

# A<sub>i</sub>Bin

## Waste Segregation using Image Classification(ML/AI)

### *Abstract*

A major part of the prevalent problem of waste management is its segregation, proper disposal and management. The collection of waste solves the problem partially, what is required is the proper disposal, for which we require an efficient system that recognizes each type of waste separately and then dispatches it to the correct channels. Our proposed model comes with:

1. A smart waste segregator based on computer vision which automatically separates waste placed on a conveyor belt in their respective dustbin chambers.
2. An integrated portal which provides the required data (related to the waste) to various parties and helps in linking all the beneficiaries

The manual separation done currently by the laborers has a variety of problems:

1. The efficiency of waste segregated by them is very less
2. It can lead to diseases, many times waste is hazardous too
3. Cuts, wounds through metallic parts
4. Children and underage individuals are made to do such lowly work (child labor)

### **Objectives**

- To tackle problems of manual segregation of waste and create an automatic segregation system that is based on Artificial Intelligence(Computer Vision). Also to differentiate our models from the already in use models using IoT and other methods.  
Create a conveyor mechanism so as to distribute the waste uniformly on the belt so that it would be easily identified by the camera and appropriate gate would be opened.
- Create a Web based portal which will automatically maintain the
  1. Amount of waste collected
  2. Type of waste collected and that data could be shared with:
    - A. Various waste management companies
    - B. Municipal Corporation
    - C. Research organisations/institutes so as to recycle it or use the data for research and analysis purposes.

### **2. Beneficiaries (For whom)**

**Environment** : Better and easier segregation of waste can help in easier and faster management of waste which in turn can reduce the untreated waste and can help us in saving the environment

**People** :The more the waste that can be recycled using these methods the less will be landfills that get piled up and more will be people beneficiaries who suffer by diseases due to those huge land pills of waste

**Nature** :Better is the quality of segregation that we have for our waste less are the chances of any waste going untreated, This in turn will reduce the type of waste that is harmful for the nature to go untreated and unattended and in turn can help us in conserving our nature

Parties linked:

1. Companies which want to collect a specific type of waste(1 or more types) or companies which simply require the data for analysis and research
2. Research organisations/research institutions which require the data/a specific type of waste for research
3. Waste management companies for which this can act as a helping hand for segregation and then selling the waste
4. Municipal Corporations which can use this technology to segregate the waste and then treat it properly rather than dumping it simply

### **3. Value of results (Usage)**

1. For the mass segregation of waste in the municipal corporation and other recycling companies and other companies that use waste as a thermal fuel to generate electricity and for lots of other purposes
2. Can be used by institutions, residences , campuses that generate huge amount of waste to segregate the waste that they generate so that it can be disposed properly
3. Can be installed near the place of huge crowd gathering or places of huge waste generation so that the real time management of waste can take place

### **iii. Background**

Waste segregation is a major problem that lies when we think about waste management in our country, Not able to separate the type of waste that can be treated from the type that can't be treated is the main reason that a lot of waste gets dumped in landfills unattended , Even when a majority of that is green waste or the type of waste that can be treated easily

The origin of this idea comes from the conventional method of segregation that we have in our country that is manual segregation of waste by the poor people, This type of segregation is very ineffective and many times exposes the worker to the harmful waste that may be hazardous for the individual.

This motivated us to come up with a solution that can do the automated segregation and in turn can help us in reducing the problem of waste management in our country

#### **iv. Statement of Problem**

##### **Waste Management**

The recent push to “Swachh Bharat ” by the Prime Minister of India has created a buzz of cleanliness in the whole country but in spite of continuous effort by the Government and the concerned authorities, the problem of waste remains stagnant, Still seven of the top ten dirtiest cities in the world are in India . What needs to be done is to change the way waste is managed and collected in our country and to use new technologies in how it can be improved. To tackle these problems, we need to come up with an innovative solution on the method of waste collection and management in our country and how the waste can be treated in more efficient ways

#### **1. Succinct definition of problem addressed (follows from material in the background section)**

Waste management is the core of urban development and it reflects how much the people of a country are concerned about their surroundings and their locality , and for the purpose of waste management it is a must to be able to segregate the waste in a more efficient and automated ways and this is the problem that we will try to tackle.

#### **v. Research**

##### **1. Present methods of tackling the problem (if any)**

Manual Segregation of waste done by poor Municipal Corporation workers and use of few mechanical setups in industry which can only separate few limited types of waste(like use of magnets for separating metallic waste)

##### **2. Proposed Solution**

Automated segregation of waste using AI and ML so that the system itself can separate all the type of waste depending upon the sample of waste that is supplied to it and is much more efficient in doing this even for complex kind of substance

##### **3. Alternate solutions/approaches**

Automated segregation of waste using machines and magnetic separation and hoopers (But this type of method can be used to separate the waste only if there are few specific types of waste that are present and when their components and properties are known specifically and before hand)

#### **4. Novelty of Approach: How is/will your solution be better than the existing products that address the same problem?**

1. Segregation in bulk
2. Cost is less
3. Automation using AI: Manual Labour reduced
4. Fast, Higher accuracy than otherwise

5. No risk of diseases, odourless environment, than would have been there in case of manual labour

## **vi. Technical Report**

### **1. Description of concepts, theories and/or approach involved in the proposed solution**

We are using Deep Learning and Artificial Intelligence techniques to achieve this. The Deep Learning Convolutional Neural Network is trained on a dataset which has the images of different classes of waste. The model takes the input image from the sources like camera and processes it and classifies it in one class of waste. We can change the classes according to our requirements. The dataset has almost every type and class of waste.

### **WEB PORTAL**

*What does it do*

*The automatic segregation system will maintain the type and approximate quantity of each type of waste on an online portal which could be easily viewable by the companies and people who would be in contact with us. He could then contact the owner directly and the waste would be sold out to them.*

*Tech Stack:*

*Web Server and a domain on which multiple types of user accounts could be made. Also the portal's database will be accessed by the waste segregator so APIs will be used to accomplish the same.*

### **2. Technical aspect of the proposed solution**

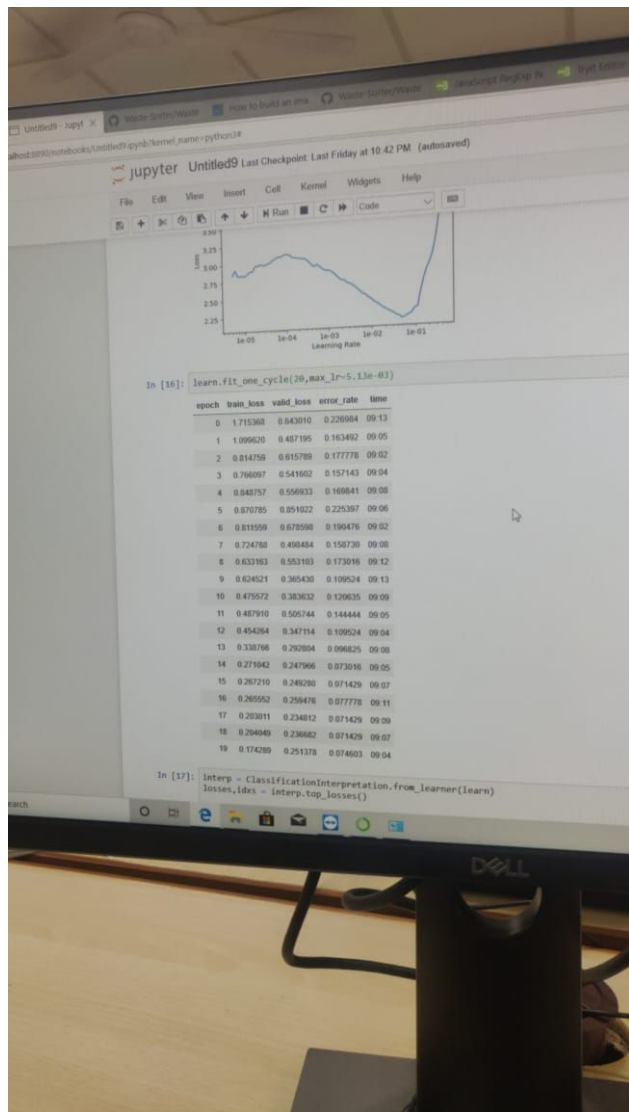
The above model would be deployed on a microcontroller(Jetson Nano or Raspberry Pi) for prototyping which would take input from a camera. The microcontroller would be connected to mechanical motors which would open the gates on the conveyor belt to segregate the waste. The waste would be laid on the belt by a hopper which would ensure easy and uniform distribution of waste so as to facilitate easy detection by the camera. It would access the portal's database and update the quantities and type of waste. So after detection a lot of IoT stuff is going to take place.

### **3. Detailed technical specifications and pictorial representations (block diagrams/ flow chart)**

In our model we will train a convolutional neural network to classify waste in different types using open sources datasets , we will be using resnet34 (A residual neural network is a convolutional neural network (CNN) with lots of layers).

Through this method we have used fast.ai on Pytorch environment and successfully achieved accuracy close to 92%.Then our model would be deployed on a microcontroller(Jetson Nano or

Raspberry Pi) and then in turn can be implemented in mechanical model as per industry.



The picture shown above shows the error we got after 20 epochs on our training and validation data and above that it represents the graph of loss vs. learning rate.

#### 4. Description of the flow of operations demonstrating key features and functionality

Our modelling pipeline is:

1. Download and extract images
2. Organize the images into different folders
3. Train model
4. Make and evaluate test predictions

We have collected our dataset from open source

#### 5. Performance estimate of the solution

Through this method we have successfully achieved accuracy close to 92%.

The picture shown above shows the error we got after 20 epochs on our training and validation data and above that it represents the graph of loss vs. learning rate.

#### **6. Experimentation/Verification done to establish the workability of the above**

NA

#### **7. A link to the video of the working model/ prototype**

NA

### **vii. Results**

#### **1. Actual findings, significant output of tests and analysis (Must be readable)**

NA

#### **2. Include problems encountered, credibility of results, accuracy estimates**

NA

#### **3. Pros and cons of your solution**

##### *Pros*

1. Automated segregation using AI thus reduces manual error.
2. Development of a model using very simple cameras and training them using sophisticated ML dataset thus saving the cost spent on complex cameras and other machineries making our model much more cost-efficient.
3. Model based on ML/AI which makes our model very fast as compared to any other method of segregation that in turn enable us for bulk segregation.

##### *Cons*

1. The ML data set is not completely accurate can be subjected to few errors
2. The one time investment cost of the model is more than other alternatives.

#### **4. Utility of results**

The data collected and the segregated waste collected will be useful to various parties and will be accordingly shared with them.

#### **viii. A link of the Google Drive Folder which contains Pictures and Video of the working model/ prototype.**

*Google Drive Link:*

<https://drive.google.com/drive/folders/149ORXiAZQjEDMWpGJppg4ZqHkSoXofFq?usp=sharing>

*GitHub Link:* <https://github.com/ashwingoyal154/AiBin>

### **ix. Application**

#### **1. Your idea as a solution to the problem**

The problem of waste management is not new to India and is also not unique to our country , The quantity of waste produced can't be changed much. So the need of the hour is to manage the waste in the most efficient way possible and this is what our model caters upon for better management of waste using automated ML & AI, it is a system that can separate the type of waste that can be treated to the type that can't be treated, and also the type of waste that is of economic importance that is the e-waste and other such type of waste. It is only after segregating these types of waste that we can treat them in a way they need and also utilise them in the most efficient way and thus solve the problem of waste management.

## **2. Additional applications**

The web portal that tries to link all the stakeholders and allows the real time monitoring of the waste that is being segregated and how the communication gap between different parties involved in waste management can be minimised. This web portal is the additional application of our model it automates the process of waste management that follows after the waste has been segregated.

## **3. Benefits to the users**

1. Real time monitoring of the waste and use of automation enables the user to utilise it to the maximum extent that reduces the quantity of waste getting dumped unattended and also makes the whole process more economical
2. Use of automation for the better segregation of the waste enables the user to increase the efficiency and also makes the whole process much faster and more economical
3. Data collected within the system will be of great use for analysis to cut down costs and for other advantages

## **x. Future prospects, research in it and further development (in brief)**

We plan to link a chunk of the waste management industry through our portal and look to make our prototype product more efficient. We look to particularly improve the method by which an individual waste entity is extracted from the bulk of the waste(through the use of conveyor belts). We also look to target more types of waste identification and classification.

## **xi. Any other details: (Patent/Business plan etc.)**

NA

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### **Team Details:**

1. Ashwin Goyal (Leader)
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