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CLASSIFICATION OF GARBAGE USING LOW-LIGHT IMAGE ENHANCEMENT

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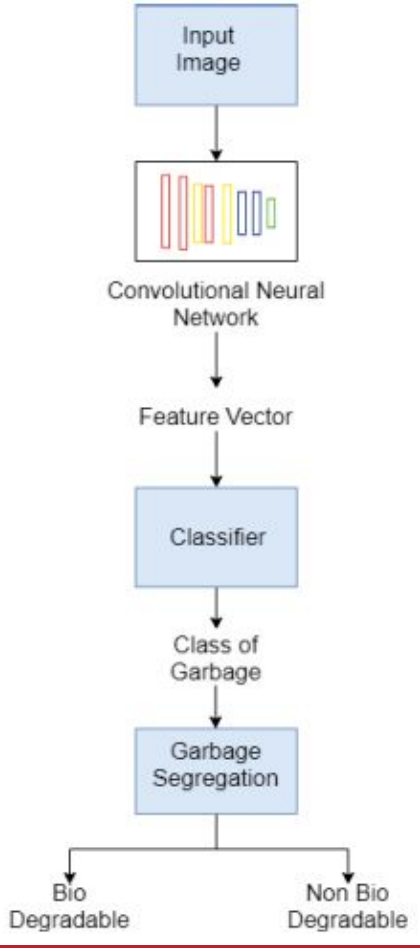
The Problem

Waste segregation refers to the separation of dry and wet garbage, which paves the way for other concepts of waste management like composting, recycling and incineration. Its end goal is to reduce waste from landfills and eventually, prevent land, water and air pollution.

India generates 62 million tonnes (MT) of waste every year, and only 43 MT is collected. Of the collected waste, close to 31 MT is dumped on landfill sites or water bodies and only 11.9 MT is scientifically treated.

The Solution

In the proposed approach, we have used deep learning to generate a representation of the image. For this, we have considered a Convolutional Neural Network (CNN) to extract features from the image. Then, classification is done using several supervised machine learning approaches. This determines the object in the image. Using this information, we segregate the waste in the image as biodegradable and non-biodegradable.


Input Image
Convolutional Neural Network
Feature Vector
Classifier
Class of Garbage
Garbage Segregation
Bio Degradable
Non Bio Degradable

Dataset

The dataset used for image enhancement contains 485 images for training and 15 for testing. We use 300 image pairs for training, and we use the remaining 185 image pairs for validation. We generate random crops of size 128 x 128 from the image pairs to be used for both training and validation.

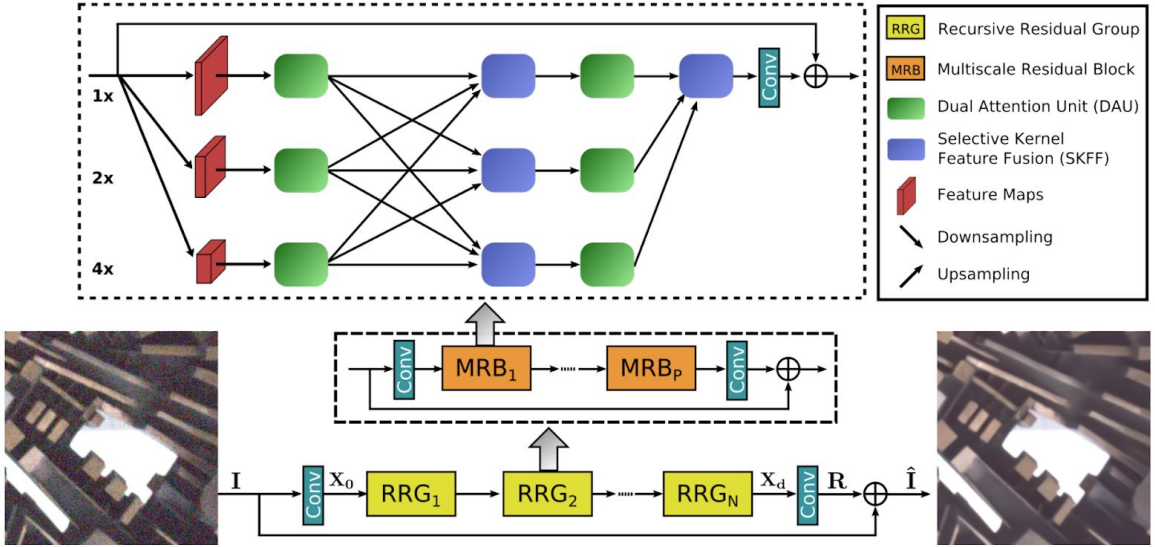
The dataset used for garbage classification are 2527 images, out of which 251 images were used for validation.

Methodology

We have used two CNN models namely MIRNet and TrashNet. MIRNet model is used for the low light image enhancement and the TrashNet model is used for the classification of the image into 6 classes of garbage (Cardboard, Glass, Metal, Paper, Plastic, General Trash) and two final group (biodegradable and nonbiodegradable).

The functions of these models are described in brief in the following slides:

MIRNet Model



TrashNet Model (Image Augmentation)

Functions of CNN Model

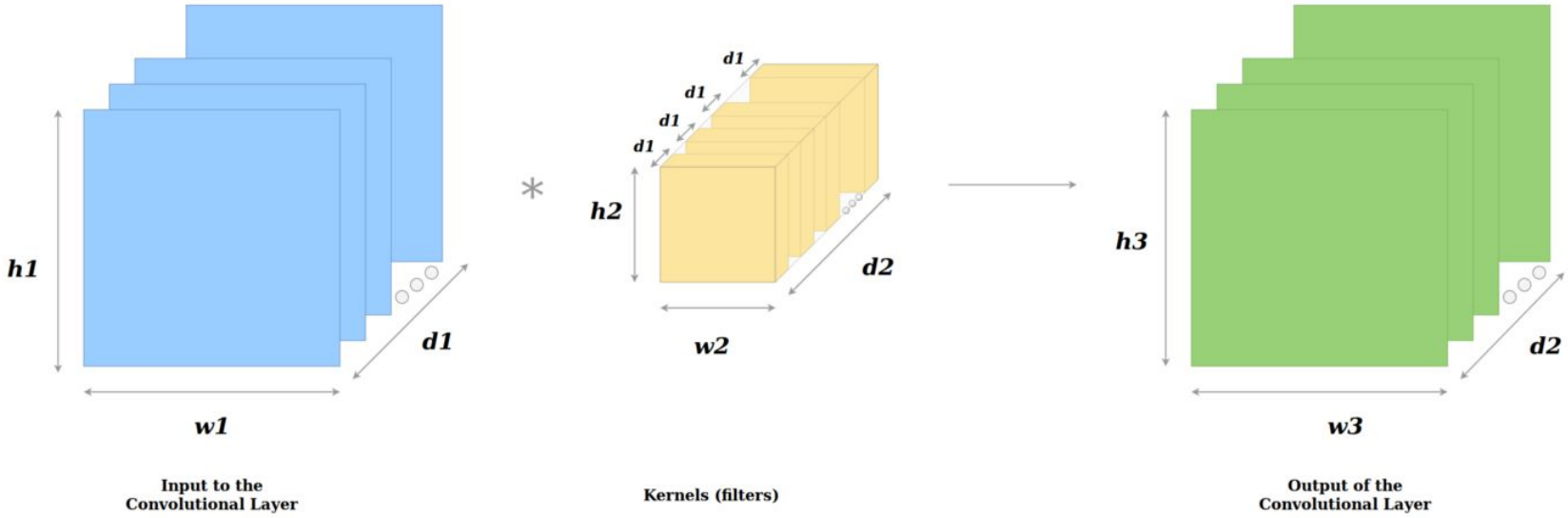
A CNN usually has 3 types of layers:

1) Convolutional Layer (CONV)

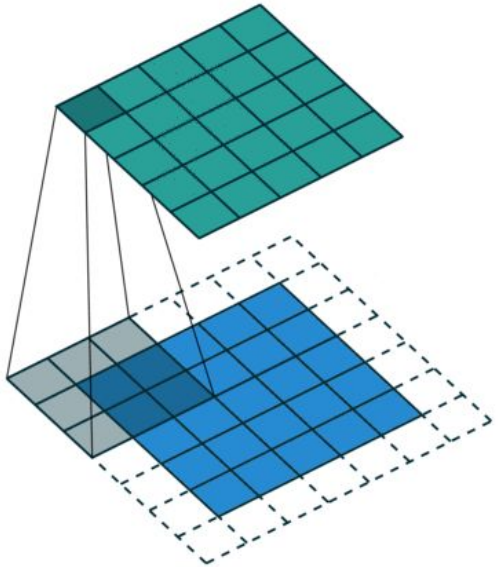
2) Pooling Layer (POOL)

3) Fully Connected Layer (FC)

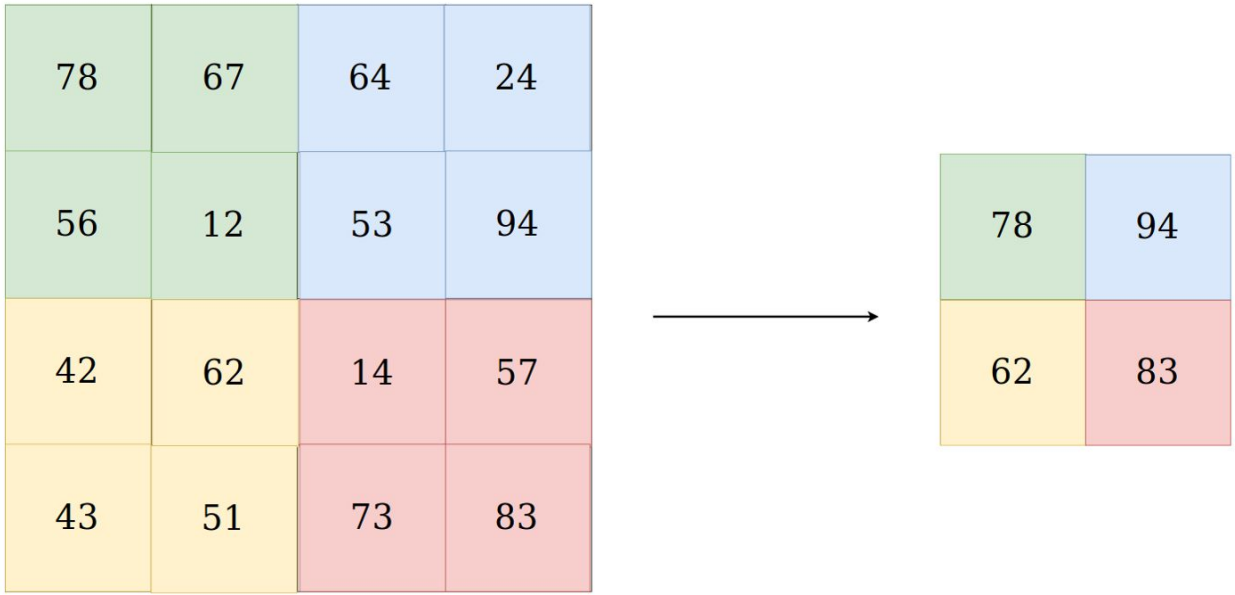
Convolutional Layer



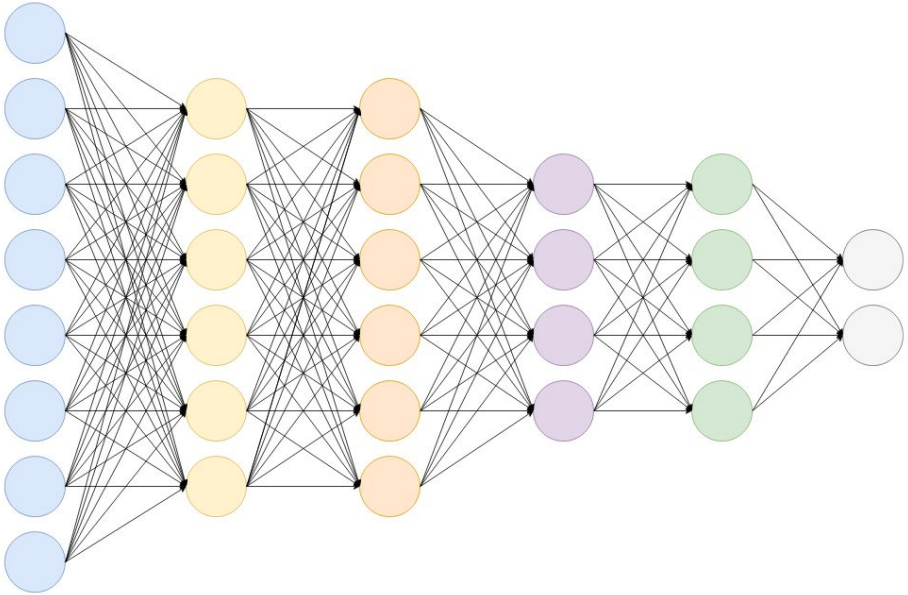
Convolutional Layer



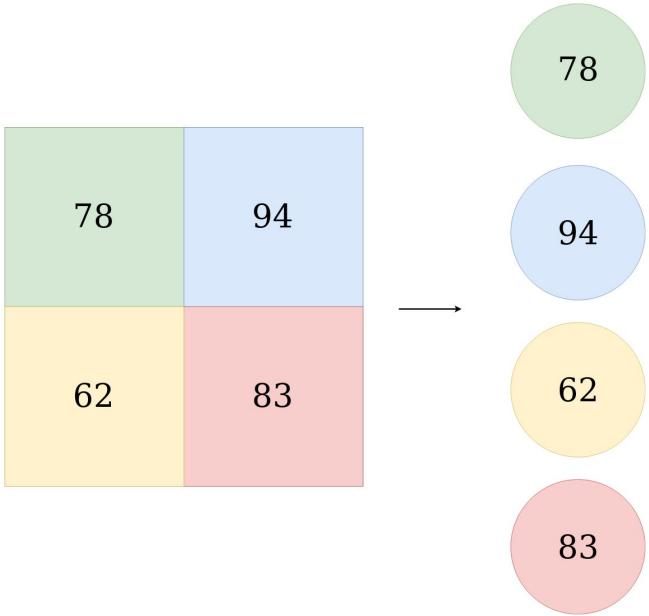
Pooling Layer



Fully Connected Layer



Flatten



TrashNet Results

With our TrashNet model we are able to classify images into 6 classes. (cardboard, paper, plastic, glass, metal, trash). We got accuracy of around 80% using clean well lit images. The remaining 251 images from the Gary-Mindy dataset were used for validating.

TrashNet Results

TrashNet Results

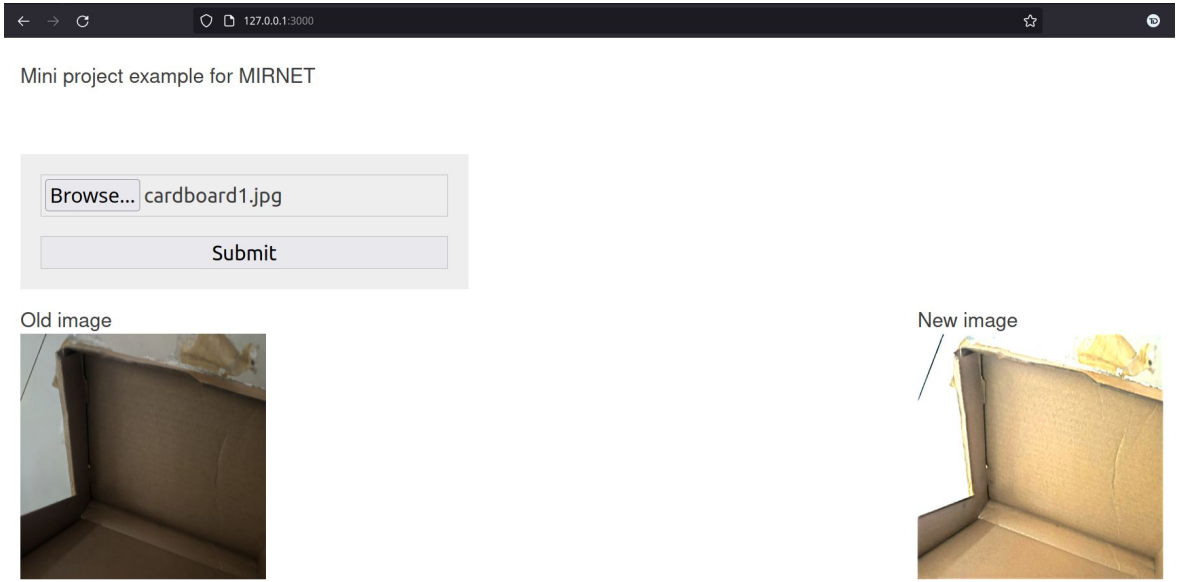
We also tested this again around 15 images of various items from our homes and with a dark environment the accuracy drops to around 35%, on the other hand passing the same set of 15 images through the MIRNet model and then running TrashNet on the batch gives us a accuracy of around 70%.

running on trash	running on output
36.36363636363637	72.72727272727273

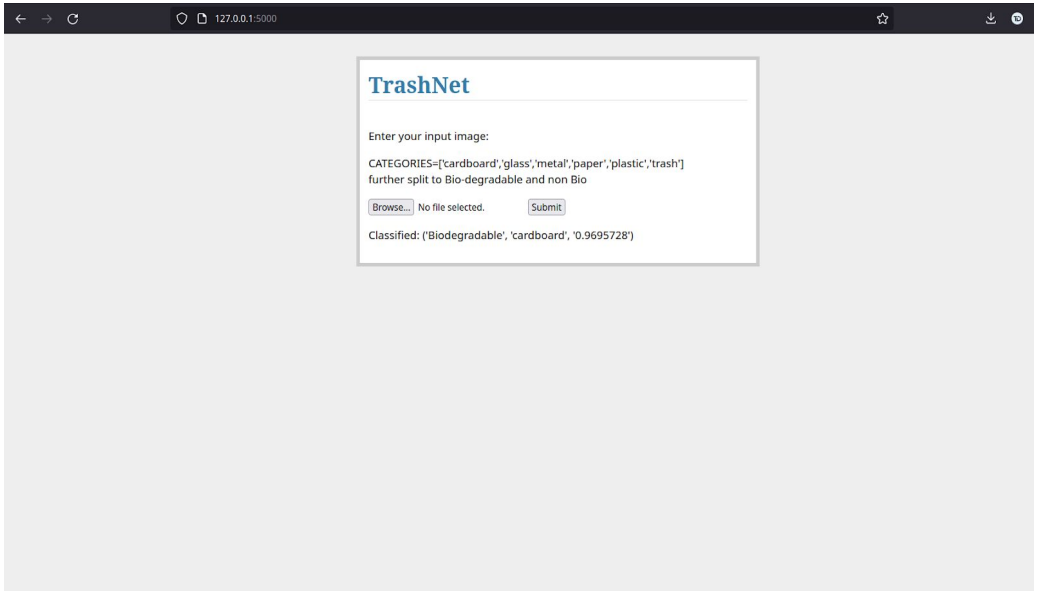
Connecting MIRNet and TrashNet

Both MIRNet and TrashNet expose a api, (running on different ports). For practical use, once the image is passed through the MIRNet model, we send a POST request to TrashNet api with our generated output file which then automatically run TrashNet on the image and returns the type of garbage and also mentions if it is biodegradable or non-biodegradable.

Web Interface of MIRNet



Web Interface of TrashNet



Results

Original

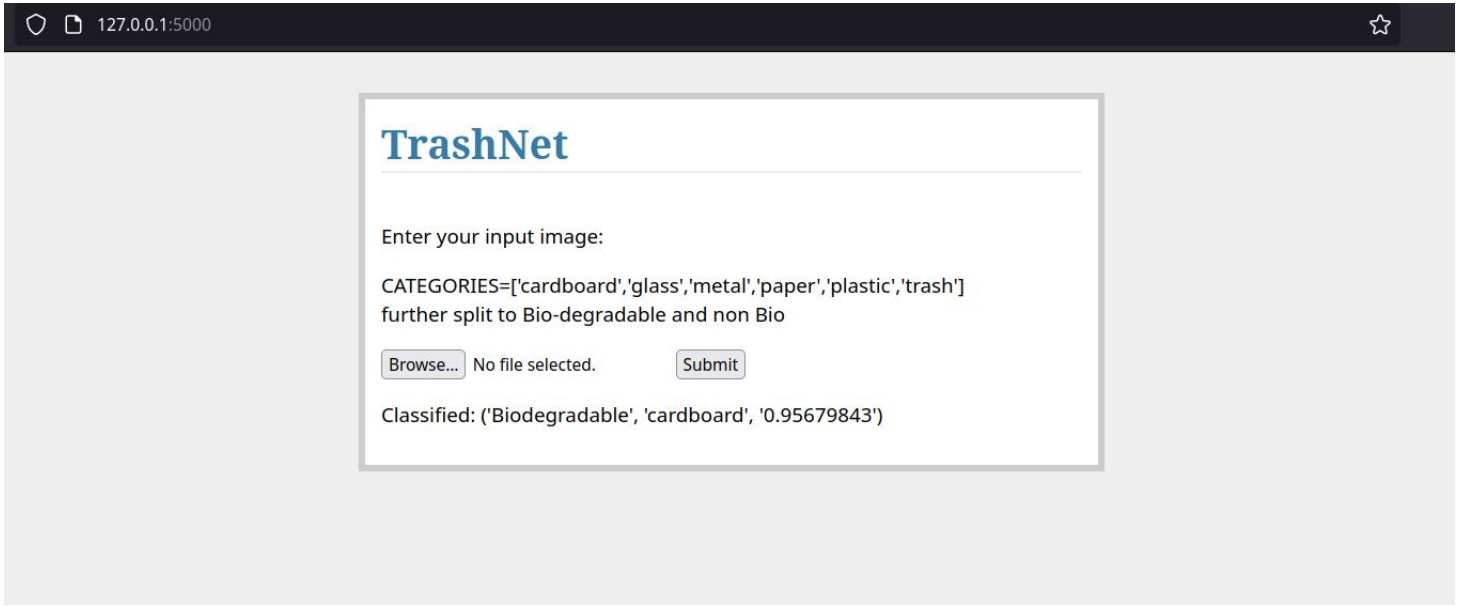
MIRNet Enhanced

Results


Results

```
p.shape: (1, 6)
prob 0.9695728
classified label: cardboard
('Biodegradable', 'cardboard', '0.9695728')
127.0.0.1 - - [04/Apr/2022 01:43:59] "POST / HTTP/1.1" 200 -
127.0.0.1 - - [04/Apr/2022 01:43:59] "GET /static/style.css HTTP/1.1" 3
04 -
```

Results


127.0.0.1:5000
TrashNet
Enter your input image:
CATEGORIES=['cardboard','glass','metal','paper','plastic','trash']
further split to Bio-degradable and non Bio
Browse...
No file selected.
Submit
Classified: ('Biodegradable', 'cardboard', '0.95679843')

Conclusion

We employed deep learning to construct a representation of the image in the suggested method. We used a Convolutional Neural Network (CNN) to extract features from the image for this. After that, multiple supervised machine learning algorithms are used to classify the data. The item in the image is determined by this. We divide the garbage in the image into biodegradable and non-biodegradable categories using this information.

Scope for Further Work

In the future, we would like to extend this project to identify and classify multiple objects from a single picture or video data. This could help recycling facilities more by processing a stream of recycling rather than single objects.

Thank You!