PROJECT REPORT

on

WEB – BASED APPLICATION DEVELOPMENT FOR MARINE LITTER CLASSIFICATION

Submitted for partial fulfilment for the award of the degree

BACHELOR OF TECHNOLOGY

in

ELECTRONICS AND COMMUNICATION ENGINEERING

By

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SRM INSTITUTE OF SCIENCE & TECHNOLOGY

VADAPALANI - 600026

BONAFIDE CERTIFICATE

Certified that this project report titled **“Analysis of Marine Litter Contribution by various countries and Waste Classification”** is the Bonafide work of **Ms. S SEETHALAKSHMI (Reg No. RA1811004040001), Ms. M RADHIKA (Reg No. RA1811004040019)** who carried out the Minor Project **(18ECP107L**) work under my supervision as a batch. Certified further, that to the best of my knowledge the work reported herein does not form any other project report on the basis of which a degree or award was conferred on an earlier occasion for this or any other candidate.

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Date:

Submitted for University Examination held in Nov-2021 at SRM IST, Vadapalani-600026.

Date:	Internal Examiner-I	Internal Examiner-II

ACKNOWLEDGEMENT

It has been an enjoyable journey over our cherished years at the SRM Institute of Science and Technology. This work would not have been completed without motivation and help from our **SRM IST MANAGEMENT.**

We would like to express our sincere gratitude to Founder and Chancellor **Dr T.R Pachamuthu**, Chairman **Mr. Ravi Pachamuthu,** Vice chancellor of SRM IST **Dr.C.Muthamizhchelvan,** Dean **Dr. C. V. Jayakumar** and Head of the Department, Electronics and Communication Engineering **Dr. A. Shirly Edward**, for her support and constant encouragement throughout the project.

We are also grateful to the faculty member **Mr. T. S. Balaji** for reviewing our project and providing valuable feedbacks and suggestions amidst his busy schedule. We would like to have a special mention of our guide **Dr. A. Shirly Edward** for her guidance.

We could not have finished this work without support from our family. They are dearest in heart and great source of motivation. Our hearty appreciation and thanks to our friends whose support and encouragement made all this possible.

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ABSTRACT

Marine debris – man-made objects that enter the marine environment through careless handling or disposal, intentional or unintentional release, or as a result of natural disasters and storms – is one of the ocean's most pervasive, yet potentially solvable, pollution problems. It can harm ocean ecosystems, wildlife, and humans. It can injure coral reefs and bottom-dwelling species and entangle or drown ocean wildlife. Some marine animals ingest smaller plastic particles and choke or starve. Human health is also at risk, as plastics may break down into smaller pieces that may subsequently end up in our food. The economic impact of marine litter is thought to be significant. While there are different types of waste that are thrown along the shoreline due to the lack of awareness about proper disposal methods, the most concern causing among them all are the plastic wastes. The aim of this project is to present a web application using **VGG16** Transfer Learning technique of Convolutional Neural Network for waste classification. In our project we analysed the extent to which the countries around the world contribute to marine plastic litter and we visualized the data. Later in order to understand and classify the different types of wastes that are being disposed in an incorrect manner, we classified the waste and provided awareness through a web application. We thus could get a holistic view of the issue.

CHAPTER 1

INTRODUCTION

On a daily basis, the country produces more than 1.50 lakh metric tonne (MT) of solid waste, according to a 2019 India Today report. With almost 15,000 MT of garbage remaining exposed every day, it has become a significant reason for rising pollution levels. Even though there are strict policies enforced by the government for proper waste disposal, many people are still not aware and do not understand the need of the hour. Thus, through our project we try to study the application of deep learning in the field of environmental protection, create a general awareness and provide a small-scale waste classification solution that can later on be implemented in large scale. For small-scale waste classification we considered 9 categories of waste: light bulbs, paper, plastic, organic, glass, batteries, clothes, metal and e-waste.

LIGHT BULBS:

Standard light bulbs should be disposed of in normal household waste. They cannot be recycled as with regular glass, as the fine wires in glass processing are very difficult to separate out and the cost to recycle these items is prohibitive. Compact fluorescent lamps contain small amounts of mercury. Although this is completely safe for users of the lamps, they must be collected separately for disposal. This ensures that valuable parts of the lamps, such as glass and metal, are not lost. Light bulbs often break when thrown into a dumpster, trash can or compactor, or when they end up in a landfill or incinerator. This causes the release of hazardous materials into the environment and can create serious public and environmental health concerns. It’s also important to remember that recycling allows the reuse of the glass, metals and other materials that make up light bulbs. Virtually all components of light bulbs can be recycled.

PAPER:

Paper recycling pertains to the processes of reprocessing waste paper for reuse. Waste papers are either obtained from paper mill paper scraps, discarded paper materials, and waste paper material discarded after consumer use. Examples of the commonly known papers recycled are old newspapers and magazines. Other forms like corrugated, wrapping, and packaging papers among other types of paper are usually checked for recycling suitability before the process. The papers are collected from the waste locations then sent to paper recycling facilities. Typically, if one doesn't recycle, those papers would merely pile up. Worse, they’ll fill up the garbage around and can constitute a nuisance to you and your environment. For instance, it emits toxic gases such as methane and carbon dioxide, which reduces the quality of air.

PLASTIC:

Plastic is one of the most popular and useful materials of modern times: we now use about 20 times more plastic than we did 50 years ago. Its popularity and widespread use is why handling it responsibly and correctly once it becomes waste is so vitally important. We can optimise the lifespan of plastics by reusing and recycling items as many times as possible. Recycling is a two-stage process: Sorting is mainly done automatically with a manual sort to ensure all contaminants have been removed. Once sorted and cleaned, plastic can either be shredded into flakes or melt processed to form pellets before finally being moulded into new products. There is a wide range of products made from recycled plastic including: refuse sacks and carrier bags, underground drainage systems for homes and national infrastructure, flower pots, seed trays, watering cans and water butts, wheel arch liners and bumpers on cars, damp proof membranes, guttering and window profiles used in construction, reusable crates and pallets, wheel bins and food caddies, composters and wormeries etc.

ORGANIC:

Organic wastes are materials originating from living sources like plants, animals, and microorganisms that are biodegradable and can be broken down into simpler organic molecules. Because of recent shortages in landfill capacity, the number of municipal composting sites for yard wastes is increasing across the country, as is the number of citizens who compost yard wastes in their backyards. On a more limited basis, some mixed municipal waste composting is also taking place. In these systems, attempts to remove inorganic materials are made prior to composting.Food waste from restaurants and grocery stores is typically disposed of through garbage disposals, therefore, it becomes a component of wastewater and sewage sludge. Organic waste recycling is the process of organic waste management where organic wastes are recycled or converted into useful matter by different recycling methods. There are different methods of organic waste recycling, each of which can be used for a particular group of waste to produce some form of useful organic matter. Some of the common methods are Animal feed, Composting, Anaerobic digestion, Rendering etc.

GLASS:

Glass is a very important inorganic material which is one of the largest productions of industries. It can be made into a variety of different products used for man’s daily living. It is an amorphous solid which can have different compositions of semiconductors but most importantly are made of molten silica along with limestone and soda ash. Glass recycling is the process of making glass materials into new glass products. This way, used glass materials pass through a recycling process that requires breaking and melting the glass. To be recycled, glass waste needs to be purified and cleaned of contamination. Then, depending on the end use and local processing capabilities, it might also have to be separated into different colors. Many recyclers collect different colors of glass separately since glass retains its color after recycling.

BATTERIES:

Battery recycling is the reuse and reprocessing practice of batteries aimed at reducing the number of batteries being disposed of as material waste. Batteries contain several poisonous chemicals and heavy metals and their dumping has attracted environmental concerns due to contamination of water and soil. As such, batteries need recycling to comply with environmental and health benefits. Rechargeable nickel–cadmium (Ni-Cd), nickel metal hydride (Ni-MH), lithium-ion (Li-ion) and nickel–zinc (Ni-Zn), can also be recycled.

CLOTHES:

Textile recycling is the process by which old clothing and other textiles are recovered for reuse or material recovery. As such, textile recycling is a significant challenge to be addressed as we strive to move closer to a zero landfill society.Once in landfills, natural fibers can take a few weeks to a few years to decompose. They may release methane and CO_2 gas into the atmosphere. Additionally, synthetic textiles are designed not to decompose. In the landfill, they may release toxic substances into groundwater and surrounding soil. Textile waste products are gathered from different sources and are then sorted and processed depending on their condition, composition, and resale value.

METAL:

Metals are essential, versatile and can be used in a number of ways. Metals can be used for industrial purposes such as the manufacture of trucks, cars, airplanes, ships, and railways. They can also be used to manufacture domestic items such as cutlery, crockery and even in packaging. The good thing about metal recycling is that metal can be recycled over and over without altering its properties. The most common recyclable metals include aluminum and steel. The other metals, for example, silver, copper, brass and gold, are so valuable that they are rarely thrown away to be collected for recycling. Therefore, they do not create a waste disposal crisis or problem. The metal recycling process is similar to the usual recycling process. The metals are first sorted on the basis of their properties. Metals are resources that are limited. The depletion of metals can be a big issue in the future since the world population grows rapidly and thus also the demand for goods made out of metal will increase.

E-WASTE:

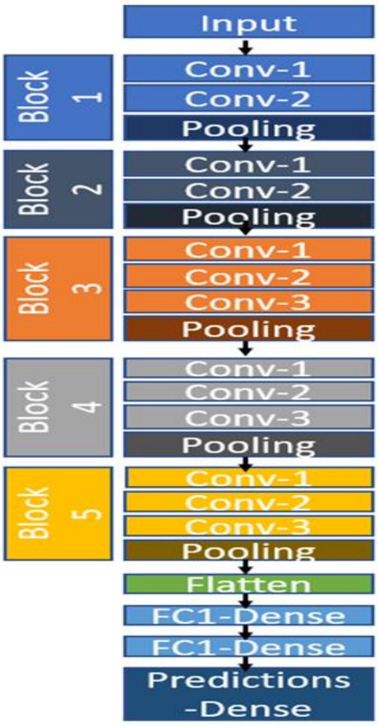
E-waste is short for electronic waste. That is, trash generated from broken, obsolete, and surplus electronic devices.Typically, these electronics often contain toxic chemicals and hazardous materials. And when not disposed of properly, it can cause the release of toxic substances into our environment. E-waste recycling then refers to the reprocessing and re-use of these electronic wastes. It is simple. It is a process that seeks to recover material from electronic waste. This way, you can use them in new electronic products. These electronic wastes may be in the form of home appliances like your air conditioners, televisions, electric cookers, air conditioners, heater, DVDs, fans, microwaves, and radios. They may also be in the form of information tech equipment like your computers, laptops, mobile phones, batteries, hard disks, circuit boards, monitors.

EXISITING SCHEME

Different types of waste warrant different management techniques and hence, proper waste segregation according to its types is essential to facilitate proper recycling. Current existing segregation methods still relies on manual hand-picking process. A method based on deep learning and computer vision concepts, to classify wastes using their images into six different waste types have been proposed. Multiple-layered Convolutional Neural Network model, specifically the well-known Inception-v3 model has been used for classification of waste, with trained dataset obtained from online sources. Apart from its complexity due to more number of hidden layers, this model overfits and provides less accuracy in some cases.

PROPOSED SCHEME

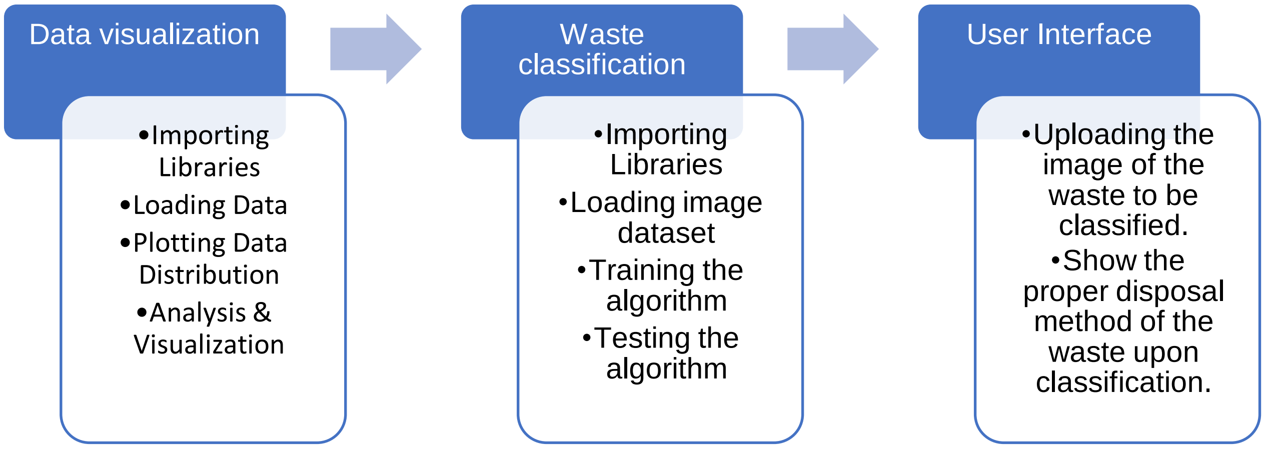
In this project, we use VGG16 Transfer learning technique of CNN for waste segregation as it is a good neural network architecture with a simple stack of convolution, pooling and fully connected layers — it starts with two convolution layers followed by pooling, then another two convolutions followed by pooling, after that repetition of three convolutions followed by pooling, and then finally three fully connected layers. This being a pre-trained model can be loaded via the Applications interface provided by Keras. By the method of Transfer learning, this model developed for a task is used as the starting point.



CHAPTER 2

PROPOSED SYSTEM

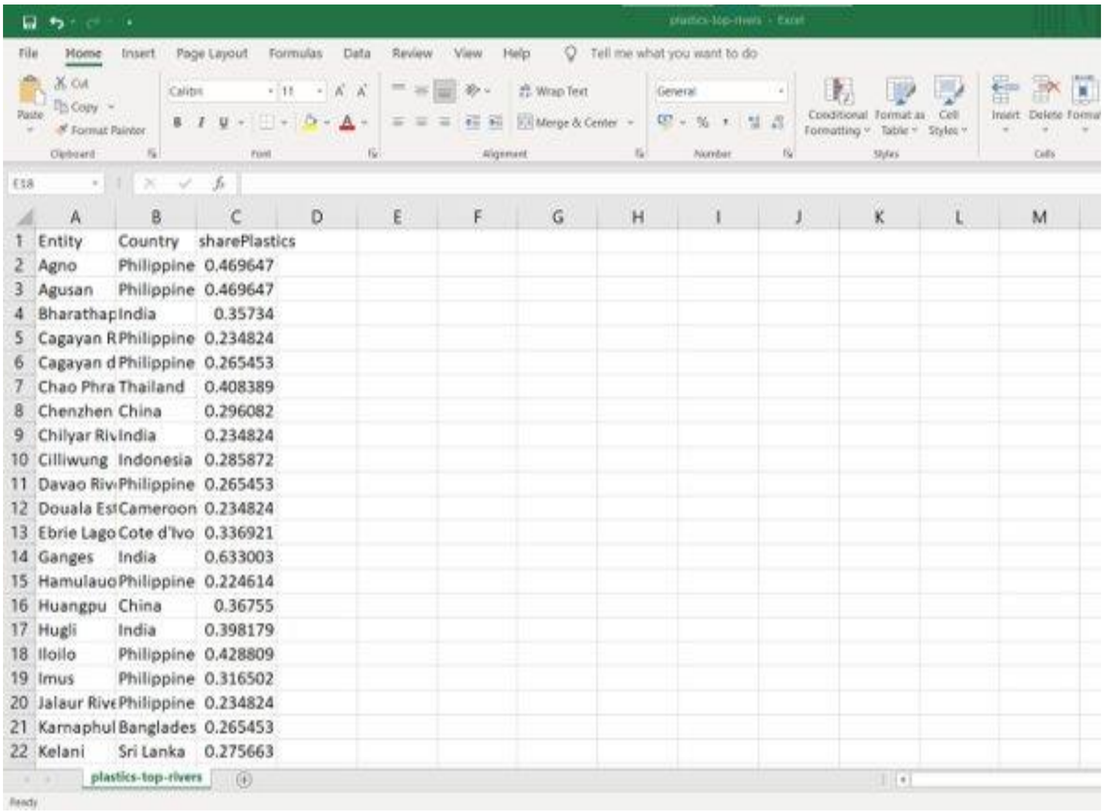
FLOWCHART



A. <u>AWARENESS THROUGH DATA VISUALIZATION</u>

We downloaded a 2019 dataset from IUCN (International Union for Conservation of Nature) website that gave information about the extent to which a few countries around the world contributed to marine plastic litter. The dataset takes into account different rivers of these countries as they act as conduits of litter from inland to ocean. Analysing the datasets that inform the degree of plastic litter in various rivers from different countries would help in visualising the contribution of every country taken into account, importantly in visualising which country contributes the most. We analyzed the data by plotting the distribution. For our analysis we used the Python 3 language and imported libraries like numpy, seaborn, pandas and matplotlib.pyplot. This process of data visualization gives a sense of understanding and awareness about the criticality of the issue.

DATASET:



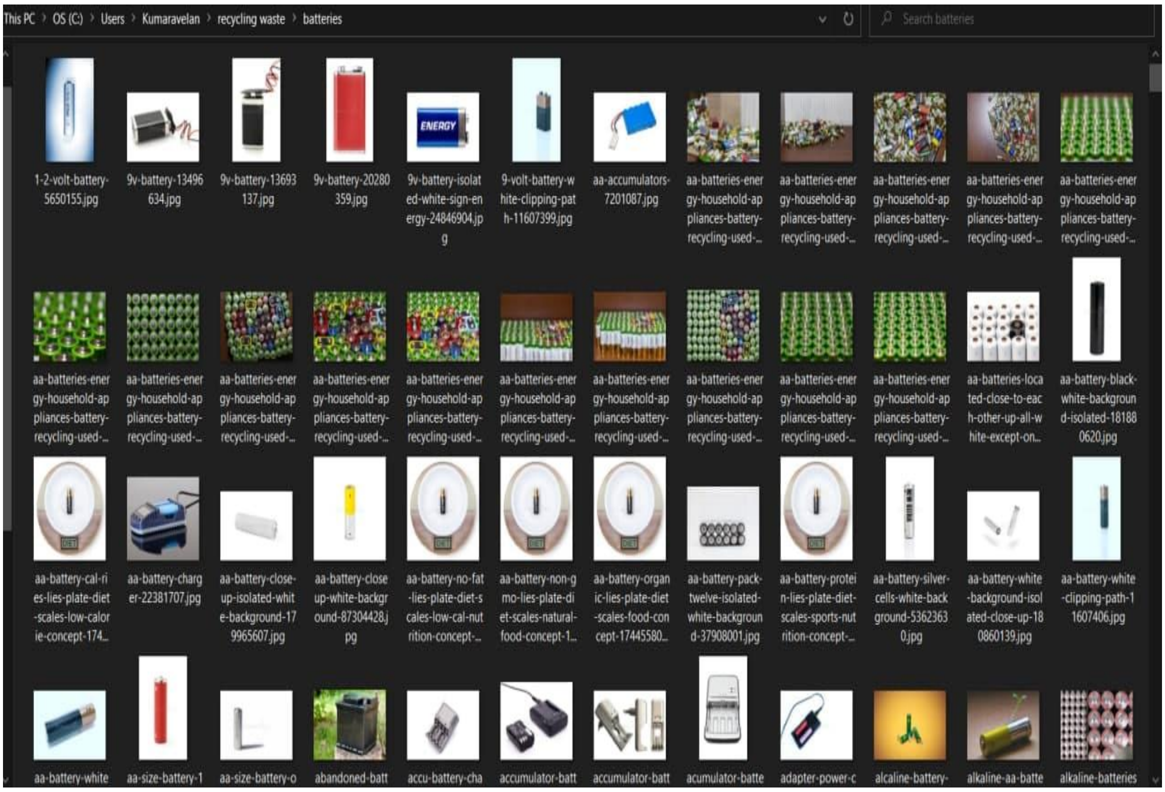
	A	B	C
1	Entity	Country	sharePlastics
2	Agno	Philippine	0.469647
3	Agusan	Philippine	0.469647
4	Bharathap	India	0.35734
5	Cagayan R	Philippine	0.234824
6	Cagayan d	Philippine	0.265453
7	Chao Phra	Thailand	0.408389
8	Chenzhen	China	0.296082
9	Chilyar Riv	India	0.234824
10	Cilliwung	Indonesia	0.285872
11	Davao Riv	Philippine	0.265453
12	Douala Est	Cameroon	0.234824
13	Ebrie Lago	Cote d'Ivo	0.336921
14	Ganges	India	0.633003
15	Hamulauo	Philippine	0.224614
16	Huangpu	China	0.36755
17	Hugli	India	0.398179
18	Iloilo	Philippine	0.428809
19	Imus	Philippine	0.316502
20	Jalaur Rive	Philippine	0.234824
21	Karnaphul	Banglades	0.265453
22	Kelani	Sri Lanka	0.275663

Source: IUCN website

B. A POTENTIAL SOLUTION THROUGH DATA (WASTE) CLASSIFICATION

Apart from just understanding the presence of plastic litter, it is necessary to classify the different categories of waste disposed along the shorelines. We downloaded an image dataset consisting of approximately 8000 images from GitHub website. All the images belong to the following 9 categories: light bulbs, paper, plastic, organic, glass, batteries, clothes, metal and e-waste. The dataset is trained using VGG16 Transfer Learning technique of Convolutional Neural Network for classification. We tried training the algorithm using different optimizers like Adam, Adamax and Nadam available in Keras library to check which provides the better result. On feeding a test image, the algorithm correctly classifies the category of the waste.

IMAGE DATASET:



Source: GitHub

C. USER INTERFACE

We extended our project by developing a web application that would help in waste classification. This web application can classify waste into 9 different waste classes. For frontend, web technologies like HTML (Hyper Text Markup Language) and CSS (Cascading Style Sheets) are used. Flask, which is a web framework in python is used for backend.

The web application works as follows:

- Click on the button "CLASSIFY IMAGE".
- Upload an image of any waste.
- The web application would then classify the waste to its respective category and display the name of the category.
- It would also provide the users with an insight on the particular type of waste and its proper disposal/recycling method.

CHAPTER 3

RESULTS AND DISCUSSION

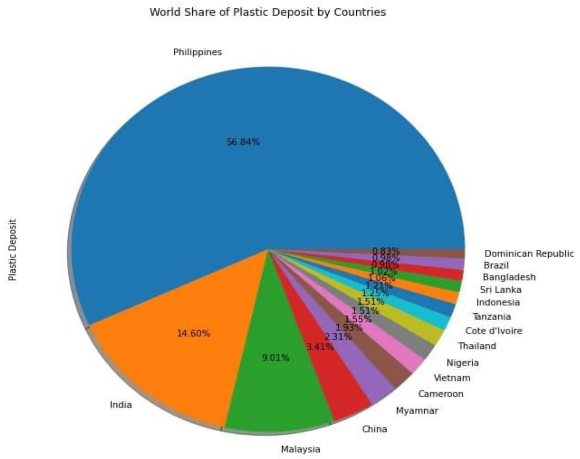
Through the first step of this project, i.e., data visualization, on analysing rivers of different countries, we were able to identify that Philippines is high in plastic deposit, with a world share of 56.84%. Its PASIG River contributes the most to this (as per 2019 dataset of IUCN). In the second step i.e., waste segregation, we were able to segregate different types of wastes using VGG16 Transfer Learning technique of CNN. On using three different optimizers available in Keras library, the results were:

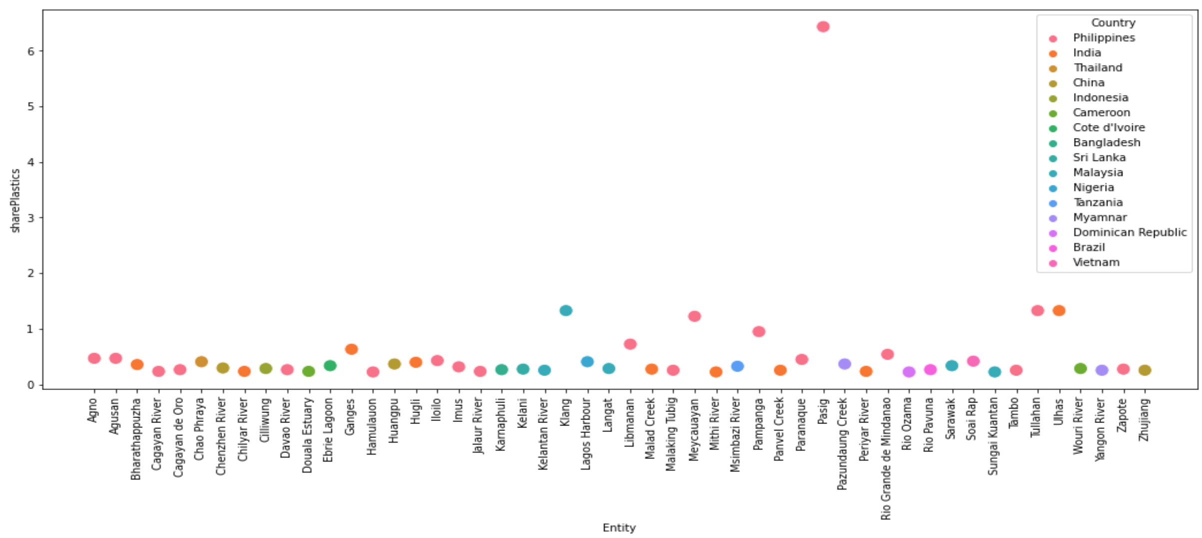
(1) NADAM optimizer did not classify the images into the correct category.

(2) ADAMAX optimizer classified the images into the correct category with an accuracy of 62 percentage.

(3) ADAM optimizer classified the images into the correct category with an accuracy of 90 percentage.

DATA VISUALIZATION OUTCOME:





OUTCOME OF WASTE SEGREGATION USING VARIOUS OPTIMIZERS:

(1) USING NADAM OPTIMIZER:

```
    test_image = np.expand_dims(test_image, axis=0)

    predicted_array = model.predict(test_image)
    predicted_value = output_class[np.argmax(predicted_array)]
    predicted_accuracy = round(np.max(predicted_array) * 100, 2)

    print("Your waste material is ", predicted_value, " with ", predicted_accuracy, " % accuracy")

In [35]: waste_prediction("C:/Users/Kumaravelan/Desktop/minor_project/toy.jpg")
```

```
Your waste material is  batteries  with  45.18  % accuracy
```

(2) USING ADAMAX OPTIMIZER:

```
    test_image = image.img_to_array(test_image) / 255
    test_image = np.expand_dims(test_image, axis=0)

    predicted_array = model.predict(test_image)
    predicted_value = output_class[np.argmax(predicted_array)]
    predicted_accuracy = round(np.max(predicted_array) * 100, 2)

    print("Your waste material is ", predicted_value, " with ", predicted_accuracy, " % accuracy")

In [20]: waste_prediction("C:/Users/Kumaravelan/Desktop/minor_project/toy.jpg")
```

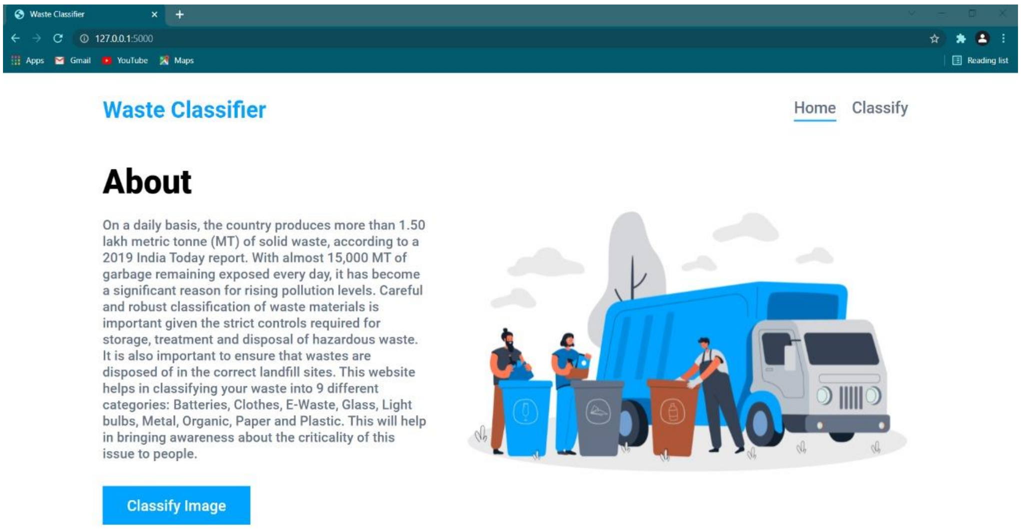
```
Your waste material is  plastic  with  51.0  % accuracy

In [ ]:
```

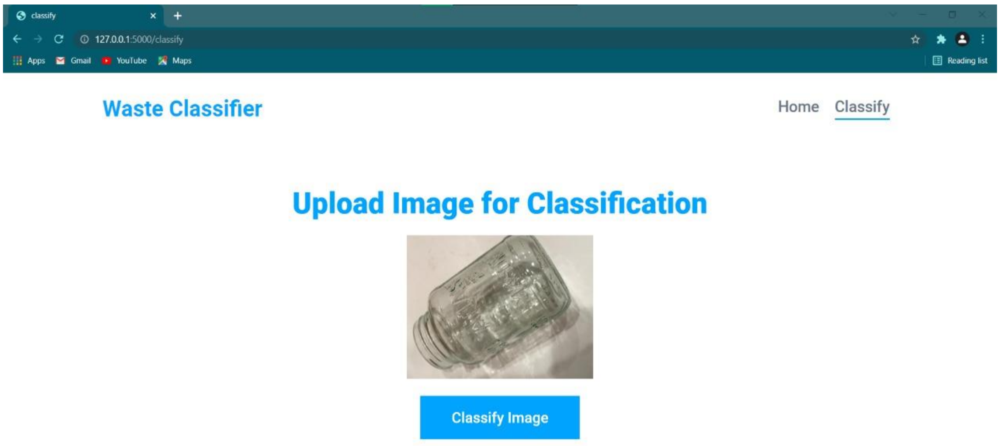
(2) USING ADAM OPTIMIZER:

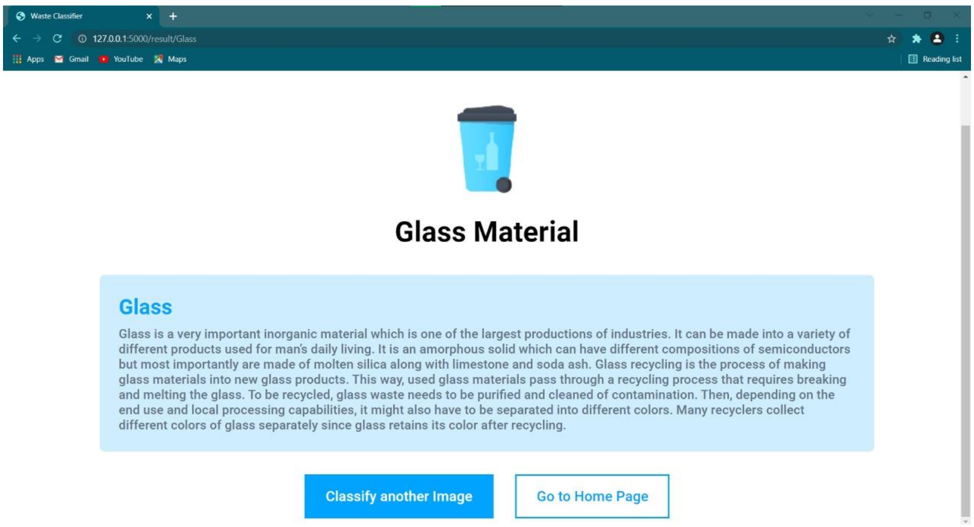
```
    test_image = image.img_to_array(test_image) / 255
    test_image = np.expand_dims(test_image, axis=0)

    predicted_array = model.predict(test_image)
    predicted_value = output_class[np.argmax(predicted_array)]
    predicted_accuracy = round(np.max(predicted_array) * 100, 2)

    print("Your waste material is ", predicted_value, " with ", predicted_accuracy, " % accuracy")

In [24]: waste_prediction("C:/Users/Kumaravelan/Desktop/minor_project/toy.jpg")
```

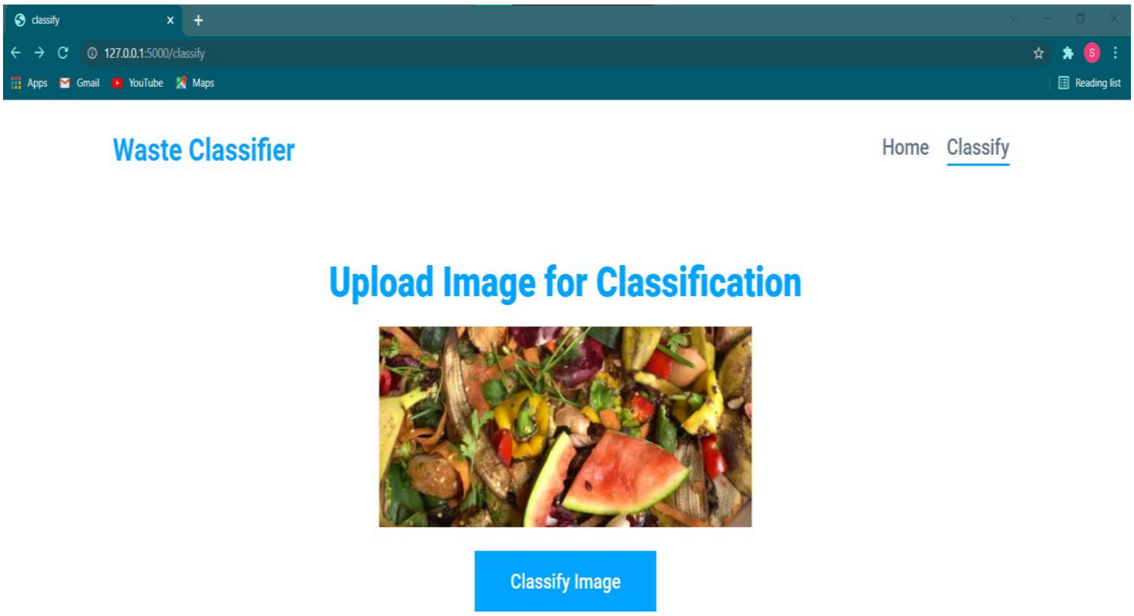
```
Your waste material is  plastic  with  81.26  % accuracy

In [ ]:
```

USER INTERFACE:





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Classify
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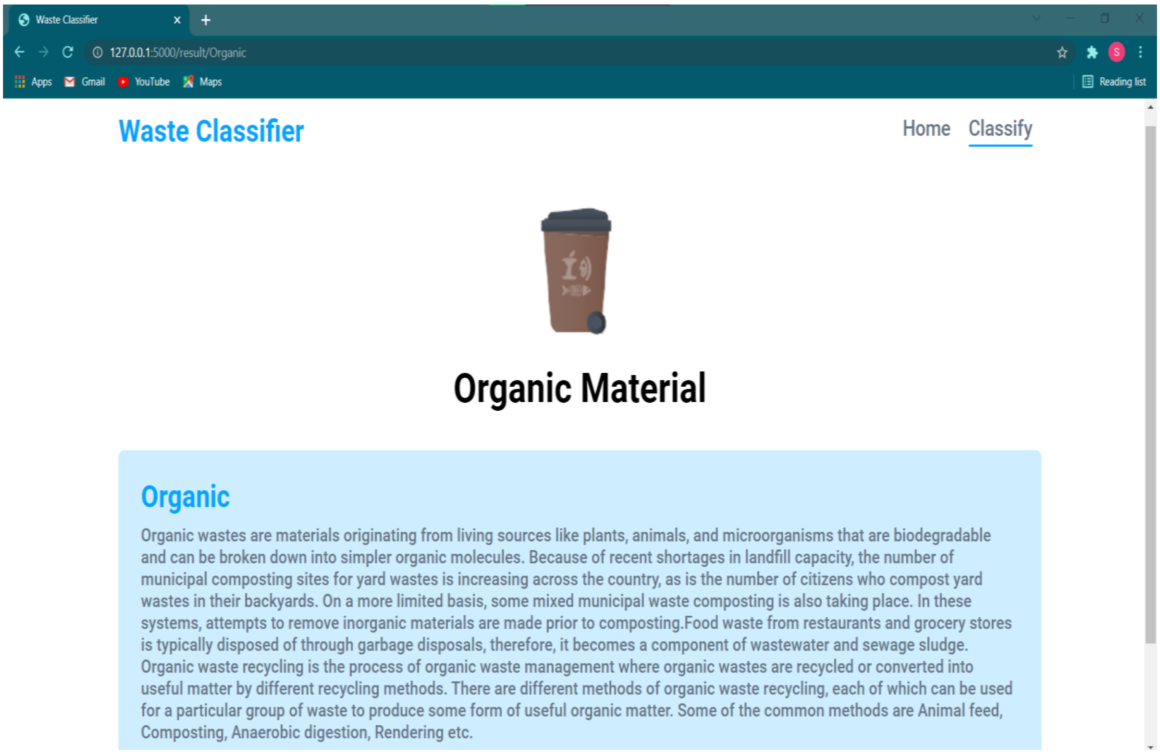
Classify Image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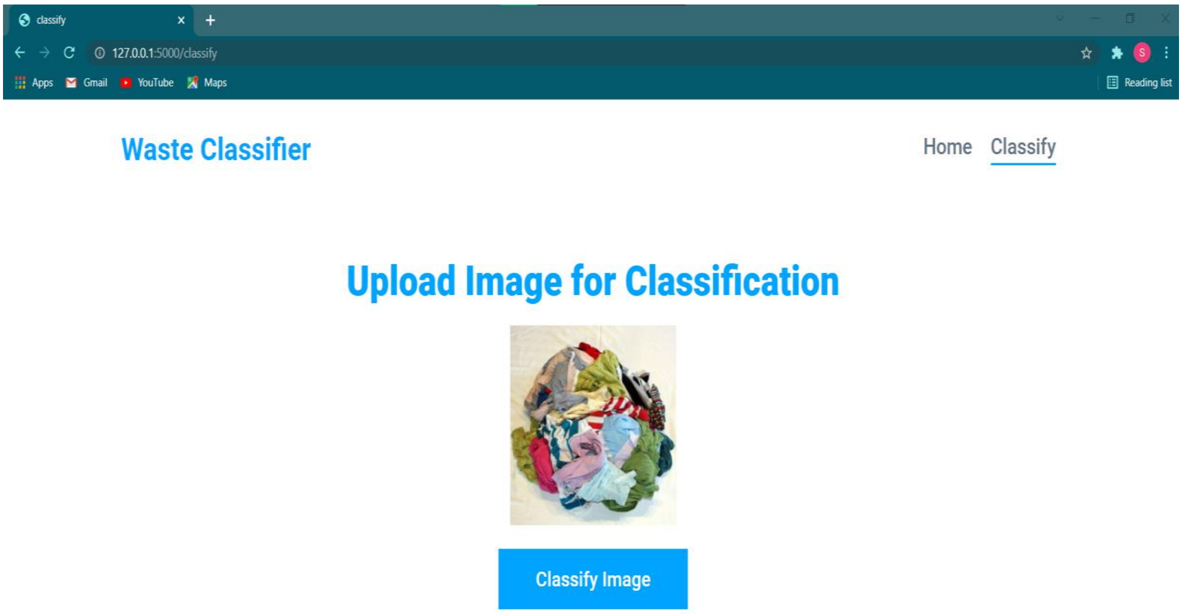
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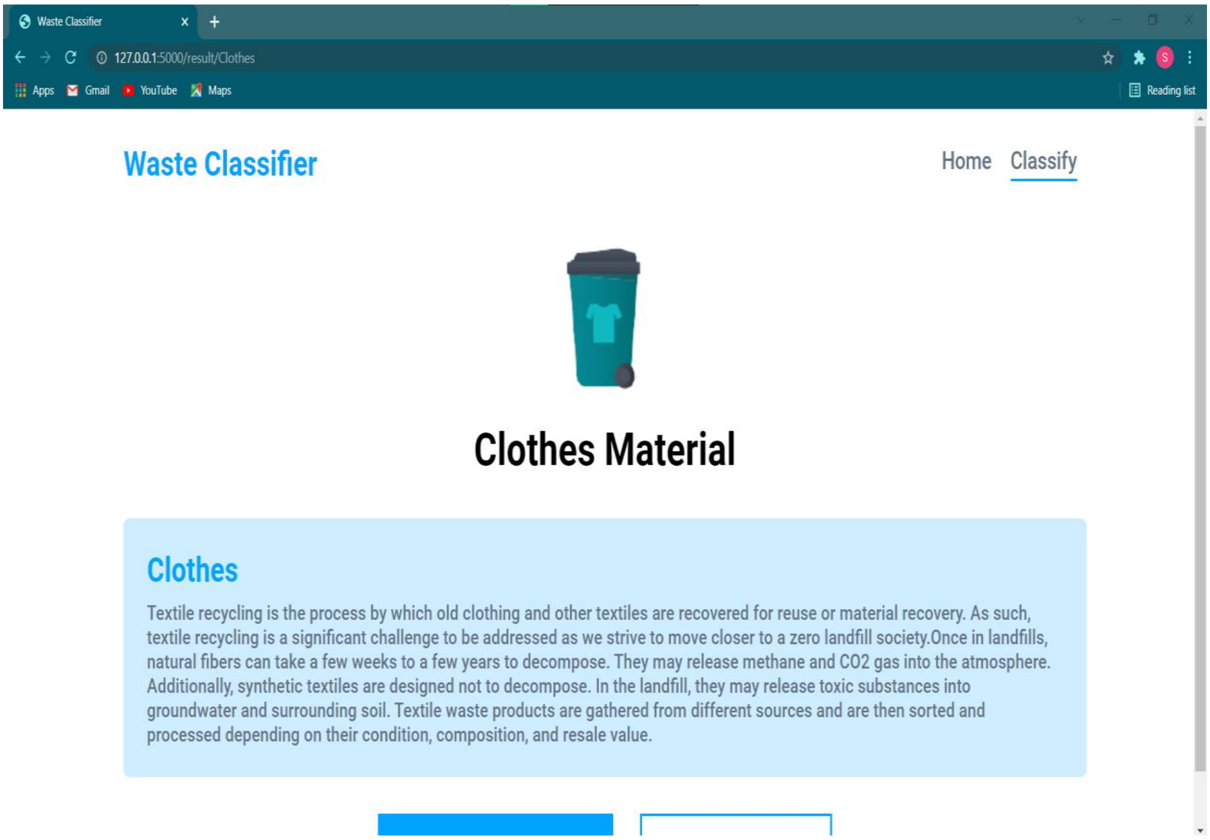
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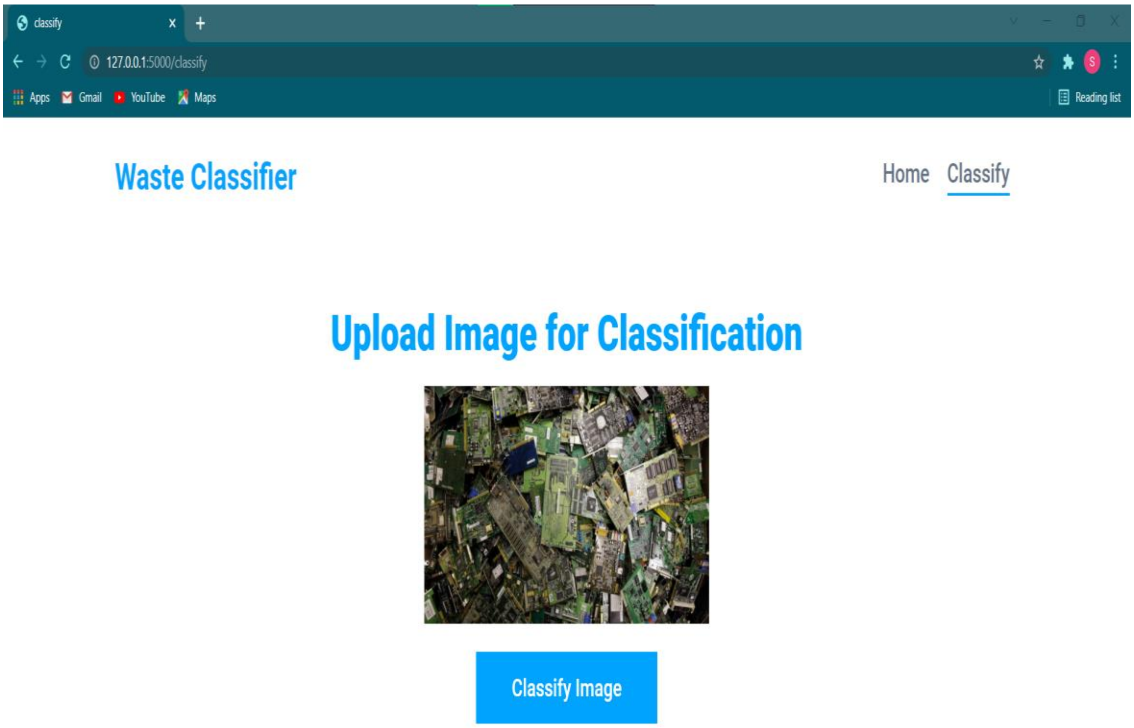
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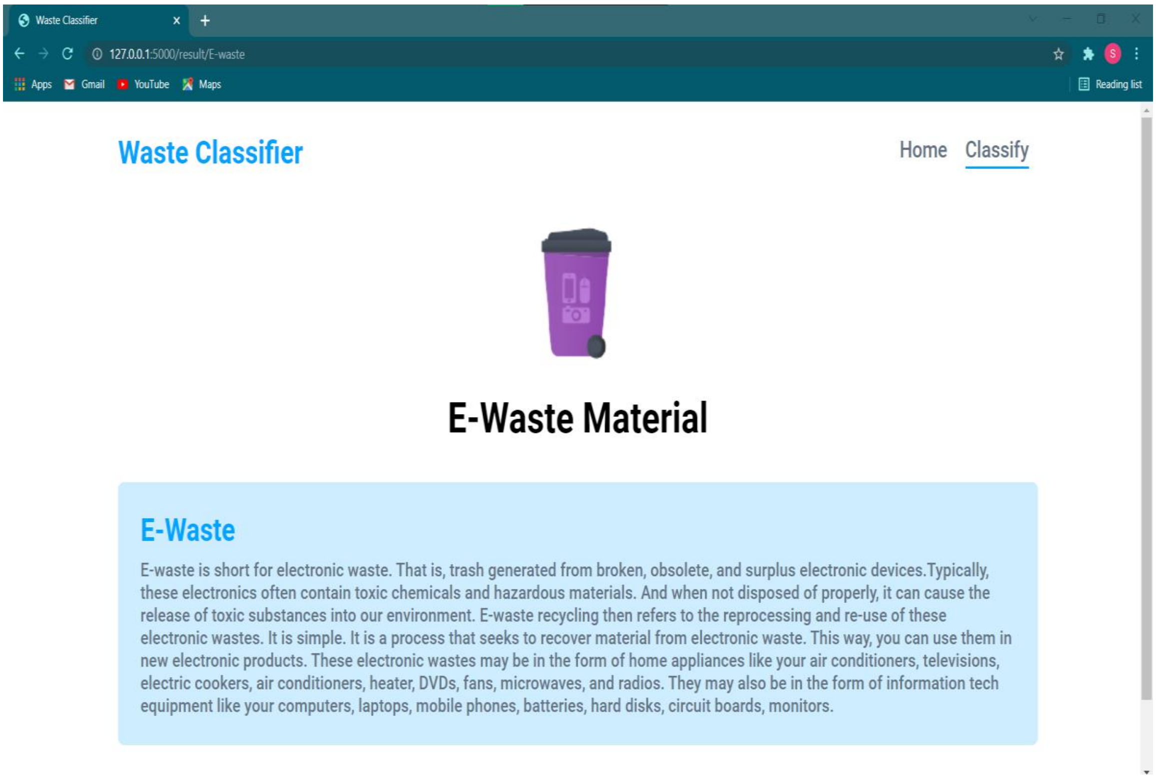
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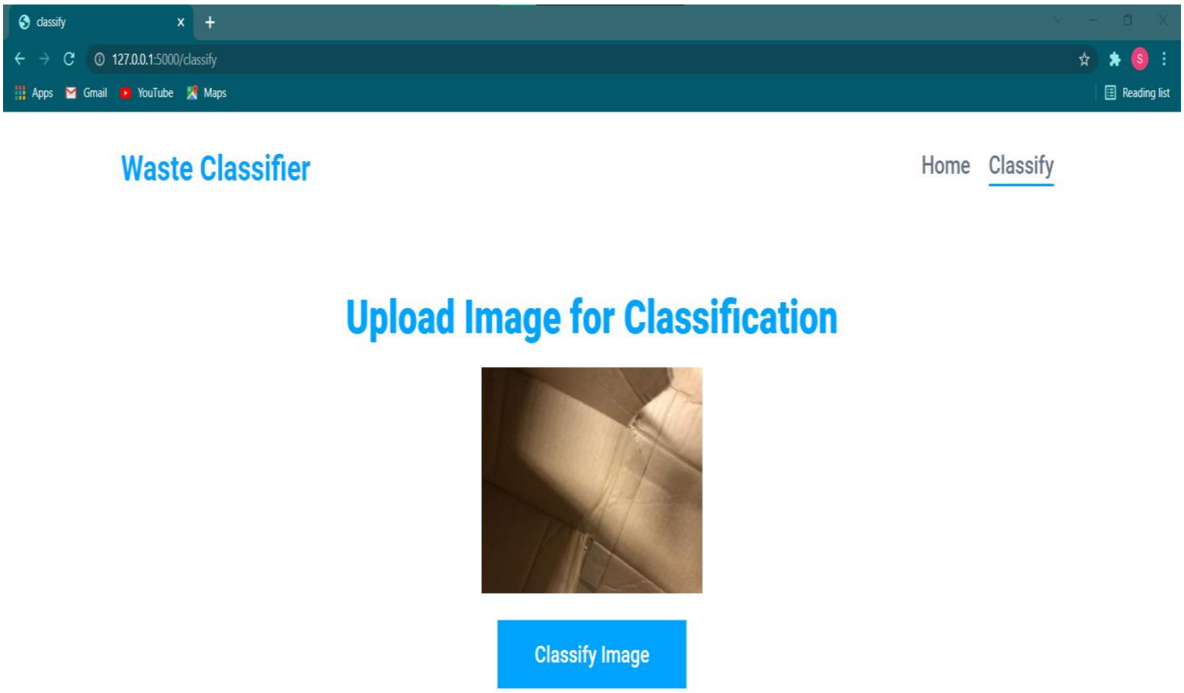
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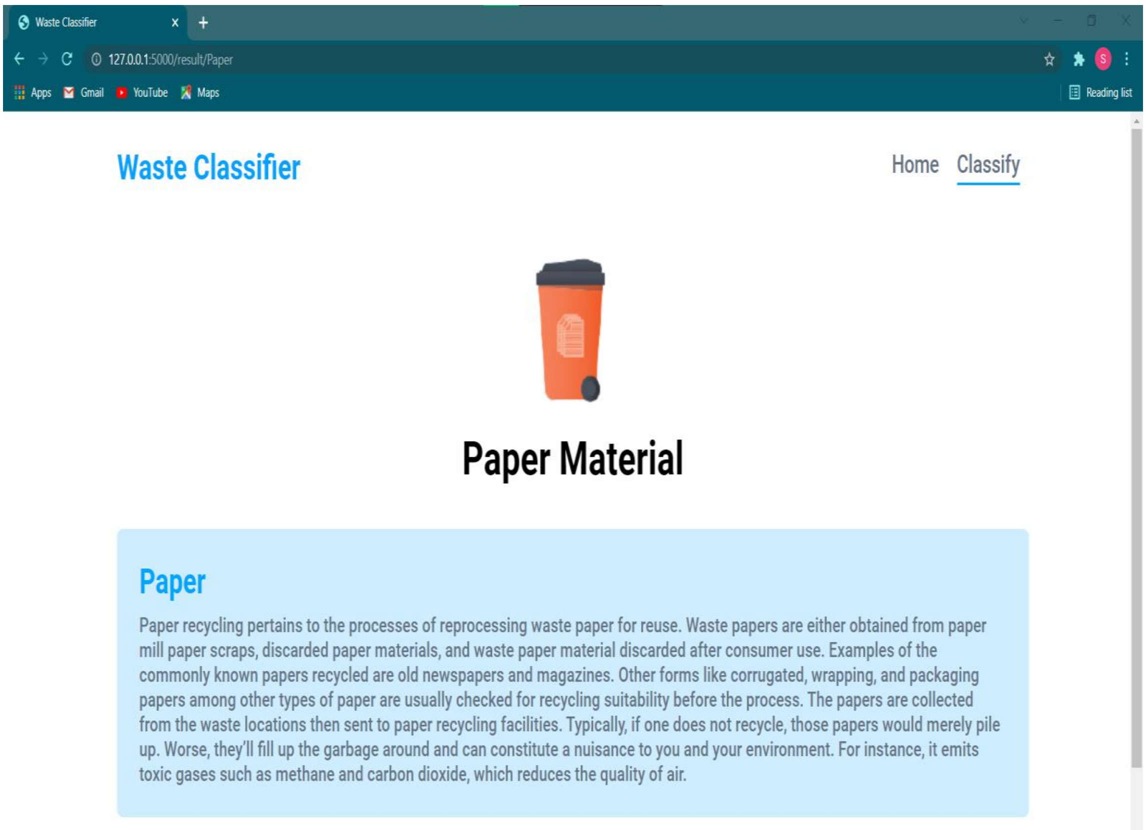
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CONCLUSION AND FUTURE SCOPE

Given the criticality of the issue of marine litter and its dire consequences, we were motivated to visualize the extent of marine litter contribution by a few countries and also develop a solution that would bring awareness. We visualized a dataset from the year 2019 and studied the contribution of a few countries as the first step of our project. We then developed a waste classification algorithm using VGG-16 as the second step of our project and found that the ADAM optimizer performed the best with an accuracy of 90 percentage. We later developed a web application that would act as a user interface; that would help in waste classification on uploading the image of any waste and provide insight and awareness. We thus could get a holistic view of the issue.

Though this is just a small-scale implementation, it could be made large-scale and useful in the future by making the automated detection process real time. It could be installed in any drone or bot that might be used to categorically collect and dispose wastes from the shorelines in the future.

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