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Automatic Domestic Waste Detection and Seperation using MCCNN

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ABSTRACT

The amount of waste made is growing globally, particularly in developing countries. This vast quantity of waste is caused severe environmental answer and resource waste. The massive variety of waste classes and also the importance of correct management of waste materials, the matter, is understood to be essential and of a selected interest. Nowadays, manpower to detect and classify domestic waste is extremely inefficient.So we propose a Multi-model Cascade Convolutional Neural Network (MCCNN) for domestic waste image detection and classification. Moreover, to suppress the faults-positive predict, we utilized a classification model cascaded with the detection part to evaluate whether the detection result are correct. To train and evaluate MCCNN, we designed a dataset, containing 22,687 domestic waste multi-labelled images with 3 categories (E-waste, Recyclable waste, Non-Recyclable waste). Here the E-waste contain 123 images, Recyclable waste 12565 images and Non-Recyclable waste 9999 images. A smart trash can (STC) is designed and applied to a community which helper to make waste detection is more efficient.

***Index terms*-Domestic waste detection and classification, MCCNN, Smart Trash Can.**

INTRODUCTION

The world bank report showed that there square measure nearly four billion a lot of waste round the world each year and therefore the urban alone contributes heaps to the present variety, the waste is expected to extend by seventieth within the year 2025. consistent with within the next twenty five years, the less developed countries waste accumulation can increase drastically. With the rise within the variety of industries within the populated area, the disposal of the solid waste is de facto turning into a giant downside, and therefore the solid waste includes paper, wood, plastic, metal, glass etc. the most technique of managing the waste is landfilling, that is inefficient and big-ticket and polluting natural setting. As an example, the lowland website will have an effect on the health of the people that keep round the lowland site. Another common approach of managing waste is burning waste and this technique will cause pollution and a few unsafe materials from the waste unfold into the air which might cause cancer. Thus it's necessary to recycle the waste to shield the setting and kith and kin health, and that we ought to separate the waste into the various elements which might be recycled victimization alternative ways. Uncollected domestic waste is inflicting health hazards moreover as polluting to the setting endangering the lifetime of the folks at giant. it's one amongst biggest supply of setting pollution. Land is contaminated with the waste drop upon it, makes the soil unproductive. There fore it's essential to treat the domestic waste with effective manner.

To verify the MCCNN model in waste detection and classification, we deployed an STC system with MCCNN. The STC system serves as a front-end part of the entire waste disposal process. The system takes an image of waste through the camera and uses the MCCNN model to recognise the image. MCCNN has two parts detection model and classification model. In here the waste is classified in three category- E-waste, Recyclable waste, Non-Recyclable waste. DSSD is a one stage detection network and Faster-RCNN is a two stage detection network. The results of each sub networks are combined and passed through the NMS algorithm finally obtaining the result of the detection model, including categories and bounding boxes, then the crop the waste image into patches using the bounding boxes the classification model (ResNet101) takes the predicted image patch as input and predicts the category of the patch. Compare the predicted category with data set category and find both are consistent.

PROPOSED METHOD

A camera module is embedded into the Smart Trash Can to capture the waste images for the purpose of object classification and detection. There are 3 various waste compartments including recyclable, non-recyclable and e-wates for seperation. A push button switch is also provided to avoid the unwanted predictions. Raspberry Pi4 is

used as the processor. Push button switch and the 3 waste bins are connected with the Raspberry Pi. Arduino Nano is embedded to this system along with Raspberry Pi to avoid shake. Connection of the 3 waste bins from the Raspberry Pi and the 2 servo motors are also connected with the Arduino. Then the particular waste image captured by the USB camera is processed. Compare the obtained waste image with the images stored in the data set. The dataset contains 22,687 images into three categories. Then the compared accuracy value is nearly 100 for the waste image, the servo motor is rotates and then fall on the corresponding waste compartment. If we get an negative prediction that is the accuracy is less. Then the system is not classify the waste.

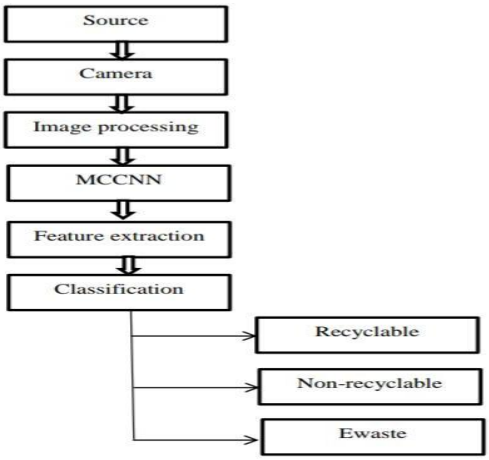
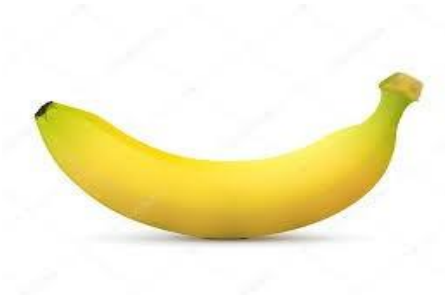


Fig 1: Block diagram of proposed method

(a)



(b)

(c)

Fig 2 : Sample images from three categories.(a)Sample image from E-waste, (b)Sample image from Recyclable waste, (c)Sample image from Non- Recyclable waste.

SYSTEM DESCRIPTION

A. Raspberry Pi4

Fig 3: Image of Raspberry Pi4

The Raspberry Pi four is integrated with broadcom 2711, 64-bit quad-core Cortex-A72 processor and 2GB RAM. It options true gigabit LAN port, 2 x USB 3.0 "Super-Speed" ports. 802.11b/g/n/ac wireless LAN (2.5 gigacycle per second &fiveGHz) Bluetooth five.0 twin micro-HDMI ports, 4K UHD video H.265 decipher (4kp60)H.264 decipher (1080p60) OpenGL Es one.1, 2.0, 3.0 graphics poet capable 5V3A USB-C power offer needed fully upgraded, re-engineered, Faster, additional powerful, twin displays 4K output on and is silent, energy-efficient will transfer information up to 10 times quicker.

Table 1: Specifications of Raspberry Pi 4

Brand	Raspberry Pi4
Wireless Communication Standard	802.11a
CPU Manufacturer	Broadcom
RAM Memory Installed Size	2GB
CPU Model	Cortex
CPU Speed	1.5 GHz

B. USB CAMERA

Fig 4: Image of USB CAMERA

A USB digital camera could be a camera that connects to a laptop, sometimes through plugging it in to a USB port on the machine. The video is fed to the pc, wherever a software system application helps North American nation to look at the photographs and conjointly transfer them to the web.

C. SERVOMOTOR

Fig 5: Image of SERVOMOTOR

A servo motor could be a actuator that enables for precise management of spatial relation. It consists of a motor coupled to a sensing element for position feedback. It additionally needs a servo drive to finish the system. The drive uses the feedback sensing element to exactly management the rotary position of the motor. A servo motor could be a actuator that enables for precise management of spatial relation. It consists of a motor coupled to a sensing element for position feedback. It additionally needs a servo drive to finish the system. The drive uses the feedback sensing element to exactly management the rotary position of the motor.

Table 2: Specifications of Servomotors

Brand	Robodo Electronics
Voltage	4.8 Volts
Item Dimensions L*W*H	50*50*50 Millimeters
Materials	Metal
Item Weight	50 Grams

D. ARDUINO NANO

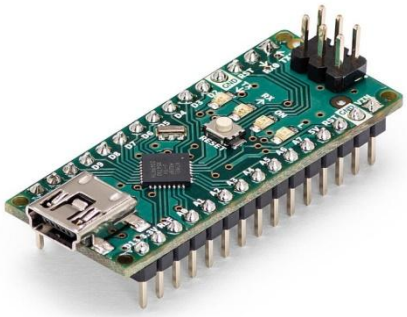


Fig 6 : Image of ARDUINO NANO

The Arduino Nano could be a tiny, complete, and breadboard-friendly board supported the ATmega328 (Arduino Nano three.x). it's additional or less an equivalent practicality of the ArduinoDuemilanove, however during a totally different package. It lacks solely a DC power jack, and works with a Mini-B USB cable rather than a customary one.

Table 3: Specifications of Arduino

Microcontroller	ATmega328
Operating Voltage	5V
Flash Memory	32 KB of which 2 KB used by bootloader
SRAM	2 KB
Clock Speed	16 Mhz
Input Voltage	7-12V

E. SD CARD

Fig 7: Image of SD CARD

The product is extraordinarily sturdy, manufactured from a cloth of premium quality, terribly proof against crash. Low battery consumption to maximise battery life in little transportable devices permits you to handily store files, videos or photos. Non-volatile solid-state information is lost once power is turned off. it's one in every of the tiniest formats on the market in shopper physical science. Straightforward to use, convenient to hold works with Older Devices, Cameras, PDA, GPS.

Table 4 : Specification f SD CARD

Brand	AMGUR
Flash Memory Type	Micro SD
Hardware Interface	MicroSD
Memory Storage Capacity	2GB

SYSTEM CONFIGURATION

A. Model Training

MCCNN is composed of a detection model and a classification model. The simplest training method is to splice the two networks and train them together by weighting the loss function. However, the training of such a huge compound model is extremely inconvenient, and because the detection results of inconsistent prediction categories are eventually discarded, the definition of the loss function is also not easy. Therefore, we use the strategy that two models are trained separately, and the trained networks are stitched together for deployment.

(1)Detection Model: We selected 22,687 waste images in the dataset, which included three categories: E-waste, Recyclable waste, Non-Recyclable waste. The dataset is divided into the training set and the testing set according to the ratio of 9:1. For the classification model, the corresponding part of the bounding box is cropped through the label file and saved into the corresponding category folder, which constitutes the dataset for classification, and is also divided into a training set and testing set. The input size of the images are 250*250 , 250*175 , 150*150

*(2)Classification Model:*In MCCNN, the classification model is a highly important part. As mentioned above, although the detection model can obtain the location and category information of the detection target, due to the complex characteristics of the waste, the wrong target for category detection often appears (non-Recyclable waste is detected as Recyclable waste). In the actual process, we pay more attention to the model's precision than the recall rate. Therefore, the system should try to avoid false detection. In order to automatically discard the wrong target of category detection, another classification network is needed. We use a mature ResNet101 network, and the flow can be described as the following: identifying the location and type of non-recyclable waste by detection model, cutting out the detected non-recyclable waste from the picture and inputting it into the ResNet101 classification network; the output of the detection model is compared with the category output by ResNet101. If the category is different, the detection box is discarded. Then the accuracy on the testing set has reached 85%.

B. Circuit Diagram

The proposed model is implemented using the below circuit diagram shown in figure 8. This diagram is designed with software called ANACONDA NAVIGATOR. Here Raspberry Pi 4 Model 4B is the processor, LINUX based operating system is used. Raspberry Pi4 contain 40 GIPO pins and ground pins. The external connections are done by this 40 GPIO pins. A push-Up configuration button is connected to the 40th GPIO pin of the Raspberry Pi4 and ground pin.The function of this button switch is to avoid unwanted predictions. An arduino Nano (Rev3.0) is connected with Raspberry pi 4 for avoid shaking. The three waste boxes are connected to the 8th, 10th and 12th pin

of raspberry pi and D4, D3, D2 pins of arduino. The two servo motors are connected with arduino for rotation. A USB camera is also connected to the USB port of raspberry pi4.

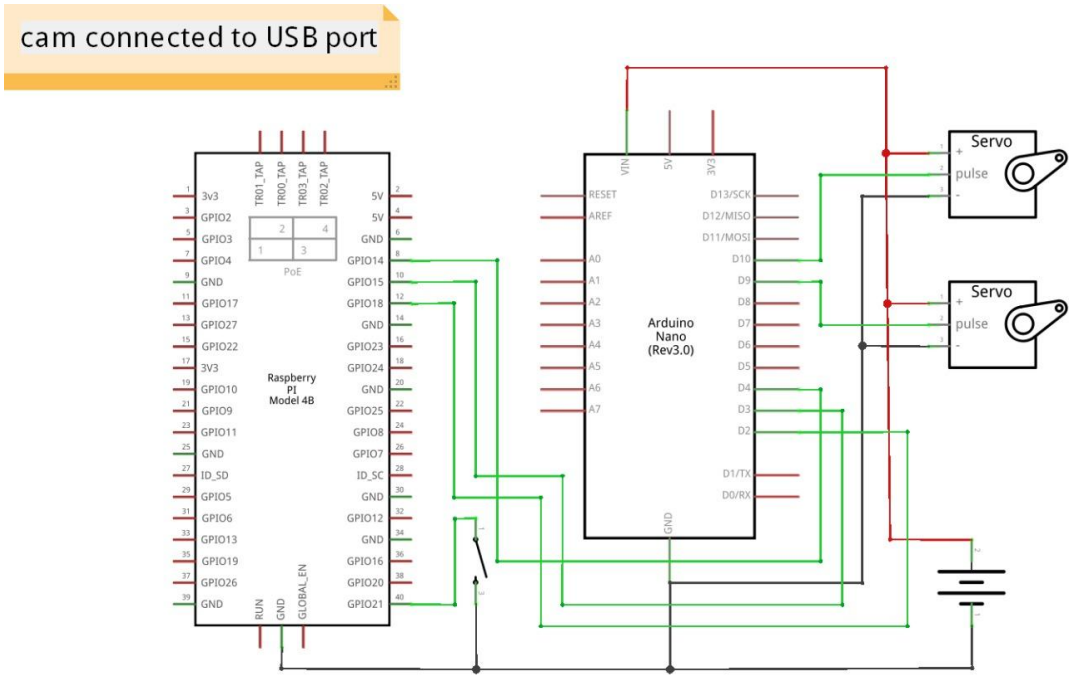


Fig 8: Circuit diagram of proposed method

EXPERIMENTAL SETUP & RESULT

This is the prototype fig 8 we proposed. There are three various classification of wastes:- Recyclable waste, Non-recyclable waste and E-waste and provides three boxes for each. Blue for Recyclable Waste, Black for E-Waste and pink for Non-recyclable Waste. The main box is embedded above three sub boxes. Waste is deposited on the main box .After that a pulse is given to the push up button. Then the system works. Camera is placed on the top of the main box and the camera capture the waste images for detection and classification. Captured image and data set images are compared. If the accuracy value is nearly 100 the waste deposited on the main box is fall on the corresponding box.

Fig 9: Proposed Prototype.

For example : If a Recyclable waste is deposited on the main box.A pulse is given to the push-up button.Camera captured the image and compared with the dataset images.If the accuracy value is nearly 100 the Recyclable waste is fall on the corresponding blue box.

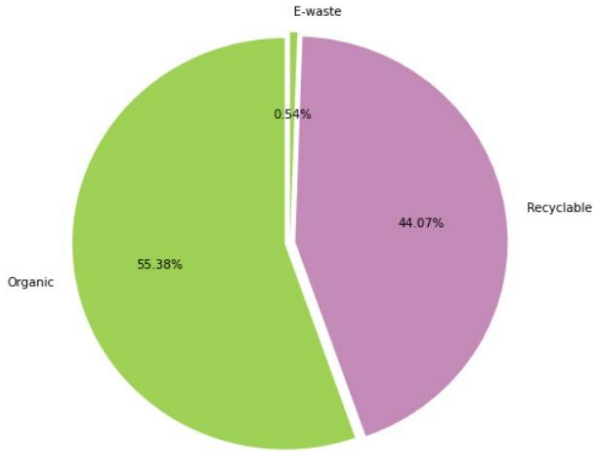


Fig 10: Chart showing the values of Recyclable waste, Non-recyclable, E-waste.

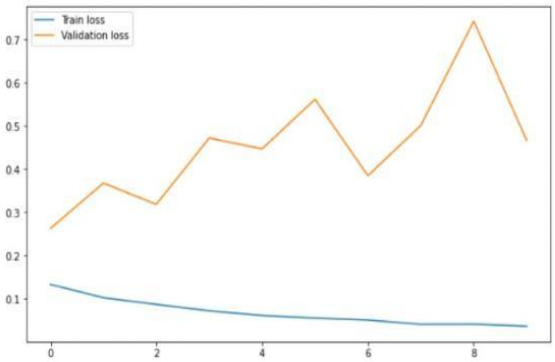


Fig 11: Graph for train loss and Validation loss.

CONCLUSION

More correct and quicker technique for the detection and classification of waste management is incredibly vital. Waste management may be outlined because the "collection, removal, processing, and disposal" of materials thought-about waste. Waste may be place into landfills, incinerated, recycled, or composted. the foremost property thanks to manage waste is to recycle and compost. Deep learning and different technologies to domestic waste treatment therefore consistently supported the obligatory waste classification .So the efficent waste classification and detection are occur.

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