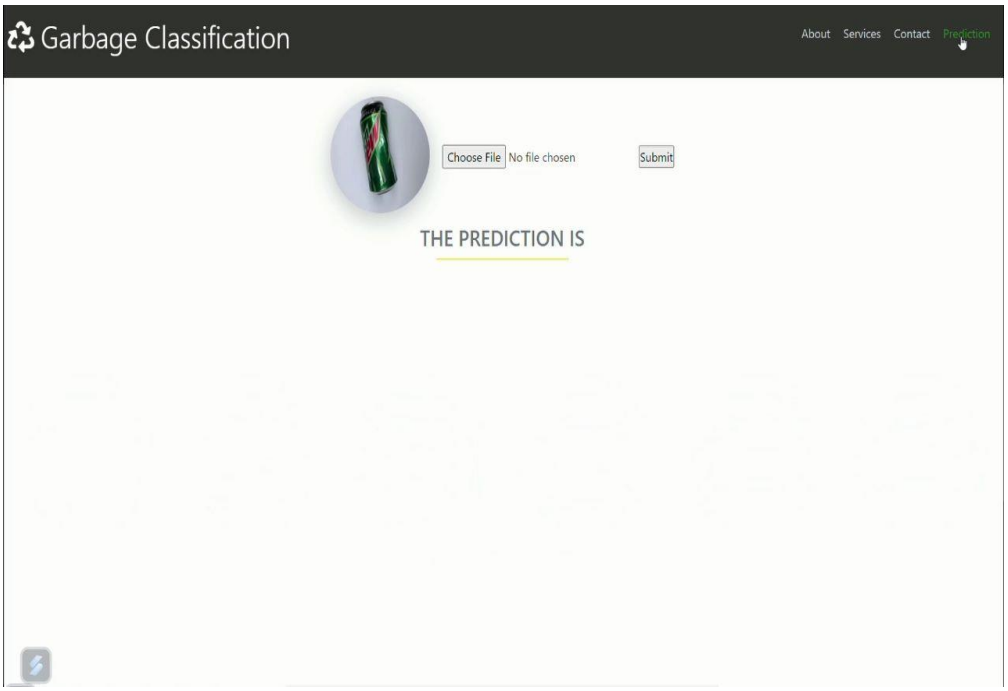
```
if __name__ == "__main__":
    app.run(debug=False)
```

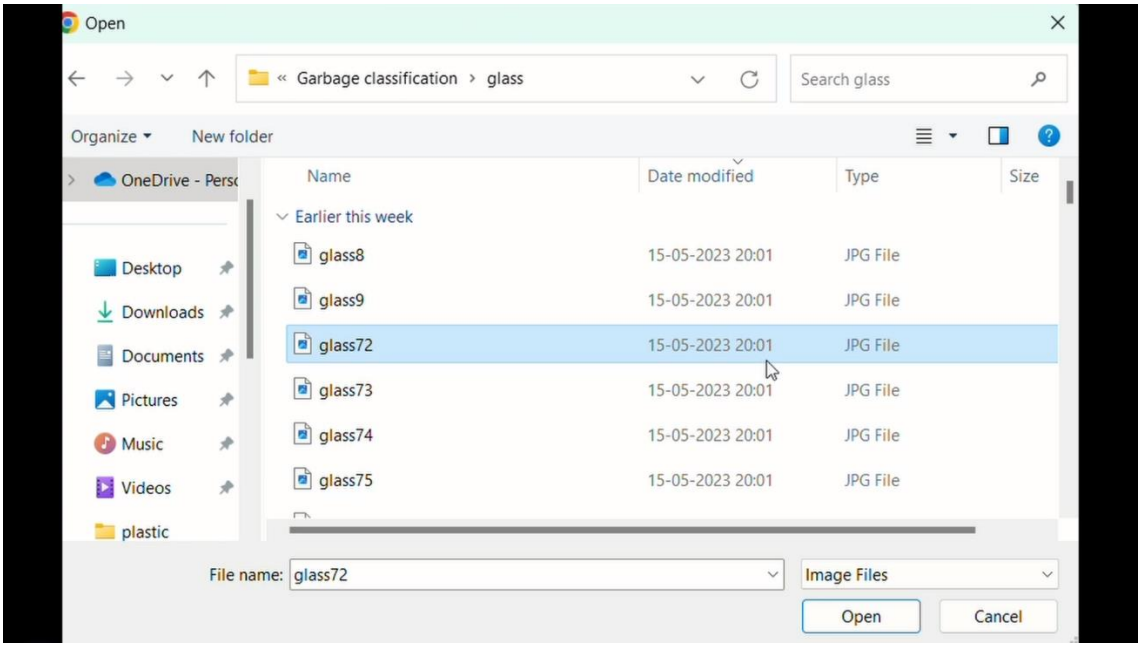
FEATURE 2:

Web Application




PAPER
Paper Waste is a severe problem in many industries and offices. Because of printing mistakes, junk mails, billings, and packaging. Lorem ipsum dolor sit amet consectetur, adipisicing elit.
PLASTIC
Plastic waste, or plastic pollution, is the accumulation of plastic objects in the Earth's environment that adversely affects wildlife, wildlife habitat, and humans.
TRASH
Trash, rubbish, or refuse is waste material that is discarded by humans, usually due to a perceived lack of utility. Lorem ipsum dolor sit amet.
CONTACT US
Address
Lorem ipsum dolor sit amet consectetur adipisicing elit. Molestias, quae.
Enquiries
websupport@xyz.com
Call Us
+911234567890
ENROLL TO OUR SERVICES
Your Name
Email Adress
Phone Number
Submit
Copyright © 2021. All Rights Reserved


Garbage Classification
About
Services
Contact
Prediction
Choose File
No file chosen
Submit
THE PREDICTION IS

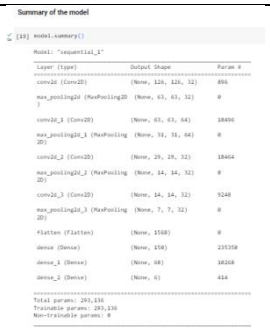
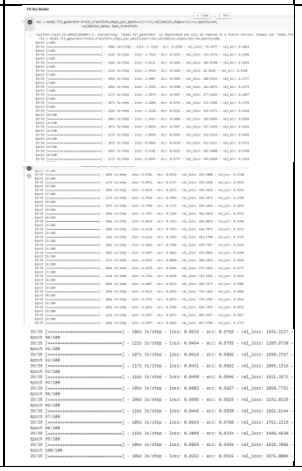

Open
Garbage classification › glass
Search glass
Organize
New folder
OneDrive - Perso
Desktop
Downloads
Documents
Pictures
Music
Videos
plastic
Name
Date modified
Type
Size
Earlier this week
glass8 15-05-2023 20:01 JPG File
glass9 15-05-2023 20:01 JPG File
glass72 15-05-2023 20:01 JPG File
glass73 15-05-2023 20:01 JPG File
glass74 15-05-2023 20:01 JPG File
glass75 15-05-2023 20:01 JPG File
File name: glass72
Image Files
Open
Cancel


THE PREDICTION IS
CARDBOARD
GLASS
METAL
PAPER
PLASTIC
TRASH


THE PREDICTION IS
GLASS

6. RESULTS

6.1 PERFORMANCE METRICS:

S.No.	Parameter	Values	Screenshot	Google Drive link for Screenshot
1.	Model Summary	Total params:293,136 Trainable params: 293,136 Non-trainable params : 0		https://drive.google.com/drive/folders/1EOuFbF2KIWsyXPXbDTlAHrkOl7YTTq_Q?usp=share_link
2.	Accuracy	Training Accuracy: 99.15% Validation Accuracy:40.62%		https://drive.google.com/drive/folders/18bD7EuXNzIr5soGIpNbyY5PKazajpjaq?usp=share_link

7: ADVANTAGES

- **Improved Accuracy**: Deep learning models can achieve high levels of accuracy in garbage classification tasks. They can learn complex patterns and features from large datasets, resulting in more precise and reliable sorting outcomes.
- **Automation and Efficiency:** Intelligent garbage classification systems can automate the sorting process, reducing the need for manual labor and increasing overall efficiency. This automation leads to faster processing times and higher throughput, enabling large quantities of waste to be sorted

quickly.

- **Enhanced Sorting Capabilities**: Deep learning algorithms can classify garbage into multiple categories with high precision. They can differentiate between various waste types, such as plastics, paper, glass, metals, and organic waste, allowing for more efficient recycling and disposal methods.

DISADVANTAGES

- **Initial Setup and Infrastructure Costs**: Implementing an intelligent garbage classification system requires significant upfront investment in hardware, software, and infrastructure. Deep learning models often require powerful computers or specialized hardware accelerators for training and inference, which can be costly. Additionally, setting up the necessary sensors, cameras, and connectivity infrastructure adds to the overall expenses.
- **Model Training and Optimization**: Training deep learning models for garbage classification requires expertise in machine learning and data science. Fine-tuning and optimizing the model parameters can be a complex and iterative process, demanding computational resources and domain knowledge. Iterative training may be necessary to address errors or improve accuracy, which can increase the overall development time and cost.
- **Data Requirements and Labeling**: Deep learning models rely on large amounts of labeled data for effective training. Collecting and annotating such datasets can be time-consuming and resource-intensive. It may be challenging to obtain a diverse and representative dataset that encompasses various waste categories, especially if the waste composition varies regionally. A lack of labeled data can limit the accuracy and generalizability of the model.

8. CONCLUSION

With the increasing focus on environmental protection and sustainable utilization of resources, garbage classification is an urgent problem for mankind. The current classification methods rely too much on manual participation, which is easily affected by personal quality, attention, sense of responsibility, and so on. Efficient and reliable automatic classification technology is extremely important and will be the inevitable trend of social development. Applying artificial intelligence.

9. FUTURE SCOPE

- **Integration with Robotics and Automation**: Intelligent garbage classification can be integrated with robotic systems to create fully automated waste sorting and disposal processes. Robots equipped with sensors and cameras can work in conjunction with deep learning models to identify, sort, and handle waste items, improving the efficiency and productivity of waste management operations.

- **Improved Accuracy and Robustness**: Researchers are continuously working on enhancing the accuracy and robustness of deep learning models for garbage classification. This involves developing more advanced architectures, exploring novel techniques such as transfer learning and ensemble models, and incorporating additional sensor data or modalities to improve classification performance.

10. APPENDIX

SOURCE CODE :

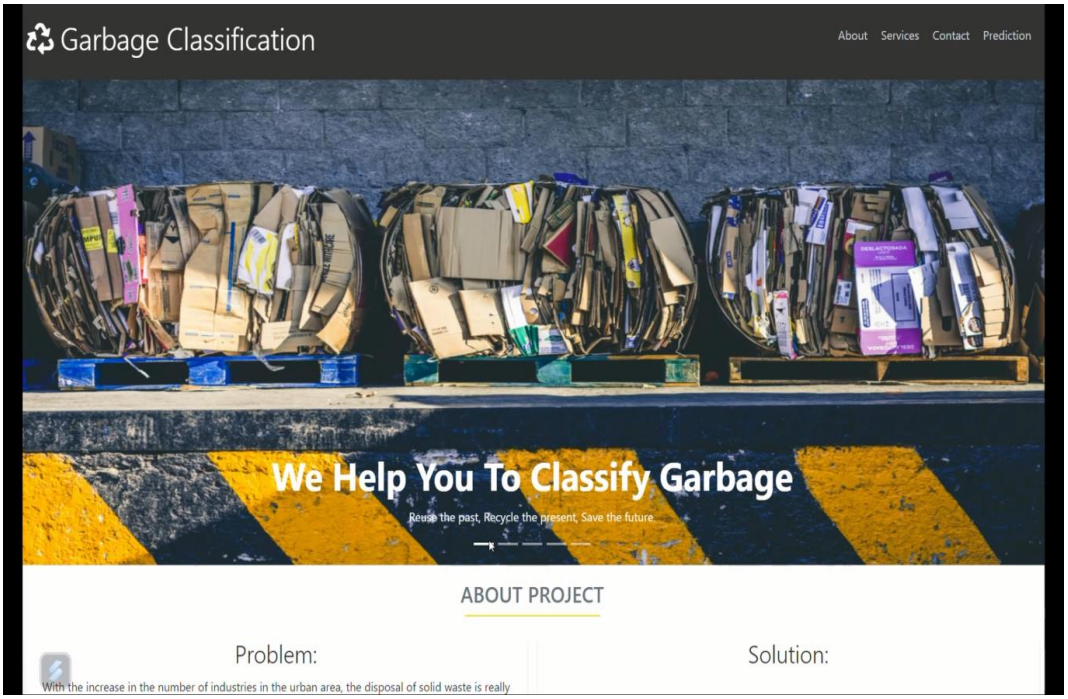
app.py

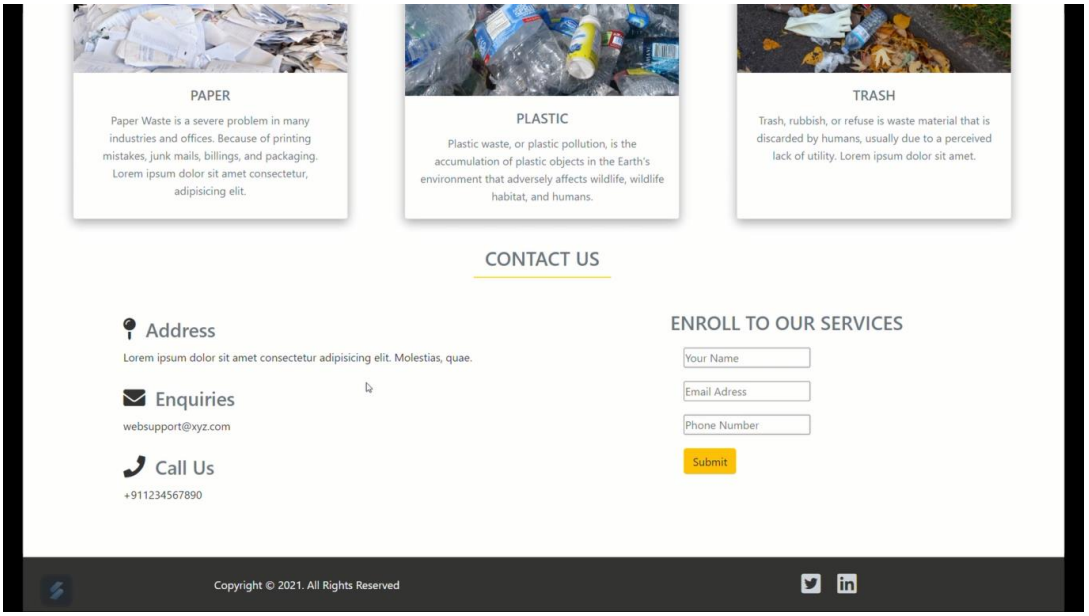
```
import re

import  numpy  as np

import os

from flask import Flask, app, request,render_template

from TensorFlow.keras import models

from tensorflow. Keras.models import load_model

from tensorflow. Keras. preprocessing import image

from tensorflow.python.ops.gen_array_ops import concat

#Loading the model

model=load_model(r"C:\Users\91630\Desktop\garbage_classification\Garbage Classification Using CNN\Flask\garbage_new.h5")
```

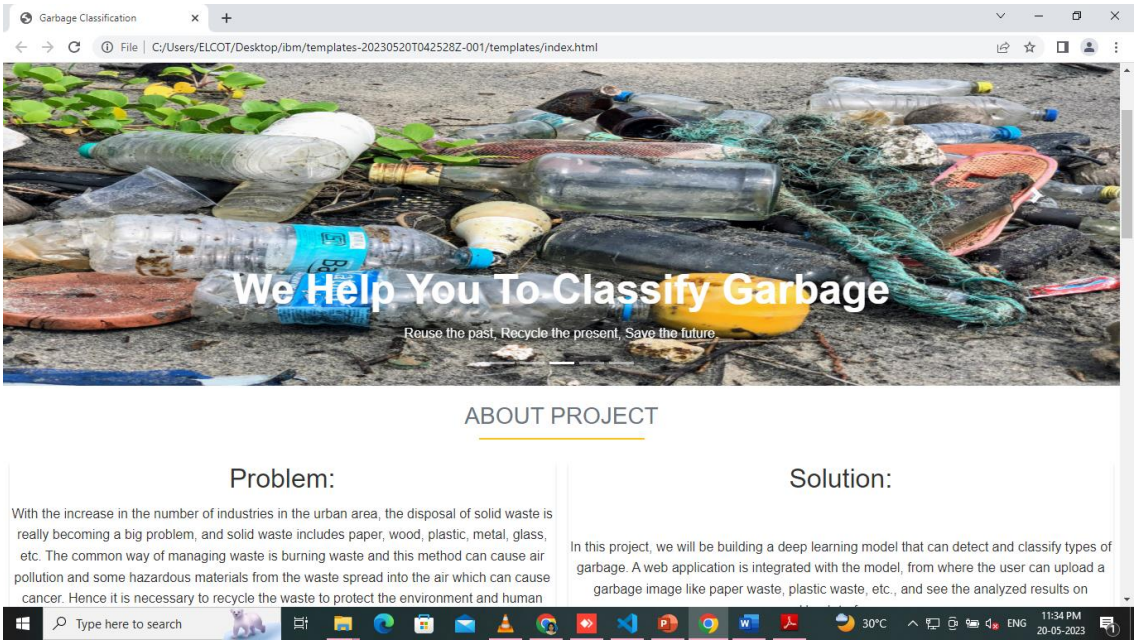
```
app=Flask(__name__)



#default home page or route
@app.route('/')
def index():
    return render_template('index.HTML)


@app.route('/prediction.html')
def prediction():
    return render_template('prediction.html')


@app.route('/index.html')
def home():
    return render_template("index.html")


@app.route('/result',methods=["GET","POST"])
def res():
    if request.method=="POST":
        f=request.files['image']
        basepath=os.path.dirname(__file__) #getting the current path i.e where app.py is present
        #print("current path",basepath)
```

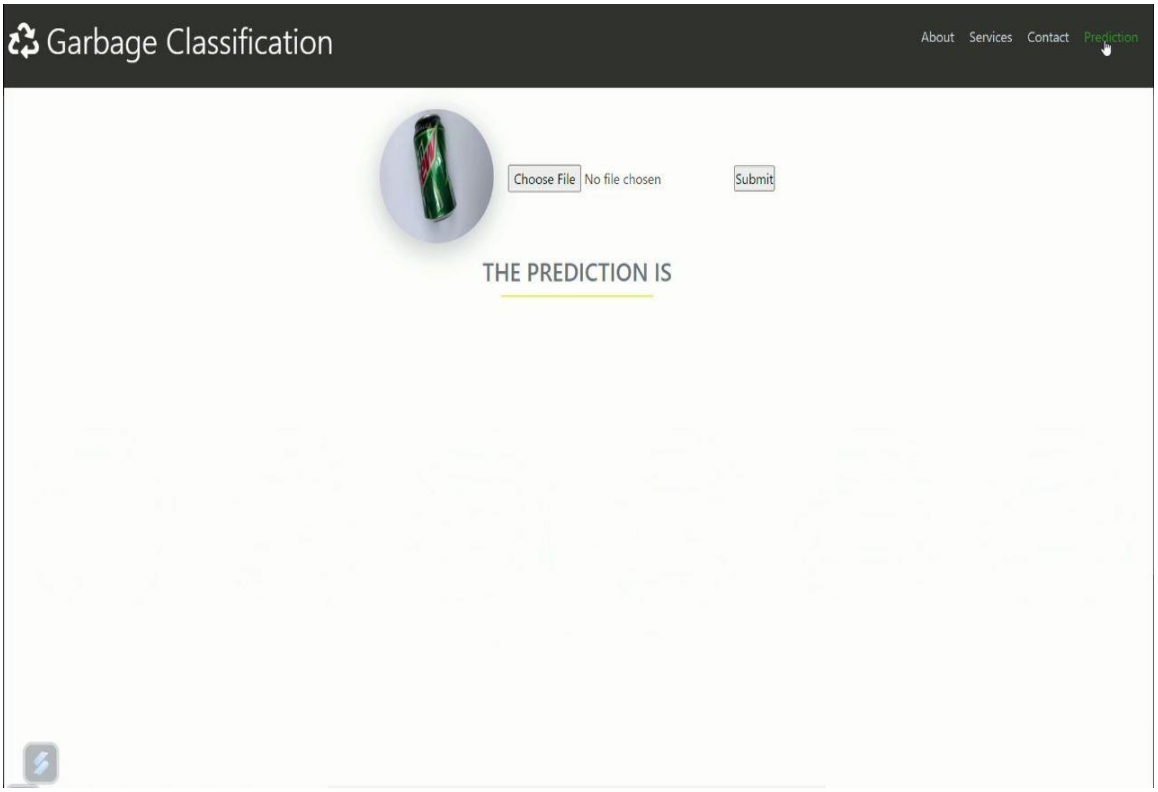
```
        filepath=os.path.join(basepath, 'uploads',f.filename) #from anywhere in the system we can give an image but we want that image later  to process so we are saving it to the uploads folder for reusing

        #print("upload folder is",file-path)

        f.save(file path)



        img=image.load_img(file path,target_size=(128,128))

        x=image.img_to_array(img)#img to array

        x=np.expand_dims(x,axis=0)#used for adding one more dimension

        #print(x)

        prediction=np.argmax(model.predict(x), axis =1) #instead of predict_classes(x) we can use predict(X) ---->predict_classes(x) gave error

        #print("prediction is ",prediction)

        index=["cardboard", "glass", "metal", "paper", "plastic", "trash"]

        result=str(index[prediction])

        result

        return render_template('prediction.HTML,prediction=result)

""" Running our application """

if __name__ == "__main__":

    app.run(debug=False,port=8000)
```

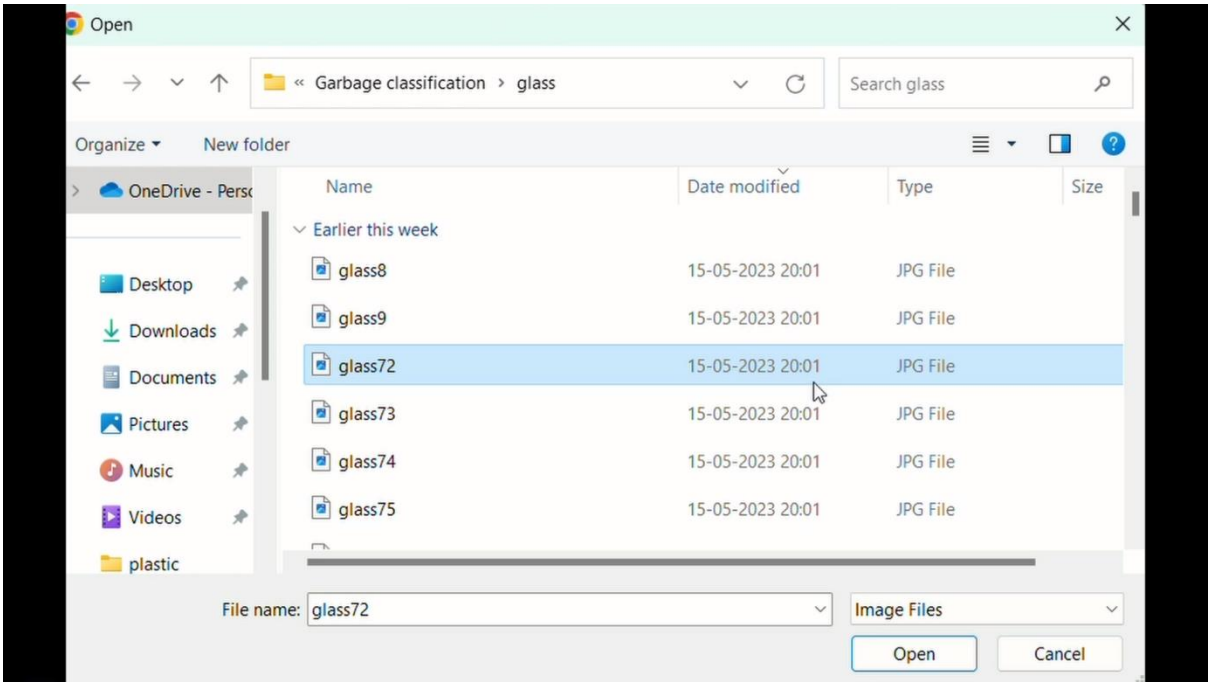
Web application and execution:

W 




Garbage Classification
File | C:/Users/ELCOT/Desktop/ibm/templates-20230520T042528Z-001/templates/index.html
We Help You To Classify Garbage
Reuse the past, Recycle the present, Save the future
ABOUT PROJECT
Problem:
With the increase in the number of industries in the urban area, the disposal of solid waste is really becoming a big problem, and solid waste includes paper, wood, plastic, metal, glass, etc. The common way of managing waste is burning waste and this method can cause air pollution and some hazardous materials from the waste spread into the air which can cause cancer. Hence it is necessary to recycle the waste to protect the environment and human
Solution:
In this project, we will be building a deep learning model that can detect and classify types of garbage. A web application is integrated with the model, from where the user can upload a garbage image like paper waste, plastic waste, etc., and see the analyzed results on
Type here to search
30°C
ENG
11:34 PM
20-05-2023


Garbage Classification
About
Services
Contact
Prediction
Choose File
No file chosen
Submit
THE PREDICTION IS


Open
Garbage classification › glass
Search glass
Organize
New folder
OneDrive - Perso
Desktop
Downloads
Documents
Pictures
Music
Videos
plastic
Name
Date modified
Type
Size
Earlier this week
glass8
15-05-2023 20:01
JPG File
glass9
15-05-2023 20:01
JPG File
glass72
15-05-2023 20:01
JPG File
glass73
15-05-2023 20:01
JPG File
glass74
15-05-2023 20:01
JPG File
glass75
15-05-2023 20:01
JPG File
File name: glass72
Image Files
Open
Cancel


THE PREDICTION IS
CARDBOARD
GLASS
METAL
PAPER
PLASTIC
TRASH

GitHub:

https://github.com/naanmudhalvan-SI/PBL-NT-GP--2777-_1680624377

Project video Demo link:

https://youtu.be/GqtbTTsNaJ8