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Image Processing Technique for Biodegradable Waste Sorter and Composter

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ABSTRACT

Normally, sorting means identifying category of object and placing it at the desired location and is done manually. Now a days, the industrial sector is more intended towards the automation and reducing human efforts in many manual tasks. With the reference to today's need, this paper proposes the sorting of waste in two categories as biodegradable and non-biodegradable. This sorting mechanism is used for the automatic waste sorter and composter. Also the non-composting materials like paper, cardboard, plastic can be recycled which can be new business. The sorting of commonly available kitchen waste objects is done by using image processing technique which recognizes shape, texture, and color of waste. The recognition result is done by setting the proper satisfaction level of the filter which is decided after hundreds of tests. The sorter uses an image processing technique based on convolution neural networks (CNN) with the help of Tensor-Flow. This approach makes the sorting job easier and reduces time of process.

Key words: Image Processing, ReLU, Tensor-Flow, Waste sorter

INTRODUCTION

The waste comes from several sectors such as industrial waste and residential waste. In India, the major category of unplanned waste placement is in municipal corporations and this municipal corporation waste is majorly from residential areas of society. There is a tremendous lag in the proper management of waste collection from residential waste and as this waste has slow impact on nearby living objects, it is not focused a lot yet. Since a decade, India is concerning more regarding this kitchen waste and run a mission named SWATCH BHARAT. This paper proposes a smaller contribution to this mission and focuses on the part of kitchen waste which can be easily degraded in soil and used as fertilizer named compost.

The main issue with handling of kitchen waste is its segregation from the rest of non-degradable waste. Also, this waste is not available in categorized form and it is mostly tied in some plastic bags. To segregate it without a human help is a tough challenge.

A robotic arm can be trained by the help of image processing technique and some basic sensors as metal detection and thermal sensing. These can be employed to make this robotic arm as good as a human and this will reduce the diseases and long-term side effects on the bodies of labors who sort this waste.

The basic meaning of image processing refers to the processing of digital image and removing the noise from it. In this paper the image processing is used to detect the pattern of objects to be sorted and then the neural networks are used to

design a self-understanding program of identifying an image category.

SYSTEM DESCRIPTION

The width of base is 3000mm and height is 1500mm. The width provided is 500mm. Based on these dimensions, the design of conveyor belt and its bearing is decided. These bearings and conveyor belts are yet to be dispatched. Once the belt and bearings delivered, next task will be to start installation of robotic arm and hopper on the conveyor belt. The arm is to be trained to recognize difference between degradable and non-degradable waste. The library of number of photos is prepared to train the robotic arm to detect the material based on shape and colour of the material. Image processing technique will be used to perform this task.

In general, any digital image processing algorithm consists of three stages: input, processor, and output. In the input stage image is captured by a camera. It sent to a particular system to focus on a pixel of an image that's gives, its output as a processed image.

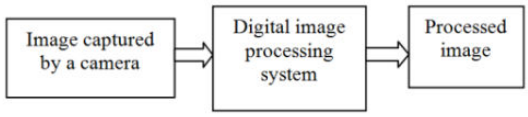


Fig. 1 Image processing process flow

The images from the library will be loaded via raspberry and then these will be recognized based on their shape and colour and moisture contain as it is degradable or non-degradable. This process will be done on multiple images of same material so that the sorting technique may identify the material more efficiently.

Redesigning of the Crusher and power calculations: -

Solar energy is required in proposed system for various applications listed below:

1) Sorter circuitry
2) Robotic arms
3) Crusher
4) Composter

The tentative energy requirement can be calculated for above sections of proposed system. The major part as per energy consumption is crusher as high torque will be required to it. This energy requirement can be calculated by assuming temporary dimensions of crusher.

1) Sorter Circuitry:

This section is a circuit consists of power electronics switches and less energy consuming parts whose voltage level is fixed at 5V and 12V DC and current carrying capacity is not more than 3- 4 Amps. The approximate power rating of this circuitry will be upto 20W.

2) Robotic arms: -

Electrically, these are nothing but stepper or servo motors.

Most popular stepper motor is Nema bipolar stepper motor which has 36N.cm holding torque and has rating of 2.8V, 1.68 Amps. Power consumption will be approximately 6W per motor.

For initial stage, assume 5 such motors will require for different processes. This means, power rating of robotic arms will not exceed 30W.

3) Crusher

Assume,

Radius of motor blades = 20cm = 0.2m

Total waste handling at a time = 10 kg

Total Degradable waste at a time = 6-7kg

For 3 cycles of operation in a day, waste handling in crusher = 2kg

Torque (T) = Force * radius

= Weight * gravity * radius

= 2* 9.81*0.2

3.924 Nm

Output Power = (Speed*Torque) / 9.55

= (100*3.924) / 9.55

= 41 W
Input Power= Output Power / efficiency
= 41/ 0.8
=50W (approx)

4) Composter: -

The composter will require periodically rotation action for movement of heap inside the tumbler. This can be done by DC motor as like in crusher. But, power usage of composter need not to be considered, because, crusher and composter working can be avoided at the same time.

CNN

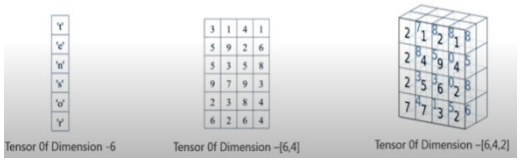
CNN is an effective image processing algorithm. These algorithms are currently the quality algorithms we have for automated image processing. Many agencies use these algorithms to do things like perceive items in an image.
Images include RGB combination data. Matplotlib can be used to import an image to reminiscence from a file. The computer does no longer see the image; all we see is a list of numbers. Color photographs are stored in three-dimensional sequences. The primary two dimensions correspond to the duration and width of the picture (quantity of pixels). The very last size corresponds to the crimson, inexperienced, and blue colors that are present in every pixel.

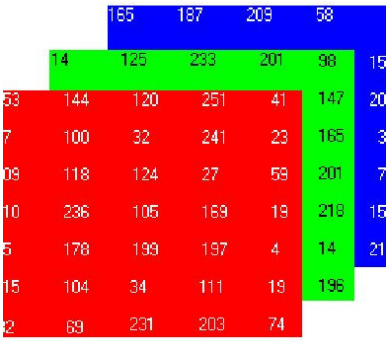
Three Layers of CNN: -

Convolution Neural networks specialize in programs for photograph and video recognition. CNN is extensively utilized in image analysis functions which include photo recognition, item detection and category.
There are three styles of layers in Convolution Neural Networks:
1) Transformation layout: In an average neural network every connecting neuron is connected to the subsequent hidden layer. At CNN, most effective a subset of neurons of the insertion layer connects to the hidden layer of neuron.
2) blend Layer: blend layer is used to lessen the scale of the characteristic map. There will be a couple of layers of software and integration within CNN's hidden layer.
3) completely connected Layer: fully linked Layers form the last few layers in a network. enter to a completely linked layer is the result from the final Pooling or Convolutional Layer, that's softened and located in a totally connected layer.

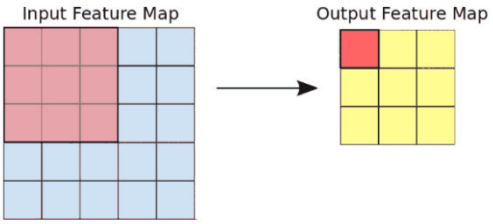
Tensor Flow: -

Tensor means multidimensional array. It can be any matrix formed array having three significant numbers at each spot. In this project, the image is divided as 156*156 arrays

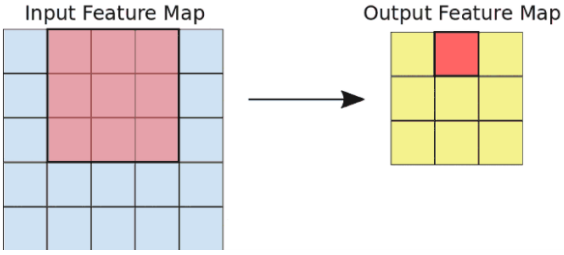




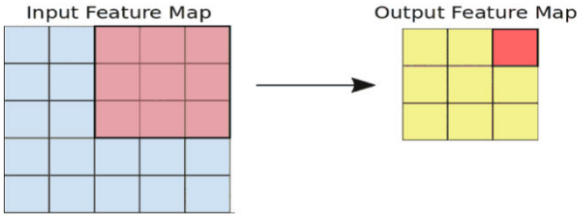
As shown in image above, any shade of color is formed by red, green and blue colour. There are 256 shades of each of these three. Hence, we have 256*256*256 shade possibilities at each pixel. This makes the uniqueness of the spot.
The CNN makes the operations like addition/multiplication of these spots arriving in one frame and then takes the output image.



As shown in the figure above, the input image is divided in 5*5 matrix. The CNN technique takes a frame of 3*3 in the input image and as shown in figure, this is reflected as 1 red box of the output image. This out image can be addition or multiplication of all 9 values of the input image.



This goes on for all possible 9 sets and then the output image map is constructed to get compared.



The output map has its uniqueness from the other image as the probability of recognizing all the possible color, characteristics, and shapes of any one object is identified.

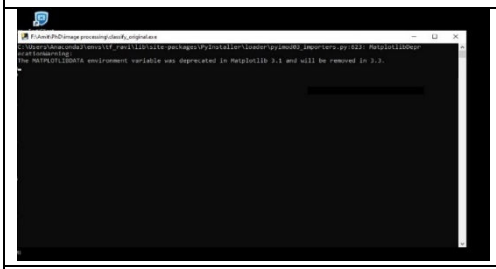
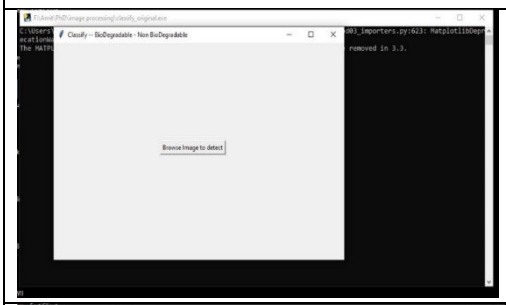
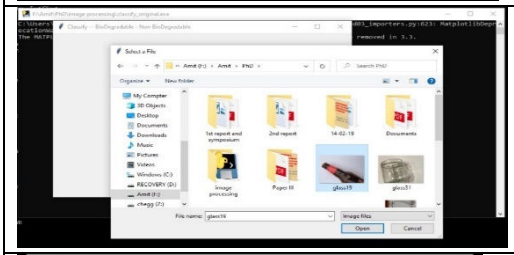
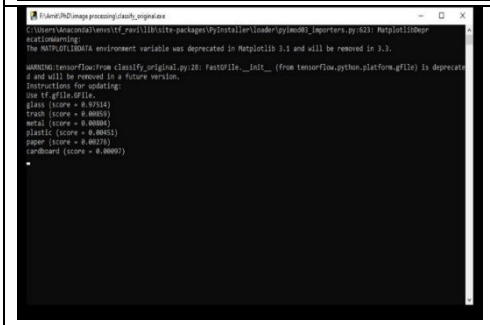
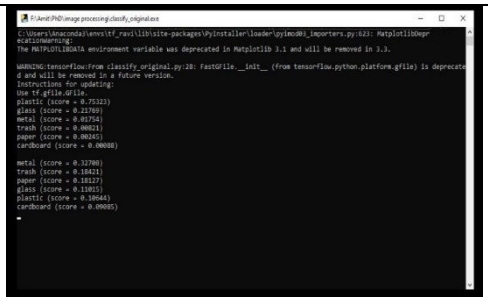
This kind of module can be trained for various images of same object to read the pattern of the same image.
glass objects - 501 images
Metal objects – 410 images
Plastic objects -482 images
trash objects -137 images
Cardboard – 403 images
Paper – 594 images
After training the module with these many objects, several images are tested and got following results.

RESULTS

Tensor flow code

```
import tensorflow as tf
import sys
import os

# Disable tensorflow compilation warnings
os.environ['TF_CPP_MIN_LOG_LEVEL']='2'
#Import tensorflow as tf
from tkinter import filedialog
from tkinter import *

root = Tk()
#root.withdraw()
#image_path = "testing4.jpg"
def browsefile():
```

```
image_path = filedialog.askopenfilename(initialdir = ".",
title = "Select a File",
filetypes = (("Image files",
"*.jpg*"),
("Image files",
"*.png*"),
("all files",
"*.*")))

if image_path:
print()

# Read the image_data
image_data = tf.gfile.FastGFile(image_path, 'rb').read()

# Loads label file, strips off carriage return
label_lines = [line.rstrip() for line
in tf.gfile.GFile("tf_files/retrained_labels.txt")]

# Unpersists graph from file
with tf.gfile.FastGFile("tf_files/retrained_graph.pb", 'rb') as f:
graph_def = tf.GraphDef()
graph_def.ParseFromString(f.read())
_ = tf.import_graph_def(graph_def, name='')

with tf.Session() as sess:
# Feed the image_data as input to the graph and get first prediction
softmax_tensor = sess.graph.get_tensor_by_name('final_result:0')

predictions = sess.run(softmax_tensor, \
{'DecodeJpeg/contents:0': image_data})

# Sort to show labels of first prediction in order of confidence
top_k = predictions[0].argsort()[-len(predictions[0]):][::-1]

for node_id in top_k:
human_string = label_lines[node_id]
score = predictions[0][node_id]
print('%s (score = %.5f)' % (human_string, score))

root.geometry('600x400')
root.title('Classify -- BioDegradable - Non BioDegradable')
B1 = Button(root,text = 'Browse Image to detect',command = browsefile)
B1.place(x=220,y=180)
root.mainloop()
```

Simulation images	**Description of process**
	This is anaconda prompt window which brows a tensor flow code of images
	This is a brows window which appears after program execution
	An image of glass bottle is loaded in the program
	The result appears as the maximum of 97% match with the trained 509 images of glass images and it detects as this object is a glass means Non biodegradable.
	Similarly few more images of a metal tool and plastic bottle are loaded and results shows that code is able to identify these objects as well.

CONCLUSION

The conclusion can be made from the above discussion as the sorting mechanism can be implemented in hardware by using the image processing technique and CNN.

The algorithm can be trained to the processor such as raspberry pi and the robotic arm can be inserted to use the sorting.

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