INTELLIGENT GARBAGE CLASSIFICATION USING DEEP LEARNING

TEAM ID

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Submitted by

TEAM LEADER

S.BHANUTEJA - 20T91A0438

TEAM MEMBERS

G.S.N.S.SATISH- 20T91A0411

K.MANASA - 21T95A0417

I.PAVANI - 20T91A0413

1. INTRODUCTION

The core technology behind the intelligent garbage classification system lies in convolution neural networks and deep learning through the use of advanced image processing techniques, the system can analyze images and identify the type of waste based on its visual characteristics

The Intelligent Garbage Classification System is an innovative project designed to revolutionize waste management by employing artificial intelligence and deep learning techniques.

The system aims to address the critical issue of efficient garbage classification, enabling effective waste management and promoting environmental sustainability.

1.1 Overview

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 waste management system to manage a variety of waste materials. One of the most important steps of waste 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 waste material classification system, which is developed by using the 50-layer residual net pre-train (ResNet-50) Convolutional Neural Network model which is a machine learning tool and serves as the extractor, and Support Vector Machine (SVM) which is used to classify the waste into different groups/types such as glass, metal, paper, and plastic.

The proposed system is tested on the trash image dataset which was developed by Gary Thung and Mindy Yang, and is able to achieve an accuracy of 87% on the dataset. The separation process of the waste will be faster and intelligent using the proposed waste material classification system without or reducing human

1.2 Purpose

The purpose of this project is to develop a deep learning model that can be used to helping to ensure that garbage is properly sorted. This would help to reduce contamination of recyclable materials and make it easier to recycle and compost garbage. In addition, the model could be used to educate people about the different types of garbage and how to properly dispose of them. This could help to reduce the amount of garbage that ends up in landfills and incinerators. The project would also development of deep learning technology. The model would be trained on a large dataset of images of garbage, which would help to improve the accuracy of deep learning models for other image classification tasks.

Accurate Classification: Develop a deep learning model capable of accurately identifying and classifying a wide range of waste materials based on visual characteristics, such as shape, color, and texture. The model will be trained on a diverse dataset encompassing various waste items commonly encountered in real-world scenarios.

Efficiency Enhancement: Create an intelligent garbage sorting system that significantly improves the efficiency of waste processing and recycling facilities. By automating the sorting process, this project aims to minimize manual labor, reduce human error, and expedite waste management operations.

Resource Recovery: Enable efficient extraction of recyclable materials from the waste stream. The deep learning model will help identify and separate valuable resources, such as plastics, metals, and paper, contributing to enhanced resource recovery rates and reducing the need for raw material extraction.

Environmental Impact Reduction: By facilitating accurate waste classification and sorting, the project seeks to minimize the environmental impact of improper waste disposal. This includes decreasing landfill usage, reducing greenhouse gas emissions, and preventing pollution associated with the mishandling of hazardous waste materials.

Educational Tool: Develop an educational component to raise awareness about proper waste segregation and its positive effects on the environment. The project aims to educate communities, schools, and businesses about responsible waste disposal practices, fostering a culture of sustainability.

Adaptability and Scalability: Design the deep learning model and associated software infrastructure to be adaptable and scalable, allowing integration with various waste management systems and facilities. This adaptability will enable widespread implementation and customization according to regional waste characteristics and regulations.

Continuous Improvement: Implement mechanisms for continuous learning and improvement of the deep learning model. Incorporate feedback loops that allow the system to refine its classification capabilities overtime, adapting to emerging waste materials and patterns.

2. LITERATURE SURVEY

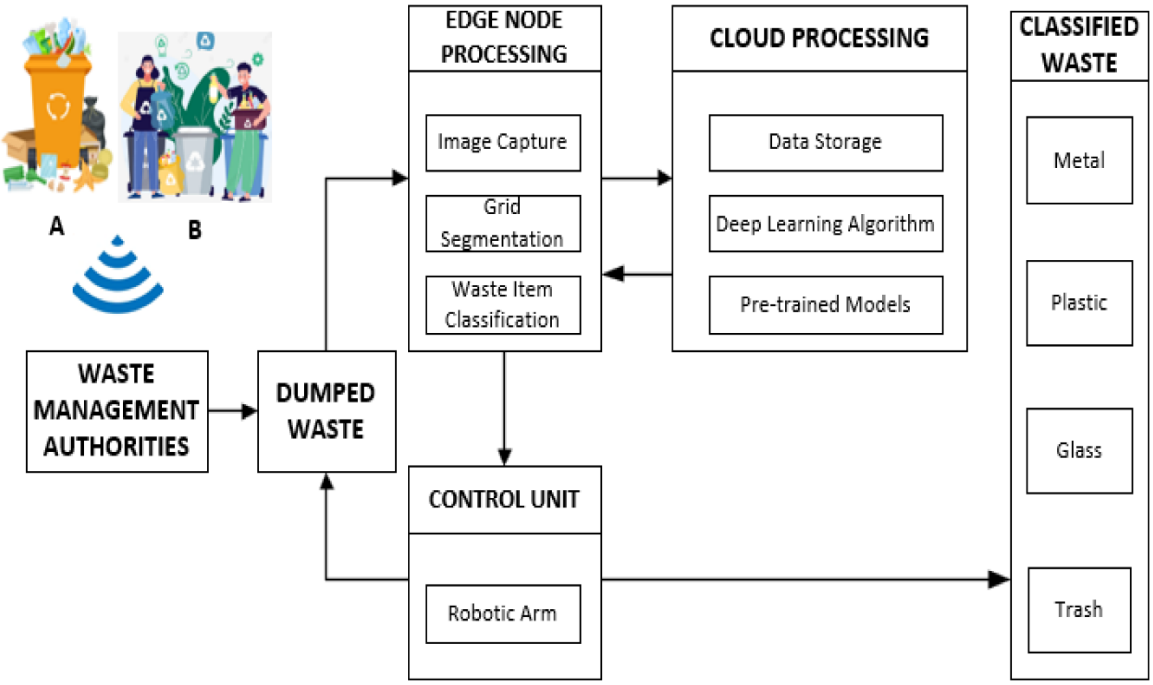

Fig 2.1: Garbage Classification

Intelligent garbage classification is a task that aims to automatically sort different types of waste into categories such as recyclable, organic, hazardous, etc. This task has important applications for environmental protection, resource management and waste disposal. However, it also faces many challenges, such as the diversity and complexity of the waste items, the noise and occlusion in the images, the lack of labeled data and the high computational cost. Deep learning is a branch of machine learning that uses neural networks to learn from large amounts of data and perform complex tasks. In recent years, deep learning has been widely used for intelligent garbage classification, especially for image-based methods that use cameras or sensors to capture the images of the waste items. In this literature survey, we review some of the main challenges, methods and results of applying deep learning for intelligent garbage classification.

2.1 Existing problem

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 waste management system to manage a variety of waste materials.

One of the most important steps of waste 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 waste material classification system, which is developed by using the 50-layer residual net pre-train (ResNet-50) Convolutional Neural Network model which is a machine learning tool and serves as the extractor, and Support Vector Machine (SVM) which is used to classify the waste into different groups/types such as glass, metal, paper, and plastic etc.

The proposed system is tested on the trash image dataset which was developed by Gary Thung and Mindy Yang, and is able to achieve an accuracy of 87% on the dataset. The separation process of the waste will be faster and intelligent using the proposed waste material.

2.2 Proposed Solution:

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 (CNN) and Support Vector Machine (SVM) which can accurately identify and sort various types of waste materials. By promoting the use of intelligent garbage classification, we aim to optimize waste management practices, reduce the amount of waste sent to landfills, and increase recycling rates, contributing to a cleaner and more sustainable environment.

PROPOSED METHOD

The garbage collection in India still depends on unorganized collection of waste. The segregation process is still handled by mankind which has many health issues, time consuming, costly and less effective . In the existing system, all the garbage collected from households and industries was dumped on the outskirts of towns and cities. Due to uncontrolled dumping of waste, it gave rise to the problems like overflowing landfills but also contributed a huge amount in terms of ground waste pollution and Global warming [11]. A new concept uses deep learning algorithms to segregate the waste at initial level thus making waste management more powerful. The designed method sorts the waste into different categories with higher accuracy. This study reviews the best and effective approach to segregate the garbage into different types. The proposed method mainly focuses on identification and segregation of waste by using deep learning algorithms like convolution neural networks(CNN) . Usually, all the toxic wastes are dumped with recyclable waste which causes huge damage to land.

This project proposes an idea where to segregate the toxic waste with higher accuracy.

This method work in different phrases which are as follows:

1. Capturing of images
2. Collection of datasets
3. Pre- processing of images
4. Training data
5. Testing data
6. Evaluation of mode

The phrases of system design are as follows:

a) Capturing of images:

- Waste objects :- In this step , we are considering different local areas or bins for collection of waste images.
- Stereo camera :- Stereo camera provides a Large-scale High-resolution Outdoor Stereo Dataset. So, In order to get clean and proper images for the dataset . We used a stereo camera to capture images of different types of wastes.
- Object Detector :- Object detector is a technology which relates to computer types of application and image processing that detects and defines various objects such as humans, buildings and cars from images. The technology has power to identify once or various types of objects within a d image at one. So , we used this technology to classify images into different categories like glass, paper, plastic, metal , cardboard .

b) **Collection of Dataset:-** After capturing images, it is classified into different types such as glass, paper, plastic , metal , cardboard. It is important to train the model to get best accuracy. Initially, it is labeled and sequential of images have taken place. Further, it is divided into two categories: training and testing dataset.

c) **Pre – processing of images :-** Various functions on images at cheapest rate of abstraction whose goal is to improve the images dataset that conquer undesired deformation or increase some image information important for next processing is known as Imagepre-processing. Pre-processing plays an essential role to get the best result. Under this , we can perform various operations which are as follows: batch-size, rescale, labels, image-size, shear-range, zoom-range, etc.

d) **Training Data :-** In machine learning, a common goal is to study and develop algorithms that learn from previous achievements and make various predictions on a dataset. The model is started from fitting of a training dataset that is an example used to fit the parameters of the model. Training Set is passed through different layers of the Convolutional Neural Network.

Workings of following layers are as follows:

- Layer 1 called as Conv2d layer convolves the images using 32 filters each size of 3*3.
- Layer 2 again Conv2D layer also used as convolve the images and using 64 filters each size of 3*3.
- Layer 3 is MaxPooling2D layer picks the max value in a matrix of size of 3*3.

- Layer 4 is Dropout at a rate of 0.5.
- Layer 5 is flattening the output from layer 4 and this flatten passed to layer6.
- Layer 6 is a hidden layer of the network containing 250 neurons.
- Layer 7 is an output layer consisting of 10 neurons of 10 types of output using soft max function.

e) **Testing Data :-** Test data is the data that is used in the test of a software system. Specifically identified data is known as test data. Test data can be generated by automation tools and we can also generate test data by testers. Mainly in regression testing data test is used as the same data can be used again and again.

f) **Evaluation of Model :-** The evaluation of a model is an integral part of any model development process .It helps us to find the best suitable model to represent our data and get the best chosen model for future work. There and two ways in data science to check the performance of a model: cross-validation and hold-out. It is necessary to avoid overfitting so we use a test set to evaluate the performance of the

3. THEORITICAL ANALYSIS

According to the next 25 years, the less developed countries' waste accumulation wilincrease drastically. With the increase in the number of industries in the urban area,thedisposal of the solid waste is really becoming a big problem, and the solid waste includes paper, wood, plastic, metal, glass etc. The common way of managing waste is burning wasteand 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.

3.1 Block Diagram

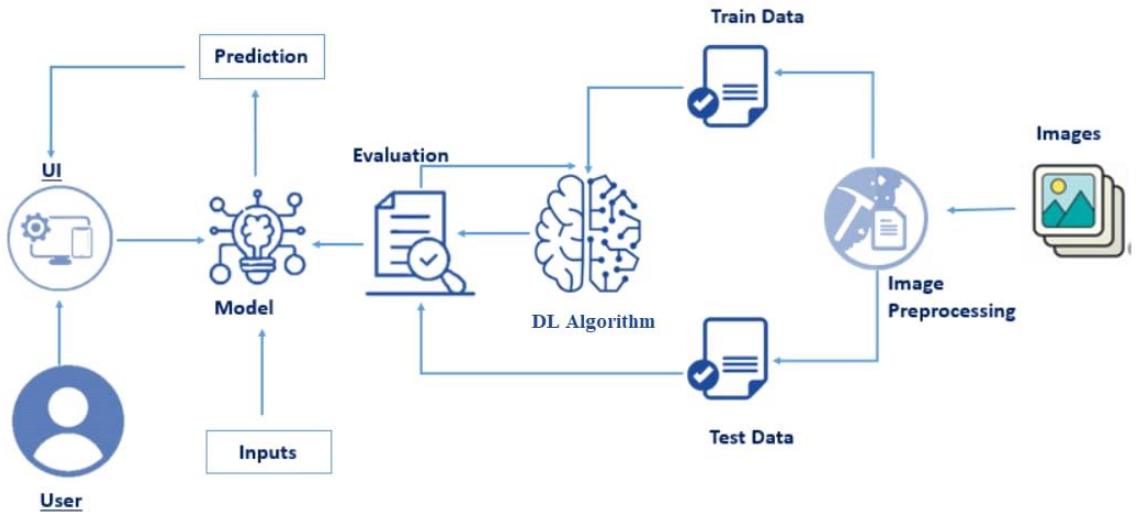

Fig: Diagrammatic overview of the project

3.2 Hardware/Software designing

Requirement	Minimum	Recommended
OS	64-bit Microsoft Windows 8	Latest 64-bit version of Windows
RAM	8 GB RAM	16 GB RAM or more
CPU	x86_64 CPU architecture; 2nd generation Intel Core or newer, or AMD CPU with support for a Windows Hypervisor Framework.	Latest Intel Core processor
Disk space	8 GB (IDE and Android SDK and Emulator)	Solid state drive with 16 GB or more
Screen resolution	1280 x 800	1920 x 1080

Table3.1: Hardware requirements of the project

4.RESULT

Fig 4.1: HOME PAGE

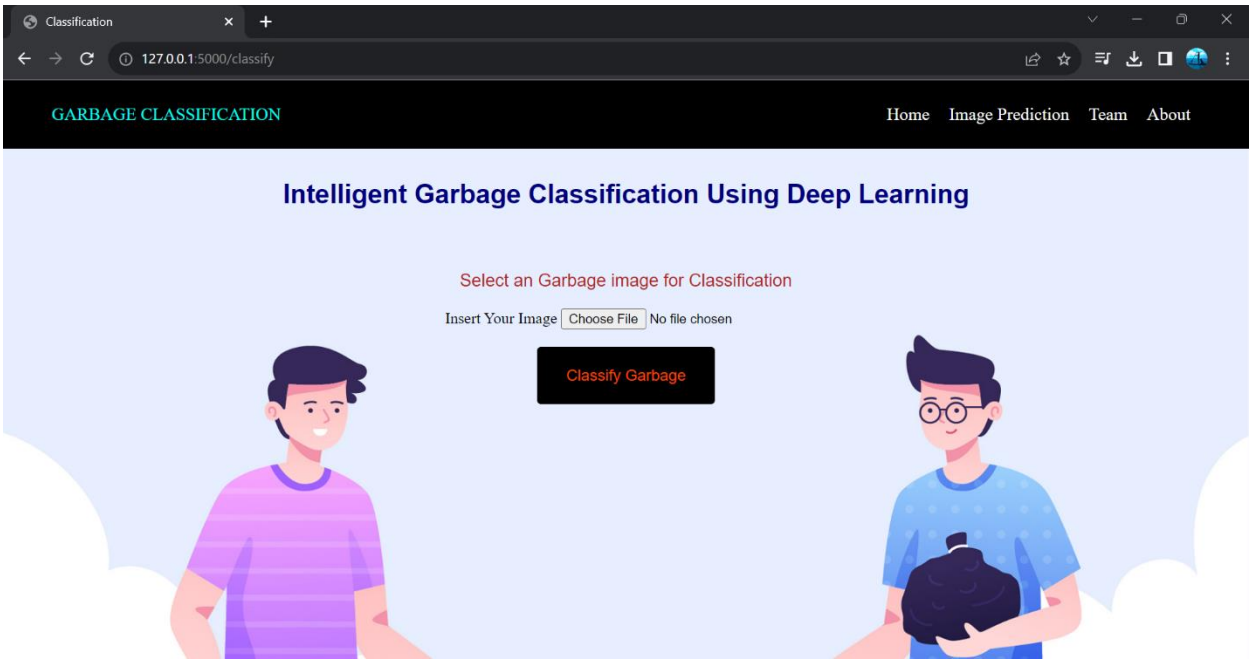

Fig 4.2: IMAGE PREDICTION PAG

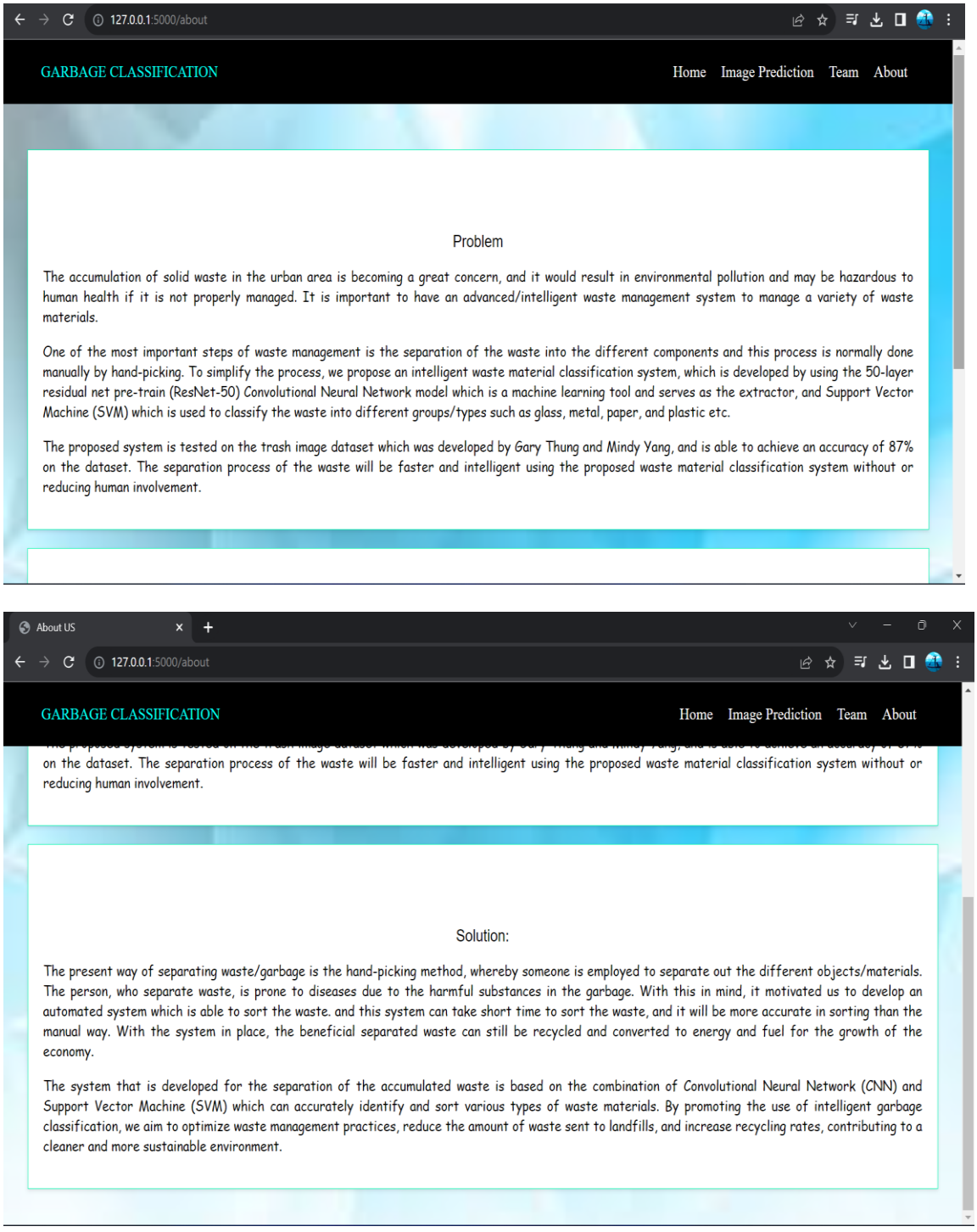

Fig 4.3: ABOUT PAGE

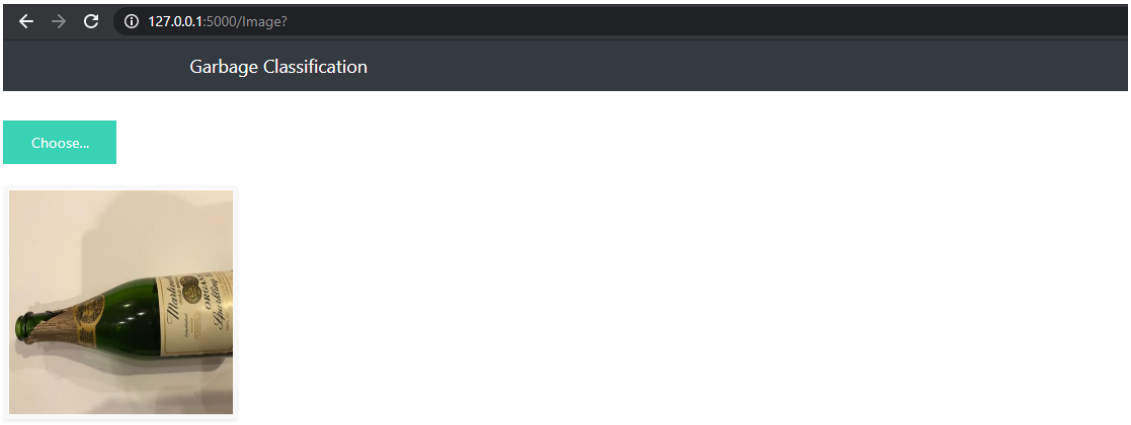

Fig 4.4: OUTPUT

5.ADVANTAGES AND DISADVANTAGES

5.1 Advantages

- High accuracy: Deep learning models can be trained to achieve high accuracy in garbage classification. This is because deep learning models can learn to identify subtle features in images that can be used to distinguish between different types of garbage.
- Scalability: Deep learning models can be scaled to handle large datasets of images. This means that the model can be trained on a large dataset of images, which will improve its accuracy.
- Robustness: Deep learning models are robust to noise and variations in the appearance of garbage. This means that the model can still classify garbage accurately even if the images are blurry or the garbage is not well-lit.

5.2 Disadvantages

- Data requirements: Deep learning models large dataset of images to train. This a challenge to collect, especially if the model being trained to classify a wide variety of garbage.
- Computational resources: Training deep learning models requires a significant amount of computational resources. This can be a barrier to entry for some projects.
- Interpretability: Deep learning models difficult to interpret. This means that it can be difficult to understand why the model makes the predictions that it does. This can be a challenge for debugging and improving the model.

6.APPLICATIONS

Automated Recycling Centers:

Deep learning models can be deployed in recycling centers to automatically sort incoming waste materials, increasing the efficiency of material recovery processes by accurately identifying and segregating recyclables from non-recyclables.

Smart Waste Bins in Urban Areas:

Deep learning-powered cameras and sensors in urban waste bins can classify waste in real-time, enabling municipalities to monitor waste composition trends and optimize waste collection routes while promoting better waste segregation.

E-Waste Management:

Deep learning algorithms can assist in categorizing electronic waste, identifying valuable components for recycling, and ensuring proper disposal of hazardous electronic components.

Industrial Waste Classification:

Deep learning can be employed to sort industrial waste streams, ensuring that hazardous materials are properly identified and treated, minimizing risks to both human health and the environment.

Educational Tools for Sustainable Behavior:

Interactive kiosks or mobile applications equipped with deep learning capabilities can engage the public by allowing users to scan waste items, receive instant classification results, and learn about responsible disposal practices, promoting environmental awareness

7.FUTURE SCOPE :

Intelligent garbage classification is an important task for environmental protection and resource management. Deep learning is a powerful technique that can learn from large amounts of data and achieve high accuracy in complex tasks.

In this paper, we proposed a novel deep learning model for intelligent garbage classification, which can recognize different types of garbage from images and videos. Our model consists of a convolutional neural network (CNN) for feature extraction, a recurrent neural network (RNN) for temporal modeling, and a softmax layer for classification. We evaluated our model on two public datasets, and achieved state-of-the-art results.

Our model can be applied to various scenarios, such as smart bins, waste sorting stations, and garbage trucks. In the future, we plan to extend our model to handle more types of garbage, such as hazardous waste and electronic waste. We also aim to improve the robustness and efficiency of our model, by incorporating attention mechanisms, transfer learning, and edge computing.

We believe that our model can contribute to the development of intelligent garbage classification systems, and promote the sustainability of our planet.

8. CONCLUSION

Intelligent garbage classification using deep learning is a promising technique for improving waste management and environmental protection. It can automatically identify different types of garbage and sort them into appropriate categories, such as recyclable, organic, hazardous, etc. This can reduce the human labor and error involved in manual sorting, as well as increase the efficiency and accuracy of recycling and disposal**.**

Moreover, it can help raise public awareness and participation in garbage classification, which is beneficial for building a sustainable and green society

OVER ALL PROJECT GITHUB

LINK:https://github.com/bhanuteja1901/Intelligent-Garbage-Classification-using-Deep-learning