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CSE3999

Technical Answers for Real World Problems (TARP)

SMART GARBAGE SEPARATION SYSTEM

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Abstract

A Garbage Separation System is basically used for separation of the garbage into different categories such as Biodegradable wastes or Non-biodegradable wastes. And we are going to accomplished this using the Hue Moments to extract features and k-means clustering for training the model. For this system we are going to make the use of database of 1000 images.

1. Introduction

With the increase in population, the amount of waste produced is also increase at a huge rate. Indians alone are responsible for producing a hopping 220 million tons of waste a year. This number is far more than any other nation in the world. Because of this fact both the government and environmental associations have developed numerous methods of dealing with the problem. Waste management is that solution, a rather complex issue that encompasses more than 20 different industries. Waste management is collection, transportation, and disposal of garbage, sewage and other waste products.

Waste management is the process of treating solid wastes and offers variety of solutions for recycling items that dont belong to trash. It is about how garbage can be used as a valuable resource. Waste management is something that each and every household and business owner in the world needs. Waste management disposes of the products and substances that you have use in a safe and efficient manner.

We will find there are eight major groups of waste management methods, each of them divided into numerous categories. Those groups include source reduction and reuse, animal feeding, recycling, composting, fermentation, land- fills, incineration and land application. You can start using many techniques right at home, like reduction and reuse, which works to reduce the amount of disposable material used.

1.1. Landfills

Throwing daily waste/garbage in the landfills is the most popularly used method of waste disposal used today. This process of waste disposal focuses attention on burying the waste in the land. Landfills are commonly found in developing countries. There is a process used that eliminates the odors and dangers of waste before it is placed into the ground. While it is true this is the most popular form of waste disposal, it is certainly far from the only procedure and one that may also bring with it an assortment of space.

1.2. Incineration

Incineration or combustion is a type disposal method in which municipal solid wastes are burned at high temper- atures so as to convert them into residue and gaseous products. The biggest advantage of this type of method is that it can reduce the volume of solid waste to 20 to 30 percent of the original volume, decreases the space they take up and reduce the stress on landfills.

1.3. Recovery and Recycling

Resource recovery is the process of taking useful dis- carded items for a specific next use. These discarded items are then processed to extract or recover materials and re- sources or convert them to energy in the form of useable heat, electricity or fuel.
Recycling is the process of converting waste products into new products to prevent energy usage and consumption of fresh raw materials. Recycling is the third component of Reduce, Reuse and Recycle waste hierarchy. The idea be- hind recycling is to reduce energy usage, reduce volume of landfills, reduce air and water pollution, reduce greenhouse gas emissions and preserve natural resources for future use

1.4. Plasma Gasification

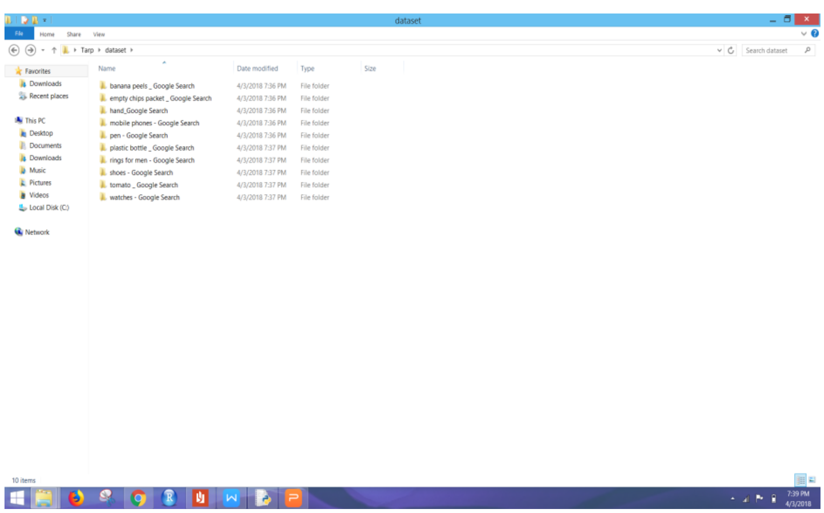
Plasma gasification is another form of waste manage- ment. Plasma is a primarily an electrically charged or a highly ionized gas. Lighting is one type of plasma which produces temperatures that exceed 12,600 F. With this

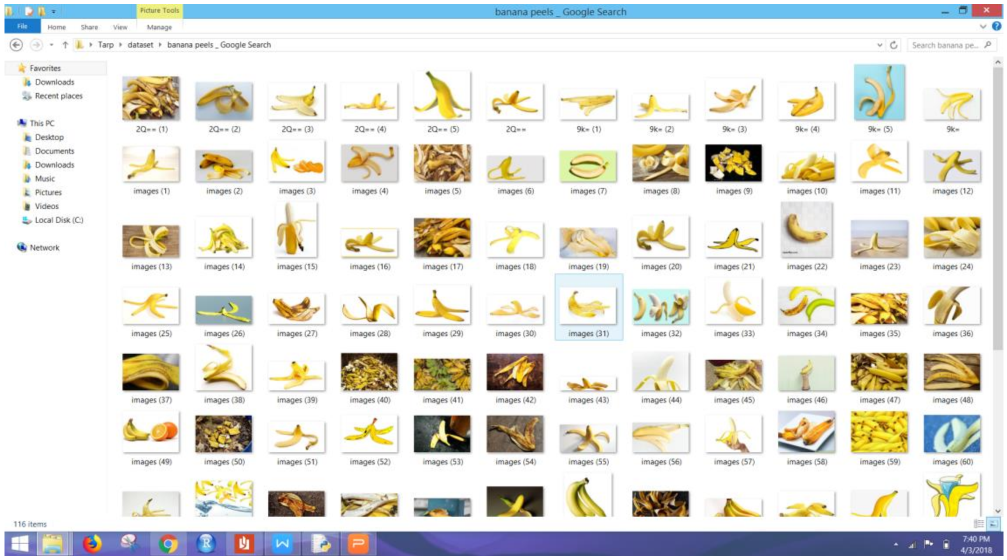
1.5. Composting

Composting is an easy and natural bio-degradation process that takes organic wastes i.e. remains of plants and garden and kitchen waste and turns into nutrient rich food for your plants. Composting, normally used for organic farming, occurs by allowing organic materials to sit in one place for months until microbes decompose it. Composting is one of the best method of waste disposal as it can turn unsafe organic products into safe compost. On the other side, it is slow process and takes lot of space.

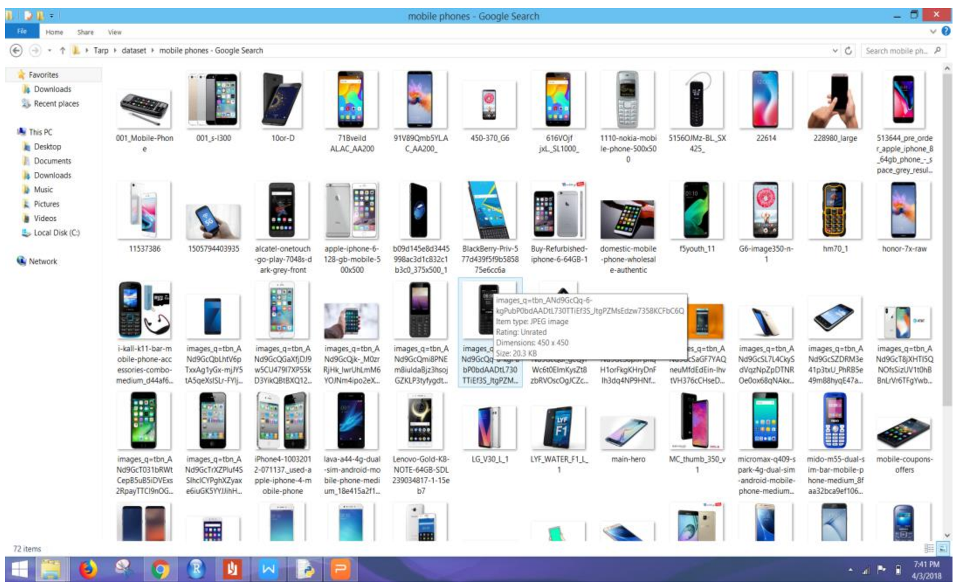
2. Database

So we need a large database around 1000 images. As we increase the number of images in the database, the size of feature vector will be also increase as a result the efficiency of our system will also increases. Our image database is completely divided into 10 categories namely - hand , banana , tomato , watch , pen , shoe , chips packet , mobile phone , rings .

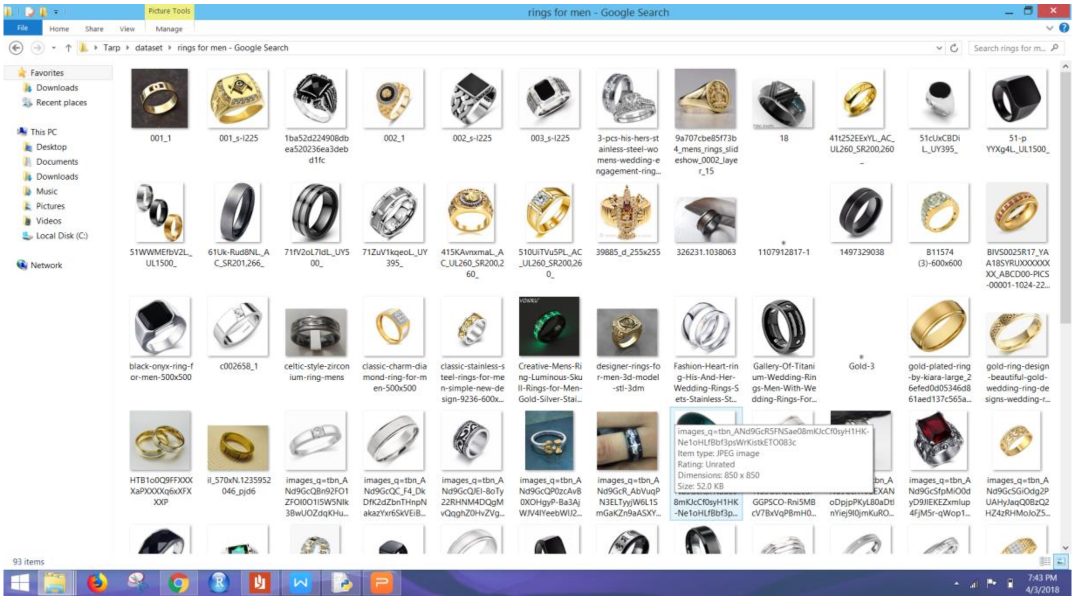




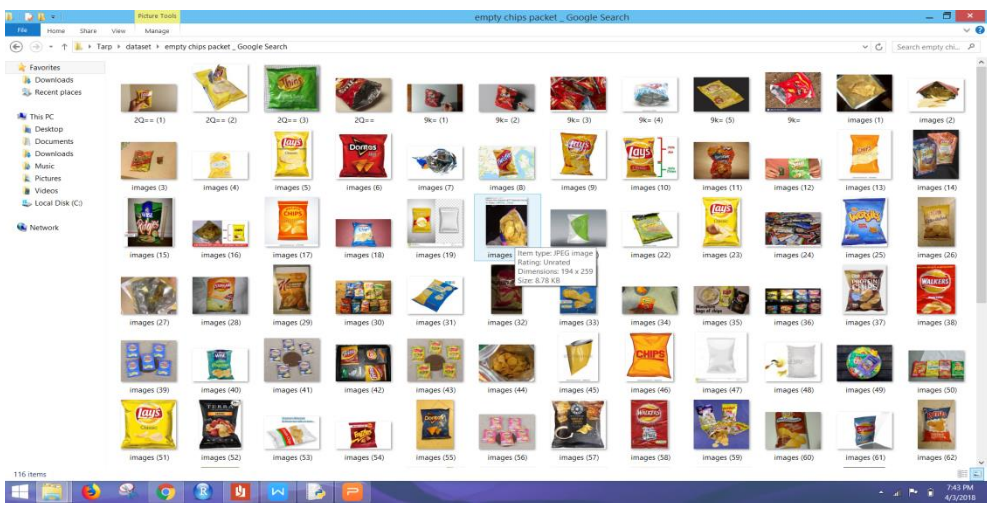
Banana_peels category



Mobile phone category Category



Rings for men Category



Empty Chips Category

3) Proposed Work

In this paper, we make the use of two algorithms in order to separate the garbage into Biodegradable waste and Non- Biodegradable waste. We make the use of Contours to detect the shape and and hue moments to extract out features of the image detected by live video feed . These features are trained using K-means clustering to detect weather the object detected is biodegradable or non-biodegradable and stored in a .csv file .The process is repeated for all the images the dataset.

3.1) Contours for Object Detection

Objects are characterized by their appearance, especially their texture, and by the shape of their contours. To make a detection we first extract edge contours E from an image using the Berkeley edge detector. We sample N interest points locations $x_1,\ldots, x_N$ uniformly along contours. At each of the locations we compute our oriented bar contour representation $b_1,\ldots,b_N$ and the texture-based geometric blur features $g_1,\ldots,g_N$. The details of these local image descriptors are. We then concatenate the descriptors at the i-th interest point into a feature vector $f_i = (b_i , g_i)$.For each of the features f_i in the test image, we find a nearest neighbor $\hat{f}_i$ in a training set. We use euclidean distance for matching and a kd-tree to make the retrieval efficient.

To represent object contours, it is important to capture local curvature as well as junctions of various degrees and angles. Thus, we seek a non-parametric representation that describes contours at an interest point as a distribution over oriented line segments, or bars. The oriented bars are a set of filters $F_1,\ldots,F_D$ that have a line segment with one endpoint in the filter center and orientation angle $\theta \in [0,2\pi]$. We create the filters by rendering a line of length L and blurring it with a Gaussian. This works to offset the discretization effects of orientation angles; a smoothed line will give a partial response to a contour that has almost the same angle. The edge map E is convolved with each of the oriented bar filters, creating D channels of contour orientation responses .

3.2) Hue Moments for Extracting Features

The non-orthogonal centralised moments are translation invariant and can be normalised with respect to changes in scale. However, to enable invariance to rotation they require reformulation. Hu described two different methods for producing rotation invariant moments. The first used a method called principal axes, however it was noted that this method can break down when images do not have unique principal axes. Such images are described as being rotationally symmetric. The second method Hu described is the method of absolute moment invariants and is discussed here. Hu derived these expressions from algebraic invariants applied to the moment generating function under a rotation transformation. They consist of groups of nonlinear centralised moment expressions. The result is a set of absolute orthogonal (i.e. rotation) moment invariants, which can be used for scale, position, and rotation invariant pattern identification. These were used in a simple pattern recognition experiment to successfully identify various typed characters. They are computed from normalized centralized moments up to order three and are shown below.
There are a total of 7 hue moments that can be generated from an image :-

$$
\begin{aligned}
I_1 &= \eta_{20} + \eta_{02} \\
I_2 &= (\eta_{20} - \eta_{02})^2 + 4\eta_{11}^2 \\
I_3 &= (\eta_{30} - 3\eta_{12})^2 + (3\eta_{21} - \eta_{03})^2 \\
I_4 &= (\eta_{30} + \eta_{12})^2 + (\eta_{21} + \eta_{03})^2 \\
I_5 &= (\eta_{30} - 3\eta_{12})(\eta_{30} + \eta_{12})[(\eta_{30} + \eta_{12})^2 - 3(\eta_{21} + \eta_{03})^2] + (3\eta_{21} - \eta_{03})(\eta_{21} + \eta_{03})[3(\eta_{30} + \eta_{12})^2 - (\eta_{21} + \eta_{03})^2] \\
I_6 &= (\eta_{20} - \eta_{02})[(\eta_{30} + \eta_{12})^2 - (\eta_{21} + \eta_{03})^2] + 4\eta_{11}(\eta_{30} + \eta_{12})(\eta_{21} + \eta_{03}) \\
I_7 &= (3\eta_{21} - \eta_{03})(\eta_{30} + \eta_{12})[(\eta_{30} + \eta_{12})^2 - 3(\eta_{21} + \eta_{03})^2] - (\eta_{30} - 3\eta_{12})(\eta_{21} + \eta_{03})[3(\eta_{30} + \eta_{12})^2 - (\eta_{21} + \eta_{03})^2].
\end{aligned}
$$

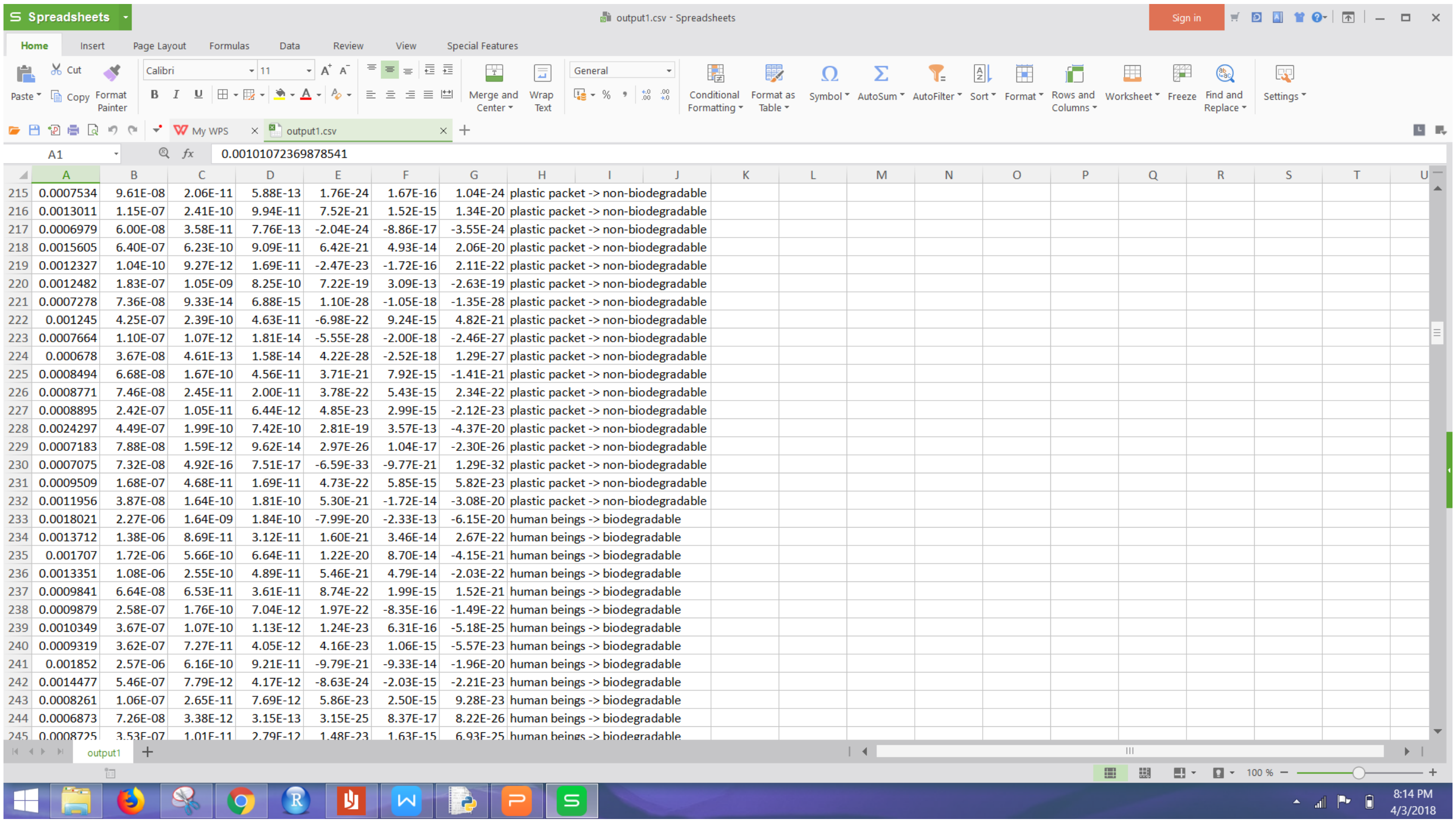
3.3)K-means clustering for training the data

k-means clustering is a method of vector quantization, originally from signal processing, that is popular for cluster analysis in data mining. *k*-means clustering aims to partition *n* observations into *k* clusters in which each observation belongs to the cluster with the nearest mean, serving as a prototype of the cluster. This results in a partitioning of the data space into Voronoi cells.

The problem is computationally difficult (NP-hard); however, there are efficient heuristic algorithms that are commonly employed and converge quickly to a local optimum. These are usually similar to the expectation-maximization algorithm for mixtures of Gaussian distributions via an iterative refinement approach employed by both *k*-means and Gaussian Mixture Modeling. Additionally, they both use cluster centers to model the data; however, *k*-means clustering tends to find clusters of comparable spatial extent, while the expectation-maximization mechanism allows clusters to have different shapes.

The algorithm has a loose relationship to the *k*-nearest neighbor classifier, a popular machine learning technique for classification that is often confused with *k*-means because of the *k* in the name. One can apply the 1-nearest neighbor classifier on the cluster centers obtained by *k*-means to classify new data into the existing clusters. This is known as nearest centroid classifier or Rocchio algorithm.

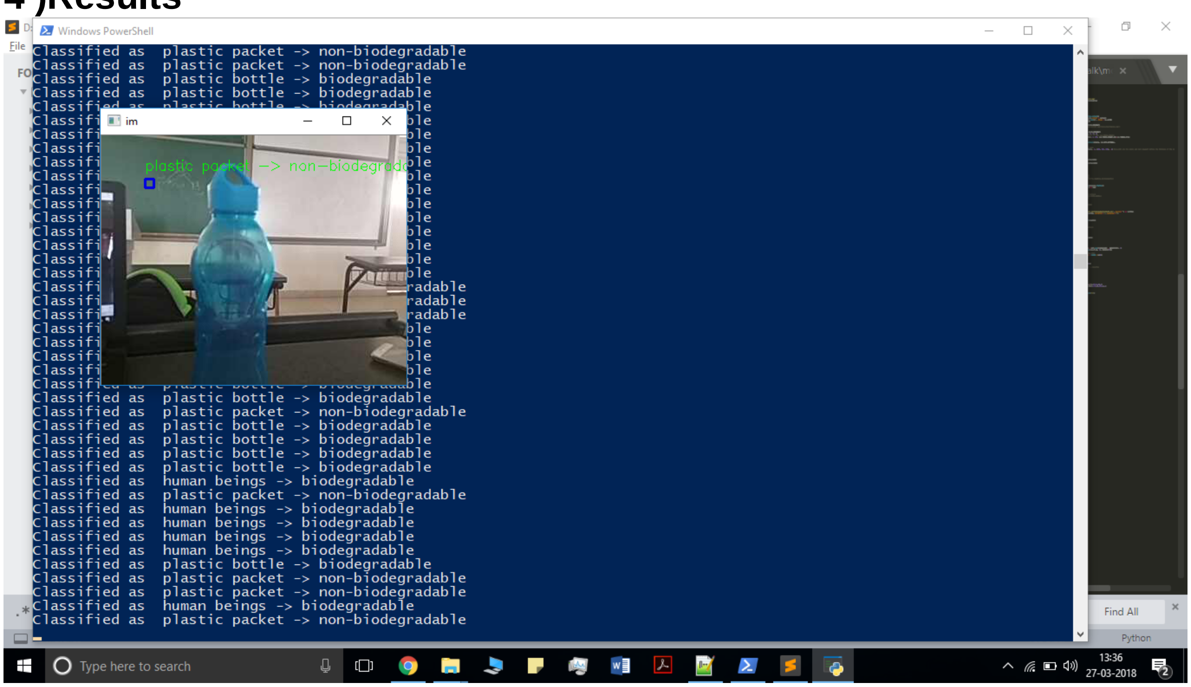
The procedure follows a simple and easy way to classify a given data set through a certain number of clusters (assume k clusters) fixed a priori. The main idea is to define k centroids, one for each cluster. These centroids shoud be placed in a cunning way because of different location causes different result. So, the better choice is to place them as much as possible far away from each other. The next step is to take each point belonging to a given data set and associate it to the nearest centroid. When no point is pending, the first step is completed and an early groupage is done. At this point we need to re-calculate k new centroids as barycenters of the clusters resulting from the previous step. After we have these k new centroids, a new binding has to be done between the same data set points and the nearest new centroid. A loop has been generated. As a result of this loop we may notice that the k centroids change their location step by step until no more changes are done.

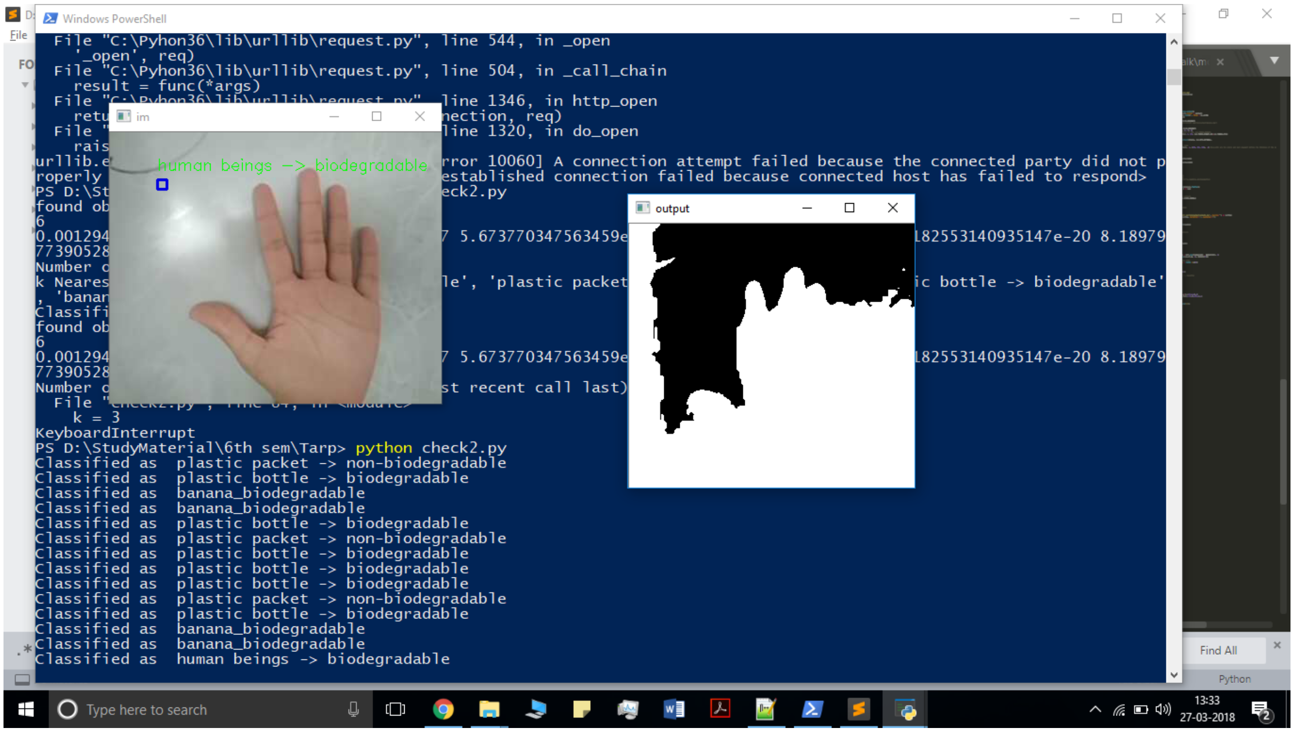


	A	B	C	D	E	F	G	H
215	0.0007534	9.61E-08	2.06E-11	5.88E-13	1.76E-24	1.67E-16	1.04E-24	plastic packet -> non-biodegradable
216	0.0013011	1.15E-07	2.41E-10	9.94E-11	7.52E-21	1.52E-15	1.34E-20	plastic packet -> non-biodegradable
217	0.0006979	6.00E-08	3.58E-11	7.76E-13	-2.04E-24	-8.86E-17	-3.55E-24	plastic packet -> non-biodegradable
218	0.0015605	6.40E-07	6.23E-10	9.09E-11	6.42E-21	4.93E-14	2.06E-20	plastic packet -> non-biodegradable
219	0.0012327	1.04E-10	9.27E-12	1.69E-11	-2.47E-23	-1.72E-16	2.11E-22	plastic packet -> non-biodegradable
220	0.0012482	1.83E-07	1.05E-09	8.25E-10	7.22E-19	3.09E-13	-2.63E-19	plastic packet -> non-biodegradable
221	0.0007278	7.36E-08	9.33E-14	6.88E-15	1.10E-28	-1.05E-18	-1.35E-28	plastic packet -> non-biodegradable
222	0.001245	4.25E-07	2.39E-10	4.63E-11	-6.98E-22	9.24E-15	4.82E-21	plastic packet -> non-biodegradable
223	0.0007664	1.10E-07	1.07E-12	1.81E-14	-5.55E-28	-2.00E-18	-2.46E-27	plastic packet -> non-biodegradable
224	0.000678	3.67E-08	4.61E-13	1.58E-14	4.22E-28	-2.52E-18	1.29E-27	plastic packet -> non-biodegradable
225	0.0008494	6.68E-08	1.67E-10	4.56E-11	3.71E-21	7.92E-15	-1.41E-21	plastic packet -> non-biodegradable
226	0.0008771	7.46E-08	2.45E-11	2.00E-11	3.78E-22	5.43E-15	2.34E-22	plastic packet -> non-biodegradable
227	0.0008895	2.42E-07	1.05E-11	6.44E-12	4.85E-23	2.99E-15	-2.12E-23	plastic packet -> non-biodegradable
228	0.0024297	4.49E-07	1.99E-10	7.42E-10	2.81E-19	3.57E-13	-4.37E-20	plastic packet -> non-biodegradable
229	0.0007183	7.88E-08	1.59E-12	9.62E-14	2.97E-26	1.04E-17	-2.30E-26	plastic packet -> non-biodegradable
230	0.0007075	7.32E-08	4.92E-16	7.51E-17	-6.59E-33	-9.77E-21	1.29E-32	plastic packet -> non-biodegradable
231	0.0009509	1.68E-07	4.68E-11	1.69E-11	4.73E-22	5.85E-15	5.82E-23	plastic packet -> non-biodegradable
232	0.0011956	3.87E-08	1.64E-10	1.81E-10	5.30E-21	-1.72E-14	-3.08E-20	plastic packet -> non-biodegradable
233	0.0018021	2.27E-06	1.64E-09	1.84E-10	-7.99E-20	-2.33E-13	-6.15E-20	human beings -> biodegradable
234	0.0013712	1.38E-06	8.69E-11	3.12E-11	1.60E-21	3.46E-14	2.67E-22	human beings -> biodegradable
235	0.001707	1.72E-06	5.66E-10	6.64E-11	1.22E-20	8.70E-14	-4.15E-21	human beings -> biodegradable
236	0.0013351	1.08E-06	2.55E-10	4.89E-11	5.46E-21	4.79E-14	-2.03E-22	human beings -> biodegradable
237	0.0009841	6.64E-08	6.53E-11	3.61E-11	8.74E-22	1.99E-15	1.52E-21	human beings -> biodegradable
238	0.0009879	2.58E-07	1.76E-10	7.04E-12	1.97E-22	-8.35E-16	-1.49E-22	human beings -> biodegradable
239	0.0010349	3.67E-07	1.07E-10	1.13E-12	1.24E-23	6.31E-16	-5.18E-25	human beings -> biodegradable
240	0.0009319	3.62E-07	7.27E-11	4.05E-12	4.16E-23	1.06E-15	-5.57E-23	human beings -> biodegradable
241	0.001852	2.57E-06	6.16E-10	9.21E-11	-9.79E-21	-9.33E-14	-1.96E-20	human beings -> biodegradable
242	0.0014477	5.46E-07	7.79E-12	4.17E-12	-8.63E-24	-2.03E-15	-2.21E-23	human beings -> biodegradable
243	0.0008261	1.06E-07	2.65E-11	7.69E-12	5.86E-23	2.50E-15	9.28E-23	human beings -> biodegradable
244	0.0006873	7.26E-08	3.38E-12	3.15E-13	3.15E-25	8.37E-17	8.22E-26	human beings -> biodegradable
245	0.0008725	3.53E-07	1.01E-11	2.79E-12	1.48E-23	1.63E-15	6.93E-25	human beings -> biodegradable

csv file created by training of dataset

4)Results





5) Conclusion

This project has highlighted the need of a new garbage separation technique which make the image feature extraction and training by k-means clustering . Our model is able to detect the paper and having the accuracy of about 65%-70% .

6) References

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- India
- http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.3.3101&rep=rep1&type=pdf
- IOT Smart Garbage Monitoring System in Cities-An Effective Way to Promote Smart City Palaghat Yaswanth Sai Department of Computer Science and Engineering, Narayana Engineering College, Gudur, Andhra Pradesh, India method of waste disposal, a vessel uses characteristic plasma torches operating at +10,000 F which is creating a gasifica- tion zone till 3,000 F for the conversion of solid or liquid wastes into a Syngas.

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