# CHAPTER 1

# INTRODUCTION

- In the current situation ,India is facing various challenges in the environment by the improper waste collection,treatment,transport,disposal.
- By making advancement in the present robotic vacuum cleaner ,it allows to be used in the public areas.
- The robot allows proper cleaning of wastes without any human intervention.
- Mainly used for the removal of garbage and other waste materials from the public places such as parks , malls and pathways,parking areas and auditorium etc,..
- Uses vacuum cleaning mechanism and a waste collecting mechaninsm with a robotic arm for waste removal and collection
- Sensors used for the detection and provide pathways'
- Basic functions ; path planning ,obstacle avoidance,smart waste monitoring etc…

Our main objectives are ;

- Wireless control mechanism of robot
- Automatic movement of robot with decision making
- Real time Vacuum Cleaner action and waste picking with robotic arm
- Waste disposal without any human intervention

# CHAPTER 2

# LITERATURE SURVEY

[1] Rohidas Waykole, Vedang Pujari, Ajay Powar and Umakant Patil (2018) ‘Electromagnetic Scrap Collecting Machine with Vacuum System .The main aim of this work is to control the robot for collecting the scrap from different areas or surfaces automatically by monitoring and regulating the direction of a dc-motor with PIC16F72 Microcontroller remotely using mobile phone techniques and DTMF (Dual Tone Multi Frequency) signaling. Different functions of moving robot are controlled like moving forward, backward, left and right.The aspect of the project is to build an actual robot that subjects wireless operation from a PC or a smartphone. The requirement of simplicity was set in order to focus on operability and functionality. The cleanup is time consuming, and represents a potentially significant source of untapped recyclable materials. By developing an autonomous robot that can locate, sort, and separately store the different containers, the manpower needed for cleaning can be significantly reduced

[2] Padmakshi Venkateshwara Rao, Pathan Mahammed Abdul Azeez, 2020 introduces the “IoT based Waste Management for Smart Cities” to overcome the challenges in the environment such as inadequate waste collection, treatment, disposal. Due to flooding of the dustbin causes unhygienic conditions are created, the dustbin is placed in the entire city; it is delivered with minimum cost embedded method to assist in tracking of the garbage, therefore the “Blynk app” is used to get the immediate SMS as early as garbage bin reaches its peak level. Therefore, instant action will be taken by the alarmed authorities once the status of a bin is notified through the internet. Ultrasonic sensor, node MCU, blynk app, a servo motor is used to develop the proposed system.

[3] Nayak, S., Hood, B., Allen, O., Foskey, C., Stevens, R., Kallal, E. & Schwartz, E. M. (2009). Recycling is the best way to create a sustainable environment and also it needs the segregation of waste materials which is a tedious time-consuming task. It is the minimal cost and effective smart recycling bin that uses the power of the cloud in order with waste classification in personal in-house usage. A centralized Information System collects measurements in smart dustbins, the waste in each bin can be classified using Artificial Intelligence and also neural networks. And it is capable of classifying different types of waste with an accuracy of 93.4%.

[4] Shashank Shetty, Sanket Salvi, 2020[3] This introduces the SAF-Sutra which can remotely monitor and is built at a very minimal cost. The design of the presented system considers the portability and ease of assembly of components as the essential factors during implementations. The demonstration shows the implemented system; its interaction with the user using the mobile along with the web application

[5] Clude-Noel Tamakloe, Dr. Elena v. Rosca, Introduces the Smart System and the Internet of Things (IoT) for waste management to provide an efficient and effective manner for waste disposal, improving the city's waste management. The proposed system is drawn and makeup a prototype of a solar powered, compact smart garbage bin whose monitoring is done with server side applications. The smart garbage bin is capable of monitoring internal garbage levels, compact them, and also free 25% of the space with each compactness. The bin detects and monitors the total weight and is capable of sending all the information to a secure server side application

[6] Chethan Kaushal, Anshu Singha, 2020[6] introduce the Architecture for garbage monitoring systems using integrated technology, proposed the novel architecture of wastemanagement that utilizes the concept of IoT and digital image processing, the architecture acts as a surveillance system to monitor the over the flow of the garbage and delivers the message to the concerned authorities to take the necessary and instant action.

[7] Rania Rizki Arinta, Dominikus Boli Watomakin, 2020[5] introduces the "Improves smart waste management to preserve tourist's attractions Yogyakarta in IoT environment", the main agenda is to make waste recycled, if it is not recycled, it will make the decomposition process more tedious. Therefore, the dustbin is integrated with the smartphone to find out information about the capacity of the garbage by using the ultrasonic sensor. The wi-fi module combined with the dustbin allows the sensor to send the data through the wi-fi module via smartphone.

# CHAPTER 3

# BLOCK DIAGRAM

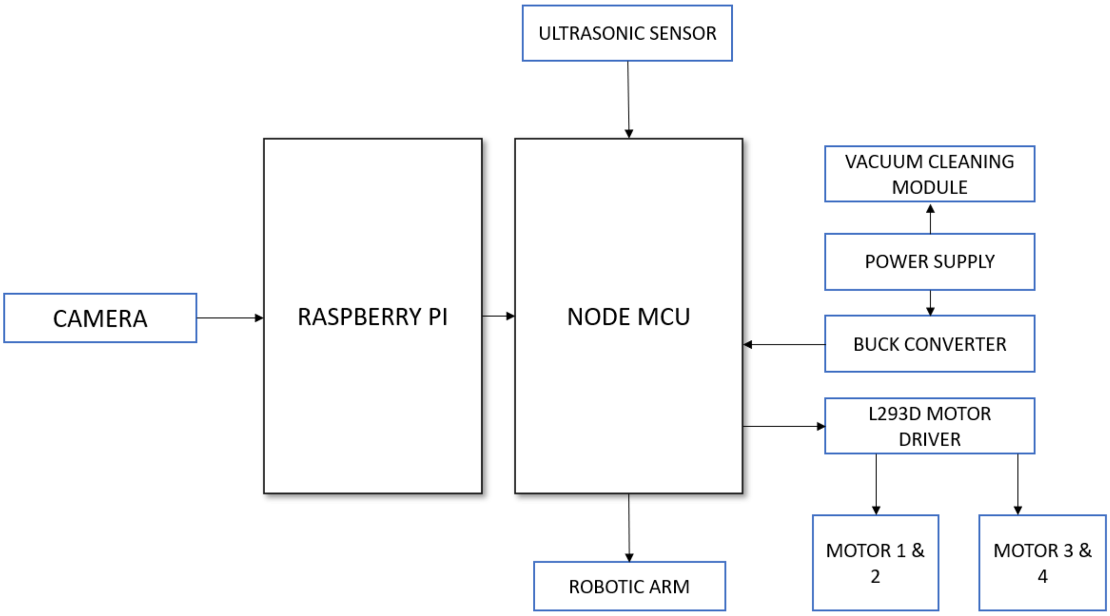


**Figure 3.1:** Block diagram of the system

# CHAPTER 4

# COMPONENTS AND COST

| SL NO | COMPONENT | COST |
|---|---|---|
| **1.** | Gear motor (5) | 600 |
| **2.** | L293D Motor Driver(2) | 500 |
| **3.** | Ultrasonic ranging module | 700 |
| **4.** | Raspberry Pi 3 Model B | 5000 |
| **5.** | ESP 8266 | 400 |
| **6.** | Buck converter | 200 |
| **7.** | Robotic Arm | 2500 |
| **8.** | Lithium-ion battery(12v-1.5A) | 2000 |
| **9.** | Web cam | 1000 |
|  | TOTAL COST | 12900 |

**Table 1:** Components and cost

# CHAPTER 5

# HARDWARE AND SOFTWARE COMPONENTS

## 5.1: L293D MOTOR DRIVER

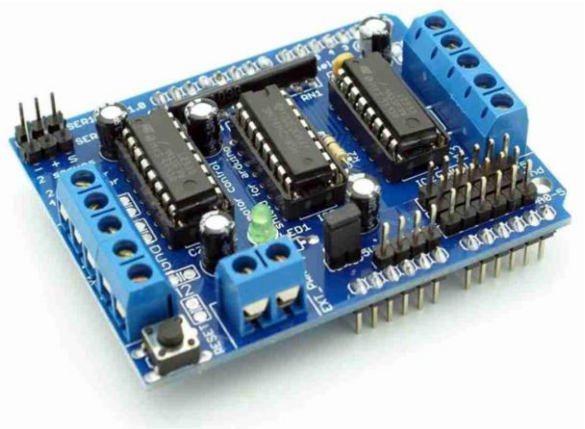


**Figure 5.1:** L293d Motor Driver

A motor driver IC is an integrated circuit chip which is usually used to control motors in autonomous robots. Motor driver ICs act as an interface between microprocessors in robots and the motors in the robot. The most commonly used motor driver IC's are from the L293 series such as L293D, L293NE, etc. These ICs are designed to control 2 DC motors simultaneously. L293D consist of two H-bridge. H-bridge is the simplest circuit for controlling a low current rated motor. For this tutorial we will be referring the motor driver IC as L293D only. L293D has 16 pins, they are comprised as follows:

Ground Pins- 4

Input Pins - 4

Output Pins -4

Enable pins - 2

Voltage Pins - 2

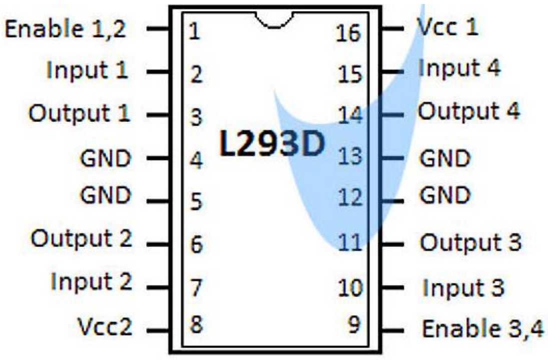


**Figure 5.2:** Pin description of L293d Motor Driver

The L293D IC receives signals from the microprocessor and transmits the relative signal to the motors. It has two voltage pins, one of which is used to draw current for the working of the L293D and the other is used to apply voltage to the motors. The L293D switches it output signal according to the input received from the microprocessor.The L293D is a 16 pin IC, with eight pins, on each side, dedicated to the controlling of a motor. There are 2 INPUT pins, 2 OUTPUT pins and 1 ENABLE pin for each motor. L293D consist of two H-bridge. H-bridge is the simplest circuit for controlling a low current rated motor.

## 5.2: ULTRASONIC SENSOR

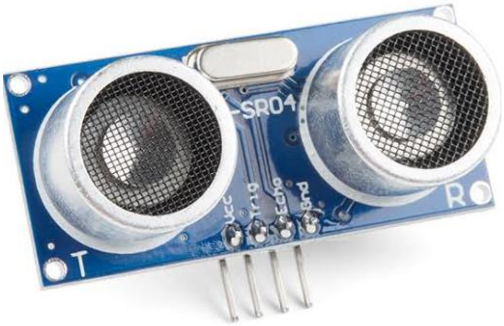


**Figure 5.3**: Ultrasonic sensor

This is the HC-SR04 ultrasonic distance sensor. This economical sensor provides 2cm to 400cm of non-contact measurement functionality with a ranging accuracy that can reach up to 3mm. Each HC-SR04 module includes an ultrasonic transmitter, a receiver and a control circuit.There are only four pins that you need to worry about on the HC-SR04: VCC (Power), Trig (Trigger), Echo (Receive), and GND (Ground).

The HC-SR04 Ultrasonic distance sensor consists of two ultrasonic transducers. The one acts as a transmitter which converts electrical signal into 40 KHz ultrasonic sound pulses. The receiver listens for the transmitted pulses. If it receives them it produces an output pulse whose width can be used to determine the distance the pulse travelled

## 5.3: RASPBERRY PI 3 MODEL B+

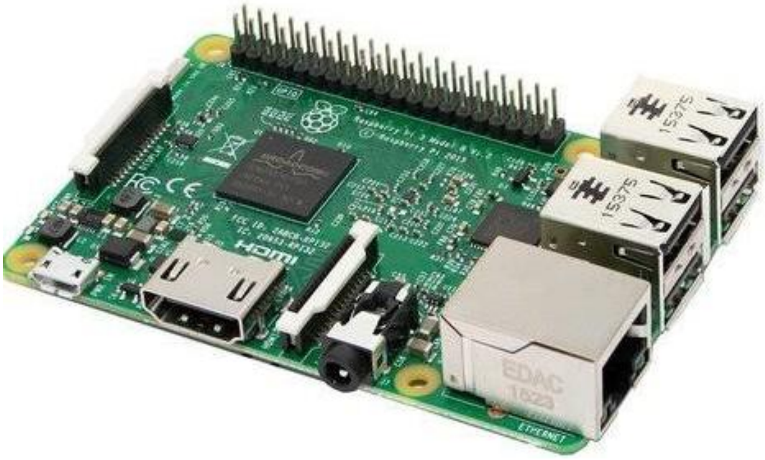
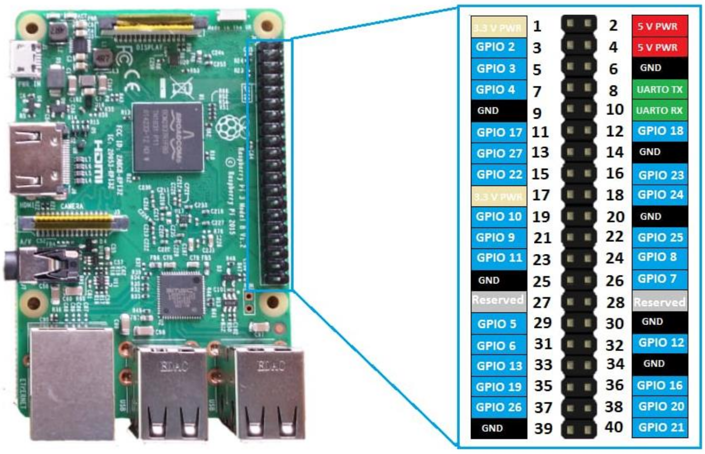


**Figure 5.4:** Raspberry PI 3 model b+

Raspberry Pi 3 Model B brings you a more powerful processer, 10x faster than the first generation Raspberry Pi. Additionally it adds wireless LAN & Bluetooth connectivity making it the ideal solution for powerful connected designs. Raspberry Pi 3 Model B comes with 64 bit quad core processor, on board WiFi and Bluetooth and USB features. It has a processing speed ranging from 700 MHz to 1.4 GHz where RAM memory ranges from 256 to 1GB.

The CPU of this device is considered as the brain of the device which is responsible for executing numbers of instructions based on mathematical and logical operation.The GPU is another advanced chip incorporated in the board that carries out function of image calculation Raspberry Pi 3 is tiny single board computer, introduced by Raspberry Pi Foundation, that comes with CPU, GPU, USB ports and i/o pins and capable of doing some simple functions like regular computer.WiFi and Bluetooth that lack in older versions(Pi 1 and Pi 2), are added in the new addition of this device(Pi 3), allowing to maintain the connection with the peripherals without the involvement of any physical connection.



| | | | |
|---|---|---|---|
| 3.3 V PWR | 1 | 2 | 5 V PWR |
| GPIO 2 | 3 | 4 | 5 V PWR |
| GPIO 3 | 5 | 6 | GND |
| GPIO 4 | 7 | 8 | UARTO TX |
| GND | 9 | 10 | UARTO RX |
| GPIO 17 | 11 | 12 | GPIO 18 |
| GPIO 27 | 13 | 14 | GND |
| GPIO 22 | 15 | 16 | GPIO 23 |
| 3.3 V PWR | 17 | 18 | GPIO 24 |
| GPIO 10 | 19 | 20 | GND |
| GPIO 9 | 21 | 22 | GPIO 25 |
| GPIO 11 | 23 | 24 | GPIO 8 |
| GND | 25 | 26 | GPIO 7 |
| Reserved | 27 | 28 | Reserved |
| GPIO 5 | 29 | 30 | GND |
| GPIO 6 | 31 | 32 | GPIO 12 |
| GPIO 13 | 33 | 34 | GND |
| GPIO 19 | 35 | 36 | GPIO 16 |
| GPIO 26 | 37 | 38 | GPIO 20 |
| GND | 39 | 40 | GPIO 21 |

**Figure 5.5:** Pin description of raspberry pi

These are the 40 GPIO pins that are used for connection with other devices.The 64-bit processor on the Raspberry Pi 3 is twice as fast as the previously used 32-bit. If it's speed you desire, the Pi 3 is 50 percent faster than its predecessor, the Raspberry Pi 2, and 10 times as fast as the original. Webpages load much more rapidly and program response has hastened, making the Raspberry Pi 3 experience feel much more like a modern machine than a $35 computer.

Installed Memory: 1 GB

Number of Cores: Quad-core

Processor Speed: 1.2 GHz

Style: Single-board

Video Port: HDMI

## 5.4: DC MOTOR

**Figure 5.6:** Dc motor

A DC motor is any of a class of rotary electrical motors that converts direct current electrical energy into mechanical energy. The most common types rely on the forces produced by magnetic fields. Nearly all types of DC motors have some internal mechanism, either electromechanical or electronic, to periodically change the direction of current in part of the motor.

Common DC gear head motors need current above 250mA. There are many integrated circuits like ATmega16 Microcontroller, 555 timer IC. But, IC 74 series cannot supply this amount of current. When the motor is directly connected to the o/p of the above ICs then, they might damaged. To overcome this problem, a motor control circuit is required, which can act as a bridge between the above motors and ICs (integrated circuits). There are various ways of making H-bridge motor control circuit such as using transistor, relays and using L293D/L298.

## 5.5: ESP 8266

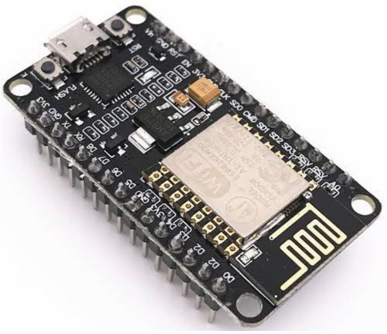


**Figure 5.7:** ESP8266

The ESP8266 WiFi Module is a self contained SOC with integrated TCP/IP protocol stack that can give any microcontroller access to your WiFi network. The ESP8266 is capable of either hosting an application or offloading all WiFi networking functions from another application processor. Each ESP8266 module comes pre-programmed with an AT command set firmware, meaning, you can simply hook this up to your Arduino device and get about as much WiFi-ability as a WiFi Shield offers (and that's just out of the box)! The ESP8266 module is an extremely cost effective board with a huge, and ever growing, community.

## 5.6: ROBOTIC ARM

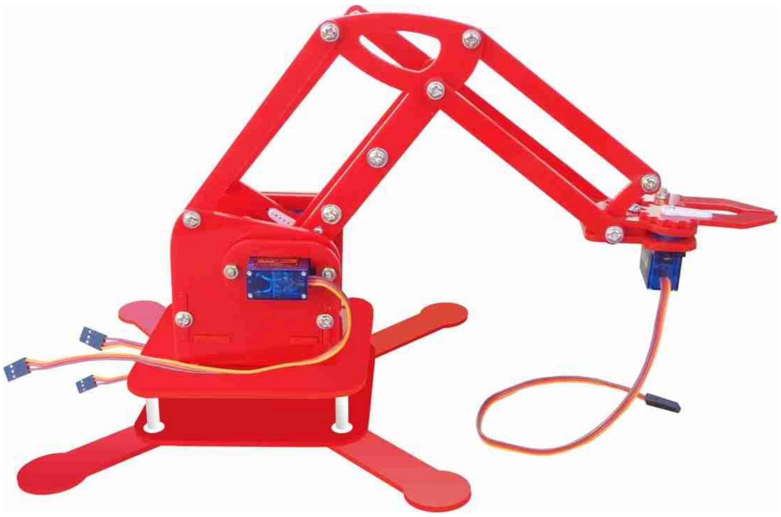


**Figure 5.8:** Robotic arm

Robotic arms can be used to automate the process of placing goods or products onto pallets. By automating the process, palletizing becomes more accurate, cost-effective, and predictable. The use of robotic arms also frees human workers from performing tasks that present a risk of bodily injury .Here are some of the most common ways manufacturers are using robotic arms today: Material Handling, WeldingInspection, Pick and Place

## 5.7: WEB CAM

**Figure 5.9:** Web cam

A webcam is a camera that connects to a computer. It captures either still pictures or motion video, and with the aid of software, can transmit its video on the Internet in real-time. Webcams are typically small cameras that sit on a desk, attach to a user's monitor, or are built into the hardware.

## 5.8: LITHIUM-ION BATTERY

**Figure 5.10:** Lithium ion battery

- Extremely high energy density to weight ratio.
- Safe: Built-in BMS prevents overcharge/discharge, overheating & short circuit.
- Environmentally responsible: No hazardous substances used in construction.
- Particularly suited for small electric vehicles

## 5.9: BUCK CONVERTER

**5.11:** Buck converter

DC – DC power converter which steps down voltage (while drawing less average current) from its input (supply) to its output (load).It contains at least two semiconductors (a diode and a transistor, although modern buck converters frequently replace the diode with a second transistor used for synchronous rectification) and at least one energy storage element, a capacitor, inductor, or the two in combination.

## 5.10: BLYNK SERVER FOR ANDROID

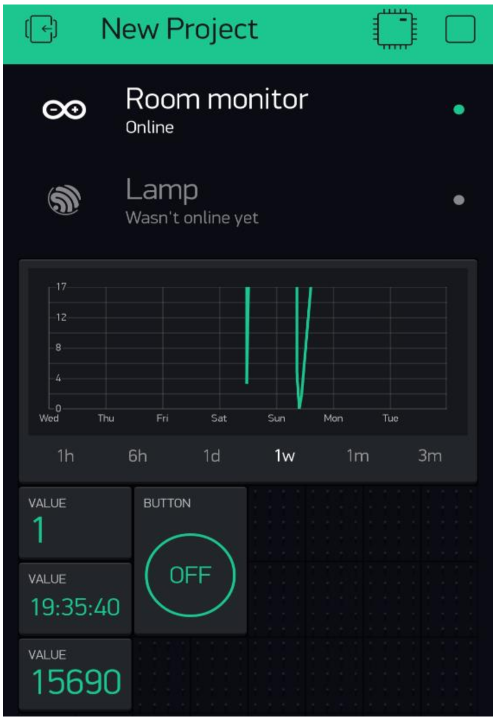


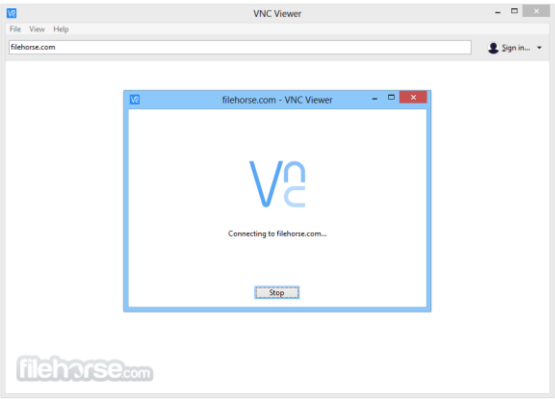
**Figure 5.12**: Blynk ui

Blynk Server is an Open-Source Netty based Java server, responsible for forwarding messages between Blynk mobile application and various microcontroller boards and SBCs (i.e. Arduino, Raspberry Pi. etc). With Blynk, you can create smartphone applications that allow you to easily interact with microcontrollers or even full computers such as raspberry pi , node mcu. The main focus of the Blynk platform is to make it super-easy to develop the mobile phone application. As you will see in this course, developing a mobile app that can talk to your Arduino is as easy as dragging a widget and configuring a pin. With Blynk, you can control an LED or a motor from your mobile phone with literally zero programming.

## 5.11: VNC VIEWER

A virtual network computing (VNC) is a graphical desktop-sharing application that uses remote frame buffer protocol to remotely control another computer. This form of desktop sharing transmits keyboard and mouse events from one system to another over the network based on screen updates.

Virtual network computing is a platform-independent remote desktop sharing application where the desktop display of one computer is remotely viewed and controlled over a network connection. A VNC viewer on one operating system connects to a VNC server on the same or another operating system.



Connecting to filehorse.com...

**Figure 5.13:** VNC window

The VNC system consists of a client, server and communication protocol:

- The VNC server is the program on the machines that share a screen, allowing the client to take control of it passively.
- The VNC client is the program that watches, controls and interacts with the server. The server is generally controlled by the client.
- The VNC protocol uses the remote frame buffer protocol, which is based on graphic primitives passed from the server to the client and event messages passed from the client to the server.

# CHAPTER 6

# SPECIFICATIONS OF HARDWARE COMPONENTS

## 6.1: RASPBERRY PI 3B +

| | | |
|---|---|---|
| 1 | SoC | Broadcom BCM2837B0 quad core A53 (ARMv8) 64-bit @1.4 Ghz |
| 2 | RAM | 1 GB LPDDR2 |
| 3 | NETWORKING | Gigabit Ethernet,2.4 and 5Ghz 802.11b/g/n/ac Wi-Fi , Bluetooth 4.2 |
| 4 | STORAGE | Micro – SD |
| 5 | GPIO | 40-pin GPIO |
| 6 | PORTS | HDMI ,3.5 mm audio jack,Camera Serial Interface ,Display Serial Interface |
| 7 | POWER SOURCE | 5V 2.5A |

## 6.2: Node MCU ESP8266

| | | |
|---|---|---|
| 1 | MICROCONTROLLER | Tensilica 32-bit RIS-C CPU Xtensa LX106 |
| 2 | DIGITAL I/O PINS | 16 |
| 3 | ANALOG INPUT PINS | 1 |
| 4 | SRAM | 4kb |
| 5 | FLASH MEMORY | 4MB |
| 6 | NETWORKING | 2.4G-2.5G (2400M-2483.5M) , 802.11 b/g/n |
| 7 | POWER SOURCE | 5V 80Ma |

## 6.3: BUCK CONVERTER

| | | |
|---|---|---|
| 1 | INPUT SUPPLY | 3-40V |
| 2 | OUTPUT LOAD | 1.5-35V 3A (max) |
| 3 | SWITCHING FREQUENCY | 150 Khz |
| 4 | IC | LM2596 |

## 6.4: L293D MOTOR DRIVER

| | | |
|---|---|---|
| 1 | IC | L293D |
| 2 | INPUT SUPPLY | 12V |
| 3 | INPUT PINS | 4 |
| 4 | OUTPUT CURRENT | 600mA per channel |
| 5 | OUTPUT PINS | 4 |
| 6 | ENABLE PINS | 2 |

## 6.5:DC GEAR MOTORS

| | | |
|---|---|---|
| 1 | INPUT SUPPLY | 12V |
| 2 | RPM | 10 |

## 6.6: WEB CAM

| | | |
|---|---|---|
| 1 | IMAGE RESOLUTION | 16 MB |
| 2 | FOCUS RANGE | 4CM TO INFINITY |
| 3 | INTERFACE | USB 2.0 |
| 4 | FRAME RATE | 30fps |

# CHAPTER 7

# YOLO ALGORITHM

## 7.1:YOLO

- YOLO is an algorithm that uses neural networks to provide real-time object detection. This algorithm is popular because of its speed and accuracy. It has been used in various applications to detect traffic signals, people, parking meters, and animals,and some specified objects

Object detection is a phenomenon in computer vision that involves the detection of various objects in digital images or videos. Some of the objects detected include people, cars, chairs, stones, buildings, and animals.

This phenomenon seeks to answer two basic questions:

1. What is the object? This question seeks to identify the object in a specific image.
2. Where is it? This question seeks to establish the exact location of the object within the image.

Object detection consists of various approaches such as fast R-CNN, Retina-Net, and Single-Shot MultiBox Detector (SSD). Although these approaches have solved the challenges of data limitation and modeling in object detection, they are not able to detect objects in a single algorithm run. YOLO algorithm has gained popularity because of its superior performance over the aforementioned object detection techniques

- YOLO is an abbreviation for the term ‘You Only Look Once’. This is an algorithm that detects and recognizes various objects in a picture (in real-time). Object detection in YOLO is done as a regression problem and provides the class probabilities of the detected images.
- YOLO algorithm employs convolutional neural networks (CNN) to detect objects in real-time. As the name suggests, the algorithm requires only a single forward propagation through a neural network to detect objects.

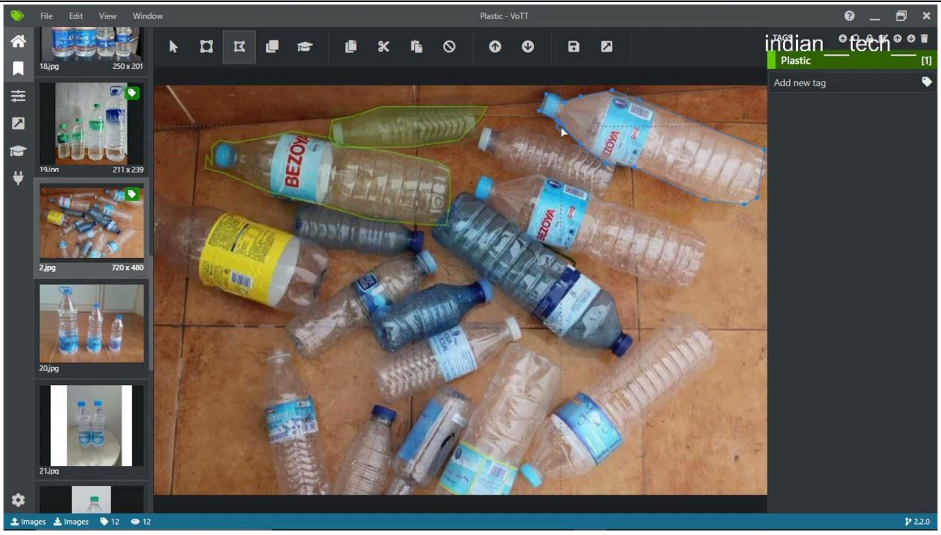


**Figure 7.1**: Custom data set for bottle detection

- YOLO is an algorithm that uses neural networks to provide real-time object detection. This algorithm is popular because of its speed and accuracy.The YOLO algorithm consists of various variants. Some of the common ones include tiny YOLO,YOLO V1, YOLO V2, YOLO V3.

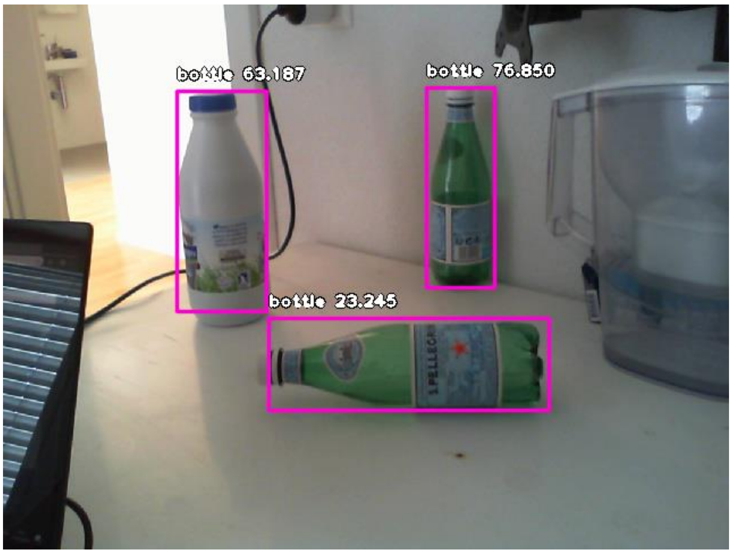


**Figure 7.2:** Bottle detection using YOLO

The YOLO algoritm already contains pretrained datasets of 80 objects which can be detected using the trained files. Therefore the process of object detection becomes easier using YOLO.

## 7.2: CHARACTERISTICS OF YOLO

- **SPEED:** This algorithm improves the speed of detection because it can predict objects in real-time.
- **HIGH ACCURACY:** YOLO is a predictive technique that provides accurate results with minimal background errors.
- **LEARNING CAPABILITIES:** The algorithm has excellent learning capabilities that enable it to learn the representations of objects and apply them in object detection.

## 7.3:WORKING OF YOLO

YOLO algorithm works using the following three techniques:

- Residual blocks
- Bounding box
- Intersection Over Union (IOU)
- Non maximum suppression

## 7.4: RESIDUAL BLOCKS

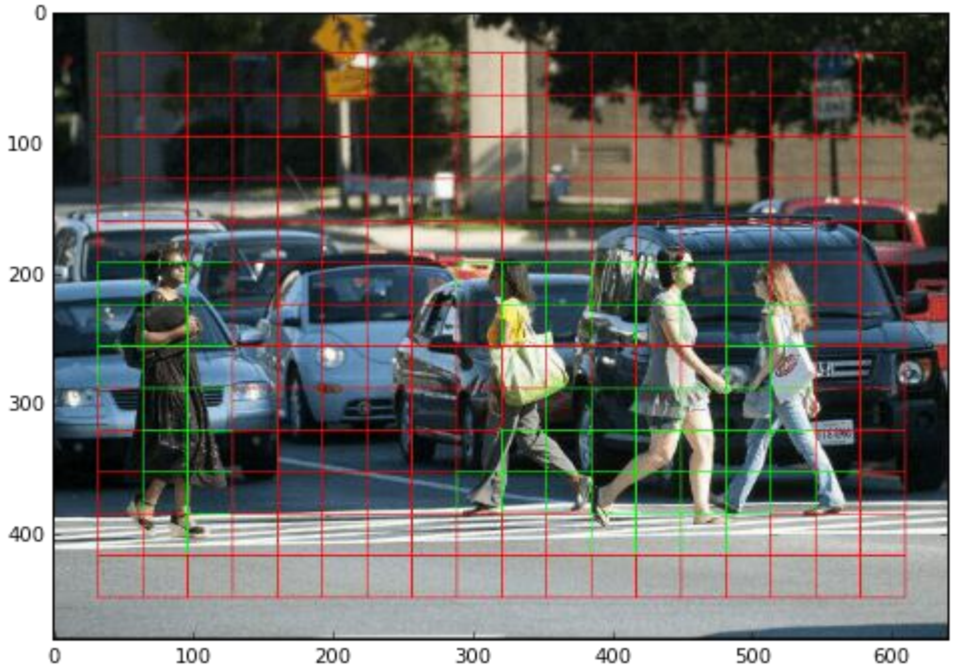


**Figure 7.3:**Covertionof image into grids

First, the image is divided into various grids. Each grid has a dimension of S x S. The following image shows how an input image is divided into grids.In the image above, there are many grid cells of equal dimension. Every grid cell will detect objects that appear within them. For example, if an object center appears within a certain grid cell, then this cell will be responsible for detecting it.

## 7.5:BOUNDING BOX

- A bounding box is an outline that highlights an object in an image.
- Every bounding box in the image consists of the following attributes
  - ➢ Width (bw)
  - ➢ Height (bh)
  - ➢ Class (for example, person, car, traffic light, etc.).This is represented by the letter
  - ➢ Bounding box center (bx,by).

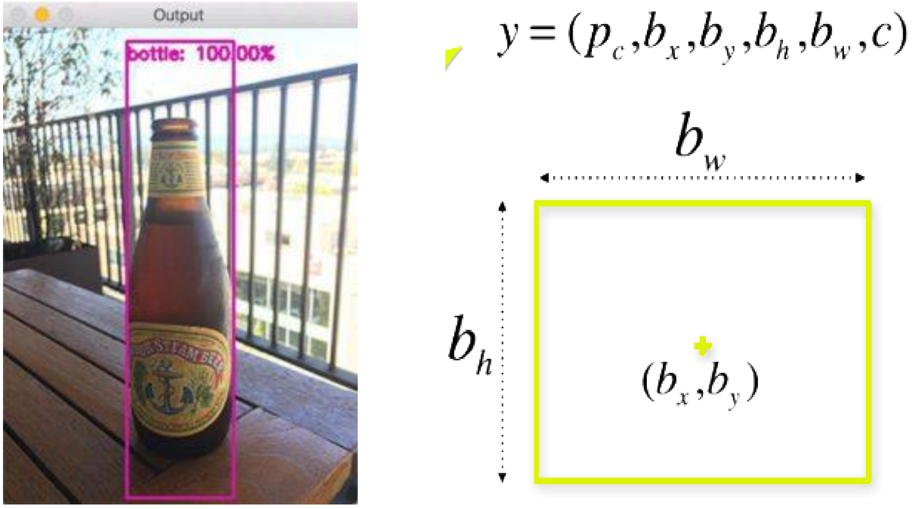


**Figure 7.4:** Bounding box

## 7.6: INTERSECTION OVER UNION (IOU)

- Intersection over union (IOU) is a phenomenon in object detection that describes how boxes overlap. YOLO uses IOU to provide an output box that surrounds the objects perfectly.
- Each grid cell is responsible for predicting the bounding boxes and their confidence scores. The IOU is equal to 1 if the predicted bounding box is the same as the real box. This mechanism eliminates bounding boxes that are not equal to the real box

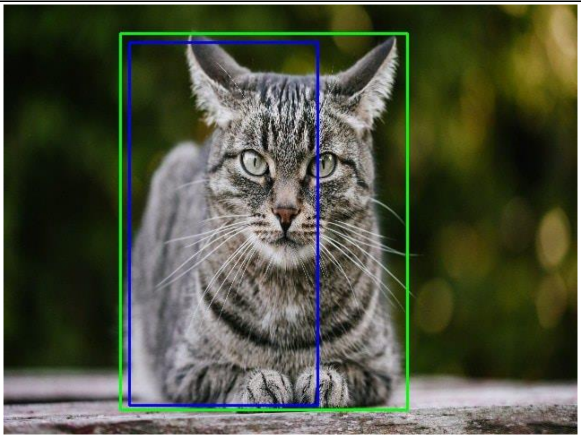


**Figure 7.5:** Intersection over union

In the image above, there are two bounding boxes, one in green and the other one in blue. The blue box is the predicted box while the green box is the real box. YOLO ensures that the two bounding boxes are equal.

IoU = Area of the intersection / Area of the union

## 7.7:NON MAXIMUM SUPRESION

There is one more technique that can improve the output of YOLO significantly – Non-Max Suppression.One of the most common problems with object detection algorithms is that rather than detecting an object just once, they might detect it multiple times. Consider the below image.

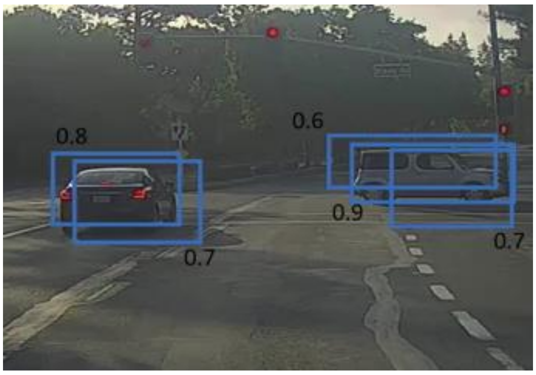
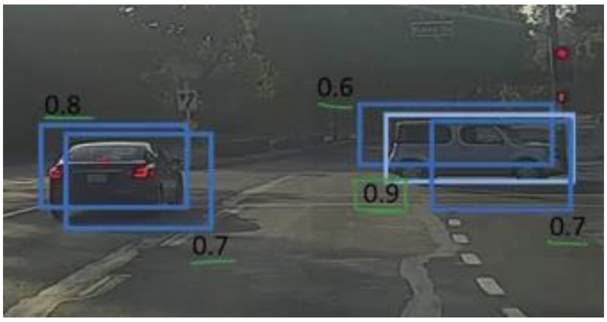


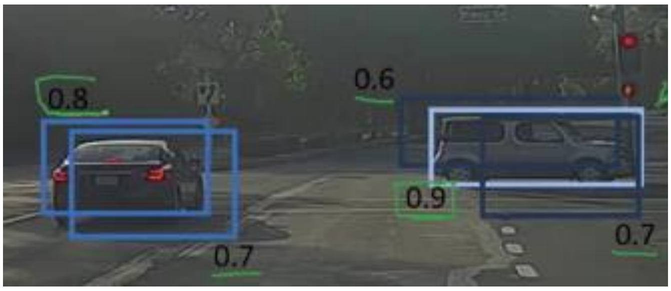
**Figure 7.6:** Non max supresion

Here, the cars are identified more than once. The Non-Max Suppression technique cleans up this up so that we get only a single detection per object. Let’s see how this approach works.

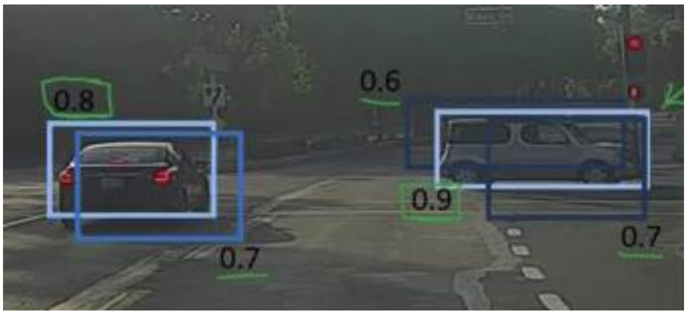
1. It first looks at the probabilities associated with each detection and takes the largest one. In the above image, 0.9 is the highest probability, so the box with 0.9 probability will be selected first:



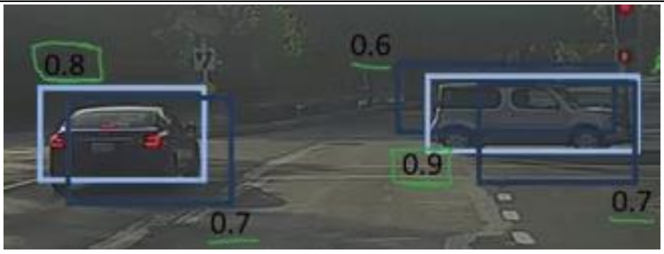
2. Now, it looks at all the other boxes in the image. The boxes which have high IoU with the current box are suppressed. So, the boxes with 0.6 and 0.7 probabilities will be suppressed in our example:



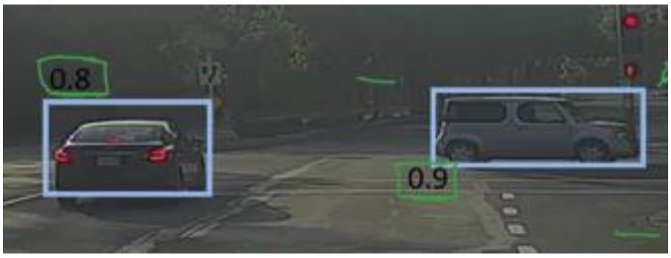
3. Now, it looks at all the other boxes in the image. The boxes which have high IoU with the current box are suppressed. So, the boxes with 0.6 and 0.7 probabilities will be suppressed in our example:



4. Again it will look at the IoU of this box with the remaining boxes and compress the boxes with a high IoU:



5. We repeat these steps until all the boxes have either been selected or compressed and we get the final bounding boxes:



## 7.8: APPLICATION OF YOLO

- Autonomous driving
- Wildlife
- Security
- Pick and place

## 7.9: LIMITATIONS

- Although YOLO does seem to be the best algorithm to use if you have an object detection problem to solve, it comes with several limitations.
- YOLO struggles to detect and segregate small objects in images that appear in groups, as each grid is constrained to detect only a single object. Small objects that naturally come in groups, such as a line of ants, are therefore hard for YOLO to detect and localize.
- YOLO is also characterized by lower accuracy when compared to much slower object detection algorithms like Fast RCNN.

# CHAPTER 8

# CONVOLUTION NEURAL NETWORK (CNN)

Convolutional neural networks, also known as CNNs or Convnets, use the convolution technique introduced above to make models for solving a wide variety of problems with training on a dataset**.** In the past few decades, Deep Learning has proved to be a very powerful tool because of its ability to handle large amounts of data. The interest to use hidden layers has surpassed traditional techniques, especially in pattern recognition. One of the most popular deep neural networks is Convolutional Neural Networks.

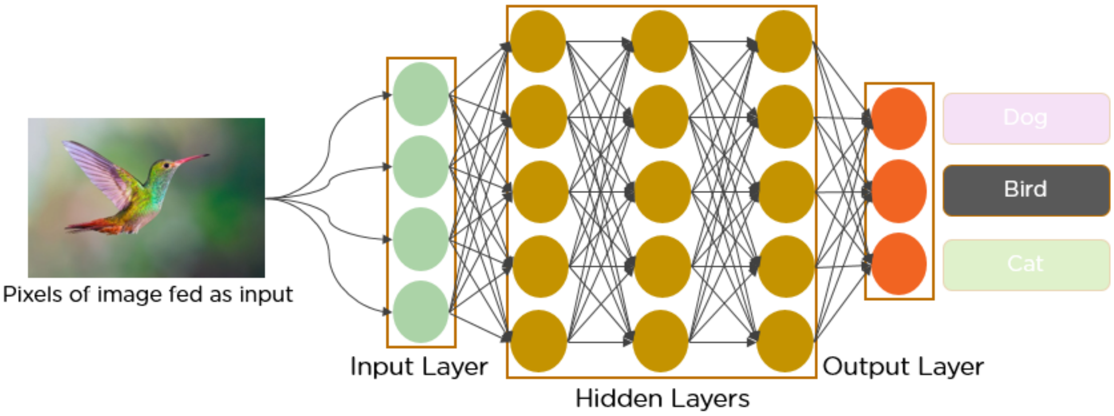


**Figure 8.1:** Convolution neural network

CNN's were first developed and used around the 1980s. The most that a CNN could do at that time was recognize handwritten digits. It was mostly used in the postal sectors to read zip codes, pin codes, etc. The important thing to remember about any deep learning model is that it requires a large amount of data to train and also requires a lot of computing resources. This was a major drawback for CNNs at that period and hence CNNs were only limited to the postal sectors and it failed to enter the world of machine learning. in 2012 Alex Krizhevsky realized that it was time to bring back the branch of deep learning that uses multi-layered neural networks. The availability of large sets of data, to be more specific ImageNet datasets with millions of labeled images and an abundance of computing resources enabled researchers to revive CNNs.

Convolutional neural networks are composed of multiple layers of artificial neurons called perceptrons. Artificial neurons, a rough imitation of their biological counterparts, are mathematical functions that calculate the weighted sum of multiple inputs and outputs an activation value. When you input an image in a ConvNet, each layer generates several activation functions that are passed on to the next layer.

The first layer usually extracts basic features such as horizontal or diagonal edges. This output is passed on to the next layer which detects more complex features such as corners or combinational edges. As we move deeper into the network it can identify even more complex features such as objects, faces, etc.

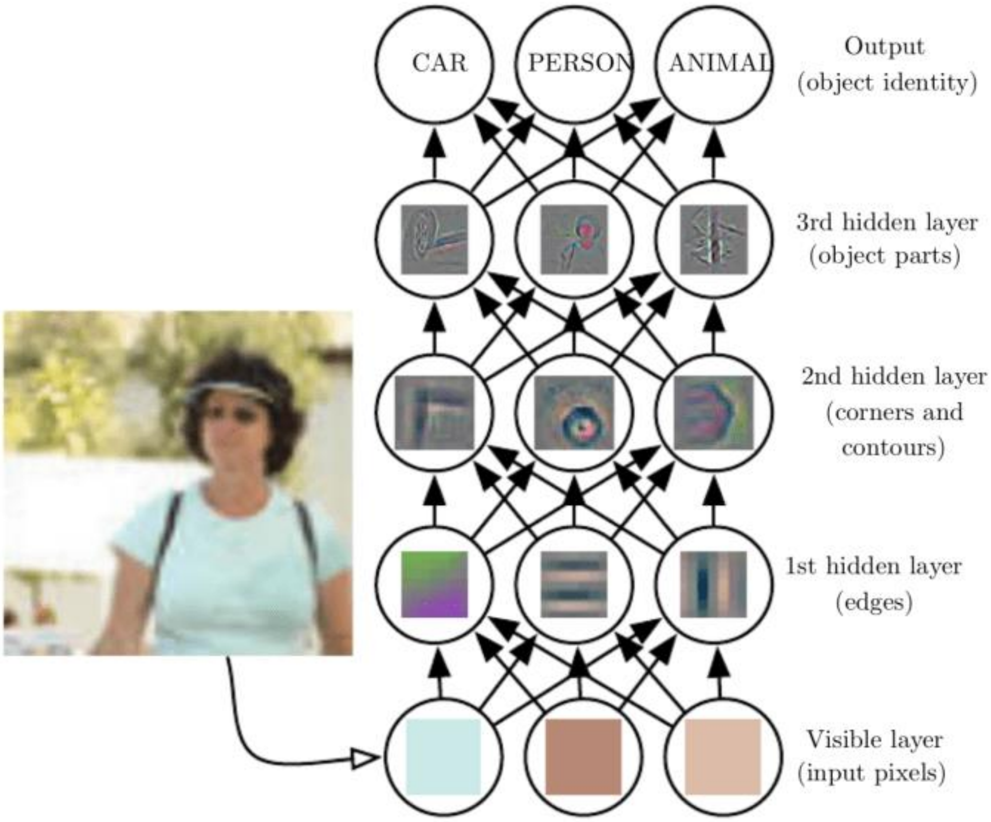


**Figure 8.2:** Layers of the CNN

Based on the activation map of the final convolution layer, the classification layer outputs a set of confidence scores (values between 0 and 1) that specify how likely the image is to belong to a "class." For instance, if you have a ConvNet that detects cats, dogs, and horses, the output of the final layer is the possibility that the input image contains any of those animals.

# CHAPTER 9

# DESIGN OF AUTOMATIC ROBOVAC

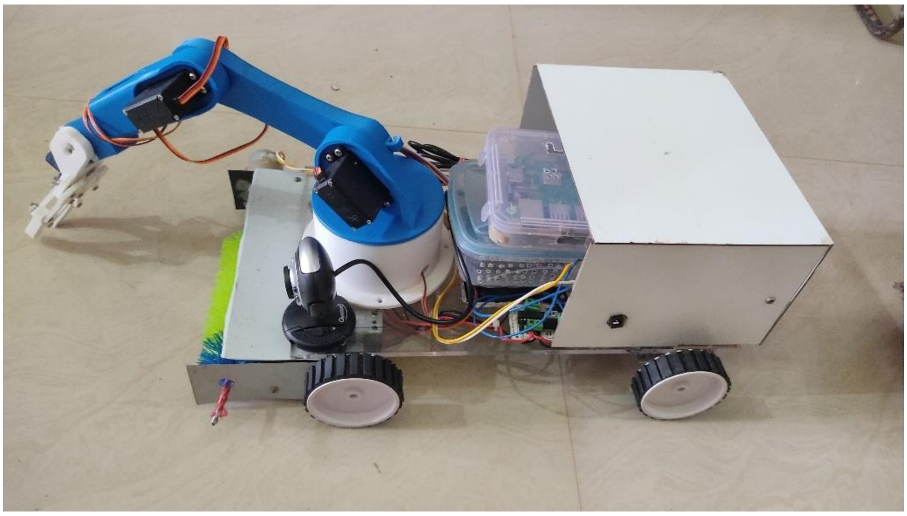


**Figure 9.1**:Automatic robovac

This is our proposed sytem-Automatic Robovac. The system is mainly used in parks, tourist spots, pathways commonly on plain surfaces for waste collection and management. The proposed system consists of three main configuration setup – vaccum based setup, a robotic arm for bottle pickup and a rotating brush setup infront of the system for collecting other kind of waste materials. The system moves on 4 gear motors controlled by a L293D motor driver. The bottle detection takes place with the help of Raspberry pi and a Node MCU to allow control via Blynk server for object pickup and motion.

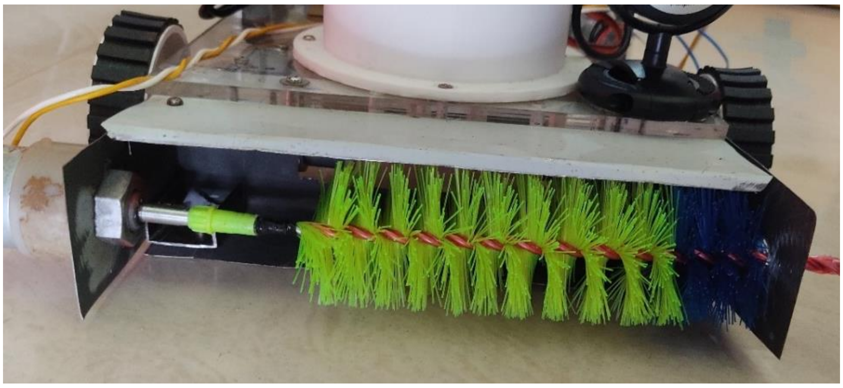


**Figure 9.2:** Rotating brush setup

The rotating brush setup infront of the system is driven by a 12v DC Gear motor.The brush used is of hard plastic material used for cleaning  bottles.The brush while rotating collects the plastic covers,burnt leaves and other waste materials into a separate box.

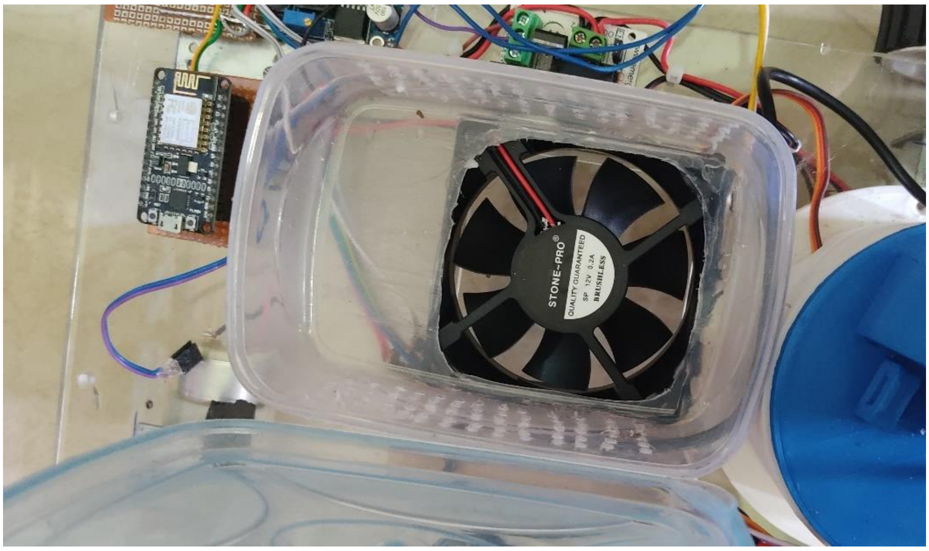


**Figure 9.3:** Fan for suction

The vaccum based setup on the system sucks small waste particles and collects them on a bin.The setup remains on at all time.

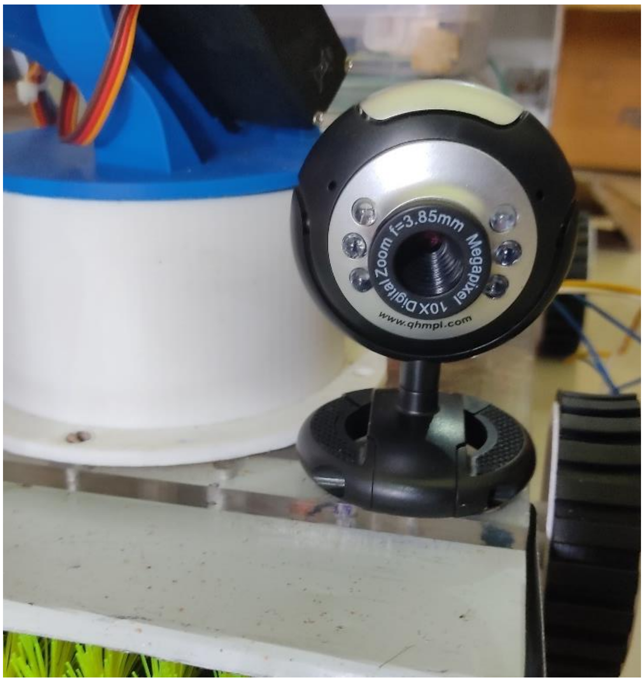


**Figure 9.4**: Web cam for bottle detection

A Web cam is placed infront of the system which monitors the surroundings in real time.The input video from cam is sent to the raspberry pi @ 8Mb/s.By using YOLO algorithm, frames are extracted from the video and analyze the presence of bottle and sent a notification to Blynk server.

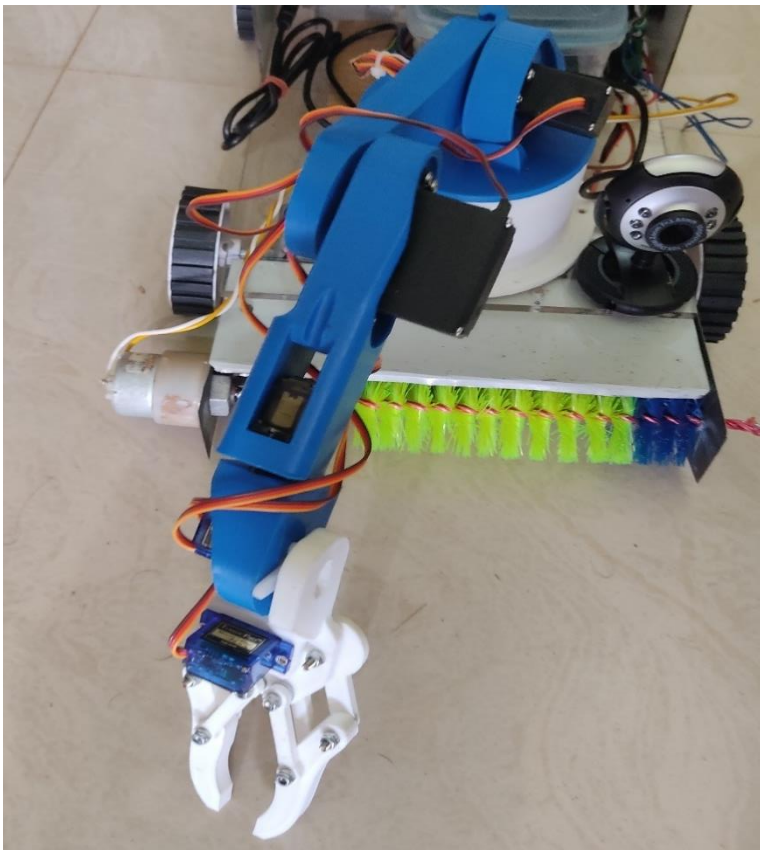


**Figure 9.5:** Robotic arm for bottle pickup

The robotic arm consists of 6 servomotors including 3 MG servo motors. Each servomotors allow 90, 180 degree of rotation. The arm provide 4 degrees of freedom. After receiving notification from blynk server of bottle detection, the robotic arm can be manually controlled to pick and place the plastic bottles.

# CHAPTER 10

## FLOW CHART OF BOTTLE DETECTION

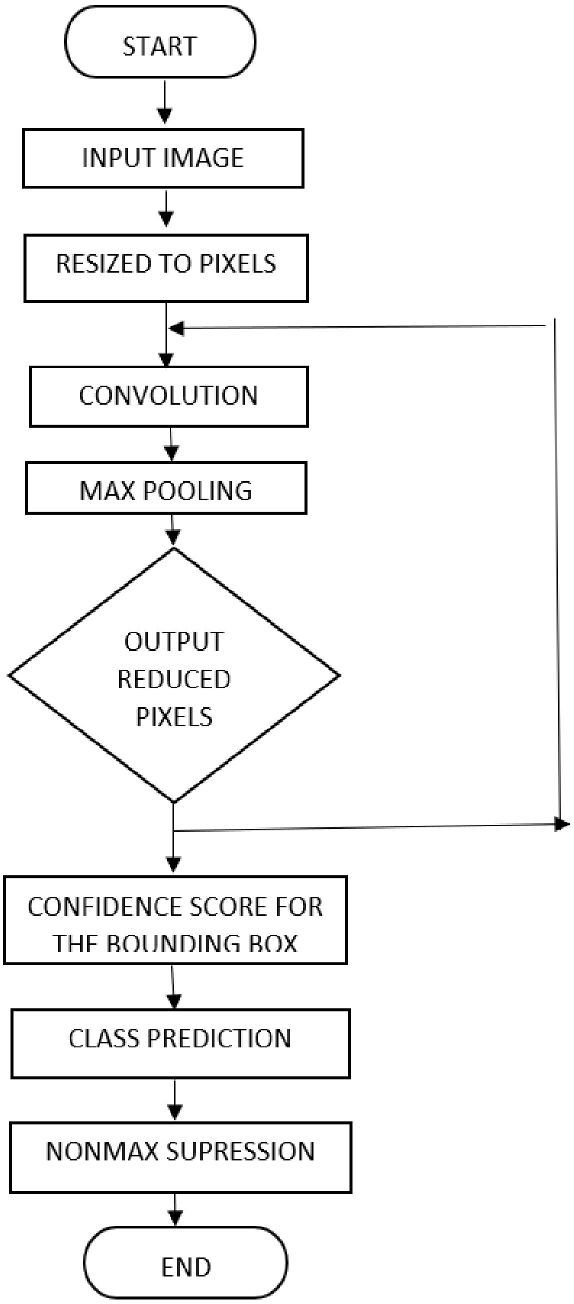


**Figure 10.1:** Flow chart of bottle detection

# CHAPTER 11

# CIRCUIT DIAGRAM

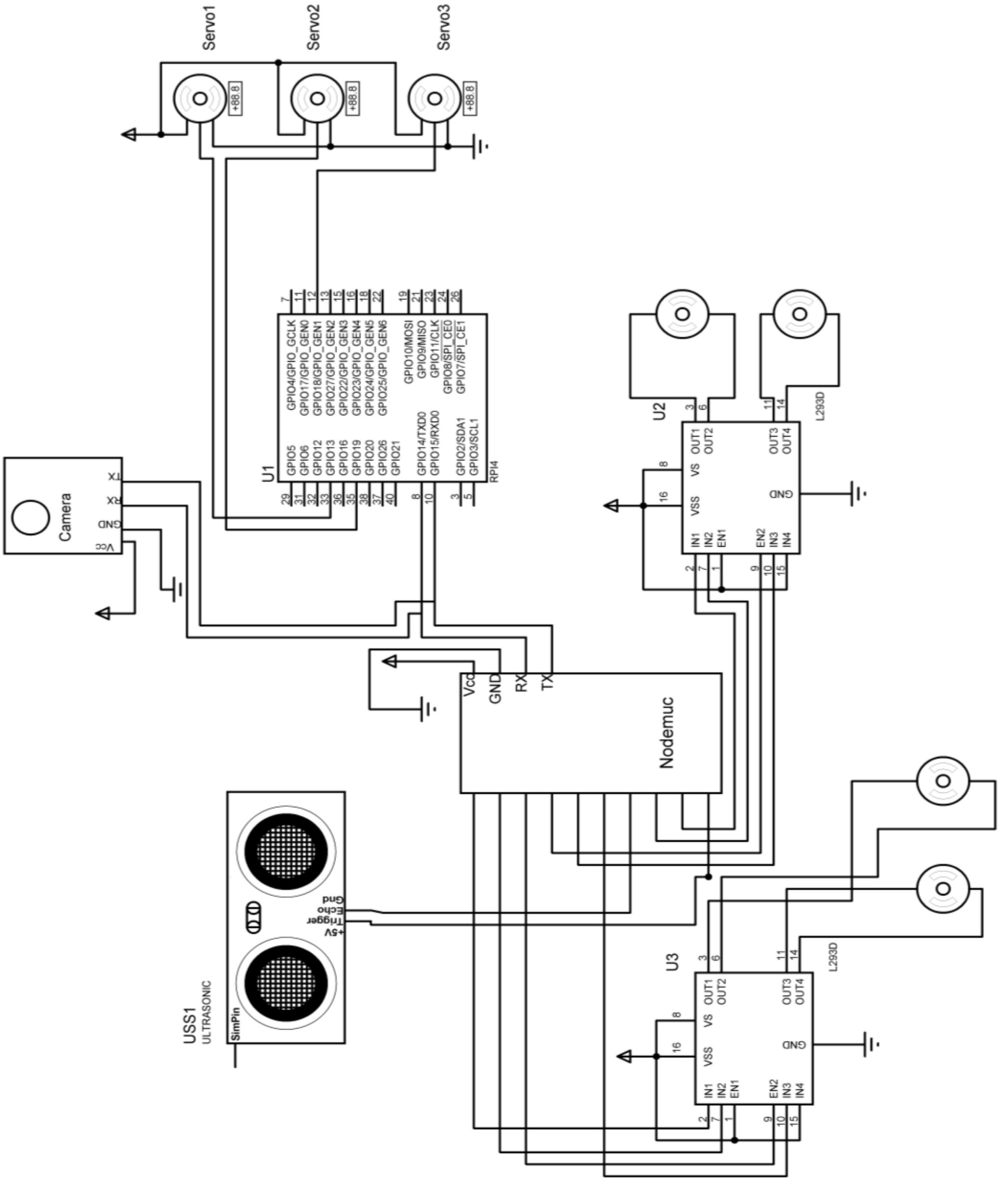


**Figure 11.1:** Circuit diagram of the proposed system

# CHAPTER 12

# WORKING OF THE SYSTEM

## 12.1: CONNECTION :

- Power supply – 12V 1A (AC adapter).
- Buck converter ( DC to DC power converter ) steps down voltage from its input (supply) to its output (load).Works as a SMPS.
- Steps down 12v into 5v.
- Node MCU connected to 5v supply.
- Motor driver and vacuum motor connected to 12v directly.
- Web cam connected to raspberry pi via type A cable.
- Raspberry pi connected to Node MCU through RXDO and TXDO pin (GPIO14 and GPIO15).
- Servomotors of Robotic arm ,Ultrasonic sensor connected to Node MCU.

## 12.2: WORKING:

- In our proposed method, Raspberry PI and Node MCU is used as a core controller. The ultrasonic sensor is used for the proper pathway of the sytem.
- System consist of 4 DC motors for the rotation of 4 wheels, L293D motor driver IC is an integrated circuit chip which is usually used to control motors in autonomous robots.
- As the vehicle moves in zig zag manner, the ultrasonic sensor detects any obstacle present infront
- Then using web cam in real time , object detection(plastic bottle) takes place using machine learning via YOLO algorithm.
- When the plastic bottle is detected , a signal (HIGH) is sent from raspberry pi to Node MCU and the robotic arm picks up the detected bottle by moving at certain angles
- System also include a vacuum setup which works all the time for the collection of dirt which is collected by a dustbag for later disposal.
- It also consists of a brush type setup powered by a dc motor to collect plastic covers,and other kind of wastes.
- Automatic (Raspberry pi) or manual control(mobile control using Blynk).

- Manual control : As the object gets detected by machine learning , a notification sent to blynk app.The blynk app consists of joystick, slider tocontrol the vehicle.

# CHAPTER 13

# CODES USED FOR THE SYSTEM

## 13.1: CODE FOR BLYNK SETUP

```
#include <ESP8266WiFi.h>
#include<BlynkSimpleEsp8266.h>
#include <Servo.h>
char auth[] = "-G7O3SJ2JHA0b4wwUIs5KPDEglpybAcD";
char ssid[] = "Airtel_9995902668";
char pass[] = "air44366";
int v, h;
Servo servo;
Servo servo1;
Servo servo2;
Servo servo3;

BLYNK_WRITE(V0) //Button Widget is writing to pin V1
{
  v = param[0].asInt();
  h = param[1].asInt();
}
BLYNK_WRITE(V1)
{
  servo.write(param.asInt());
}
BLYNK_WRITE(V2)
{
  servo1.write(param.asInt());
}
BLYNK_WRITE(V3)
{
  servo2.write(param.asInt());
}
```

```
BLYNK_WRITE(V4)
{
  servo3.write(param.asInt());
}
void setup()
{
  // Debug console
  Serial.begin(9600);
  pinMode(D8, OUTPUT);
  pinMode(D7, OUTPUT);
  pinMode(D6, OUTPUT);
  pinMode(D5, OUTPUT);
  pinMode(D1,INPUT);
  servo.attach(D0);
  servo1.attach(D2);
  servo2.attach(D3);
  servo3.attach(D4);

  Blynk.begin(auth, ssid, pass);
  delay(1000);
  {
   digitalWrite(D8, 0);//forward
   digitalWrite(D7, HIGH);
   digitalWrite(D6, HIGH);
   digitalWrite(D5, 0);
  }
  delay(8000);
  {
   digitalWrite(D8, LOW);//right
   digitalWrite(D7, HIGH);
   digitalWrite(D6, LOW);
   digitalWrite(D5, HIGH);
  }
  delay(10000);
  {
   digitalWrite(D8, 0);//forward
   digitalWrite(D7, HIGH);
   digitalWrite(D6, HIGH);
   digitalWrite(D5, 0);
  }
  delay(11000);
  {
   digitalWrite(D8, LOW);//right
   digitalWrite(D7, HIGH);
   digitalWrite(D6, LOW);
   digitalWrite(D5, HIGH);
  }
  delay(10000);
   {
   digitalWrite(D8, 0);//forward
   digitalWrite(D7, HIGH);
   digitalWrite(D6, HIGH);
   digitalWrite(D5, 0);
  }
  delay(11000);
    {
    digitalWrite(D8, LOW);//stop
    digitalWrite(D7, LOW);
    digitalWrite(D6, LOW);
    digitalWrite(D5, LOW);
    }
  // You can also specify server:
  //Blynk.begin(auth, ssid, pass, "blynk-cloud.com", 80);
  //Blynk.begin(auth, ssid, pass, IPAddress(192,168,1,100), 8080);
}
void loop()
{ Blynk.run();
if(digitalRead(D1)==1)
```

```
{
 Blynk.notify("bottle detected");
}
if ((v == 512) && (h == 512)) //initial
 {
  //    Serial.print("stop");
  digitalWrite(D8, LOW);
  digitalWrite(D7, LOW);
  digitalWrite(D6, LOW);
  digitalWrite(D5, LOW);
 }

 if ((v > 350) && (v < 650) && (h > 950)) //frwd
 {
   digitalWrite(D8, 0);
  digitalWrite(D7, HIGH);
  digitalWrite(D6, HIGH);
  digitalWrite(D5, 0);
 }
 if ((v > 350) && (v < 650) && (h < 50)) //rev
 {
  digitalWrite(D8, HIGH);
  digitalWrite(D7, 0);
  digitalWrite(D6, 0);
  digitalWrite(D5, HIGH);
 }
 if ((v > 950) && (h < 650) && (h > 350)) //right
 {
  digitalWrite(D8, LOW);
  digitalWrite(D7, HIGH);
  digitalWrite(D6, LOW);
  digitalWrite(D5, HIGH);
 }
 if ((v < 50) && (h < 650) && (h > 350)) //left
```

```
  {
    digitalWrite(D8, HIGH);
    digitalWrite(D7, LOW);
    digitalWrite(D6, HIGH);
    digitalWrite(D5, LOW);
  }
}
```

### 13.2: CODE FOR BOTTLE DETECTION (USING YOLO ALGORITHM):

```
import cv2
import numpy as np
import serial
import time
#serialcomm = serial.Serial('COM23', 9600)
cap = cv2.VideoCapture(0)
net = cv2.dnn.readNet("yolov2-tiny.weights", "yolov2-tiny.cfg")
classes = []
with open("coco.names", "r") as f:
    classes = [line.strip() for line in f.readlines()]
layer_names = net.getLayerNames()
output_layers = [layer_names[i-1] for i in net.getUnconnectedOutLayers()]
colors = np.random.uniform(0, 255, size=(len(classes), 3))
while True:
  ret, frame = cap.read()
    frame = cv2.resize(frame, None, fx=0.4, fy=0.4)
    height, width, channels = frame.shape
    # Detecting objects
    blob = cv2.dnn.blobFromImage(frame, 0.00392, (416, 416), (0, 0, 0), True,
crop=False)
    net.setInput(blob)
    outs = net.forward(output_layers)
    # Showing informations on the screen
    class_ids = []
    confidences = []
    boxes = []
    for out in outs:
        for detection in out:
            scores = detection[5:]
            class_id = np.argmax(scores)
            confidence = scores[class_id]
if confidence > 0.5:
                # Object detected
                center_x = int(detection[0] * width)
                center_y = int(detection[1] * height)
                w = int(detection[2] * width)
                h = int(detection[3] * heigh
# Rectangle coordinates
                x = int(center_x - w / 2)
                y = int(center_y - h / 2)

                boxes.append([x, y, w, h])
                confidences.append(float(confidence))
                class_ids.append(class_id)

    indexes = cv2.dnn.NMSBoxes(boxes, confidences, 0.5, 0.4)
    font = cv2.FONT_HERSHEY_PLAIN

    for i in range(len(boxes)):
        if i in indexes:

x, y, w, h = boxes[i]
            label = str(classes[class_ids[i]])
            color = colors[i]
            if label=="bottle":
cv2.rectangle(frame, (x, y), (x + w, y + h), color, 2)
                cv2.putText(frame, label, (x, y + 30), font, 3, color, 3)
                # to_cleaner="on"
                # serialcomm.write(to_cleaner.encode())
            # time.sleep(1)
            # break

   cv2.imshow("Image", frame)
   if cv2.waitKey(1) == ord('q'):
      break
cap.release()
cv2.destroyAllWindows()
```

# CHAPTER 14

# ADVANTAGES & DISADVANTAGES

## 14.1: ADVANTAGES

- Waste disposal without any human intervention.
- Easily controllable(through android application).
- Efficient.
- Automatic movement of robot with decision making
- Real time Vacuum Cleaner action and waste picking

## 14.2: DISADVANTAGES

- Continuous power supply.
- Can’t differentiate waste materials accurately.
- Waste storing capacity
- Weight
- Not efficient enough.

# CHAPTER 15

# CONCLUSION

The problem of waste management is a major issue. Manual collection of wastes is often complex and time consuming. Availability of labours is also a drastic challenge. Automation represents one of the major trends of the 20th century. The drive to provide increased levels of control to electro-mechanical systems, and with it a corresponding distancing of the human from direct system control, has grown out of the belief that automated systems provide superior reliability, improved performance and reduced costs for the performance of many functions.

This project provides a solution to the above problem with the advancement of vacuum cleaning setup and the implementation of machine learning to detect and collect waste materials. This project has some limitations to work practically but with the further modification of the project provides a future asset for waste collection.

# CHAPTER 16

# FUTURE SCOPE

Robotic vaccum cleaners focused on the technology and science impacts the cleaning sector and future of cleaning itself. Multinational coperations are currently releasing various robotic vaccum cleaners,that in honesty appear large,clumsy and slightly like mini spaceship .However the inovetion cannot be criticised as they have the potential to completely change the face of cleaning industry and our role with in it.

Our project automatic robovac is just a simple and small but a reliable and compact vaccum cleaner with some limitations. The cleaning robot functions with some delay during the process of object detection and pickup and the accuracy of functioning is less. With the advancement of the technology modification and improvement in the product is possible. Future intelligent devices may be able to learn ,think and act, with the inevitably of robotic humanbeing in our everyday lives.Smart cleaning technology is also changing the industry ,implementing new equipment to achieve the best clean and hygene. Accuracy may be strengthened ,labour productivity and safety standards raised.

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