ARTIFICIAL INTELLIGENCE BASED SMART DUSTBIN COLLECTOR FOR SUSTAINABLE ENVIRONMENT

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Abstract- In the present days, the public are providing much waste in and around their houses. The waste can be categorized as biodegradable and non biodegradable. The biodegradable wastes are those degrade or break down naturally. Material such as plants, fruits, vegetable, animals, flower and paper are fall under biodegradable waste that can be used to generate energy and fertilizer for plants. At the same time the items such as rubber, plastic, chemicals and plastic are fall under non biodegradable waste that can be recycled to produce new items. At present the municipality has placed three different types of dustbin such as red, green and blue. The red dustbin is used to collect household wastage, green dustbin is to collect recycle material and blue dustbin for degradable material and dry garbage. The public needs to place the waste in corresponding dustbin which can't be monitor. To overcome this problem the image classification algorithm is applied using TensorFlow in executing digital image processing to find the corresponding champers for waste collection.

Index Terms- Biodegradable, Non Biodegradable, TensorFlow, Image Classification

I. Introduction

This paper is focused to predict the waste item category by capturing image and collects in separate champers. The camera placed inside the dustbin will capture the image of the waste item. The Raspberry pi helps to compare the image with the dataset in the cloud. The Artificial Intelligence concept is applied to train itself to find the captured waste item category. The image classification algorithm is applied using TensorFlow in executing digital image processing to find the corresponding champers for waste collection. The TensorFlow is a Python friendly open source library for numerical computation that makes machine learning concepts in an efficient manner. The algorithm will be trained with all types of waste material and thus while throwing the waste into the dustbin, it get predicted and as per the prediction the corresponding chamber opens to collect waste. The project helps in collecting waste in different chambers by detecting biodegradable and non biodegradable waste. The manual collection of waste can be overcome therefore the collection of waste can be computerized and accuracy level will be more. This will decrease the percentage of non biodegradable waste into land which increases the land water and overcome the pollution. The waste management places a vital role in Smart city and Clean India mission that can be achieved by separating the solid waste into two medium and make use of those waste effectively for recycling and energy production.

II. IDENTIFY, RESEARCH AND COLLECT IDEA

Most recyclable waste ends up in a dump yard due to the lack of efficient waste management. Waste management rules in India are based on the principles of "sustainable development", "precaution" and "polluter pays". These principles mandate municipalities and commercial establishments to act in an environmentally accountable and responsible manner—restoring balance, if their actions disrupt it. The increase in waste generation as a by-product of economic development has led to various subordinate legislations for regulating the manner of disposal and dealing with generated waste are made under the umbrella law of Environment Protection Act, 1986 (EPA). Specific forms of waste are the subject matter of separate rules and require separate compliances, mostly in the nature of authorisations, maintenance of records and adequate disposal mechanisms.

With rapid urbanisation, the country is facing massive waste management challenge. Over 377 million urban people live in 7,935 towns and cities and generate 62 million tonnes of municipal solid waste per annum. Only 43 million tonnes (MT) of the waste is collected, 11.9 MT is treated and 31 MT is dumped in landfill sites. Solid Waste Management (SWM) is one among the basic essential services provided by municipal authorities in the country to keep urban centres clean. However, almost all municipal authorities deposit solid waste at a dump yard within or outside the city haphazardly. Experts believe that India is following a flawed system of waste disposal and management.

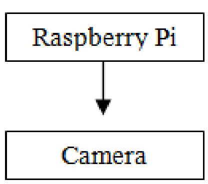
All those wastes can be used almost 99 % in an effective manner without ends up in landfills. This can be achieved by separating the waste into two different medium as recycle and energy generated. This research is focused on this area to make India as a success in Smart City mission and Clean India.

In Tamil Nadu more than 59 % of waste ends up in landfills that contaminate the soil, ground water and emit dangerous green house gases. Manual separation of biodegradable and non biodegradable wastes can't succeed.

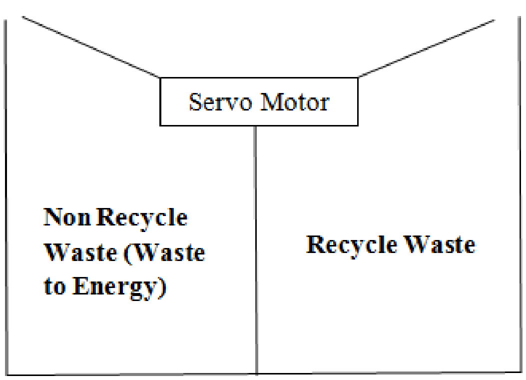
The TN government constructs Biomethanation Plant to generate energy from Biodegradable waste constructed at Bharathi Park, Coimbatore which generates 150 – 170 Unit of electricity per day. The main problem is that the unit can't get biodegradable waste in proper manner.

III. STUDIES AND FINDINGS

Design and Implementation



Capture Item Image for Comparison



Municipality Dustbin

AI to predict type of waste

The camera attached in the dustbin will capture the image of object thrown into the dustbin. The API will be trained by MS COCO dataset (Common Object in Context) which will be compared with the captured image to predict level of waste medium.

- Medium 1 – Waste for recycle (plastic, metal, glass)
- Medium 2 – Waste for producing energy by using WtE (Waste to Energy) project.

The camera attached with the Raspberry pi is used to capture the waste item image which gets compare to find the medium for waste collection.

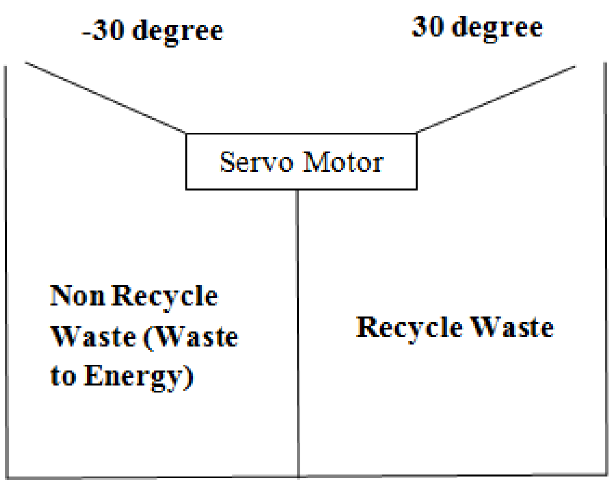
Raspberry pi to upload code (Python)

Camera Module to capture waste object image

Operate Servo Motor

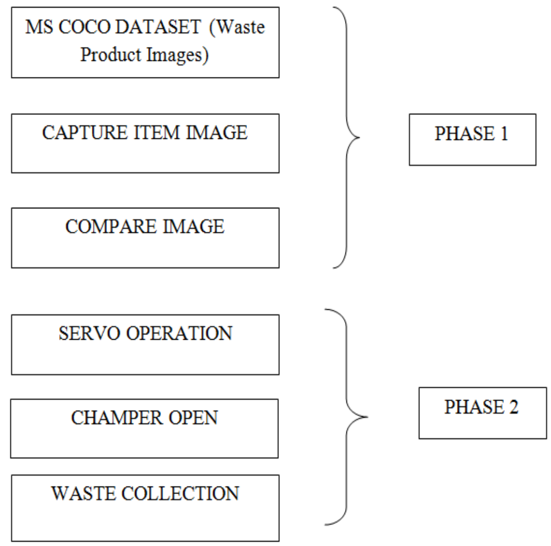
The servo motor attached in the dustbin will operate as per the degree to collect the waste in two different separations as per the medium. The value of degree for servo motor to open is as follows.

- 30 degree – to open recycle waste collection door
- -30 degree – to open non recycle waste collection door



Servo Motor to operate dustbin door

Classification Block Diagram



Steps in Detection the Object in Municipality Dustbin

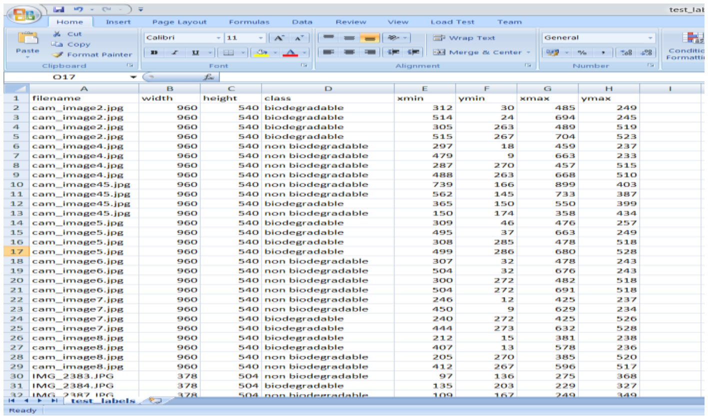
- Gather & Label object pictures
- Generate Training Data
- Train Object Detector
- Export inference graph
- Implement Algorithm (R-CNN)
- Test object detection

Gather & Label object pictures

The dataset is trained by 225 different biodegradable and non biodegradable waste images and labeled. This dataset is used to compare with the current captured image, to predict the waste category.

Generate Training Data

The dataset separated into 20 % as Testing Data and 80 % as Training Data to predict accuracy level. The training data generates the fields such as image width, height, waste type, x and y values. This trained data helps to predict the type of product in accurate manner.

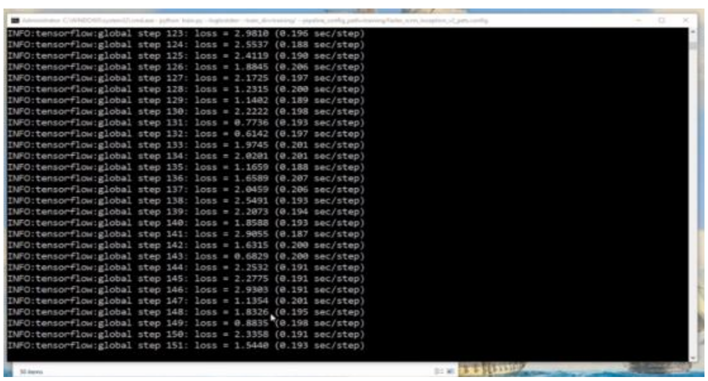


	A	B	C	D	E	F	G	H
1	filename	width	height	class	xmin	ymin	xmax	ymax
2	cam_image2.jpg	960	540	biodegradable	312	30	485	249
3	cam_image2.jpg	960	540	biodegradable	514	24	694	245
4	cam_image2.jpg	960	540	biodegradable	305	263	489	519
5	cam_image2.jpg	960	540	biodegradable	515	267	704	523
6	cam_image4.jpg	960	540	non biodegradable	297	18	459	237
7	cam_image4.jpg	960	540	non biodegradable	479	9	663	233
8	cam_image4.jpg	960	540	non biodegradable	287	270	457	515
9	cam_image4.jpg	960	540	non biodegradable	488	263	668	510
10	cam_image45.jpg	960	540	non biodegradable	739	166	899	403
11	cam_image45.jpg	960	540	non biodegradable	562	145	733	387
12	cam_image45.jpg	960	540	biodegradable	365	150	550	399
13	cam_image45.jpg	960	540	non biodegradable	150	174	358	434
14	cam_image5.jpg	960	540	biodegradable	309	46	476	257
15	cam_image5.jpg	960	540	biodegradable	495	37	663	249
16	cam_image5.jpg	960	540	biodegradable	308	285	478	518
17	cam_image5.jpg	960	540	biodegradable	499	286	680	528
18	cam_image6.jpg	960	540	non biodegradable	307	32	478	243
19	cam_image6.jpg	960	540	non biodegradable	504	32	676	243
20	cam_image6.jpg	960	540	non biodegradable	300	272	482	518
21	cam_image6.jpg	960	540	non biodegradable	504	272	691	518
22	cam_image7.jpg	960	540	non biodegradable	246	12	425	237
23	cam_image7.jpg	960	540	non biodegradable	450	9	629	234
24	cam_image7.jpg	960	540	biodegradable	240	272	425	526
25	cam_image7.jpg	960	540	biodegradable	444	273	632	528
26	cam_image8.jpg	960	540	biodegradable	212	15	381	238
27	cam_image8.jpg	960	540	biodegradable	407	13	578	236
28	cam_image8.jpg	960	540	non biodegradable	205	270	385	520
29	cam_image8.jpg	960	540	non biodegradable	412	267	596	517
30	IMG_2383.JPG	378	504	non biodegradable	97	136	275	368
31	IMG_2384.JPG	378	504	biodegradable	135	203	229	327
32	IMG_2387.JPG	378	504	non biodegradable	109	167	249	349

test_labels

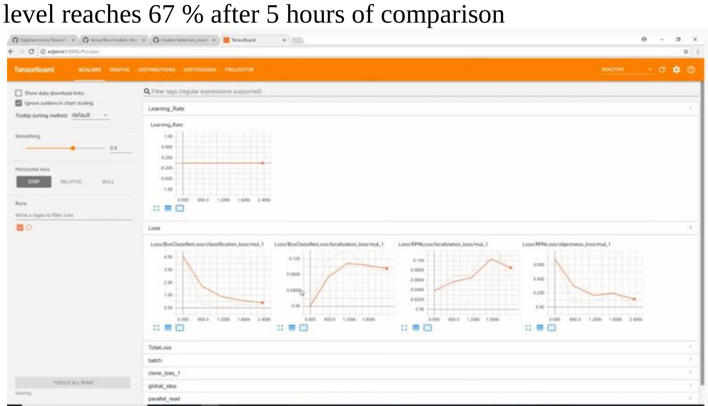
Train Object Detector

The tensor flow is used to train the data and its coordinate details. This helps to find the similarity of objects and predict the type of waste object with more accuracy.



Export inference graph

The inference graph shows the level of data trained. Here the level reaches 67 % after 5 hours of comparison



Implement Algorithm (R-CNN)

Problem Faced

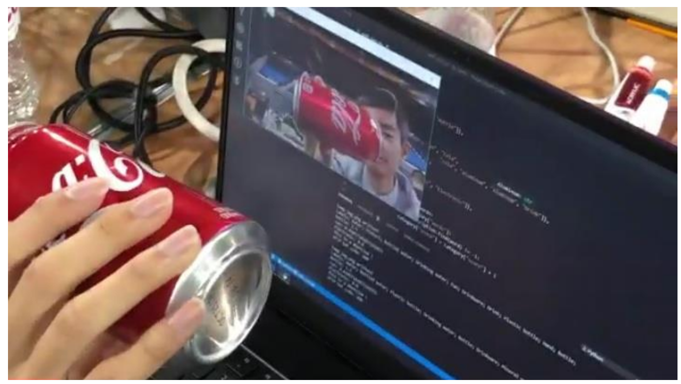
Different objects or even the same kind of objects can have different aspect ratios and sizes depending on the object size and distance from the camera.

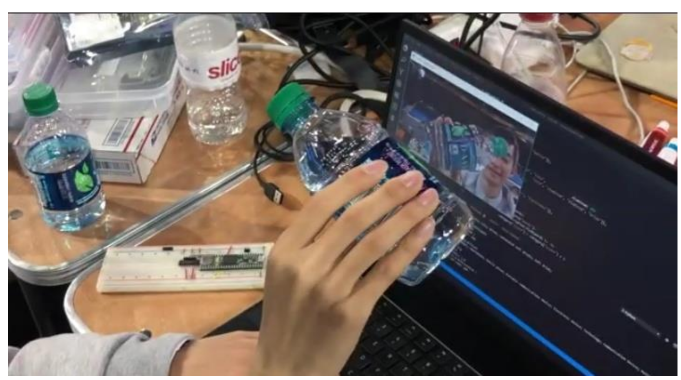
Solution

To overcome this problem R – CNN Algorithm is used to slit image into various boundary box. Instead of matching overall image, each boundary get matched therefore prediction will be high and accurate

IV. Result

The overall waste images are trained and form a dataset. The camera opens to capture the image and compared with the dataset to predict the type of waste.





Detect Biodegradable & Non Biodegradable Waste by Camera capturing

The servo motor attached with the dustbin will open the corresponding chamber to collect the biodegradable and non biodegradable waste. The dustbin can be computerized and thus the waste can be used in an effective manner for both energy production and recycle.

Collect Biodegradable & Non Biodegradable Waste in corresponding chamber

V. CONCLUSION

This implementation helps in collecting biodegradable and non biodegradable in different champers in effective manner .The biodegradable waste can be used to generate methane gas that helps to produce electricity. The Non biodegradable waste can be recycled. Therefore the 59 % of waste ends up in landfills can be reduced more than below 5 %.

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