

# Development of ROBO Using Deep Learning for Smart City Application

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**Abstract** — This paper presents a garbage picking robot which can operate on the ground. Waste management is being given utmost importance these days. We know how tiresome repetitive cleaning is. It takes up a great deal of resources and labour. Efforts such as recycle bins and 3R's campaign aren't completely effective. This project helps in replacing the existing infra and to develop smart waste management system by using an automatic robot that can detect the garbage accurately. With the garbage recognition and automatic navigation functions, the robot can pick the garbage on the ground in places like parks or schools efficiently. Experimental results show that the garbage recognition accuracy can reach as high as 90%, and even without path planning, the navigation strategy can reach almost the same cleaning efficiency with traditional methods. Thus, the proposed robot can serve as a good assistance to relieve dustman's physical labor on garbage cleaning tasks.

**Keywords:** Deep Learning, Detection, Collection, Image Processing, Raspberry Pi, Pi Camera

## I. INTRODUCTION

Manual picking garbage and cleaning it is difficult and repetitive undertaking, and self-sufficient robot can be made use for this type of applications. The self-reliant robotic floor-cleaning, aquatic-cleaning, wall-cleaning, Robotic Vacuum, Window Cleaning Robot and garbage gathering robots had been evolving for years, while autonomous cleaning robot which could function on the ground will remain as a hard project because of the shortage of garbage reputation ability, obstacles and uneven ground levels. Motivated by means of the garbage picking robots that are being operated on the seaside for picking plastic waste and tins, this paper pursues to expand a robot which could pick out the garbage and pick it up. As the important thing of such robots, computerized trash detection algorithm the use of ultrasonic sensors for moving become proposed in existing models, but it would be confusing while sensing an obstacle with garbage due to its limited perception ability of ultrasonic sensors. In order to overcome this, IR sensor is used to detect garbage accurately than ultrasonic sensors. Besides, deep learning has been implemented successfully for the detection, segmentation of objects in the image reputation of items in pics and collecting. In order to make easy, the highly large garbage, a manipulator instead of the vacuum or roller brush used on most present commercial ground-cleansing robots. Specifically, Blynk IOT based controller is used to command the manipulator for garbage pickup. Besides these key components that are mentioned, the robot provided on this paper will also afford fundamental capabilities along with path planning, impediment avoidance and surroundings belief. Thus, the prototype model we had came up with an automatic garbage detecting and collecting garbage.

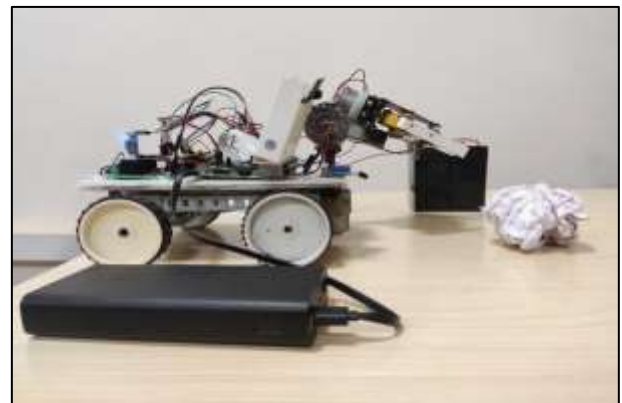


Fig. 1.1: Prototype of the proposed robot system.

Artificial intelligence can be added for this machine to increase intelligence. Being more specific, machine learning can be used here as it is a part of artificial intelligence which will focus on training machines instead of programming. The model is a good solution for solid waste management in open grounds, parks, schools, hospitals, and for indoor waste collection as well. The system is capable of detecting the objects in random movement. After detecting the object, the robot will capture and detect the object using pi camera, followed by image processing and garbage segmentation.

Based on segmentation results if the object is a garbage, then the robot will collect the garbage using its arm. Concluding, the report explains a system that is similar to working as a human in terms of detecting and collecting the garbage. The system is capable of achieving 10 frames per second on the Raspberry Pi and is capable of detecting the garbage in real-time with 90% accuracy. This is the prototype model that can even move in uneven grounds in Fig. 1. The rest of the paper is organized as follows, Section II provides the overview of the proposed robot, which consists of the hardware configuration and system architecture. The methodology of the garbage-cleaning robot is presented in

Section IV which includes perception, object tracking, navigation, and so on. Section V shows some experimental results and demonstrates the effectiveness of the proposed robot system. The conclusions are drawn in Section V.

## II. LITERATURE SURVEY

This project mainly established a small daily items detection data set with the rapid development of deep learning, great breakthroughs have been made in the field of object detection. In this project, deep learning algorithm is applied to the detection of daily objects, and some progress has been made in that direction. The data set is then trained on different object detection models and has achieved good results in daily object detection. Compared with traditional object detection methods, the daily objects detection method based on deep learning is faster and more accurate. The main research work of this article are collecting a small data set of

daily objects, TensorFlow framework to build different models of object detection, and use this data set training model, training process and effect of the model are improved by fine-tuning the model parameters. Those well-trained models can be used in the microprocessors, mobile platform, Nao robot platform or other intelligent devices, the daily items to achieve accurate detection.

This project proposes the method where a robot can be used to clean the polluted areas such as garbage around the dustbin. A Robot is powered by Solar Panel, which again saves the electric power. Robot has the advantages of the powerful image processing and ultrasonic sensor to sense the surrounding area and accordingly action can be taken. An image processing has been used here to avoid interaction with the wild life. An Ultrasonic sensor is used to detect the object and the distance between the object and Robot. The Ultrasonic sensor is also used to employ a movement algorithm for the movement of the robot. The garbage is collected efficiently and effectively the garbage gets detected when it is at 20 cm from the trash [3] The main concept of this project was to make a cost-effective system that uses IoT to optimize the working of a network of garbage collectors. Adoption and optimization of the best features from existing technologies, into a single integrated system has made it very efficient. The deployment of OpenCV in a real-time environment for image processing and classification, makes the module dynamic. The system is cost-effective and time optimal. The image processing algorithm can be improved upon without any constraint in processing hardware. It can also be used for nuclear-waste collection, where human presence is unsafe. It is primarily proposed for a smart city.

### III. OVERVIEW OF THE PROPOSED MODEL

This section describes about the hardware configuration and system architecture of the proposed robot system.

#### A. Hardware Configuration

As shown in below Fig. 3, the complete system of this robot includes six major parts:

- 1) Robo Base
- 2) IR sensor
- 3) Raspberry pi
- 4) Pi camera
- 5) Esp8266
- 6) Dc motors
- 7) Battery
- 8) Dc Relay.

#### B. Software Configuration

- 1) Python,
- 2) Advance IP scanner
- 3) OpenCV
- 4) Vnc viewer
- 5) Blynk IOT app

#### C. Block Diagram

The robotic base is the main frame of the robot, equipped with all dc motors, battery, IR sensor, raspberry pi and pi camera. A low-cost IR sensor is used to continuously detect for any obstacles and get accurate location information for moving of robot. In Raspberry pi the movement of Robo and CNN is implemented.

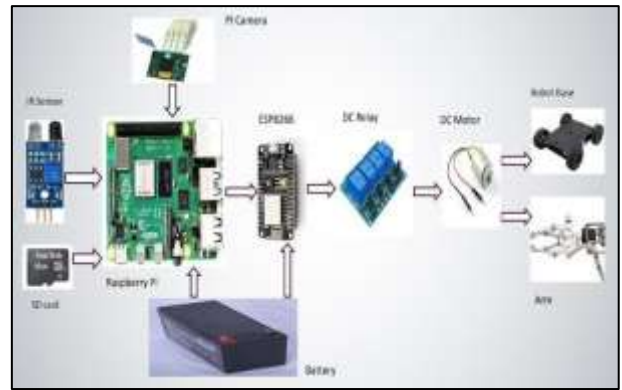
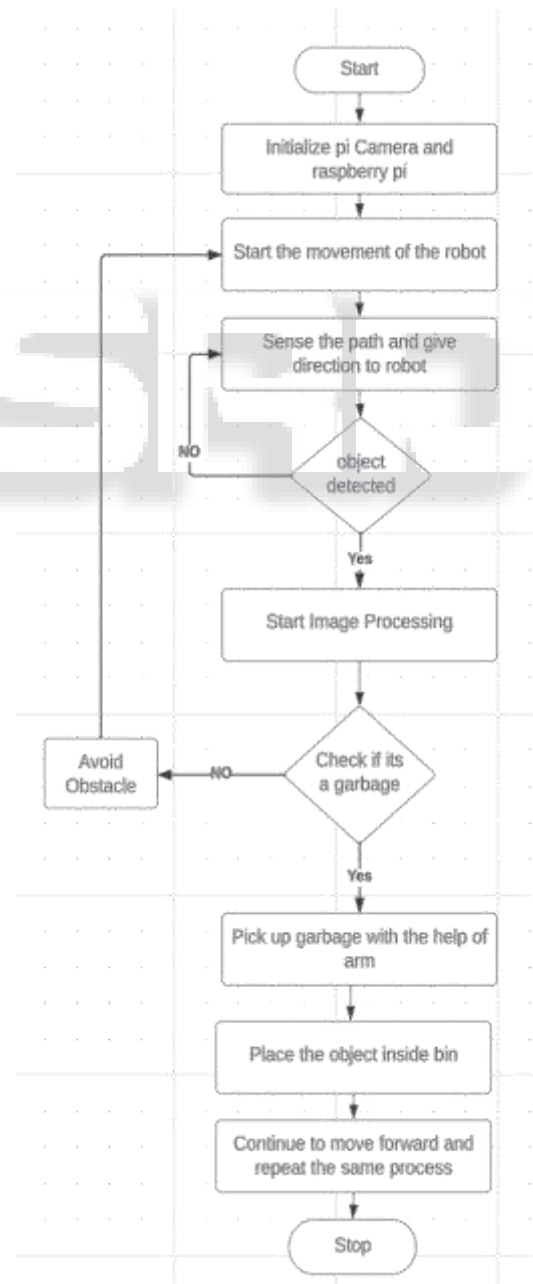


Fig. 3.3.1: Block Diagram

Pi camera is used for capturing images of object detected. The movement of robot and arm is done using dc motors. The dc motors are connected to wheels of robot.

#### D. Flow Chart



#### IV. KEY METHODOLOGY

The methodology of this project includes designing a robot that detects obstacles using IR sensor. Here the robot will be moving automatically and stops whenever it detects the object. After detecting any obstacle the robot captures the obstacle using pi camera. The obtained image from the pi camera is sent to the Raspberry pi for classifying whether the object is garbage and non- garbage object using Tensor Flow This object detection API runs on a pre-trained object detection model, which is lightweight and suitable to run on low-computing power devices such as Raspberry Pi. YOLO (You Only Look Once) is an object detector that is used to detect multiple objects within a single image. The detection model is based on a convolutional neural network that predicts the bounding boxes and confidence scores for each object. After classification if the obstacle is garbage, the robot picks it using its arm which will be operated manually using Blynk IOT. If the object is not a garbage then the robot changes its position automatically and moves forward.

#### V. EXPERIMENTAL RESULTS AND DISCUSSIONS

##### A. Recognition Accuracy

The key point for picking up the garbage is the garbage recognition. If the recognition module fails to recognize the object as garbage or non-recognize, then the entire system will fail.



Fig. 5.1.1: Images captured by Raspberry Pi

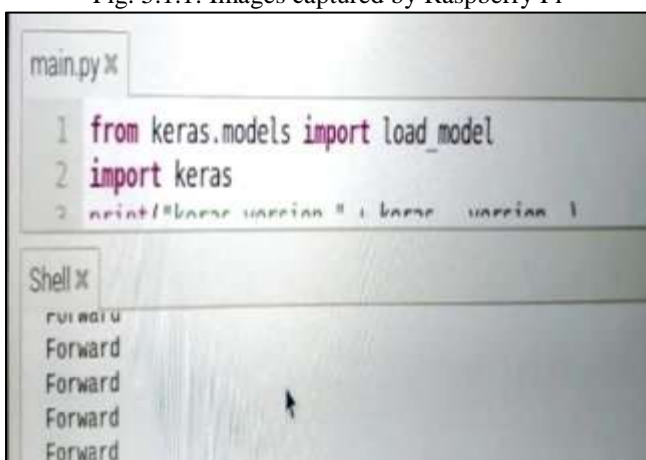


Fig. 5.1.2: Initial movement of Robo

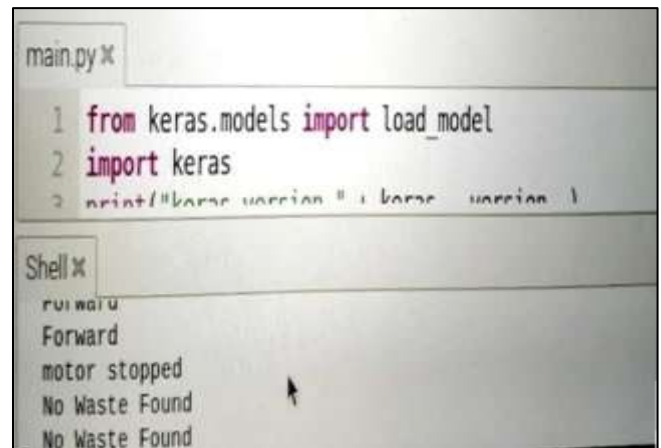


Fig. 5.1.3: No waste detected

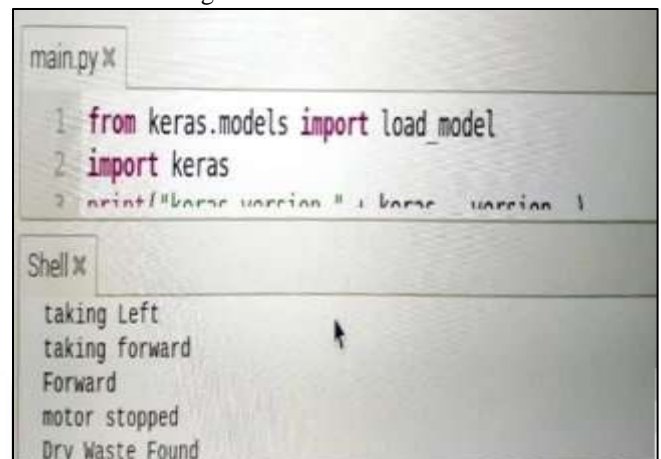


Fig. 5.1.4: Changing direction of Robo

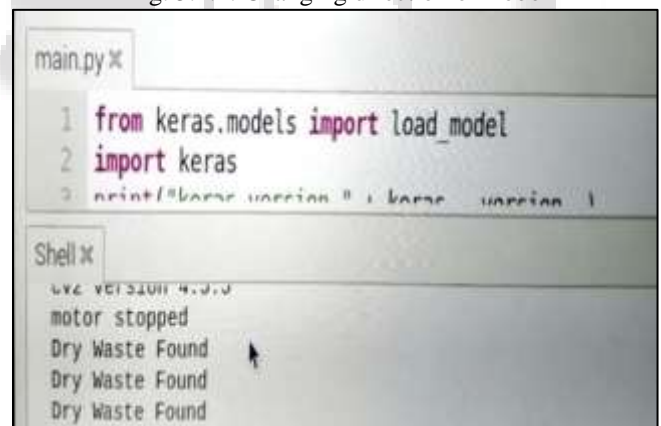


Fig. 5.1.5: Waste Detected

Thus, results to improper working of robot. So because of this reason we made the recognition and made it accurate before testing. The dataset consists of 1050 training images in which 500 crushed paper, 500 bottles and 50 inhaler. We had experimented on the existing training set and evaluated on the test set.

If we bring all together in one system, then it will make automatic garbage detection and collection robot. We just need to keep this system on the floor or ground. The robot will start moving and the camera will start capturing the images and machine learning algorithms will check for the presence of garbage frame by frame in real- time. If an object is detected, then it will capture and sends to raspberry pi. The arm will use this instruction in order to pickup the object.

## VI. CONCLUSION

This document affords a novel robotic device for detecting the garbage automatically. With the help of sensor, the proposed robot can recognize the object without any human assistance. Besides Deep Learning based algorithm is proposed for segmentation of the garbage. This robot can be used in large grounds to reduce human labor. It can also be used in institutions, hospitals and shopping malls by detecting the garbage automatically using sensor and openCV and the robot will pick the garbage with its arm which is operated with help of a human. Experimental outcomes proved that the proposed robot could understand the garbage appropriately and move efficaciously. This robot can serve as a powerful tool for cleaning the garbage.

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