

# Robotic Vehicle for Garbage Collection

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**Abstract** - Now-a-days, Collecting and segregating of waste has become one among the greatest challenging task for municipal corporations, all around the globe. An exponential rise in population, there's an increased production of waste, and also an enormous amount of litter consisting of plastic, paper, and other such products carelessly thrown about and scattered publicly. No one is paying attention to surrounding environmental problems. One of the major issues is garbage collection. To deal with this problem we come up with a "Robotic Vehicle for Garbage Collection". Robot is able to perform human tasks of collecting garbage. In this project, we are designing a robot which is capable of collecting the waste products from various places like footpaths, parks, schools & colleges etc. This robot is capable for detection of objects in random movement. The main controller of this project is Raspberry Pi 3B. The robot is built on a wooden base of size 50x40 cm which is powered by battery of 12V. The movement of robotic vehicle is controlled by programming the Arduino. After detecting the objects, the robot senses by webcam & followed by Image processing, the object gets collected with the robotic arm and place into the container. The robot keeps collecting the waste until it reaches certain height within the bin. Once the bin is full then it is notified to the operator. This robotic vehicle is working automatically and saves the human power.

**Key Words:** Robotic Vehicle, Robotic ARM, Image Processing, Segregation, Garbage Collection

## 1. INTRODUCTION

Garbage is the major problem not only in cities but also in rural regions of India. It is a major source of pollution. Indian cities alone generate more than 100 million tons of solid waste a year. Though there is no single effective system for waste management.

In 2000, India's Supreme Court administered all Indian cities to implement a comprehensive waste-management program that might include household collection of segregated waste, recycling and composting. Municipal solid waste workers (MSWWs), universally expose too many work-related health hazards and safety risks and other diseases of the systema respiratorium.

At present the method of cleaning up is manually. With trends in industries shifting towards automation, it should also be definitely applied towards waste management. While manual labour to clean up garbage is good source of employment there are several problems with manual labour like health issues of workers, not able to clean the garbage at high risks like high radiation and dangerous gases produced by wastes. The environmental issue which comes up from year to year and still cannot be solved is about the waste. Hence to beat this major problem of waste collection "Robotic Vehicle for Garbage Collection" is developed.

## 2. NECESSITY

Necessity of this project is to clean the surrounding environment. This robot is tasks individually with highest degree of autonomy. In many of the old system, requires human intervention to operate and it is time consuming process. This robot can obtain the information about its surrounding and move on the path without human intervention. Image processing is used for detection of obstacle and proceed for garbage collection. Large amount of recycle waste in different type are not segregated properly. A solution to this a robotic vehicle which is intended to automate the sorting of metallic and non-metallic waste.

## 3. OBJECTIVE

- To enhance a healthy & hygiene environment.
- To send alert message to the owner of the robot if the dustbin is full.
- To build an autonomous robot which is more intelligent in its cleaning procedure and make it capable of picking up larger quantity of garbage.

## 4. MOTIVATION

- With increase of population, the scenario of cleanliness with respect to garbage management is degrading tremendously. In city there are many public places where we see that garbage bins or dustbins are placed but are overflowing. This creates unhygienic condition within the nearby surrounding. Also creates ugliness and a few serious diseases, at an equivalent time bad

smell is additionally spread and it also degrades the valuation of that area.

- Many times, we see that people throwing the garbage carelessly on the public places instead of dustbin which can lead many hazardous diseases.
- To avoid such situation, we come up with project Robotic Vehicle for garbage collection which automatically detect and collect the garbage using image processing.

## 5. BLOCK DIAGRAM

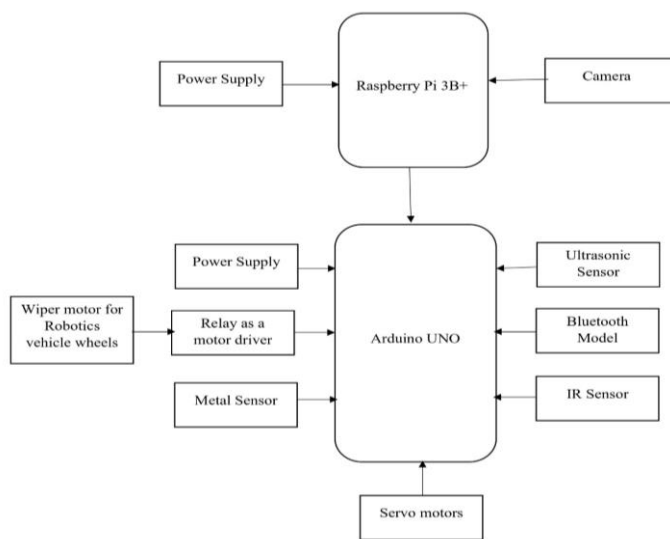


Fig -1: Block Diagram of Robotic Vehicle for Garbage Collection

## 6. BLOCK DIAGRAM DESCRIPTION

### 6.1 Raspberry Pi 3B+

Raspberry P 3B+ is a system on chip (SOC) device. A cost effective simple open-source processor board like a Raspberry Pi 3 is a good solution for basic computations, Image processing and sensor data acquisition. A Raspberry pi could be a credit card sized onboard computer which consumes very less power so advantageous during a portable device like a smart trashcan.

Here Raspberry Pi 3B+ is used for image processing. Raspberry Pi supports Linux OS which can run python tools for easy yet powerful user-friendly applications. This computational core comes with a bunch of General-Purpose Input & Output pins or GPIO for short so that one can easily interface a good number of sensors to sense the physical parameters which makes it suit for this application. The

Python programming language which may be run easily on a Linux operating system which has good powerful libraries.

### 6.2 Arduino UNO

Arduino is an open-source prototyping platform supported easy-to-use hardware and software. Arduino consists of both a physical programmable circuit board and a bit of software, or IDE (Integrated Development Environment) that runs on user's computer, want to write and upload code to the physical board. The Arduino Uno microcontroller board is based on the ATmega328P. It's 14 digital input/output pins (of which 6 are often used as PWM outputs), 6 Analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller. It will be powered by simply connecting to a computer with a USB cable or with an AC-to-DC adapter or battery to get started. we have used Arduino because it's an open- source device which may be programmed through any OS like Windows, Mac, Linux, etc. The language used is understandable and straightforward, changing of program is additionally very easy.

### 6.3 Ultrasonic Sensor

There is an ultrasonic sensor in ahead on the chassis, which is used for obstacle detection. The ultrasonic sensor takes +5 VC. As well as it has a range from 2 cm to 3 m.



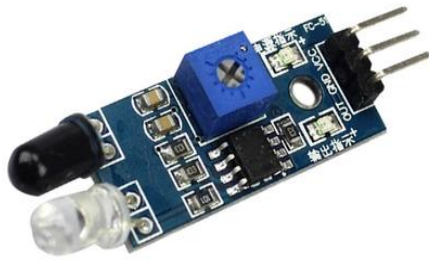
Fig-2: Ultrasonic Sensor

As shown above the **HC-SR04 Ultrasonic (US) sensor** is a 4pin module, whose pins are Vcc, Trigger, Echo and Ground respectively. The module has two eyes like structure in the front which forms the Ultrasonic transmitter and Receiver. The Ultrasonic transmitter transmits an ultrasonic wave, this wave travels in air and when it come in contact with object it gets reflected back toward the sensor this reflected wave is observed by the Ultrasonic receiver module.

The distance can be calculated using the formula:

$$\text{Distance} = \text{Speed} * \text{Time.}$$

### 6.4 IR Sensor



**Fig-3:** IR Sensor

An infrared (IR) sensor is a device that emits so on sense some aspects of the environment. An IR sensor can detect the heat of an object as well as the motion. Whenever the IR sensor senses an object close enough to that, the light from the LED bounces back from the obstacle and into the light sensor. Usually, all the objects radiate some form of thermal radiations in the infrared spectrum. These are invisible kind of radiations to our eyes that may be sensed by an infrared sensor. An IR LED (Light Emitting Diode) is just an emitter and an IR photodiode is just a detector which is sensitive to IR light of an equivalent wavelength that is emitted by the IR LED.

### 6.5 Metal Detector Sensor

Metal detector sensor is used to check whether the garbage picked up is a metal or non-metal. A metal detector is a device which takes advantage of the electrical and magnetic properties of metals (Eddy currents) to detect metals. Eddy currents are electric currents induced inside conductors by a changing magnetic flux within the conductor. The detector generates electromagnetic fields by passing an electrical current through the coil. The magnetic field surrounds the coil. If the item has a magnetic field, the magnetic field will create the current. As a result, the metal generates a magnetic field of its own, and therefore the detector senses this field and detects metal.

The metal detector is placed in the arm. When the arm can pick up the object, the metal detector is turned on to detect a metallic object. In case if the metal detector detects a metallic object, object is dump into the bin which has partition for metallic.



**Fig-4:** Metal Detector Sensor

### 6.6 Wiper Motor

The Built Robot with windshield wiper Motors's project may be a heavy-duty type robotic design. In this project, the wiper motors are modified into motors which can be controlled by H-bridge motor driver.

The wiper motor is incredibly powerful and versatile. The high electric motor torque is often used to power a robotic vehicle. In most projects of this kind, enthusiasts employ two motors to rotate the wheels. In addition to torque, other advantages include the ability to manage speed of the vehicle.

### 6.7 Servo Motor

MG995 Metal Gear Servo Motor is a high-speed standard servo motor which may rotate approximately 180 degrees. Digital Servo Motor can receive and processes PWM signal faster and simpler. It equips Knowledgeable internal circuitry that gives good torque, holding power, and faster updates in response to external forces. movement of the dustbin. The collected trash is transferred to the robot platform. The dustbin has two separate partitions for metallic and non-metallic trashes. Another servo motor is attached to the dustbin for rotating the dustbin in order that the collected waste will for into the corresponding partition.

### 6.8 Bluetooth Module

HC-05 Bluetooth module is a simple to use of Bluetooth SPP (Serial Port Protocol) module, designed for transparent wireless serial connection setup. The HC-05 Bluetooth Module are often employed in a Master or Slave configuration, making it an excellent solution for wireless

communication. This interface of Bluetooth module is fully qualified Bluetooth V2.0+EDR (Enhanced Data Rate) 3Mbps Modulation with complete 2.4GHz radio transceiver and baseband.

This device is used for wireless serial data communications via the Bluetooth radio system. It is a low cost, compact and straightforward to use this module. It will connect to the microcontroller via RS232 serial port. The HC-05 has two operating modes, one is that the info mode during which it can send and receive data from other Bluetooth devices and also the other is that the AT Command mode where the default device settings are often changed.

### 6.9 Raspberry Pi Camera

Here, Raspberry Pi Camera is employed for capturing the photos from surrounding. The Raspberry Pi Camera Board is di plugs directly into the CSI connector on the Raspberry Pi. It's ready to deliver a crystal clear 5MP resolution image, or 1080p HD video at 30fps. The sensor itself features a native resolution of 5 megapixel, and contains a fixed focus lens onboard. In terms of images, the camera is capable of 2592 x 1944 pixel static images.

### 6.10 Relay Module

A relay is often defined as a switch that's applied with electrical signal which successively connects or disconnects another circuit. An IR relay may be a device during which the relay is often operated wirelessly by a foreign, with the assistance of Infrared signals. We are using 1 set of 4 channel relays in our project. The 4 Channel Relay Module could even be a convenient board which might be used to control high voltage, high current load like motor, solenoid valves, lamps and AC load. it's designed to interface with microcontroller like Arduino, PIC and etc. The relays terminals (COM, NO and NC) is being brought out with screw terminal. It also comes with a LED to point the status of relay.

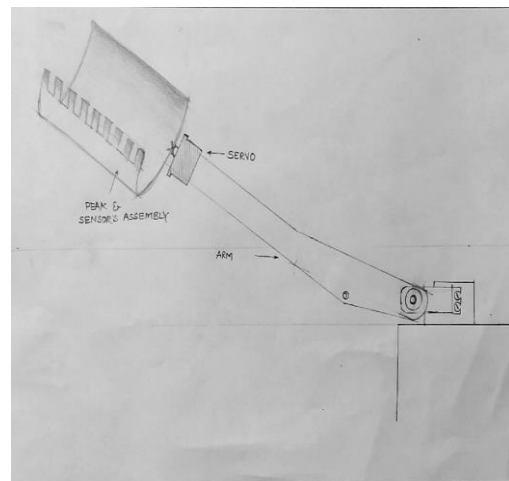
### 6.11 Power Supply

Battery is used as power supply to robotic vehicle. As the power source a 12V and 9Ah, lead acid heavy duty battery is used. The reason for this is that the motors require 12V power source and the acid-lead battery is available at a low cost compared with more energy. Two different DC levels of +5V & +12V are used. The battery as it is delivering 12V is used to drive the DC motors & H-Bridge, whereas for the

remaining electronic circuitry consists of microcontroller requires +5V constant supply.

### 6.12 Robotic ARM

A Robotic arm is a type of mechanical arm, usually programmable with similar functions to a human arm. Movement of arm is controlled by using servo motors. Another servo motor is connected to the palm like structure of the arm. Servo motor will rotate a palm in certain angle such that trash will be grab by the arm. At the palm structure, metal detector sensor is mounted for the detection of metallic or non-metallic waste.



**Fig-5: Robotic ARM**

## 7. SYSTEM OPERATION

In this work, robot is designed using wiper motors and motor drivers. The motion of the robot is controlled by Arduino programming. The robot can travel in any terrain and operates on a battery. Rubber wheels can be used for smooth drive quality which improves the robot's mechanical life.

There is an ultrasonic sensor in front of the chassis which is used for the detection of obstacle. The camera mounted on the chassis of the robot remains inactive until an obstacle is detected by ultrasonic sensor. Raspberry Pi 3 is a good controller board for basic computation of image processing. When an object is detected by the ultrasonic sensor then the Arduino sends the data to the Raspberry Pi and activate the camera. The camera captures a single image and sends it to the server for image processing classification to detect it as garbage or non-garbage. After classifying object as a garbage

then the controller initiates the robotic arm to pick the object. Robotic arm can pick up the object.

Metal detector sensor is mounted on the arm for segregation of metallic or non-metallic waste accordingly. Two separate partition-based dustbin is designed for waste collection and segregation. As soon as the metal detector sensor is placed in the arm check the waste picked to be metal or non-metal and are dumped its corresponding partition in the dustbin.

IR sensor placed in the dustbin monitor the level of the waste in the bin. The robot keeps collecting the waste until it reaches certain height within the bin. Once the bin is full then it is notified to the operator.

### 8. IMAGE PROCESSING

Image processing is a method of processing images so that essential features can be extracted from the image and those features can be used either to recognize the objects in digital images or as an input for other algorithms or processes. There are so many algorithms present but the best algorithm for real time image processing in minimum time is Haar-Cascade Algorithm which is best for object and garbage detection. It is a best and fastest real time object detection algorithm. It's basically a machine learning algorithm that uses a bunch of images of garbage and non-garbage to train a classifier that can later be used to detect faces in real time. The algorithm implemented in OpenCV also can be used to detect other things, as long as to place the garbage in its appropriate classifiers. While we would not be paying emphasis on garbage recognition, our main focus is to obtain faster real-time object detection so that it can help to classify the garbage within fraction of time so that it may understand the output direction and can choose his direction according to the direction directed by this algorithm.

### 9. FLOW CHART

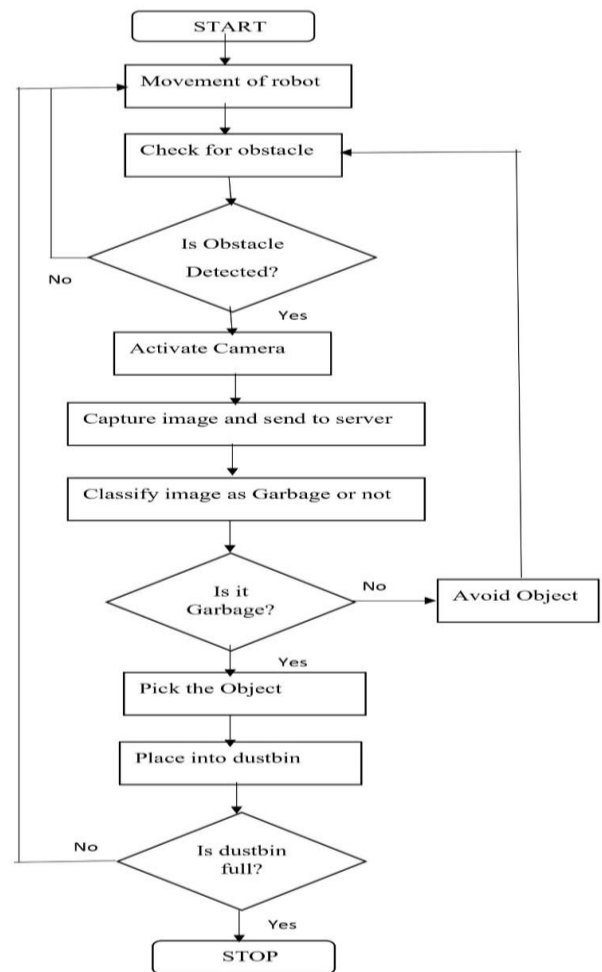


Fig-6: Flow Chart

### 10. DESIGN OF ROBOT

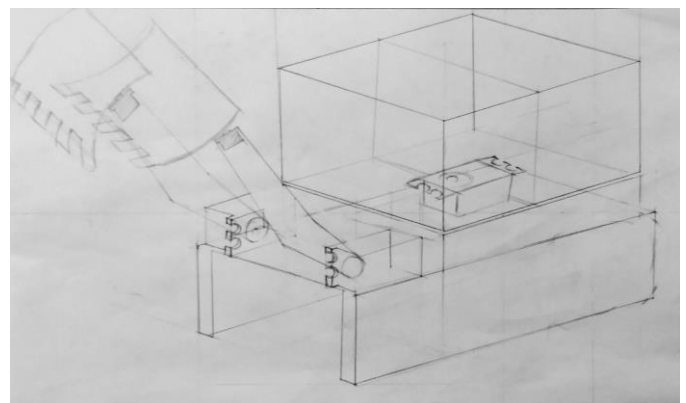


Fig-7: Design of Robot

## 11. CONCLUSION

The garbage collecting work is physically demanding and it causes workers to several occupational hazards. This project is designed to fulfil the task of collecting garbage from public places. When the ultrasonic sensor is triggered, the camera is actuated and through the image processing garbage is detected. Robotic arm will collect the waste then the metal proximity sensor will able to sort out metallic and non-metallic waste and according to this arm dump the waste in respective slot. This segregation system is efficient and time saving process than the currently employing method.

The process of creating the things automatic is being exploited in almost all the major fields of life. It ensures safety and does not consumes time and also safety for humans preventing from allergic and other diseases.

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