Smart Bin

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Abstract: In the present world, due to rapid increase in population, generation of waste has increased and waste management is strenuous. If waste is not being segregated and disposed properly, it may lead to health issues. Segregation of waste is very important, if the waste is not separated properly, it all gets mixed up in the landfills. Disposal of non degradable wastes and toxic wastes might lead to soil pollution. Leakage of the waste might also pollute ground water. Segregation of waste will also help in recycling of waste. This paper is about a smart bin robot which can travel like a robot and will have different bins to collect different types of wastes. It will be able to identify waste materials in the street through image processing technique and through its robotic arm, it will pick up and drop the waste in the particular bin which it carries. The smart bin can also be used as a collector of waste materials from houses through the mobile app using the GPS location of the user. Whenever the bins are filled, it will send a notification to the garbage truck for emptying it.

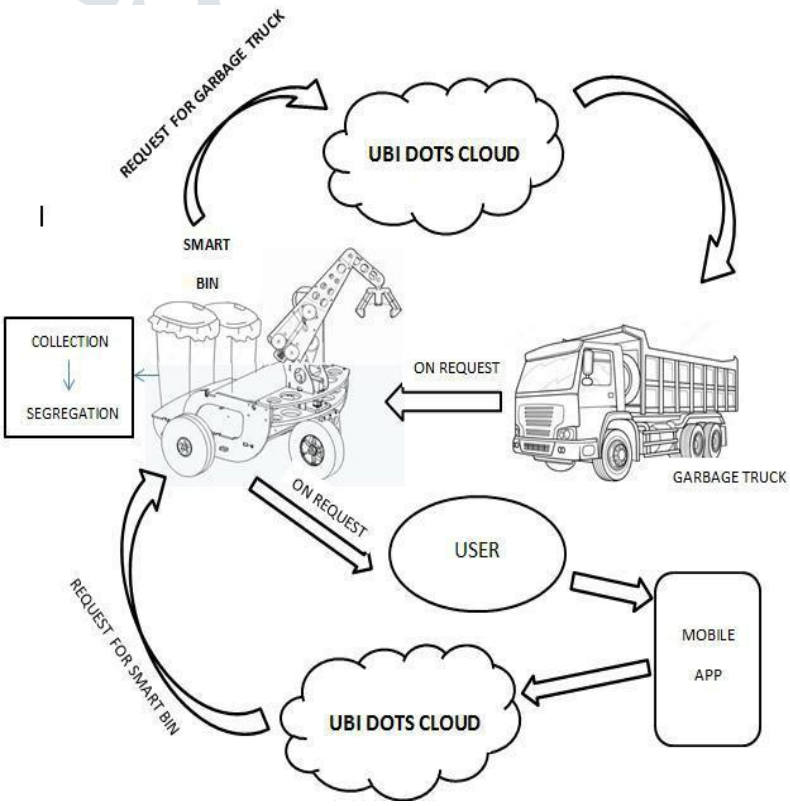
Key words- Machine Learning , Collection, Segregation, mobile app, Google maps, YOLO

I. INTRODUCTION

Waste generation is increasing rapidly in the present world. As the population rises, simultaneously generation of waste also increases. According to the latest available estimates, India generates about 157,478 tonnes of solid waste per day. Only 20% of the waste generated can be disposed properly. Waste should be segregated properly into degradable and non-degradable, paper waste, metal waste, plastic waste, E-waste, glass waste and organic waste. If the segregation of waste does not take place, all the waste will get mixed up in the landfills and after a period of time, due to leakage of waste, it results in leachate or toxic soup at the bottom, which can contaminate ground water and release explosive methane gas. Due to landfills and accumulation of waste, air, water and land will get contaminated which will also cause health problems. Accumulation of waste in the environment will cause loss to the economy, interrupts bio-geo-chemical cycles and damages historic monuments. Hence proper measures like segregation of wastes should be taken for disposal of waste. Segregation of wastes will also help in recycling of waste.

To make our environment sustainable, handling, segregating and recycling of waste household and in industries is a complicated task. Hence, this paper is about an automated smart bin robot, which identifies the waste materials using image processing techniques and using its robotic arm, it will pick up the waste identify it and will drop it inside the respective bin which it carries for that particular type of waste. This smart bin will collect the waste on streets or houses and will segregate the waste. The smart bin can also be called using the mobile app, using the Google maps, the smart bin will be able to travel to the user to collect the waste. Then the waste collected is segregated. Once the smart bin is filled, it will automatically send a notification to garbage truck collector for emptying it.

II. BLOCK DIAGRAM



III. IDENTIFICATION AND CLASSIFICATION OF THE WASTE

- Through the camera, the smart bin will take the images and by using machine learning technique, it can identify what the object is.
- By using YOLO:Real time objection detection system, the smart bin can identify the images whether it is waste or not by using the datasets.
- YOLO is prior detection systems repurpose classifiers or localizers to perform detection. They apply the model to an image at multiple locations and scales. High scoring regions of the image are considered detections.
- It applies a single neural network to the full image. This network divides the image into regions and predicts bounding boxes and probabilities for each region. These bounding boxes are weighted by the predicted probabilities.
- This model has several advantages over classifier-based systems. It looks at the whole image at test time so its predictions are informed by global context in the image.
- This is extremely fast , more than 1000x faster than R-CNN and 100x faster than Fast R-CNN.
- YOLO will display the current FPS and predicted classes as well as the image with bounding boxes drawn on top of it.
- Hence, we will need a webcam connected to the computer or OpenCV.
- We can also train YOLO from scratch with different datasets to identify whether the image is waste or not.
- Hence, by using this technique we can identify the object and segregate it into degradable, non-degradable, paper, metal, plastic, E-waste, glass waste.

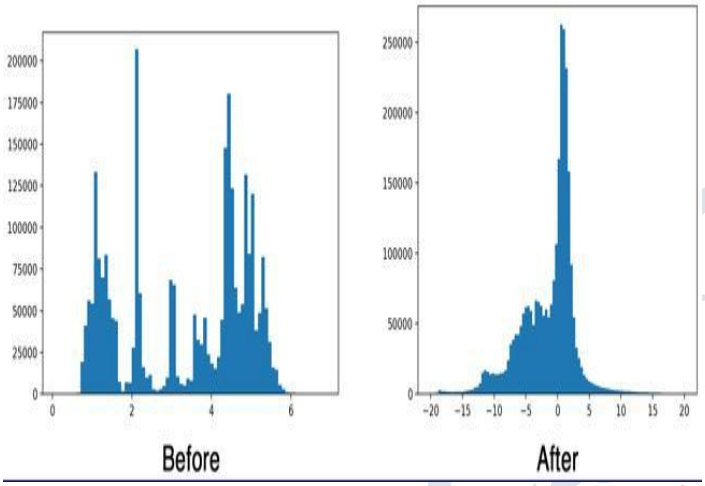
IV.REAL - TIME OBJECT DETECTION WITH YOLO

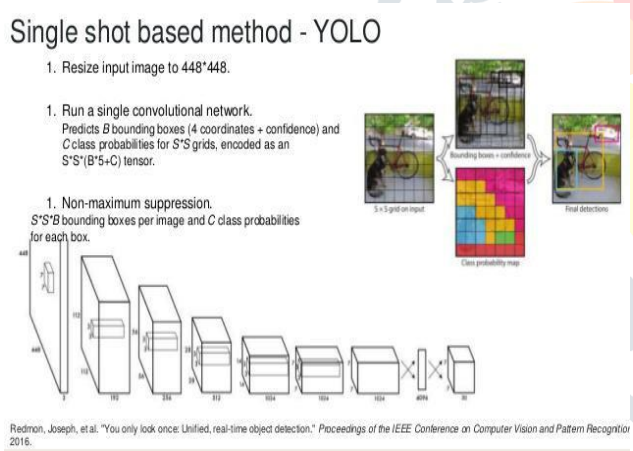
- Object detection is one of the classical problems in computer vision.
- YOLO is a clever neural network for doing object detection in real-time. YOLO actually looks at the image just once (hence its name: You Only Look Once) but in a clever way.
- YOLO divides up the image into a grid of 13 by 13 cells.
- Each of these cells is responsible for predicting 5 bounding boxes. A bounding box describes the rectangle that encloses an object.
- YOLO also outputs a confidence score that tells us how certain it is that the predicted bounding box actually encloses some object. This score doesn't say anything about what kind of object is in the box, just if the shape of the box is any good.
- The predicted bounding boxes may look something like the following (the higher the confidence score, the fatter the box is drawn).
- For each bounding box, the cell also predicts a class. This works just like a classifier: it gives a probability distribution over all the possible classes. YOLO is trained on the PASCAL VOC dataset, which can detect 20 different classes such as: bicycle, boat, car, cat, dog, person, etc.The confidence score for the bounding box and the class prediction are combined into one final score that tells us the probability that this bounding box contains a specific type of object.

THE NEURAL NETWORK

- The architecture of YOLO is a convolutional neural network.
- This neural network only uses standard layer types: convolution with a 3×3 kernel and max-pooling with a 2×2 kernel.
- The very last convolutional layer has a 1×1 kernel and exists to reduce the data to the shape 13×13×125. This 13×13 should look familiar : that is the size of the grid that the image gets divided into.
- So, there will be 125 channels for every grid cell. These 125 numbers contain the data for the bounding boxes and the class predictions. Since each grid cell predicts 5 bounding boxes and a bounding box is described by 25 data elements, hence there will be in 125 channels.
- Using YOLO is simple: we have to give it an input image (resized to 416×416 pixels), it goes through the convolutional network in a single pass, and comes out the other end as a 13×13×125 tensor describing the bounding boxes for the grid cells. All we need to do then is compute the final scores for the bounding boxes and throw away the ones scoring lower than 30%.
- YOLO is written in Darknet, a custom deep learning framework from YOLO's author. The downloadable weights are available only in Darknet format.
- YOLO uses a regularization technique called batch normalization after its convolutional layers.
- The idea behind "batch norm" is that neural network layers work best when the data is clean.
- Ideally, the input to a layer has an average value of 0 and not too much variance. The technique is called "feature scaling" or "whitening" on our input data to achieve this.
- Batch normalization does a similar kind of feature scaling for the data in between layers. This technique really helps neural networks perform better because it stops the data from deteriorating as it flows through the network.
- Batch normalization usually happens after the convolutional layer but before the activation function gets applied (a so-called "leaky" ReLU in the case of YOLO).

- Since both convolution and batch norm perform a linear transformation of the data, we can combine the batch normalization layer's parameters with the weights for the convolution.
- This is called "folding" the batch norm layer into the convolution layer.
- Below is a histogram of the output of the first convolution layer without and with batch normalization:





- A convolution layer calculates: if x is the pixels in the input image and w is the weights for the layer, then the convolution basically computes the following for each output pixel: out[j] = x[i]*w[0] + x[i+1]*w[1] + x[i+2]*w[2] + ... + x[i+k]*w[k] + b.
- This is a dot product of the input pixels with the weights of the convolution kernel, plus a bias value b.
- And here's the calculation performed by the batch normalization to the output of that convolution:

```
   gamma * (out[j] - mean)
bn[j] =  ----------------------  + beta
            sqrt(variance)
```

- It subtracts the mean from the output pixel, divides by the variance, multiplies by a scaling factor gamma, and adds the offset beta. These four parameters — mean, variance, gamma, and beta — are what the batch normalization layer learns as the network is trained.
- To get rid of the batch normalization, we can shuffle these two equations around a bit to compute new weights and bias terms for the convolution layer:

```
          gamma * w
w_new = --------------
            sqrt(variance)

          gamma*(b - mean)
b_new = ----------------  + beta
            sqrt(variance)
```

- Performing a convolution with these new weights and bias terms on input x will give the same result as the original convolution plus batch normalization.
- Now we can remove this batch normalization layer and just use the convolutional layer, but with these adjusted weights and bias terms w_new and b_new.
- We repeat this procedure for all the convolutional layers in the network.
- Once we've folded all the batch norm layers into their preceding convolution layers, we can convert the weights to Metal.
- This is a simple matter of transposing the arrays (Keras stores them in a different order than Metal) and writing them out to binary files of 32-bit floating point numbers.
- Tiny YOLO can do up to 200 frames per second.

V. WORKING OF THE SMART BIN

The smart bin contains an ultrasonic sensor, to find out whether bins are filled or not, a nodeMCU which processes and sends the data to the cloud, a web- camera to detect the waste along with the robotic arm to pick up the waste.

1. When the user requests for the smart bin using the app. The request goes to the cloud along with the user's location.

2. The cloud sends the message to the nodeMCU attached to the smart bin.

3. The smart bin reaches the user using the GPS location of the user. It finds the shortest route to the destination using Google maps.

4. The user can also track the smart bin through the app.

5. It picks up the waste using the robotic arm. The camera that is fixed to the smart bin takes the pictures of the waste,processes it, finds out what type of waste it is, using machine learning technique.

6. Then the robotic arm drops the waste into its respective bin which it carries. Hence, the segregation process is completed.

7. The ultrasonic sensor attached to the top of the bin keeps a track on the garbage level of the bin.

8. When the bin is 90% full a request is sent to the cloud through nodeMCU along with the smart bins location which is obtained from nodeMCU module.

9. The garbage truck then receives this request from the cloud.

10. The garbage truck then finds the smart bin using its GPS location. The waste is collected without different types of waste getting mixed.

VI. CONCLUSION

Segregation, disposal and recycling of waste is very important in waste management and if proper measures are taken, then there will be no health issues in our country. Thus the smart bin will identify, collect and segregate the waste materials. By using the smart bin, the streets and houses can be kept clean. Hence, the main motive of this project is to follow the three R's -Reduce, Reuse and Recycle in order to let our future be clean again.

VII. REFERENCES

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