SMART GARBAGE SEGREGATING ROBOT

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BY

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CERTIFICATE

This to certify that

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Have satisfactorily carried out the PROJECT work titled "**SMART GARBAGE SEGREGATING ROBOT"** in partial fulfillment of the degree of Bachelor of Engineering as laid down by the University of Mumbai during the academic year 2019-2020.

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This project report entitled SMART GARBAGE SEGREGATING ROBOT

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DECLARATION

I declare that this written submission represents my ideas in my own words and where others Ideas or words have been included, I have adequately cited and referenced the original sources.

I also declare that I have adhered to all the principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in my submission.

I understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which thus have not been properly cited or from whom proper permission have not been taken when needed.

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Abstract

Waste management is one of the major issues we are facing today. The Government of India took an initiative towards reducing waste management by starting Swaccha Bharat Abhiyaan Mission. Under this mission people were asked to dump wet and dry waste separately for proper waste management as a result this step reduces the 1st step of waste segregation. But due to cease of time or due to illiteracy or awareness problem people mix the garbage in both dustbins so instead of reducing the task of waste segregation it had convoluted their task.

Smart garbage segregating robot is based on Deep Learning concept, which will overcome this problem. This robot will have his own feelings, expressions, voice too and it will be an animal friendly robot.

Robot can perform following tasks :

1. **Garbage collection:** This robot will identify the waste, pick it up, segregate it and dispose it in correct dustbin.

2. **Robo-Arm Movement :** It has a Robotic arm that will perform movements as per it's target location.

3. **Waste detection :** It will detect objects and colours of waste and dustbins like red, yellow, green, blue to dispose wet, dry, e-waste, metallic, sanitary waste.

This robot can be used in malls ,offices, schools, residential areas. If it is designed as a vehicle; it can be used to collect and segregate waste at large scale.

Acknowledgement

I would like to thank Fr (Dr). John Rose S.J. (Director of XIE) for providing us with such an environment so as to achieve goals of our project and supporting us constantly.

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Prajakta Pednekar _____

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CHAPTER 1

INTRODUCTION

With rapid urbanization, the country is facing massive waste management challenge. Over 377 million urban people live in 7,935 towns and cities and generate 62 million tonnes of municipal solid waste per annum. Only 43 million tonnes (MT) of the waste is collected, 11.9 MT is treated and 31 MT is dumped in landfill sites. Solid Waste Management (SWM) is one among the basic essential services provided by municipal authorities in the country to keep urban centres clean. However, almost all municipal authorities deposit solid waste at a dump yard within or outside the city haphazardly. Often in the chain of solid waste management, waste goes from households either to waste collectors or into the bin. From the bin, the waste travels to transfer stations and then finally to the landfill sites. However, through this entire journey, neither the households nor the municipal corporation actively segregate the waste. In some places, the aim is for the solid waste to be segregated in the end to be fed to a waste-to-energy plant, but in most cases they are just landfilled. Waste in landfill remains as it is and releases

poisonous harmful gases in soil as well as air and affects their quality.

The billions of tons of litter end up in the ocean each year reportedly bring 250 million tons of trash into the sea every year. Dumping involves depositing all the waste materials from factories and industries, tankers and ships and sewerage waste materials into the oceans and seas. Some of the materials emitted by the industrial wastes and sewage wastes contain materials like mercury, cryolite and DDT (dichloro diphenyl trichloroethane). Certain industrial wastage also includes radioactive materials. Even small amounts of these substances tend to have negative effects. The scale and the magnitude of the ocean dumping are not just vast but are so huge, that our entire civilization could be wiped out with the intensity of careless dumping. The discharge of ballast water also causes the problem by way of ocean waste. Ballast water tends to proliferate and transfer organisms that debilitate the growth of naturally occurring fishes in a particular oceanic area to ensure that the waste management. The main aim of Swacchha Bharat or Clean India campaign is to solve the sanitation problem and waste management in India. In our country, managing waste and other related issues is a big bottleneck for the development of our country.

In this modern era, machines performs various tasks right from the mobile or alarm clock alarm for waking up to the large big machines present in various industries and factories used to do even a small task. Machines make tasks simpler and help us to complete our work quickly. Nowadays the robots replaces human beings and performs the tedious jobs, reduces human harm .Robots are used in military, as traffic police, patrol, as surgical arm, etc.

Sofia: A humanoid who can communicate and perform all tasks of normal human being

Starship: Technologies have developed this local delivery robot designed to quickly deliver parcels and post within a two-mile radius

Kuri: It is a robot for the home designed with personality, awareness of its surroundings and the power to move about the house freely too. Its designed to fit into your home and become part of the family - entertaining your loved ones, playing music and capturing special moments.

Cafe X: An automated, robot powered coffee bar built with the power to deliver the very best in specialty coffee via advanced automation.

Moley: Moley Robotic kitchen is, as you might expect, a fully-automated cooking robot that can cook for you

Aeolus A general-purpose consumer robot designed to help around the house with various chores.

Pepper: Japanese humanoid robot that can sense emotion and exhibit its own feelings.

Foldimate: A robotic laundry folding machine could be a real life-changer or at least ease the misery of household chores.

Smart garbage segregating robot (SGSR) is a user friendly moving robot who not only collects garbage detects it as wet ,dry or metallic and disposed it in respective coloured dustbins thus save user time and make the task of waste disposers even more simpler and help in Cleaning Campaigns. When any object is picked it will detect if it is an animal if so then it keeps it aside.It can also entertain and perform patrolling even when it is placed on charging. It also sweeps the floor with the help of brush .

1.1 Problem Definition

Approximately 0.2 to 0.6 kg of waste is generated every year by each person in India. There are an estimated 1.5 million to 4 million waste pickers in India, who pick up, clean, sort and segregate recyclable waste and sell it further up the value chain.

Though different dustbins are provided on railway station, roads, shops, malls or outside residential areas, etc provided for dumping wet and dry garbage by citizens. Due to lack of knowledge or lack of time people often dump wet and dry garbage in any of the dustbin and mixes both of the garbage so this fails to segregate waste properly. When the garbage collector vehicles collects the garbage from these dustbins and dump in dumping ground it doesn't verify the garbage type and dump everything together. Most of the time when the dustbin gets full at these public places the garbage spells out and makes place unclean, untidy and smelling. The non-segregated waste dumped in landfill continues to remain as it is and piles up to resemble mountains, and eventually start discharging poisonous gases and leach into the air and soil respectively. When this poisonous gases mixed with soil and air, this air is breathe by people which affects their health. When this poisonous products mixes with water it affects the water quality. It increases the pollution and blockage of drainage system which increases the amount of flood occurring.

Waste collected by these waste pickers contains hazardous medical waste, sanitary waste, biological waste gets disposed into general waste. It can be quite an exploitative system. Workers face all kinds of injuries and cuts while sorting through garbage. Prevalence of respiratory symptoms such as difficulty in breathing and chronic cough was found to be significantly higher among the waste-pickers (28%).

Stomach problems, viz. nausea, dysentery and intestinal pain, were found to be higher among the waste-pickers. Additionally, the nature of their occupation requires the waste-pickers constant bending, which raised the risk of musculocskeletal disorders (MSD)in many body parts. Waste-pickers have to climb all the way up a pile of garbage to collect waste and climb down with the pile of garbage usually with heavy bags of collected waste rested either on their back, head or shoulders. Hence carrying of heavy weights could also be a reason for the higher prevalence of MSDs among the waste-pickers. People living near the garbage dumping areas face

health issues.

Besides the large chunk of industrial wastes, the dumping of plastic is another biggest source of pollution as it slowly leads to adverse effects. Materials like plastic are non-degradable which means they will not be absorbed and recycled. When oceanic creatures and birds consume plastic inadvertently, they choke on it which causes a steady decline in their population. According to activists the creatures who suffer from the plastic debris are dolphins, sharks, turtles, crabs, and sea birds, among others. The Pacific Ocean Garbage Patch is a very good example of plastic being hazardous and Islands like Henderson have transformed from the beautiful lands to Plastic Junkyards.For proper disposal of waste it is important that waste should be segregated well i.e wet , medical waste ,dry waste ,metallic –non-metallic waste should be separated .Wet garbage should be disposed out of house and dry garbage should be recycled .Main problem faced by waste pickers or while disposing garbage is while segregating garbage collected from residential areas ,schools and other areas.

A. ENVIRONMENTAL ISSUES:

1) Burning of garbage: Many residential areas burn garbage containing polythene bags, leaves of trees, paper, rubber to reduce the volume and uncover metals. Thus a thick smoke is created which consists of carbon monoxide, soot and nitrogen oxides which degrade air quality and affect human health.

2) Pollution: If mix waste is left for a long time then chemical reactions take place to form hazardous gases which later leaches into the ground and contaminates ground and surface water

3) Floods: The uncollected waste blocks the drainage system this results in floods where a huge amount of loss takes place of both life and economy.

4) Water pollution: People often throw wet waste as well as dry waste in water bodies which contaminates the water. As a result aquatic life gets endangered.

B. HEALTH ISSUES:

Flooding of water results in the breeding of mosquitoes or the contamination of water bodies and increases the water- borne diseases, malaria, dengue. Residential solid waste con taining excreta and other refuse from the household can cause serious health hazards and spread infectious diseases. Un treated waste attracts flies, rats, other creatures which in turn increases health issues and creates an unhygienic environment. As per UN-Habitat health data, the rate of diarrhea and acute respiratory infections are significantly higher for children living in households

where solid waste is dumped, or burned in the yard, compared to households or in the cities that receive a regular waste collection service.

1.2 Scope of the project

1. It can be used in waste dumping areas to segregate garbage.
2. If designed as a vehicle then it will be used on roads to collect and segregate huge amount of wet and dry garbage.
3. It will be an Eco-friendly robot.
4. As it uses algorithms which detect colors and objects, it can identify materials which might be a valuable or some kind of lost belonging.

On social side it will reduce the task of waste collectors which indirectly will take off a huge burden of work off their shoulders and help to develop a clean city.

1.3 Existing System

1. **DEEBOT**

   Its is Eco-friendly vaccum cleaning bot which is able to go below furniture. It is efficient in cleaning, deeper cleaning .The N79SE provides an efficient, versatile cleaning solution thanks to multiple specialized cleaning modes, including Max Mode, and an integrated 3-Stage Cleaning System. While standard suction power easily performs daily tasks, the Max Mode function increases suction power to approximately twice that of normal mode for a deep, thorough clean that's great for hard floors, carpets and tackling those particularly problematic messes.Auto charging, stair safety technology ,obstacle detection, high efficiently filter, app control and time scheduled robot.

Figure 1.1: Existing System -Debbot

2. **ROBELF**

   Robelf, a smart robot that monitors your home and acts as a friendly assistant to keep your home and family safe at all times , keeping you entertained to making jokes and even storytelling, Robelf's Moving Monitoring System works its magic using its free-roaming nature. It constantly scans your home and its surroundings to monitor foreign or unwelcome intruders. From there, the system lets you know of any possible attacks by sending alerts to your connected smart phone or tablet. Even when stationed for charging, it continuously scans its nearby surroundings and be fully aware of any situation. Built-in

facial recognition helps Robelf define your family members and close relatives, and alerts you if any unrecognized person comes in. And when you're away, it still does its job by scanning and monitoring for any changes even without your presence.

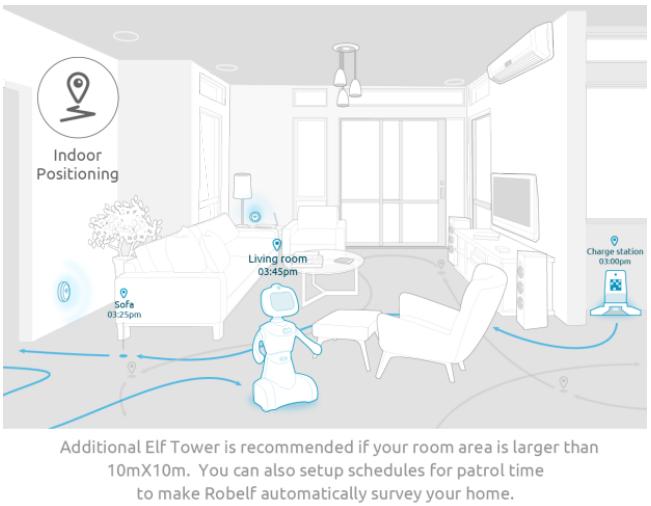

Figure 1.2: Existing System -Robelf robot

3. **GROMER**

A remote controlled robot .Has a soft hand ,label recognition ,pet recognition,smart interaction .Have a strong grip to hold objects Message transfer ,recording sharing .Face/emotion recognition ,graphical programming ,voice command ,augmentation .Gromer is friendly robot which takes care of your house or office .It is small in size so it can be easily transported and it can easily go under any small areas in house or office.

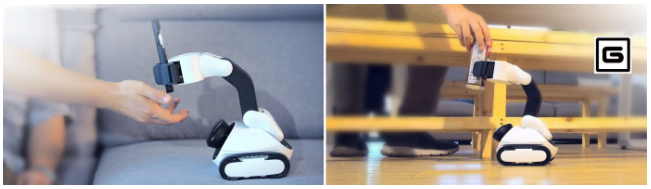

Figure 1.3: Existing System -Gromer robot

4. **BUDDY**

BUDDY connects, protects and interacts with every member of your family. Behind his cheerful and sweet little face, BUDDY is your personal assistant, watches over your home, entertains your children and interacts with your smart home connected devices, among many other services. Its your personal assistance, playmate .It provides edutainment,multimedia,security,real time house mappinglocalization, autonomous collision obstacle avoidance,a remote controlled

Figure 1.4: Existing System -Buddy robot

1.4 Proposed system

The proposed system mainly focuses on identification, clas- sification, and segregation of waste. Segregation of waste will help to separate wet, dry, metallic, non-metallic, hazardous and sanitary waste the separation which will reduce the pollution problem and threat to aquatic life and human beings too. Time to time segregation of waste will ensure that there is no non-decompose waste and also there wont be any accumulation of waste in the form of the heap in dumping areas anymore. Segregation of garbage which was a the tedious job will now be the simplest one and help to reduce the time and work complexity. This proposed system will identify and segregate waste without human involvement. It has an auto- update facility i.e. when a new object is found then based on the previous predictions it will find probability and classify it.

CHAPTER 2

REVIEW OF LITERATURE

Garbage is the major problem not only in cities but also in rural areas of India. It is a major source of pollution. A home in Indian cities alone generates more than 100 million tons of solid waste a year. In 2000, India's Supreme Court directed all Indian cities to implement a comprehensive waste-management program that would include household collection of segregated waste, recycling and composting. These directions have simply been ignored. No major city runs a comprehensive program of the kind envisioned by the Supreme Court. It is not wrong to say that India is on verge of garbage crisis even though 9000 crore rupees are allotted for cleanliness campaigns.

Waste management can be done by segregating wet and dry waste so that dry waste can be recycled and wet waste can be composted .Segregation reduces the collection of waste at landfills which in turn reduces the air, water, soil pollution. Dry waste contains items like aluminum foils, tetra packs, glass, paper, plastic, metals ,etc.whereas wet garbage contains stale food,

fruit, vegetable[1]. Segregation on daily basis if done in a proper manner, waste management not only eliminates the surrounding waste, but also will reduce the intensity of the greenhouse gases like methane, carbon monoxide which gets emitted from the wastes accumulated[5]. The depth of the existing landfills will be also curbed, thereby cutting down whatever is toxic to the environment. The number of fossil fuels will also get reduced in this manner, leading to a cleaner and a green[7].

On 26 July 2005 Mumbai was flooded like never before

The rains paralyzed the city.The city received a rainfall of 944 mm, a 100-year high, in a span of 24 hours. The rain continued and at least 1,000 people lost their lives and 14,000 homes were destroyed. The city had to bear a direct loss of about Rs 5.5 billion.Mumbai's life-line was halted. One of the reason for this flood to occur was blockage of drainage pipelines due to accumulation of garbage near the opening of drainage systems. Majority of waste contained plastic and other metallic and non metallic waste too. During flood a huge amount of garbage was found floating in water everywhere in city[11].

Figure 2.1: Mumbai flood 26 July 2005

On 13 July 2018 Mumbai's Marine Drive turned into a necklace of trash

A high tide washed ashore an eye-popping 9 metric tonnes of trash along the Marine Drive promenade. According to experts waste must be floating at the middle of sea washes ashore on the beaches because of intense action[12]. When the bigger the waves arrived all the heavier the items i.e all sorts of garbage, from glass and plastic bottles to pieces of stones and bricks to tetra packs which were dumped into the seashore got carried and resulted into this 4.8m high trash heap formation[13].

Figure 2.2: 13 July 2018 Marine Drive

Unpaid and undervalued, how India's waste pickers fight apathy to keep our cities clean

This focuses on the problems faced by waste collectors during collecting or segregating garbage. Also it focuses on different types of diseases or health issues they suffered because of improper waste segregation. Problems faced are sometimes also related to attitude people have towards them is also mentioned in this. They face various muscles disorders, economic instability, humiliation almost every day yet they collect, segregate the garbage and help to develop a clean city[10].

Eco-Friendly IOT Based Waste Segregation and Management Automatic Floor Cleaner

In recent years collection and segregation of waste is the major challenge faced by all metropolitan cities worldwide, this is due to the rapid increase in population, industrialization and urbanization. There is lack of knowledge about segregation of waste at the domestic level. The major problems faced due to improper waste management include health hazards to human kind, environmental issues etc. Therefore leading to an unhealthy atmosphere to survive. Segregation of wastes at junk yards is a tedious and time consuming process hence recycling of wastes is not effectual. These drawbacks can be overcome by proper waste management at domestic level. The main objective of this paper is effective and efficient methods of waste collection and segregation at domestic level based on their nature of composition i.e. metal, plastic and biodegradable, the waste is stored accordingly in their respective segments of the dustbin.[14].

An Automatic Classification Method for Environment

Recent enforcement of law by the Indian government for the welfare of sanitation workers has raised the need for an automated system in waste management. The existing garbage disposal system in India consists of unclassified waste collected from homes which are then segregated at a station manually. This segregation of solid waste done by manual labor can bring about many health hazards for the waste sorters in addition to being less efficient, time consuming and not completely feasible due to their large amount. In our paper, we have proposed an automated recognition system using Deep learning algorithm in Artificial Intelligence to classify objects as biodegradable and non-biodegradable, where the system once trained with an initial dataset, can identify objects real-time and classify them almost accurately. Biodegradable waste is used to generate power, enrich soil and act as food to animals. This process does not harm the earth making it valuable, ecologically safe and helps us to protect our environment, rich ecosystem and human inhabitants in future.[15].

Smart Garbage Separation Robot with Image Processing Technique

Smart robot which is capable of separating degradable and non- degradable waste using image processing techniques. The proposed robot is in random motion whenever it senses any object it stops and camera takes image of the object, after processing and segmentation is done, it separates waste into degradable and non-degradable waste. In this project one robot with robotic arm is used to segregate the garbage automatically. Robot is made with PIC controller and DC motors, robot can move left, right, forward and backward and robotic arm can do movement as clockwise, anticlockwise, open and close. There are two modes to operate the project, manual and auto.

A. Manual Mode - In manual mode, user will give command manually from PC GUI and through USB to TTL command will received from PC, be given to PIC controller. According to command robot will act

B. Auto Mode - In this mode, waste will be segregated using image processing; camera is attached in front of robot. Which will capture the image of waste and will give it to MATLAB for image processing. PC will give command to robot to start move forward and till any obstacle is detected using obstacle sensor it will continue to move forward. After detecting any obstacle robot will stop and camera will on to take garbage image.MATLAB will process it and according to garage detected, robotic arm will dump it in respective bin.

MATLAB Image processing algorithm

The program should recognize the objects like circles,rectangles, and squares from the input image. This is a shape classifier based on the properties of each shape, like roundness, ratio of dimensions, centroid etc. In this classifier we will recognize only shapes like circles, rectangles, and squares from the input image. So, we will concentrate on the steps we will follow to recognize from any input image. We have seven steps:

1. Read the RGB (colored) image in from user.
2. Convert image from (RGB) colored to gray image.
3. Threshold the image (convert gray image to binary image).
4. Invert the binary image (in order to speed up the time of processing).
5. Find the boundaries concentrate.

6. Determine shapes properties (ratio of dimensions, roundness).

7. Classify shapes according to its properties. A. Input : RGB image have the shapes to recognize. B.Output: The RGB image with shapes recognized and labeled[16].

Application of Artifical Intelligence in Construction Waste Management

Nowadays, the construction industry faces numerous problems, among which, managing construction and demolition waste are of key concern. As this waste is a threat to the environment and it demands significant financial resources to be tackled. Though human being can think in multidimension, but to consider all the contributing attributes for waste management is beyond its limit. For this purpose, there has been always a need of a artificial intelligence (AI) which could help in directing towards the management of the produced waste. Generation of construction and demolition (CD) waste is unavoidable in any circumstance and handling this waste is always a menace to the managers. This requires high technicalities and a huge amount of resources to be spent on proper waste control. This paper aims to develop a conceptual framework for an effective construction waste management system (EMS) by application of artificial intelligence (AI), which could decide a suitable technique to be implemented on the produced waste. A comprehensive review of waste generation attributes, waste management techniques, and adaptability feasibility is carried out to identify loopholes and limitations of each technique. The proposed EMS will help the construction practitioners to apply the most suitable, most viable, most feasible and most economical waste management technique to control on-site construction and demolition waste, based on its own capacity and type of waste[17].

Research on Data Mining Models for the Internet of Things

In this paper, we propose four data mining models for the Internet of Things, which are multi-layer data mining model, distributed data mining model, Grid based data mining model and data mining model from multi-technology integration perspective. Among them, multi-layer model includes four layers: 1) data collection layer, 2) data management layer, 3) event processing layer, and 4) data mining service layer. Distributed data mining model can solve problems from depositing data at different sites. Grid based data mining model allows Grid framework to realize the functions of data mining. Data mining model from multi-technology integration

perspective describes the corresponding framework for the future Internet. Several key issues in data mining of IoT are also discussed[18].

A Survey of Human-centered Intelligent Robots

Intelligent techniques foster the dissemination of new discoveries and novel technologies that advance the ability of robots to assist and support humans. The human-centered intelligent robot has become an important research field that spans all of the robot capabilities including navigation, intelligent control, pattern recognition and human-robot interaction. This paper focuses on the recent achievements and presents a survey of existing works on human-centered robots. Furthermore, we provide a comprehensive survey of the recent development of the human-centered intelligent robot and discuss the issues and challenges in the field[19].

CHAPTER 3

SYSTEM DESIGN AND ANALYSIS

Smart garbage segregating robot is an auto-operating robot, which is designed to identify, pick and segregate waste in dumping areas. Segregation of garbage which was a tedious job will now be the simplest one and help to reduce the time and work complexity. It is animal friendly robot so it doesn't harm animals. It can avoid obstacle while moving. It can detect person using facial and voice recognition and reply to their commands. All tasks like waste detection, waste segregation, object detection, human detection are done using deep learning concepts. It can reply in his own voice. It can show various expression on its face too. It provides good firm to hold any objects. It is Eco-friendly and human friendly robot.

3.1 Design

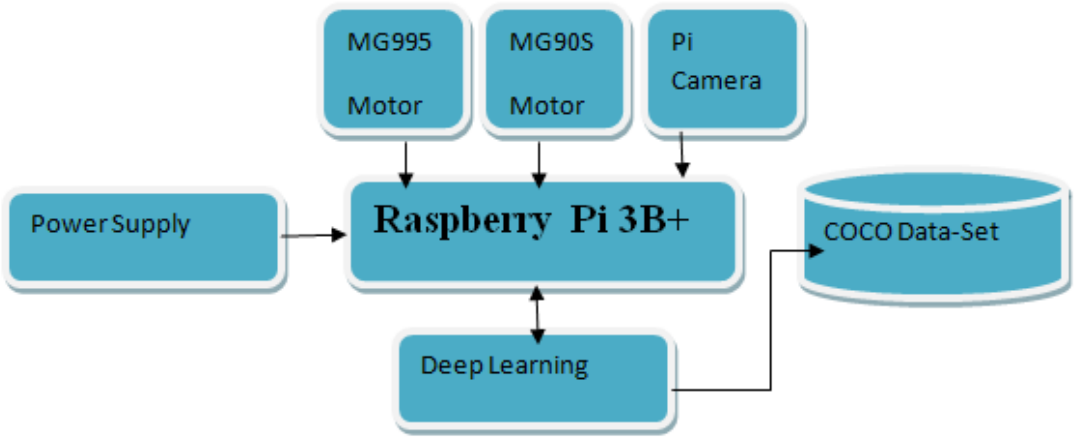

Figure 3.1: Block diagram of Smart Garbage Segregating Robot

1. When robot sees any waste object
2. He will pick it up, capture its image and use YOLOV3 deep learning concept.
3. It implements YOLOV3 algorithm of deep learning for waste detection and segregation on CoCo dataset .
4. It uses coco dataset for identification of waste.
5. The result of deep learning waste detection method helps to classify garbage as wet/dry/hazardous/pla waste.
6. 4 Colourful dustbins i.e yellow, red, green and blue colour dustbin are placed at an angle of 45 degrees around robotic arm position.
7. Servo motor is used for movement of robot arm.

3.2 Algorithm

Step 1 : Start

Step 2 : Accept the input image or video

Step 3 : Perform an analysis of the captured images by comparing it with trained data.

Step 4 : Objects are classified then localized using YOLO object detection algorithm

Step 5 : Combination of classification and localization results in the identification of an object

Step 6 : Based on identification predictions are made and probability is found.

Step 7 : The prediction having the largest probability will be the output.

Step 8 : The output tells the type of waste.

Step 9 : Robot will rotate at an angle of 45 degrees, 90 degrees, 135 degrees, 180 degrees respectively depending on type of waste to dispose wet waste, dry waste, hazardous waste and plastic waste respectively.

Step 10 : Dispose the waste properly in correct dustbin.

Step 11 : Look for more waste if waste is over then Stop

3.3 Analysis

3.3.1 State Diagram

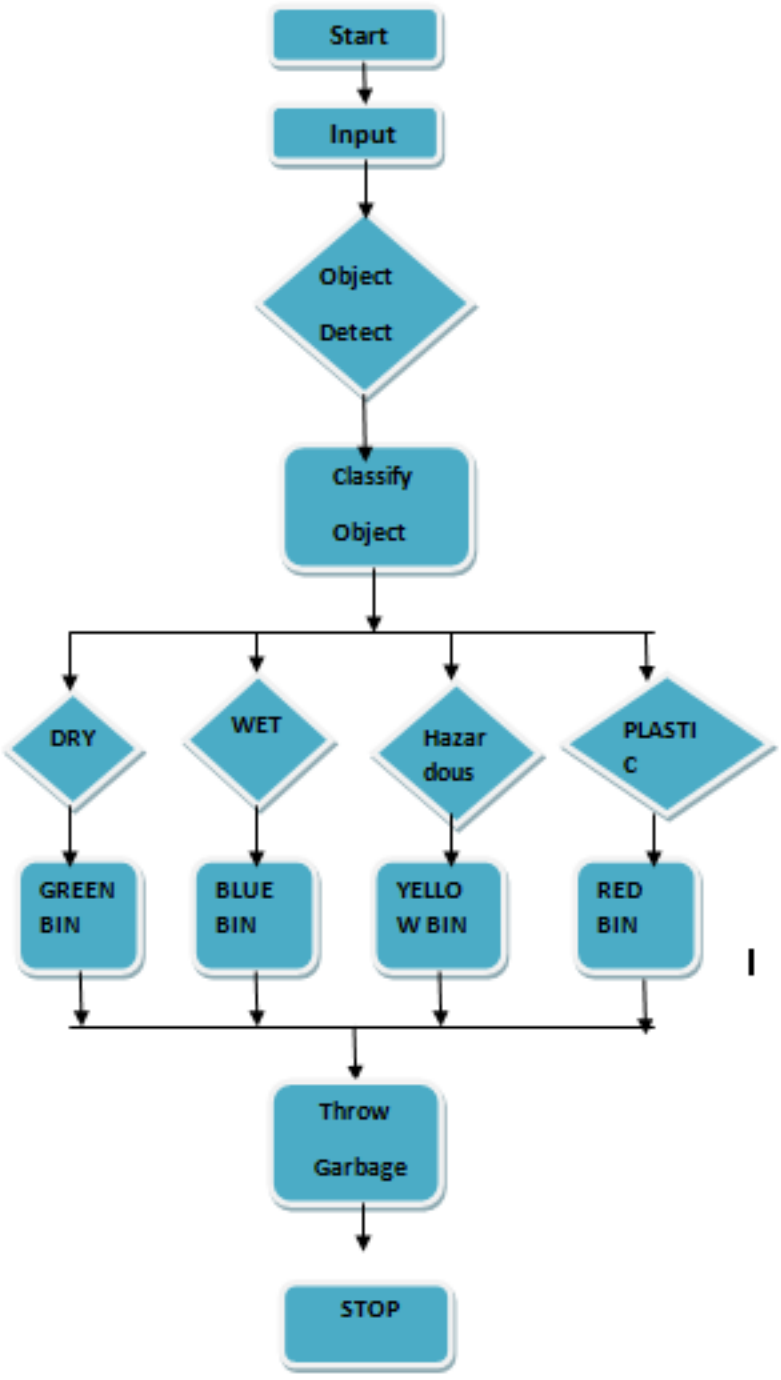

Figure 3.2: State Diagram of Smart Garbage Segregating Robot

3.3.2 Data flow Diagram

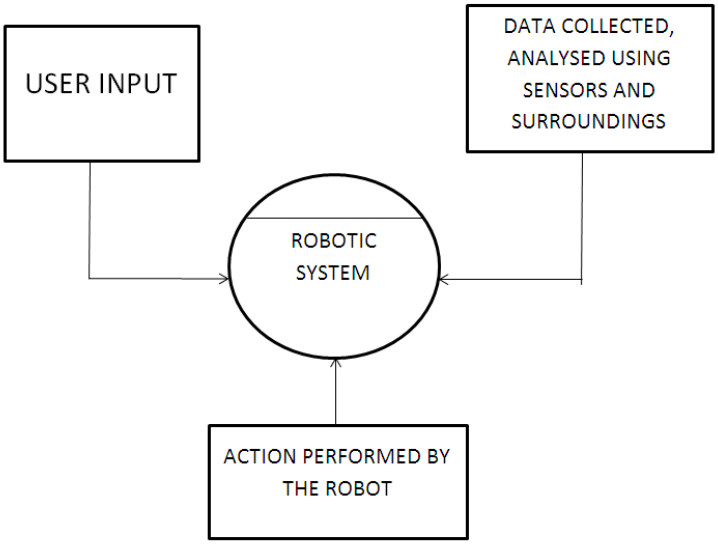

Figure 3.3: Level 0 Data flow Diagram of Smart Garbage Segregating Robot

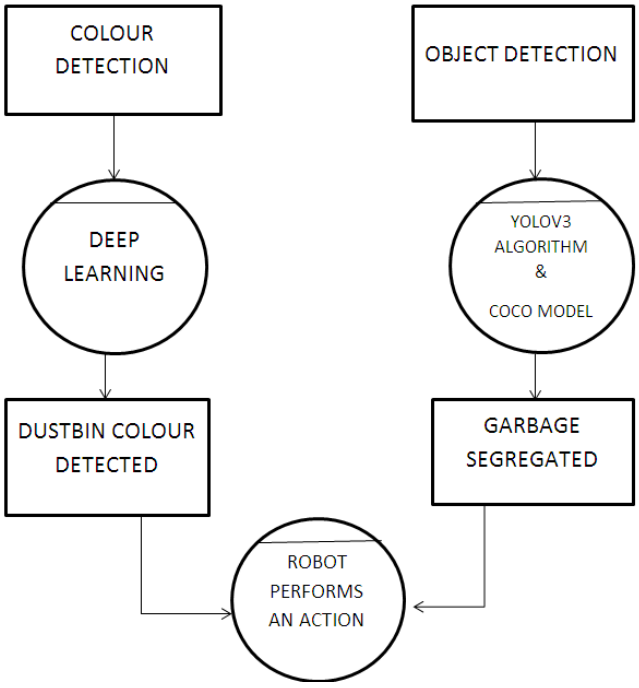

Figure 3.4: Level 1 Data flow Diagram of Smart Garbage Segregating Robot

3.4 Details of Hardware & Software

3.4.1 Hardware requirement

1. **Raspberry Pi 4 board:**

   The Raspberry pi is a single computer board with credit card size, that can be used for many tasks that your computer does, like games, word processing, spreadsheets and also to play HD video. The raspberry pi board comprises a program memory (RAM), processor and graphics chip, CPU, GPU, Ethernet port, GPIO pins, Xbee socket, UART, power source connector. And various interfaces for other external devices. It also requires mass storage, for that we use an SD flash memory card. So that raspberry pi board will boot from this SD card similarly as a PC boots up into windows from its hard disk. Essential hardware specifications of raspberry pi board mainly include SD card containing Linux OS, US keyboard, monitor, power supply and video cable. Optional hardware specifications include USB mouse, powered USB hub, case, internet connection, the Model A or B: USB WiFi adaptor is used and internet connection to Model B is LAN cable.

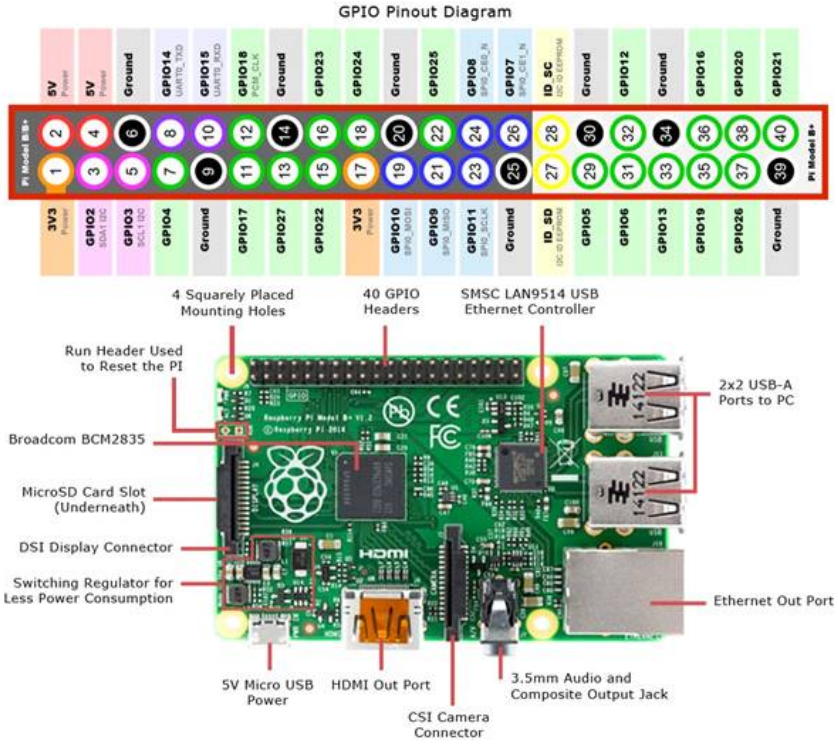

Figure 3.5: Raspberry Pi board

2. **PiCamera:**

The Raspberry Pi camera module can be used to take high-definition video, as well as stills photographs. It's easy to use for beginners, but has plenty to offer advanced users if you're looking to expand your knowledge. There are lots of examples online of people using it for time-lapse, slow-motion and other video cleverness. You can also use the libraries we bundle with the camera to create effects. If you're interested in the nitty-gritty, you'll want to know that the module has a five megapixel fixed-focus camera that supports 1080p30, 720p60 and VGA90 video modes, as well as stills capture. It attaches via a 15cm ribbon cable to the CSI port on the Raspberry Pi. It can be accessed through the MMAL and V4L APIs, and there are numerous third-party libraries built for it, including the Picamera Python library.

The camera module is very popular in home security applications and in wildlife camera traps.

Figure 3.6: Pi camera

3. **Servo Motor:**

Servo motor is a simple electrical motor controlled with the help of servo mechanism.If the controlled motor is operated by AC, it is called AC Servo motor otherwise DC Servo motor.Most servo motors can rotate about 90 to 180 degrees.Even some rotate through a full 360 degrees or more.Some of the Applications of servo motor in Robotics is Servo motor application in robotic i.e., A simple pick and place robot, it is used to pick an object from one position and place the object at different position. Servo motor in Conveyors

are used in industrial Manufacturing and assembling units to pass an object from one assembly station to another. For Ex:- A Bottle Filling process. Servo motor MG995 and MG90s are used in the robotic arm since the continuous rotation servo motor is used.

- The MG995 High-Speed Digital Servo Motor rotates 90 in each direction making it 180 servo motor. It is a Digital Servo Motor which receives and processes PWM signal faster and better. It equips sophisticated internal circuitry that provides good torque, holding power, and faster updates in response to external forces.
- MG90S is a micro servo motor with metal gear. This small and lightweight servo comes with high output power, thus ideal for RC Airplane, Quadcopter or Robotic Arms.

Figure 3.7: Servo motor MG90S

Figure 3.8: Servo motor MG995

3.4.2 Software

4. **Raspbian Operating system:**

   Raspbian is a Debian-based computer operating system for Raspberry Pi. There are several versions of Raspbian including Raspbian Buster and Raspbian Stretch. Since 2015 it has been officially provided by the Raspberry Pi Foundation as the primary operating system for the family of Raspberry Pi single-board computers

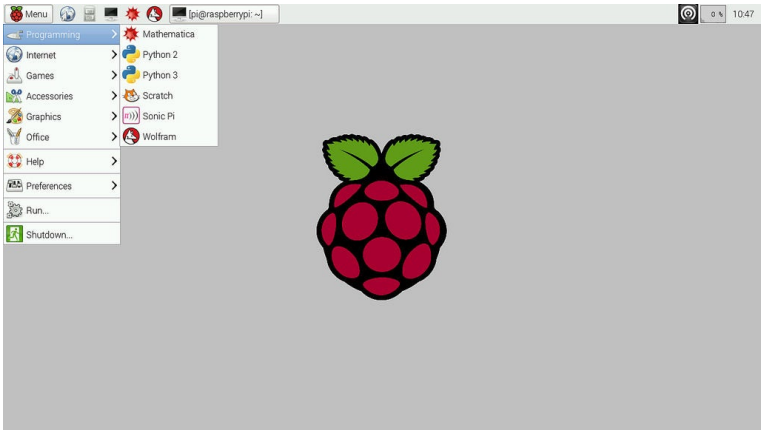

Figure 3.9: Raspberry pi operating system

5. **Python:**

   Python latest version:3.6+ recommended for better use Any Python IDE:

   - Pycharm
   - Jupyter
   - Spyder

   Libraries:

   - Tensorflow
   - Numpy
   - Opencv

CHAPTER 4

IMPLEMENTATION

During the initial stages of the implementation of the prototype of robotic arm, we built the arm using cardboard and Servo Motor SG90. The final model is now built of acrylic material(3D Printed Robot) which makes the robotic arm more stable, balanced and durable.

4.1 Installation of Raspberry Pi OS

1. Search Raspbian Os on google and click on the very first link given
2. Now click on Raspbian Os
3. After clicking on Raspbian you will get three options from that you need to download the Raspbian Stretch with Desktop zip file

4. After completing the download, unzip the file and extrat the file in D drive
5. Now you need to download a SD card Formatter for formatting the SD card
6. After the SD formatter is installed, insert SD card in your laptop and then that SD card will get detected in that SD card Formatter
7. In the next step you need to download etcher software which will detect your operating system automatically.
8. You need to download some Softwares like Putty, Advance IP Scanner and VNC Viewer and then download IP Scanner
9. Go to SD card boot partition and create a new text document named ssh.txt and now remove the .txt extension
10. Now you need to set your wifi name and password in the given document
11. Copy this file in your SD card drive and then eject the SD
12. Remove the SD card from your laptop and insert it in the Raspberry pi board and power up the board
13. Open the Advanced IP scanner and run it as administration
14. Connect the laptopto the hostop/ wifi to which your smart phone is connected.
15. It is very important to match the hotspot of your laptop with the hotspot connected to your Raspberry pi Board.
16. To get the IP address open the command prompt and type ipconfig to get your laptop IP address
17. Copy this IP address to the IP Scanner
18. Open the Putty Software and copy the Raspberry pi IP address in it
19. A window will appear login credentials where the username is “pi” and the password is “raspberry”
20. You need to enter a command to change the setting of raspberry pi and enable SSH and also enable VNC.

21. Open the VNC Server and copy the IP address of raspberry pi in the IP address space.

22. Click on the icon of raspberry appearing in the VNC server and raspberry pi window will be opened in your laptop.

4.2 Install OPENCV on RPI

1. Expand your filesystem and then select the “7 Advanced Options” menu item followed by selecting “A1 Expand filesystem

2. Once prompted, you should select the first option, “A1 Expand File System”, hit enter on your keyboard, arrow down to the “Finish” button, and then reboot your Pi — you may be prompted to reboot

3. After rebooting, your file system should have been expanded to include all available space on your micro-SD card. You can verify that the disk has been expanded by executing ”df -h”

4. Install dependencies by updating and upgrading any existing packages and we then need to install some developer tools, including CMake, which helps us configure the OpenCV build process

5. Next, we need to install some image I/O packages that allow us to load various image file formats from disk. Examples of such file formats include JPEG, PNG, TIFF, etc

6. Just as we need image I/O packages, we also need video I/O packages. These libraries allow us to read various video file formats from disk as well as work directly with video streams

7. The OpenCV library comes with a sub-module named ’highgui’ which is used to display images to our screen and build basic GUIs. In order to compile the ’highgui’ module, we need to install the GTK development library and prerequisites

8. Install Python 3 header files so we can compile OpenCV with Python bindings

9. Create your Python virtual environment and install NumPy and also install virtualenv and virtualenvwrapper. Once both virtualenv and virtualenvwrapper have been installed, open up your /.bashrc file

10. Next, create your Python 3 virtual environment. If you have a Raspberry Pi Camera Module attached to your RPi, you should install the PiCamera API now as well

11. pip install OpenCV 4 and Test your OpenCV 4 Raspberry Pi BusterOS install

12. As a quick sanity check, access the cv virtual environment, fire up a Python shell, and try to import the OpenCV library

4.3 Implementation of Waste Detection

1. Download the models containing yolo3.weights (pre-trained network weights), yolov3.cfg (network configuration), and coco.names files (a class name used in COCO (Common Objects in Context) dataset)

2. Initialize the parameters like input height, input width, the confidence threshold value, non-maxima suppression (NMS) threshold value. Note: If NMS is too low then it won't detect overlapping objects of the same or different objects whereas if it's set too high then it can detect multiple objects of same or different classes.

3. Load the model and class (yolov3.cfg, yolov3.weights, coco.names) file.

4. Take input using a camera or load image or video.

5. Input frame read from image or video is passed to blobFromImage function where an input image is converted into a the required format called as a blob.

6. An input image is divided into SxS grid cells size of cells is input height, input width size.

7. Each grid cell predicts n bounding boxes in images and confidence.

8. Accuracy of the bounding box is represented by confidence i.e. the object is present inside the bounding box or not (Irrespective of class).

9. YOLO predicts the classification score for each box for every class in training.

Type of waste	Colour of dustbin
Wet Waste	Green
E-waste	Blue
Metallic waste	Yellow
Plastic waste	Red
Other waste	White

Table 4.1: Mapping of type of waste with disposal dustbin colour

10. To find the probability of each class being present in a predicted box combine both the classes.

11. The number of predicted boxes is SxSxN boxes

12. The process of eliminating the predicted bounding boxes with the low confidence value is called as non- maximum suppression.

13. To remove the predicted boxes having the low value set a threshold level of confidence as 30%.

14. This will eliminate the boxes having confidence value higher in another cell.

15. Draw the boxes around the filtered boxes and assign class labels and confidence scores.

16. To add more objects to be detected as per your choice. Garbage detection is done similarly as object detection and model is trained to classify an object as wet, dry, metallic, non-metallic, sanitary, medical, hazardous waste.

4.3.1 Working with YOLO

You Only Look Once are a popular object detection algorithm which not only predicts the category of an object but also detects its location. It applies a Single Neural Network to the Full Image which divides the image into regions and predicts bounding boxes and probabilities for each region. Predicted probabilities are used to find the weights of these bounding boxes. [2] YOLO is faster and more accurate compared to Single Shot MultiBox (SSD) object detection algorithm. Use of OpenCV for YOLO:

- Supports Python

- Easy integration with OpenCV application
- The CPU version of OpenCV is 9x times faster

Given below is the code of YOLO used in implementation for detection purposes.

```
import numpy as np
import argparse
import cv2 as cv
import subprocess
import time
import os
import imutils
from yolo_utils import infer_image, show_image

FLAGS = []
metal = ['sink', 'vase', 'scissors', 'needle', 'knife', 'wires', 'fork']
electronics = ['parking meter', 'tv monitor', 'laptop', 'mouse', 'remote', 'keyboard', 'cellphone', 'microwave ove
               'toaster', 'refrigerator', 'clock', 'hairdryer']
dry = ['bench', 'cloth', 'umbrella', 'handbag', 'tie', 'suitcase', 'skis', 'baseball', 'glove', 'skateboard',
       'tennis racket', 'cup', 'bowl', 'spoon']
wet = ['banana', 'apple', 'orange', 'brocoli', 'carrot', 'hot dog', 'pizza', 'sandwich', 'donut', 'cake', 'cucumbe
       'tomato', 'potted plant']
plastic = ['bottle', 'toothbrush', 'plastic bags', 'medicine strips', 'tiffin box', 'containers', 'remote covers']
c=""
if __name__ == '__main__':
    parser = argparse.ArgumentParser()

    parser.add_argument('-m', '--model-path',
                        type=str,
                        default='./yolov3-coco/',
                        help='The directory where the model weights and \configuration files are.')

    parser.add_argument('-w', '--weights',
                        type=str,
                        default='./yolov3/yolov3.weights',
                        help='Path to the file which contains the weights \ for YOLOv3.')

    parser.add_argument('-cfg', '--config',
                        type=str,
                        default='./yolov3/yolov3.cfg',
                        help='Path to the configuration file for the YOLOv3 model.')

    parser.add_argument('-i', '--image-path',
                        type=str,
                        # default='./images/dog',
                        help='The path to the image file')

    parser.add_argument('-v', '--video-path',
                        type=str,
                        help='The path to the video file')

    parser.add_argument('-vo', '--video-output-path',
                        type=str,
                        default='./output.avi',
                        help='The path of the output video file')

    parser.add_argument('-l', '--labels',
                        type=str,default='./yolov3/coco-label',
                        help='Path to the file having the \
                                    labels in a new-line seperated way.')
```

```
parser.add_argument('-c', '--confidence',
                    type=float,
                    default=0.5,
                    help='The model will reject boundaries which has a \
                            probabiity less than the confidence value. \
                            default: 0.5')

parser.add_argument('-th', '--threshold',
                    type=float,
                    default=0.3,
                    help='The threshold to use when applying the \
                            Non-Max Suppresion')

parser.add_argument('--download-model',
                    type=bool,
                    default=False,
                    help='Set to True, if the model weights and configurations \
                            are not present on your local machine.')

parser.add_argument('-t', '--show-time',
                    type=bool,
                    default=False,
                    help='Show the time taken to infer each image.')

FLAGS, unparsed = parser.parse_known_args()

# Download the YOLOv3 models if needed
if FLAGS.download_model:
    subprocess.call(['./yolov3-coco/get_model.sh'])

# Get the labels
labels = open(FLAGS.labels).read().strip().split('\n')


# Intializing colors to represent each label uniquely
colors = np.random.randint(0, 255, size=(len(labels), 3), dtype='uint8')

# Load the weights and configuration to form the pretrained YOLOv3 model
net = cv.dnn.readNetFromDarknet(FLAGS.config, FLAGS.weights)

# Get the output layer names of the model
layer_names = net.getLayerNames()
layer_names = [layer_names[i[0] - 1] for i in net.getUnconnectedOutLayers()]


# If both image and video files are given then raise error
if FLAGS.image_path is None and FLAGS.video_path is None:
    print('Neither path to an image or path to video provided')
    print('Starting Inference on Webcam')

# Do inference with given image
if FLAGS.image_path:
    # Read the image
```

```
    try:
        img = cv.imread(FLAGS.image_path)
        height, width = img.shape[:2]
    except:
        raise 'Image cannot be loaded!\n\
                            Please check the path provided!'

    finally:
        img, _, _, _, _ = infer_image(net, layer_names, height, width, img, colors, labels, FLAGS)
        show_image(img)

elif FLAGS.video_path:
    # Read the video
    try:
        vid = cv.VideoCapture(FLAGS.video_path)
        height, width = None, None
        writer = None
    except:
        raise 'Video cannot be loaded!\n\
                            Please check the path provided!'

    finally:
        while True:
            grabbed, frame = vid.read()

            # Checking if the complete video is read
            if not grabbed:
                break

            if width is None or height is None:
                height, width = frame.shape[:2]

            frame, _, _, _, _ = infer_image(net, layer_names, height, width, frame, colors, labels, FLAGS)

            if writer is None:
                # Initialize the video writer
                fourcc = cv.VideoWriter_fourcc(*"MJPG")
                writer = cv.VideoWriter(FLAGS.video_output_path, fourcc, 30,
                                        (frame.shape[1], frame.shape[0]), True)
            writer.write(frame)


        print("[INFO] Cleaning up...")
        writer.release()
        vid.release()


else:
    # Infer real-time on webcam
    count = 0

    vid = cv.VideoCapture(0)
    while True:
```

```
        _, frame = vid.read()
        height, width = frame.shape[:2]

        if count == 0:
            frame, boxes, confidences, classids, idxs = infer_image(net, layer_names, \
                                                                    height, width, frame, colors, labels, FLAGS)
            count += 1
        else:
            frame, boxes, confidences, classids, idxs = infer_image(net, layer_names, \
                                                                    height, width, frame, colors, labels, FLAGS,
                                                                    boxes, confidences, classids, idxs, infer=False)
            count = (count + 1) % 6

        cv.imshow('webcam', frame)

        if cv.waitKey(1) & 0xFF == ord('q'):
            break

    vid.release()
    cv.destroyAllWindows()
```

4.4 Implementation of Robotic arm

1. Make different parts of robot using plastic/cardboard
2. Join the parts one by one; fix servo motors
3. Write code of motors and check its working
4. Join all parts and check the overall working of them

The PWM generated by Python on Raspberry Pi is software PWM. This PWM has timing resolution of 1 us which is better than Software PWM generated using C (WiringPi library). The PWM which is generated here is Software PWM and can generate on any GPIO pin.

- start (Duty Cycle)

  It is used to start PWM generation of specified Duty Cycle.

- ChangeDutyCycle(Duty Cycle)

  This function is used to change the Duty Cycle of signal. We have to provide Duty Cycle in the range of 0-100.

- ChangeFrequency(frequency)

  This function is used to change the frequency (in Hz) of PWM. This function we have not used in above program. But, we can use it for changing the frequency.

- stop()

  This function is used to stop the PWM generation.

Given below is the code for the movement of the arm.

```
import RPi.GPIO as GPIO
from time import sleep

def SetShoulderAngle(angle):
        duty = angle / 18 + 2
        GPIO.output(15, True)
        pwm.ChangeDutyCycle(duty)
        sleep(1)
        GPIO.output(15, False)
        pwm.ChangeDutyCycle(0)

GPIO.setmode(GPIO.BOARD)
GPIO.setup(15, GPIO.OUT)
pwm = GPIO.PWM(15, 50)
pwm.start(0)
SetShoulderAngle(60)
SetShoulderAngle(0)

pwm.stop()
GPIO.cleanup()
GPIO.setwarnings(False)


def SetElbowAngle(angle):
        duty = angle / 18 + 2
        GPIO.output(11, True)
        pwm.ChangeDutyCycle(duty)
        sleep(1)
        GPIO.output(11, False)
        pwm.ChangeDutyCycle(0)

GPIO.setmode(GPIO.BOARD)
GPIO.setup(11, GPIO.OUT)
pwm = GPIO.PWM(11, 50)
pwm.start(0)
SetElbowAngle(0)
SetElbowAngle(110)

pwm.stop()
GPIO.cleanup()
GPIO.setwarnings(False)
```

```
def SetWristAngle(angle):
        duty = angle / 18 + 2
        GPIO.output(18, True)
        pwm.ChangeDutyCycle(duty)
        sleep(1)
        GPIO.output(18, False)
        pwm.ChangeDutyCycle(0)

GPIO.setmode(GPIO.BOARD)
GPIO.setup(18, GPIO.OUT)
pwm = GPIO.PWM(18, 50)
pwm.start(0)
SetWristAngle(60)


pwm.stop()
GPIO.cleanup()
GPIO.setwarnings(False)


def SetGripperAngle(angle):
        duty = angle / 18 + 2
        GPIO.output(16, True)
        pwm.ChangeDutyCycle(duty)
        sleep(1)
        GPIO.output(16, False)
        pwm.ChangeDutyCycle(0)

GPIO.setmode(GPIO.BOARD)
GPIO.setup(16, GPIO.OUT)
pwm = GPIO.PWM(16, 50)
pwm.start(0)
SetGripperAngle(75)
SetGripperAngle(0)


pwm.stop()
GPIO.cleanup()
GPIO.setwarnings(False)
```

```
def SetElbowAngle(angle):
        duty = angle / 18 + 2
        GPIO.output(11, True)
        pwm.ChangeDutyCycle(duty)
        sleep(1)
        GPIO.output(11, False)
        pwm.ChangeDutyCycle(0)

GPIO.setmode(GPIO.BOARD)
GPIO.setup(11, GPIO.OUT)
pwm = GPIO.PWM(11, 50)
pwm.start(0)
SetElbowAngle(0)
SetElbowAngle(110)

pwm.stop()
GPIO.cleanup()
GPIO.setwarnings(False)


def SetWristAngle(angle):
        duty = angle / 18 + 2
        GPIO.output(18, True)
        pwm.ChangeDutyCycle(duty)
        sleep(1)
        GPIO.output(18, False)
        pwm.ChangeDutyCycle(0)

GPIO.setmode(GPIO.BOARD)
GPIO.setup(18, GPIO.OUT)
pwm = GPIO.PWM(18, 50)
pwm.start(0)
SetWristAngle(60)


pwm.stop()
GPIO.cleanup()
GPIO.setwarnings(False)
```

```
def SetGripperAngle(angle):
        duty = angle / 18 + 2
        GPIO.output(16, True)
        pwm.ChangeDutyCycle(duty)
        sleep(1)
        GPIO.output(16, False)
        pwm.ChangeDutyCycle(0)

GPIO.setmode(GPIO.BOARD)
GPIO.setup(16, GPIO.OUT)
pwm = GPIO.PWM(16, 50)
pwm.start(0)
SetGripperAngle(75)
SetGripperAngle(0)


pwm.stop()
GPIO.cleanup()
GPIO.setwarnings(False)


def SetBaseAngle(angle):
        duty = angle / 18 + 2
        GPIO.output(3, True)
        pwm.ChangeDutyCycle(duty)
        sleep(1)
        GPIO.output(3, False)
        pwm.ChangeDutyCycle(0)

GPIO.setmode(GPIO.BOARD)
GPIO.setup(3, GPIO.OUT)
pwm = GPIO.PWM(3, 50)
pwm.start(0)
SetBaseAngle(180)

GPIO.setmode(GPIO.BOARD)
GPIO.setup(16, GPIO.OUT)
pwm = GPIO.PWM(16, 50)
pwm.start(0)
SetGripperAngle(75)
SetGripperAngle(0)
```

```
GPIO.setmode(GPIO.BOARD)
GPIO.setup(3, GPIO.OUT)
pwm = GPIO.PWM(3, 50)
pwm.start(0)
SetBaseAngle(90)


GPIO.setmode(GPIO.BOARD)
GPIO.setup(11, GPIO.OUT)
pwm = GPIO.PWM(11, 50)
pwm.start(0)
SetElbowAngle(0)

GPIO.setmode(GPIO.BOARD)
GPIO.setup(15, GPIO.OUT)
pwm = GPIO.PWM(15, 50)
pwm.start(0)
SetShoulderAngle(60)


GPIO.setmode(GPIO.BOARD)
GPIO.setup(18, GPIO.OUT)
pwm = GPIO.PWM(18, 50)
pwm.start(0)
SetWristAngle(0)


pwm.stop()
GPIO.cleanup()
GPIO.setwarnings(False)
```

CHAPTER 5

Results & Discussions

The training versus validation graph is plotted to find loss and accuracy while training data is shown in Fig5.2 and 5.3 respectively. The red line graph shows validation graph and blue line indicates training graph respectively. The validation loss is more compared to training loss and validation accuracy is less than training accuracy.The accuracy obtained in waste identification is 83.60% as shown in Fig 5.1.

Object detection performed by YOLOV3 displays the type of waste and the accuracy of that waste object. The Fig5.4 is the output of waste identification on sample testing images. It has successfully detected tennis racket, tie, teddy bear and book as dry waste; bowl, knife, broken wine glass and vase as hazardous waste, plastic bottle, toy cycle, toothbrush as plastic waste; apple, sandwich, cake and orange as wet waste. The Fig 5.5 is the result of real time waste detection done on sample waste objects. Fig 5.5 shows that book is identified as dry waste with an accuracy of 0.939251 , an apple is identified as wet waste with an accuracy of 0.958695, vase

as hazardous waste with an accuracy of 0.997976 and plastic bottle as plastic waste with an accuracy of 0.999392 respectively.

The Fig 5.6, 5.8, 5.10, 5.12 shows how robot picks up paper ball, orange peel, plastic bottle, and expired tablet. Fig 5.7, 5.9, 5.11 and 5.13 shows how robot places paper ball in yellow dustbin, orange peels in green dustbin, expired tablet packet in blue dustbin and plastic bottle in red dustbin respectively.

Table 5.1 represents the test cases for successfully identifying and disposing waste in correct dustbins. 5 objects of each wet waste, dry waste, hazardous waste and plastic waste are considered. Each object is tested using 10 images taken from different angles and shapes. The total average accuracy obtained after testing is 86.78%.

```
[INFO] Calculating model accuracy
154/154 [==============================] - 13s 86ms/step
Test Accuracy: 83.6038961038961
```

Figure 5.1: Model Test Accuracy

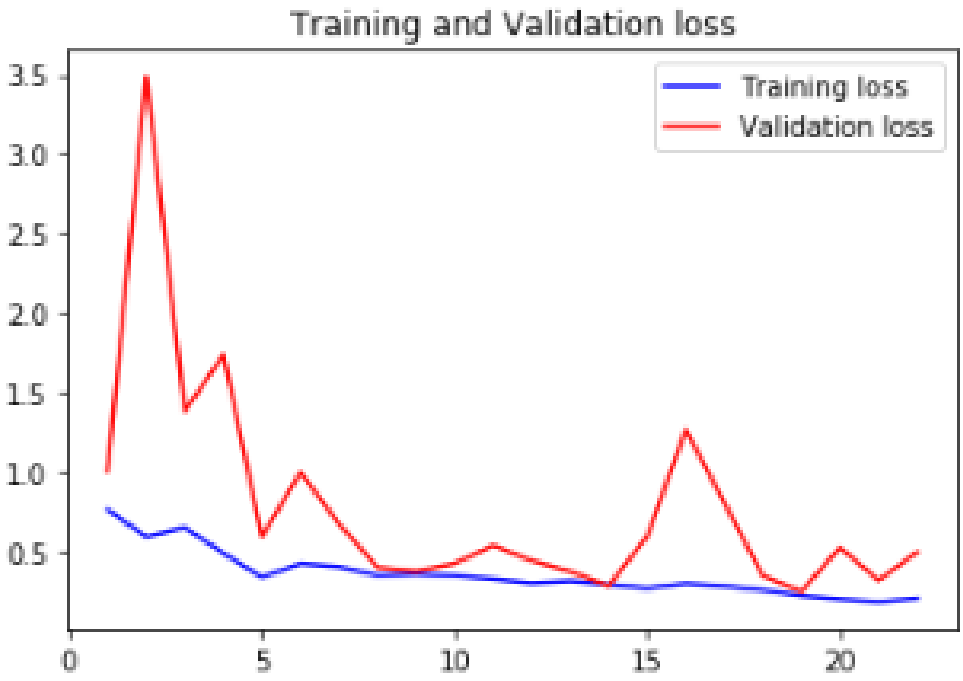

Figure 5.2: Training and validation loss graph

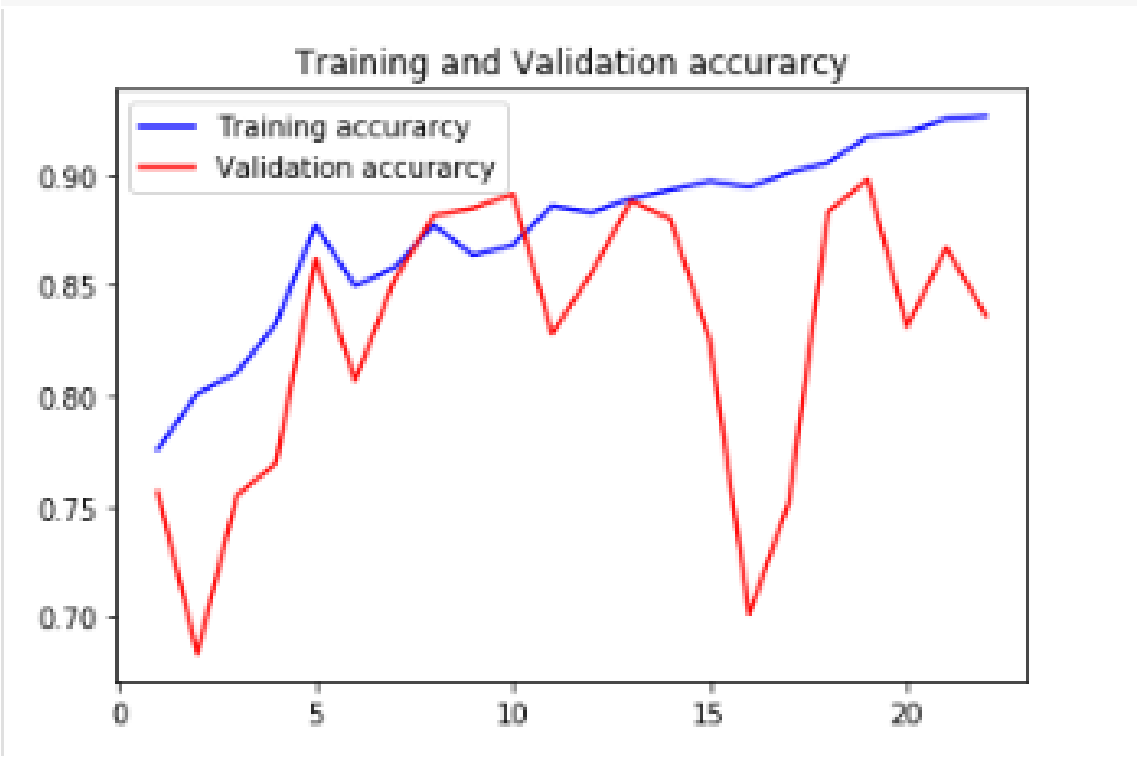

Figure 5.3: Training and validation accuracy graph

Table 5.1: Test Cases

Sr.No	Object	Waste type	Count	Accuracy
1	Paper	Dry waste	10	88
2	Cardboard	Dry waste	10	86.67
3	Book	Dry waste	10	93.8
4	Clothes	Dry waste	10	86
5	Paper plates	Dry waste	10	80
6	Fruits	Wet Waste	10	87
7	Peels of fruits	Wet Waste	10	90.51
8	Packaged food	Wet Waste	10	88
9	Flowers	Wet Waste	10	86
10	Leaves	Wet Waste	10	80
11	Glass	Hazardous waste	10	85
12	Vase	Hazardous waste	10	89.81
13	Expired medicines	Hazardous waste	10	88.78
14	Sanitary pads	Hazardous waste	10	88.65
15	Diapers	Hazardous waste	10	85.21
16	Plastic threads	Plastic waste	10	80
17	Plastic bags	Plastic waste	10	90.35
18	Plastic bottles	Plastic waste	10	91.21
19	Pens	Plastic waste	10	86.21
20	Clay	Plastic waste	10	84.51
Total average accuracy obatined				86.78%

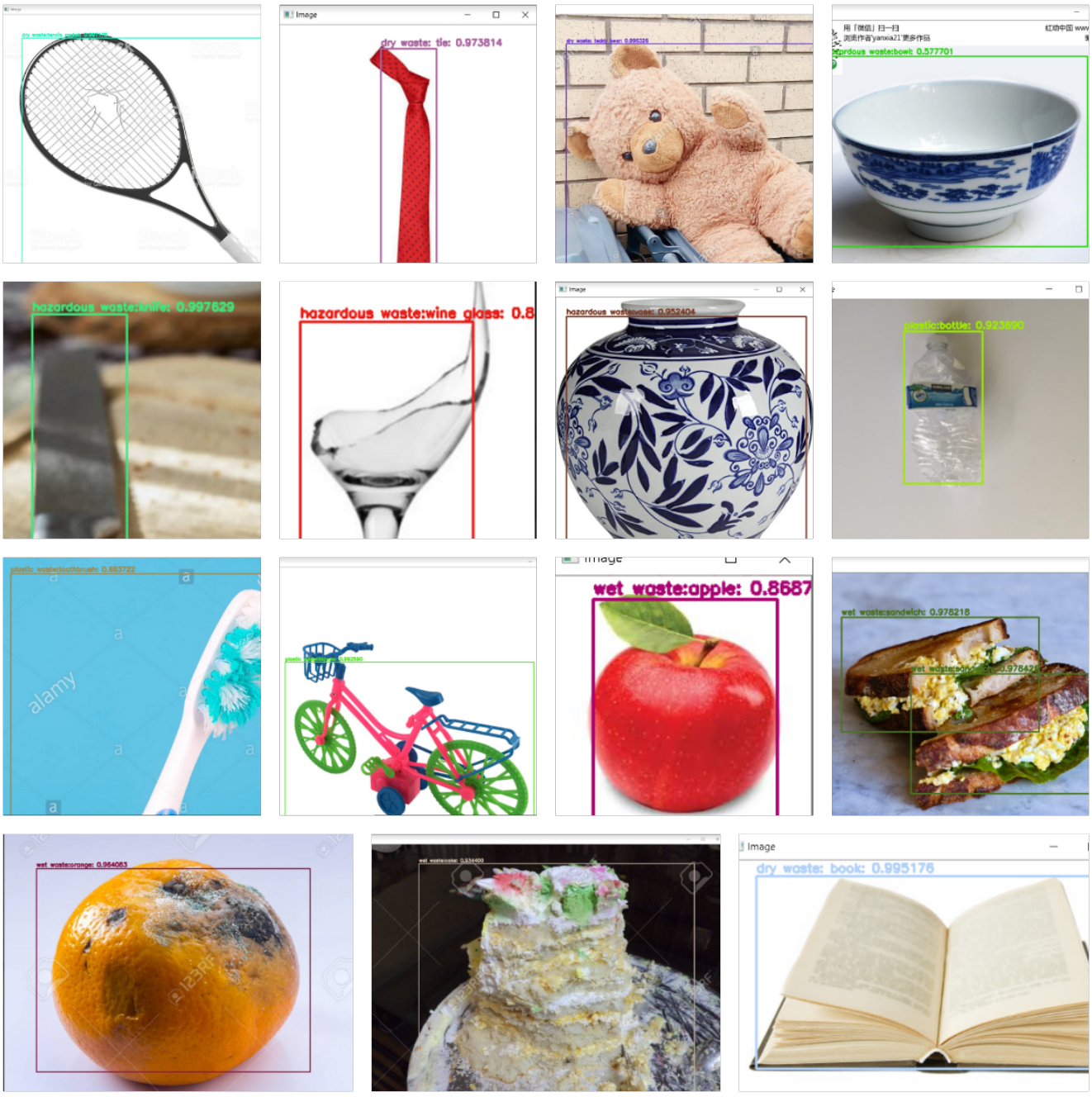

Figure 5.4: Waste identification on sample object images

Figure 5.5: Waste identification on real-time objects

Figure 5.6: Robotic Arm while picking up dry object

Figure 5.7: Robotic Arm while segregating dry object in dustbin

Figure 5.8: Robotic Arm while picking up wet object

Figure 5.9: Robotic Arm while segregating wet object in dustbin

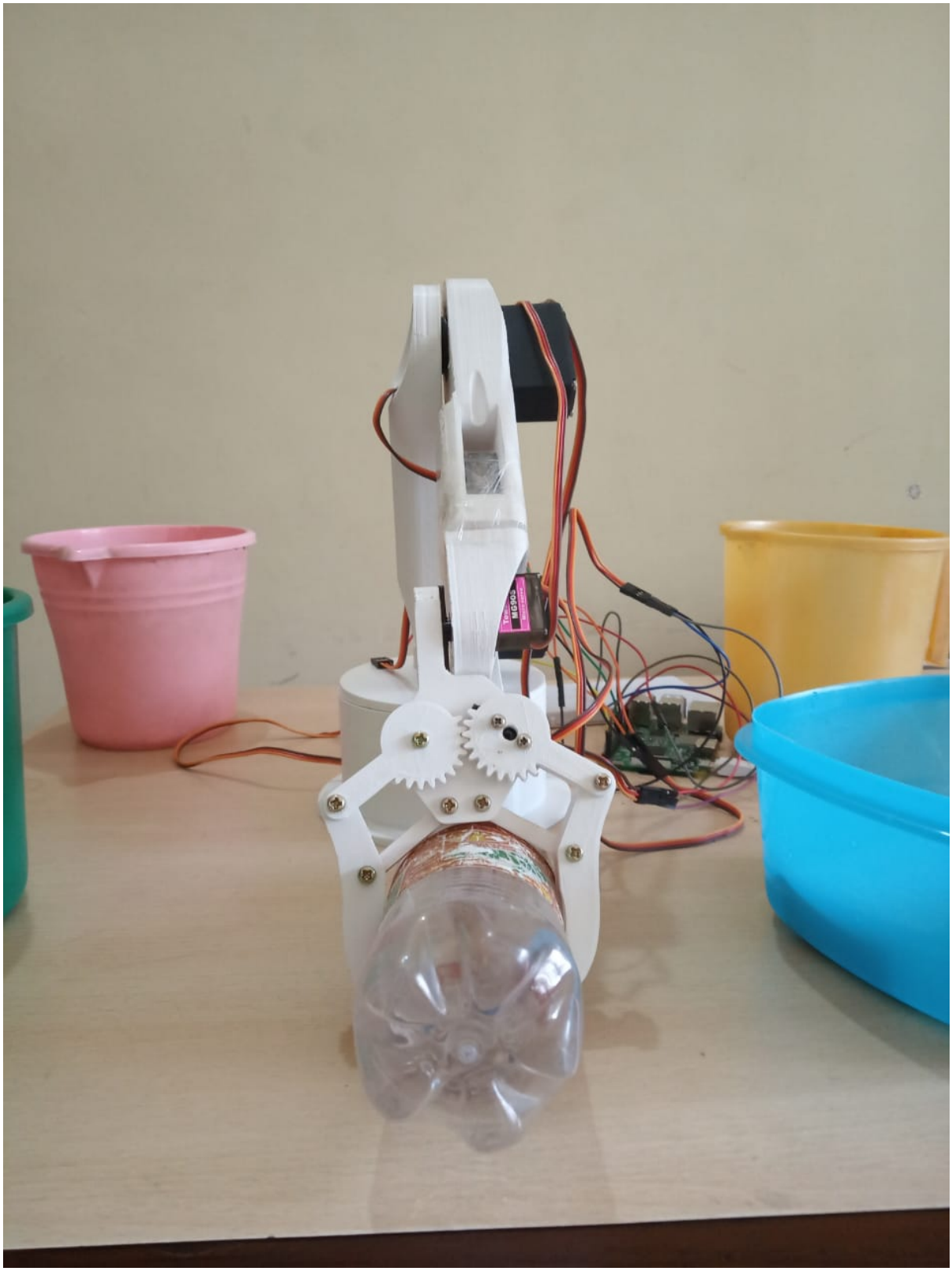

Figure 5.10: Robotic Arm while picking up plastic object

Figure 5.11: Robotic Arm while segregating plastic object in dustbin

Figure 5.12: Robotic Arm while picking up hazardous object

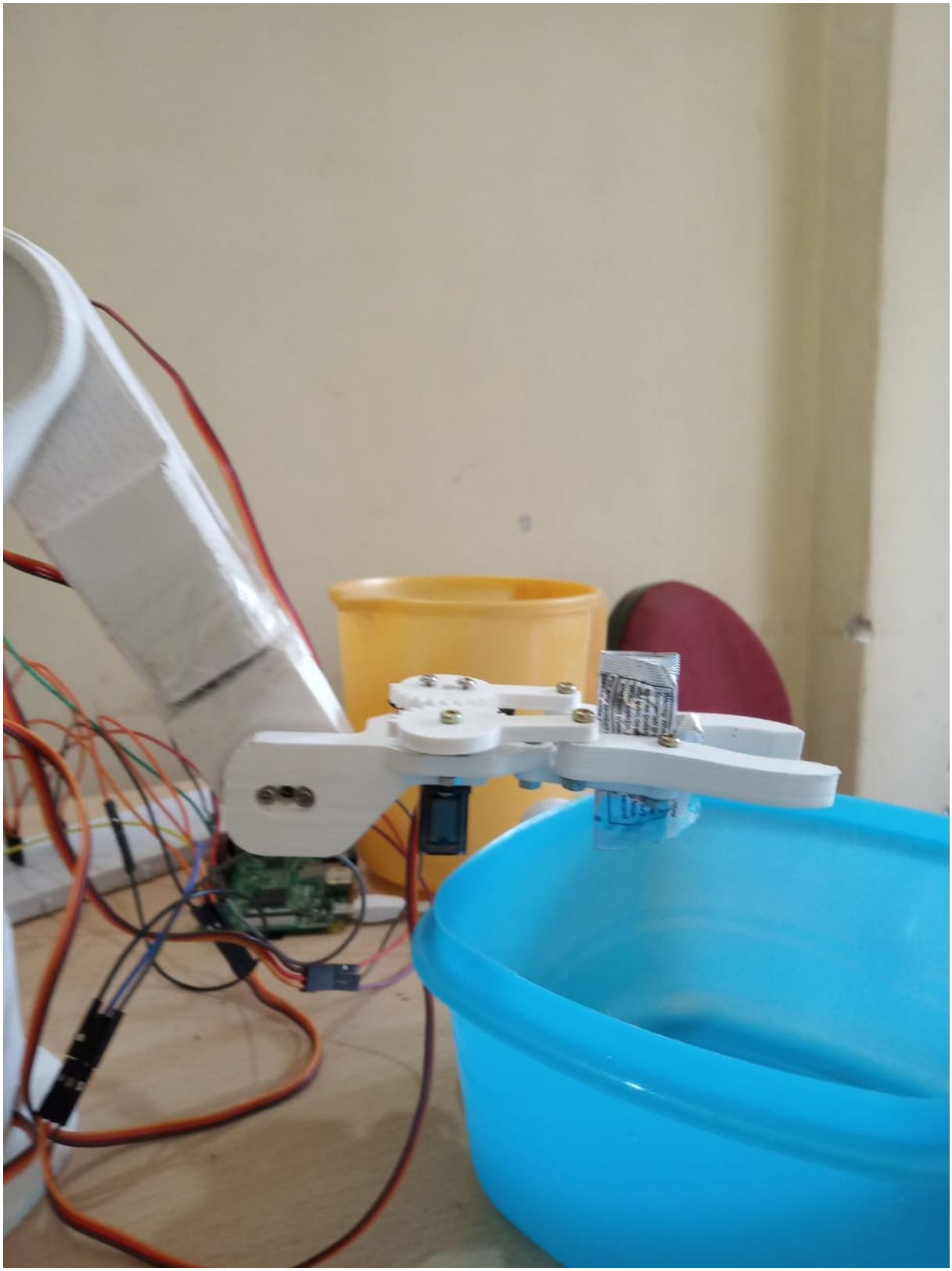

Figure 5.13: Robotic Arm while segregating hazardous object in dustbin

CHAPTER 6

CONCLUSION

Automated method not only reduces the time for performing any task but also reduces the human errors as compared to manual work. The waste segregating robot is self learning model so the model will identify new object and classify it as wet waste, dry waste, hazardous waste and plastic waste respectively. This is an eco-friendly method which is cheap and easy to built. This system can be used at small scale i.e in educational institutes, medical institute , etc as well as in large scale like in landfills. This system can be extended by defining more types of waste and training it as per them. This system will reduce the task of rag pickers and risks associated with their health and lives. A moving robot can be implemented further who will collect waste if found on roads and will segregate it and place in correct dustbin. It will also inform the number of heaps of waste segregated and segregated waste containing dustbins are full. Waste segregation of basic wet and dry garbage at homes,malls or any commercial or residential area will be the first step towards making our city clean and tidy.

In order to simplify the task of human in segregating waste we have planned to design this waste segregating robot. This robot will collect and segregate the waste using Deep learning You Look Only Once (YOLO V3) algorithm. The Coco dataset containing around 80 objects have been used for object detection. The detected objects are classify as wet waste, dry waste, metallic waste, e-waste, plastic waste and other waste. This robot will detect the type of waste and segregate it by disposing different variety of waste in different colour dustbins. This segregation will help in proper disposal of waste and reduce the pollution and health problems caused. Waste segregation method is auto-mated and don't requries human involvement, hence this method helps to prevent various health issues of ragpickers. This will help us to maintain a clean and green city. Considering all the ill effects that the environment and living organism have to face due to improper waste segregation we understand that waste segregation is one of the most important steps in waste disposal. Various automated methods discussed are easy to use, eco-friendly, reduces segregation time, human errors are more suited over the manual segregation method. Keeping surroundings clean we can live a healthy lifestyle so hence it's better to switch to automated methods for waste segregation.

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