CS 308 - Project Report
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IIT Bombay

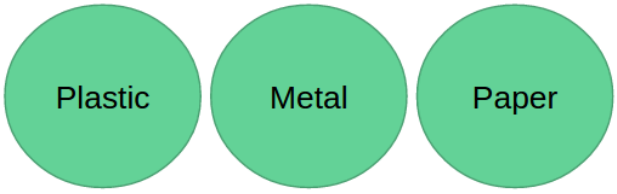
BINC - Automated Waste Segregator

Idea of BinC

Waste Segregation has been a major problem in waste disposal. Especially in a country like india with very high population density this problem get multi-folded. According to reports 70% of government's investment into waste segregation and transportation. [Source]

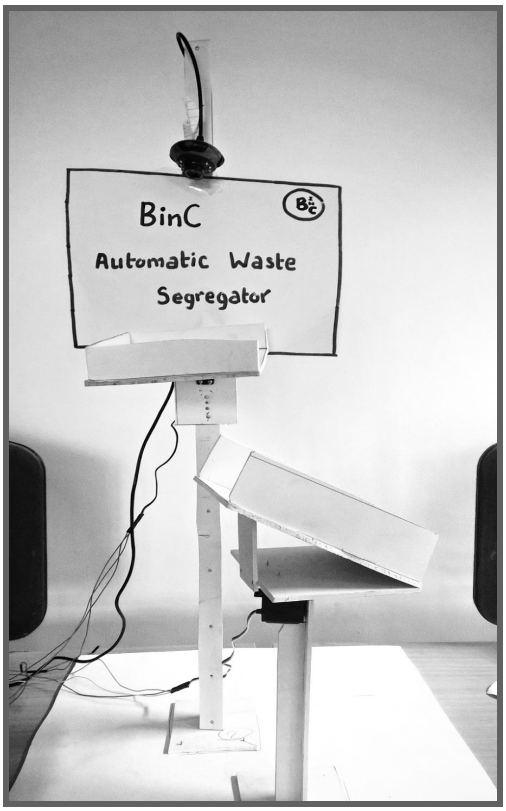
One possible solution to tackle this problem and is widely used is Colored bins. But the final sorting efficiency of traditional bins is just 11%. [Source]

BINC is an electromechanical machine that helps in smart waste segregation by classifying waste into one of the three different categories



The innovation in the BINC lies in the cheap and robust technology that makes it possible for it to replace the colored bins that are placed all over the places but the effective output of which is low.

Model of the Device



BINC at work - Implementation

The demo video of Binc at work can be found here. The mechanism of BINC can be divided into three stages.

(1) Scanning - BINC runs a motion detection algorithm that helps detect if there is some object kept in the scanning area. BINC does not employ any extra sensors for the purpose and achieves it solely using the camera. The powerful motion detection algorithm implemented in the raspberry-pi does the task of motion detection

(2) Classification - In the traditional approaches for classification, many sensors are used to do the task of classification. We have used an entirely new method by employing neural network for image classification

(3) Disposal - Once the classification is done the object has to be disposed off in the right bin. BINC has a layer solely aimed to serve this purpose

Technology behind BINC - Requirements

The important components of BINC are:

(1) R-pi and tiva board
(2) Camera
(3) Motors

Motion Detection - Motion detection is done by taking photos using the webcam at small regular intervals and checking for difference with the background. When the difference exceeds a threshold value, program considers it as an object being put. First frame just after each object is deposited in a bin is taken as background frame for the next round of detection.

Image Classification - The task of image classification is done by using computer vision approach. We employ a neural network to do the task of detecting class for objects. The neural network training is done offline on a machine of high configuration. The final weight vector learned from training the neural network is employed on the Raspberry Pi to detect the images. The separation of training and task of online classification helped us to make BINC more modular wherein the learned weight can be changed anytime in BINC. The complete code can be found in the git repository.

Disposal - Object is initially put on a panel where photo of it is taken. Once the classification is done, a rotatable ramp points to the dustbin as per result of the classification. The panel then rotates and drops the object onto the ramp.

Two servo motors power the depositing mechanism: one for the panel and one for the ramp. Power supply for servo motors are taken from Tiva board. Angle of the servo is determined by the PWM output from the Raspberry Pi.

Testing - Testing is done on a dataset consisting of selected materials that were used for training which world like a charm. For training we used one material for each category with 15 images for each and trained the neural network which successfully did the task of classification on those objects.

What makes it special - Discussion

- Hassle free waste disposing
- Separation for easy recycling
- Lots of money saved for final stage segregation
- Low cost of transportation

Apart from the highly efficient task of image classification BINC can be used for any other task involving image classification. We could train the neural network for any other task that involves segregation and the whole system would still work just by importing new weight vectors into BINC. This modular design makes it special because it can be deployed to solve any classification for any real life tasks.

Shortcomings

The current version of BINC is not trained extensively to deal with lots of other items except the once in the testbed. Apart from that because everything is done by a simple camera it takes up some seconds to do the object detection using motion controller. Other classification techniques can be tried out to make the system better and more robust. We could take a middle way out by employing a magnetometer to detect metal and using the neural network classify plastic vs paper.

Future works

(1) Improving the network by using more images for classification
(2) Automatic notification when the BINC is full
(3) Indication of the tasks in the pipeline using a LED

Important Link

(1) BINC: Demo, Setting Up
(2) Reports and Surveys
(3) CodeBase Link
(4) Investor Pitch

References

(1) https://github.com/jorgenkg/python-neural-network
(2) https://www.raspberrypi.org/forums/viewtopic.php?t=45235
(3) https://www.raspberrypi.org/documentation/usage/camera/python/README.md