AUTOMATIC WASTE SEGERATION ROBOT

BY USING IOT

A PROJECT REPORT

Submitted by

S.VIJAY **(911716106307)**

A.KARUPPIAH **(911716106702)**

G.ARUNBALAJI **(911716106301)**

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ANNA UNIVERSITY: CHENNAI 600 025

BONAFIDE CERTIFICATE

Certified that this project report **"AUTOMATIC WASTE SEGERATION ROBOT BY USING IoT"** is the bonafide work of "VIJAY.S (911716106307), KARUPPIAH.A (911716106702), and ARUNBALAJI.G (91716106301)" who carried out the project work under my supervision.

SIGNATURE
Dr.S.ROBINSON, M.E., Ph.D.,
HEAD OF THE DEPARTMENT
Associate Professor,
Department of ECE,
Mount Zion College of Engg & Tech,
Pudukkottai - 622 507

SIGNATURE
Mr.S.GANESAN, M.E.,
SUPERVISOR,
Assistant professor,
Department of ECE,
Mount Zion College of Engg &Tech
Pudukkottai - 622 507

Submitted for the project work and viva-voce Examination held on _____

INTERNAL EXAMINER **EXTERNAL EXAMINER**

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S. VIJAY

A. KARUPPIAH

G. ARUNBALAJI

ABSTRACT

In India, Junks remains at 0.4 to 0.6 kilograms of waste per head every day. Waste collection management is a subject undergoing extensive study about it. Nowadays there is increased production of many waste products. In automatic waste segregation robot using Arduino microcontroller the trash is picked, and is segregated into metallic wastages and non-metallic wastages. In such several government and non-government organizations have made try to reduce waste on clean public space. One of possible solution is segregating the wastes by both wastes. This project connected with IoT, which is used to monitoring system. It is a very innovative system that helps to reduce waste to keep our city clean. If the trash bin gets filled it is notified to the person operating the robot as messages in the IoT interface.

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LIST OF ABBREVATIONS

IOT	Internet of Things
IDE	Integrated Development environment
LED	Light Emitting Diode
USB	Universal Serial Bus
SCADA	Supervisory Control and Data Acquisition
CPU	Central Processing Unit
WIFI	Wireless Fidelity
TCP	Transmission Control Protocol
IP	Internet Protocol
MCU	Multipoint Control Unit
PWM	Pulse Width Modulation
TTL	Transistor- Transistor Logic
UART	Universal Asynchronous Receiver/Transmitter
ICSP	In Circuit Serial Programming
EEPROM	Electrically Erasable Programmable Read Only Memory
GND	Ground
PCB	Printed Circuit Board
SMS	Switched Mode Power Supply
GSM	Global System Mobile Communication

CHAPTER-1

INTRODUCTION

1.1 INTERNET OF THINGS

The Internet of things (IoT) is the inter-networking of physical devices, vehicles (also referred to as “connected devices” and “smart devices”), buildings, and other items embedded with electronics, software, sensors, actuators, and network connectivity that enable these objects to collect exchange data.

The IoT allows objects to be sensed or controlled remotely across existing network infrastructure, creating opportunities for more direct integration of the physical world into computer-based systems, and resulting in improved efficiency, accuracy, and economic benefit in addition to reduced human intervention.

The Internet of things (IoT) is a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers and the ability to transfer data over a network without requiring human to human or human to computer interaction.

The Internet of things which can be used to improve the resource utilization ratio and integrating human society and physical system, the IoT in which uses certain application as Smart home, Smart grid, Transportation, Environmental management and Medical system.

The Internet of things extends internet connectivity beyond traditional devices like desktop and laptop computers, Smart phones and tablets to a diverse range of devices and everyday things that utilize embedded technology to communicate and interact with the external environment, all via the Internet.

Fig 1.1 Internet of things

1.2 ROBOTICS

A robot is a machine-especially one programmable by a computer- capable of carrying out a complex series of actions automatically. Robot any automatically operated machine that replaces human effort, though it may not resemble human beings in appearance or perform functions in a humanlike manner. By extension, robotics is the engineering discipline dealing with the design, construction, and operation of robots.

Robots are widely used in such industries as automobile manufacture to perform simple repetitive task, and in industries here work must be performed in environments hazardous to humans.

Robot is an artificial agent, meaning it acts instead of a person, doing things it is designed for. Robots are usually machines controlled by a computer program or electronic circuitry. They may be directly controlled by humans.

Robot software is the set of coded commands or instructions that tell a mechanical device and electronic system, known together as a robot, what task to perform. Robot software is used to perform autonomous tasks. Many software frameworks have been proposed to make programming robots easier.

A simpler, they are five types of robot: Cartesian, cylindrical, SCARA, 6-Axis and delta. Each industrial robot type has specific elements that make them best-suited for different applications. The main differentiators among them and their speed, six and workspace.

The goal of robotics is to design intelligent machine that can help and assist humans in their day-to-day lives and keep everyone safe. Robots can be used in many situations and for lots of purposes, but today many are used for lots of purposes, but today many are used in dangerous environments, manufacturing, in high heat and clean up.

Today, robotics is a rapidly growing field, as technological advances continue; researching, designing, and building new robots serve various practical purposes, whether domestically, commercially, or militarily.

A robot has some consistent characteristics:

- Robots all consist of some sort of mechanical construction. The mechanical aspects of a robot help it complete task in the environment for which it's designed example.
- Robots need electrical components that control and power the machinery, essentially, an electric current (a battery, for example) is needed to power a large majority of robots.
- Robot contain at least some level of computer programming, without a set of code telling it what to do, a robot would just be another piece of simple machinery. Inserting a program into a robot gives it the ability to know when and how to carry out a task.

- The robotics industry is still relatively young, but has already made amazing strides. From the deepest depths of our oceans to the highest heights of outer space, robots can be found performing tasks that humans couldn't dream of achieving.

1.3 ARDUINO

Arduino is an open- source electronics platform based on easy to use hardware and software. Arduino boards are able to read inputs-lights on a sensor, a finger on a button, on a Twitter message- and turn it into an output- activating a motor, turning on an LED, publishing something online. You can tell your board what to do by sending a set of instructions to the microcontroller on the board. To do so you use the Arduino programming language (based on wiring), and the Arduino Software (IDE), based on Processing.

The Arduino platform has become quite popular with people just starting out with electronics, and for good reason. Unlike most previous programmable circuit boards, the Arduino does not need a separate piece of hardware (called a programmer) in order to load new code on to board you can simply use a **USB** Cable.

Additionally, the Arduino IDE uses a simplified version of C++, making it easier to learn the program. Finally, Arduino provides a standard form factor that breaks out the functions of the program of the micro-controller into a more accessible package.

Arduino Microcontrollers are pre-programmed with a boot loader that simplifies uploading of programs on the on-chip flash memory. The default boot loader of the Arduino UNO is the Opti boot loader. Boards are loaded with program code via a serial connection to another computer.

Some of the circuits to convert between RS-232 logic levels and **TTL** level signals. Current Arduino boards are programmed via **USB**, implemented using USB-to-Serial adapter chips such as **FTDI** FT232. AVR chip containing USB-to-serial firmware, which is reprogrammable via its own **ICSP** header.

Other variants, such as the Arduino Mini and the unofficial Arduino, use a detachable USB-to-Serial adapter board or cable, Bluetooth or other methods. When used with traditional microcontroller tools, instead of the Arduino IDE, standard AVR in system programming (ISP) programming is used.

1.4 WASTE SEGREGATION ROBOT

To developing the metallic and nonmetallic waste collection robotics system. This autonomous robot can perform task such as obstacle avoidance and metal detection. Some of the factors considered in this work are cost size, flexibility, weight, and autonomy.

The propose of this work is to detect metallic objects in a specific area and pick them up by using a robot arm. Arduino microcontroller can be programmed using the Arduino programming language. Sensor such as ultrasonic sensor and metal detector plays a significant role to identify and metal object and pick up by arm and put in trash-bins.

The trash bins are separate as two part for metal and nonmetal waste are control by servo motor to segregate the wastes objects. This robot has four wheels for moving function to collect the objects. Through Arduino program this collects the waste object automatically and controls the vehicles. This robot avoid obstacle by using ultrasonic sensor.

The robot moves and the ultrasonic sensors check for any object, in case the sensor finds an object the robot will stop and then go to pick-up step to pick the

object up. After that the robot will check if the object is metal or nonmetal object by metal detectors and put in trash bin.

The operation of the robot can be classified into three main categories. They are motion control of the robot, garbage collection and segregation. the robot can travel predetermined path by using a combination of motors, drivers, and sensors connected to the Arduino. The ultrasonic sensors act as input to the Arduino. The motors are connected to the motors are connected to the output of the Arduino through the drivers. The ultrasonic sensors detect the obstacles and the motor are made to rotate based n pre-programmed instruction in the Arduino.

When the sensors detect static obstacles, the mechanism rotates and the garbage is pushed into a bin which is placed right behind the mechanism the robot keeps collecting the garbage until it reaches certain height of the bin. Once the bin is filled the collected garbage is disposed to a selected place.

To build an automatic trash robot using Arduino microcontroller which detect and collect waste items automatically and process it. So, this reduces the requirements of manual clearance of metal and nonmetal waste.

SUMMARY

This Chapter describes about Internet of things, Robotics, Arduino, and Waste Segregation Robot of the proposed system.

CHAPTER 2

LITERATURE REVIEW

[1]. Dr. Sumaiya MN, Dr. Kavitha GR [2020] discussed about the Smart Robotic Arm Based Waste Segregation system. It is based on waste segregation using robotic arm; the robotic arm will able to sort out the three different materials like paper, glass, and metals. When the sensors are triggered and motor-powered arm is actuated and the materials are dispensed onto its proper bins. The trash collection and detection of wastes automated in nature. It would work for solid waste collection and monitoring system. The disadvantage has spent researching mechanical design of the robotic arm, the problems led to limited functionality of robot.

[2].S.A.A.Jude, S.Selva Prabhu, J.Veerapandian, M.Muthamilselvan, S.Prem kumar, B.Krishnasamy [2019] discussed about the Automatic Waste Segregation and Monitoring System of Municipal Solid Waste. It is based on waste segregation. The waste into three major classes: Plastic, organic, metallic. It would be able to monitor the solid waste collection process and management of the overall collection process. The inlet section is provided with open and close mechanism to regulate the flow of waste on to the conveyor. Inductive proximity sensor is used to detect metallic waste. A blower mechanism is used to segregate dry and wet waste. The timing movement of the conveyor belt is controlled by Arduino Uno.

[3].T.Saminathan, Akash Musipatla, P.Manideep varma, P.Shahid Khan, G.Mahesh Kumar [2019] discussed about the IoT Based Automated Waste Segregator for Efficient Recycling. It is based on municipal waste segregator, which can segregate the dumped waste immediately, leading to more recyclable

paper. The smart bin can be programmed to send information about the dumped garbage, such that respective action can be taken. Metal sensor, Moisture sensor, Smart bin, and motors are interface with Arduino board connecting and monitoring by the IoT.

[4]. Sneha M P, Varshitha C K, Vandhana H S, Varshini H K, Dr. M B Anandraju [2019] discussed about the Advanced Robot for Automatic Waste Segregation and Status Alert. It sorts the wastes into three different categories namely metal, dry, and wet (organic) waste. We have tested the household wastes which are generated in every home today and we have come up. In any kind of wastes is placed on robotic hand the sensor will sense the material and container moves in a particular position. And also, the robotic hand flips the waste into particular partition. Then the waste is segregated. The IR sensor used to sense the garbage level and it indicates it.

[5]. Shikha Parashar, Pankaj Tomar [2018] discussed about the Waste Management by a Robot- A smart and Autonomous Technique. In 'Garbage Monitoring system' of the trash filled in the fixed part bin is identified using an ultrasonic sensor, This is a fully automated system in which the garbage moves automatically when it gets a signal via RF Module from Garbage bin. Hence, the IR sensor used to garbage level detection on Garbage car. Arduino board is used to interface the ultrasonic sensor, motor and RF module.

[6]. Gaurav Pawar, Abhishek Pisal, Ganesh Jakhad, Godson Koithodathu, Prof. Piyush G. Kale [2018] discussed about the Raspberry PI Based Automated Waste Segregation System. It is used to design and develop a sorting system that sorts and waste automatically. We will be going to design is consists of,

Raspberry Pi3, a Servo motor, Ultrasonic sensor, Moisture sensor, Inductive proximity sensor. The Moisture sensor used to identify the waste is dry or wet.

[7]. V.V.Joshi, Roshan Ghugikar, Bhagavat Bhise, Pradip Bhawar,Shivam Kakade [2017] discussed about the Waste Segregation Using Smart Robotic Arm. The system delivers the process of collecting the waste that is sorted by AWS, to minimize human interference. We can approach sensors, along the robotic arm as the Automated Waste Sorter. The mobile Robot is able to pick up the waste and put in trash bin. It consists of Robotic arm, Proximity sensor, USB-TTL, Limit Switch, Solid waste etc…

[8]. Aleena V.J.*, Kavya Balakrishnan, Roshmi T.B., Swathy Krishna K.J., Sreejith S, T.D. Subha [2016] discussed about the Automatic Waste Segregator and Monitoring System. It segregates system for households, so that wastes can be sent directly for processing. It is designed into different categories such as metals, plastic, and organic. Ultrasonic sensor is used for monitoring waste collection process. The sensors are placed to garbage bins, if the garbage reaches the level of sensor, the indication to the microcontroller. The microcontroller will give indication to the driver of garbage collection truck by sending SMS using GSM technology.

[9]. Saravana kannan G, Sasi kumar S, Ragavan R, Balakrishnan M [2016] discussed about the Automatic Garbage Separation Robot Using Image Processing Technique. The robot detect by object by the ultrasonic sensor can collect the garbage automatically by sensing using web camera by the image processing technique using mat lab, the robot can able to separate the garbage into degradable and non-degradable waste. Embedded C programming used for arm and gripper movement by the PIC micro-controller and the separation of garbage is done by image processing technique of size, color and texture.

[10]. M.K. Pushpa, Aayushi Gupta, Shariq Mohammed Shaikh, Stuti Jha, Suchitra V [2016] discussed about the Microcontroller Based Automatic Waste

Segregator. It is designed to sort the waste into 3 categories, namely metallic, wet and dry, thereby waste management is more effective. It is based on 8051 microcontroller forms the system. The metallic waste is used to detect inductive proximity sensor. The continuous and unnecessary operation of any particular section is thus avoided.

SUMMARY

This chapter describes about the literature survey of existing method.

CHAPTER-3

EXISTING SYSTEM

Smart robot Arm based waste segregation system. It is based on waste segregation robotic arm; the robotic arm will able to sort out the three different materials like paper, glass and metals. When the sensors are triggered and motor-powered arm is actuated and the materials onto its proper bins. The trash collection and detection of wastes automated in nature .it would work for solid waste collection and monitoring system. The disadvantage has been spent researching mechanical design of the robotic arm, whose problem led to a limited functionality of the robot.

Automatic waste segregation and monitoring system of municipal solid waste. It is based on waste segregation. The waste into three major classes: plastic, organic, metallic. It would be able to monitor the solid waste collection process and management of the overall collection process. The inlet section is provided with open and close mechanism to regulate the flow of waste on to the conveyor. Inductive proximity sensors are used to detect the metallic waste. A blower mechanism is used to segregate dry and wet waste. The timing and movement of the conveyer belt is controlled by Arduino Uno.

IoT based automatic waste segregator for efficient recycling. A municipal waste segregator, which can segregate the dumped waste immediately, is leading to more recyclable paper. The smart bin can be programmed to send information about the dumped garbage, such that respective action can be taken. Metal sensor, moisture sensor, smart bin and motors are interface with Arduino board connecting and monitoring with IoT.

Advanced robot for automatic waste segregation and status alert. It sorts the waste into three different categories namely metal, dry and wet (organic) waste. We have tested the household wastes which are generated in every home today and we have come up in any kind of wastes is placed on robotic hand sensor will sense the material and container moves in a particular position. And also, the robotic hand flips the waste into particular partition. Then the waste is segregated. The IR sensors used to sense the garbage level and it indicates it.

Waste management by a robot- A smart and autonomous technique. In garbage monitoring system of the trash filled in the fixed part bin is identified using an ultrasonic sensor, this is a fully automated system in which the garbage moves automatically when it gets a signal via RF Module from garbage bin. Hence, the IR sensors used to garbage level detection on garbage car. Arduino board is used to interface the ultrasonic sensors, motor and RF module.

Raspberry PI based automation waste segregation system. It is used to design and develop a sorting system that sorts and waste automatically. We will be going to design is consists of raspberry Pi3, a servo motor, ultrasonic sensors, moisture sensor, inductive proximity sensor. The moisture sensors used to identify the waste is dry or wet.

Waste segregation using smart robotic arm. This system delivers the process of collecting the waste that is sorted by AWS, to minimize human interference. We can approach sensors, along the robotic arm as the automatic waste sorter. The mobile robot is able to pick up the waste and put in trash bin. It consists of robotic arm, proximity sensor, USB-TTL; limit switch, solid waste etc.…

Automatic waste segregator and monitoring system. It segregates system for households, so that wastes can be sent directly for processing. It is designed into different categories such as metals, plastic and organic. Ultrasonic sensors are used for monitoring waste collection process. The sensors are placed to garbage bins, if

the garbage reaches the levels of sensors, the indication to the microcontroller. The microcontroller will give indication to the drivers of garbage collection truck by sending SMS using GSM technology.

Automatic garbage separation robot using image processing technique. The robot detects by object by the ultrasonic sensor can collect the garbage automatically by sensing using web camera by the image processing technique using mat-lab, the robot can able to separate the garbage into degradable and non-degradable waste. Embedded C programming used for arm and gripper movement by the PIC microcontroller and the separation of garbage is done by image processing technique of size, color and texture.

Microcontroller based automatic waste segregation. It is designed to sort the waste into 3 categories, namely metallic, wet and dry, thereby waste management is more effective. It is based on 8051 microcontroller forms the system. The metallic waste is used to detect inductive proximity sensors. The continuous and unnecessary operation of any particular section is thus avoided.

SUMMARY

This Chapter describes about waste segregation using microcontroller, Image processing, Sensors are used.

CHAPTER 4

PROPOSED METHODOLOGY

Plastic pollution is the accumulation of plastic particles in earth's environment that adversely affects humans, wildlife habitat, approximately 380 million tons of plastic is produced the worldwide each year, and also metal scrap from metals having hazardous materials it affects humans and wildlife. So, to minimize this we have the following method.

In this method robot is operated using an android mobile for that two operating models involved namely,

- Manual Mode
- Autonomous Mode

4.1 BLOCK DIAGRAM

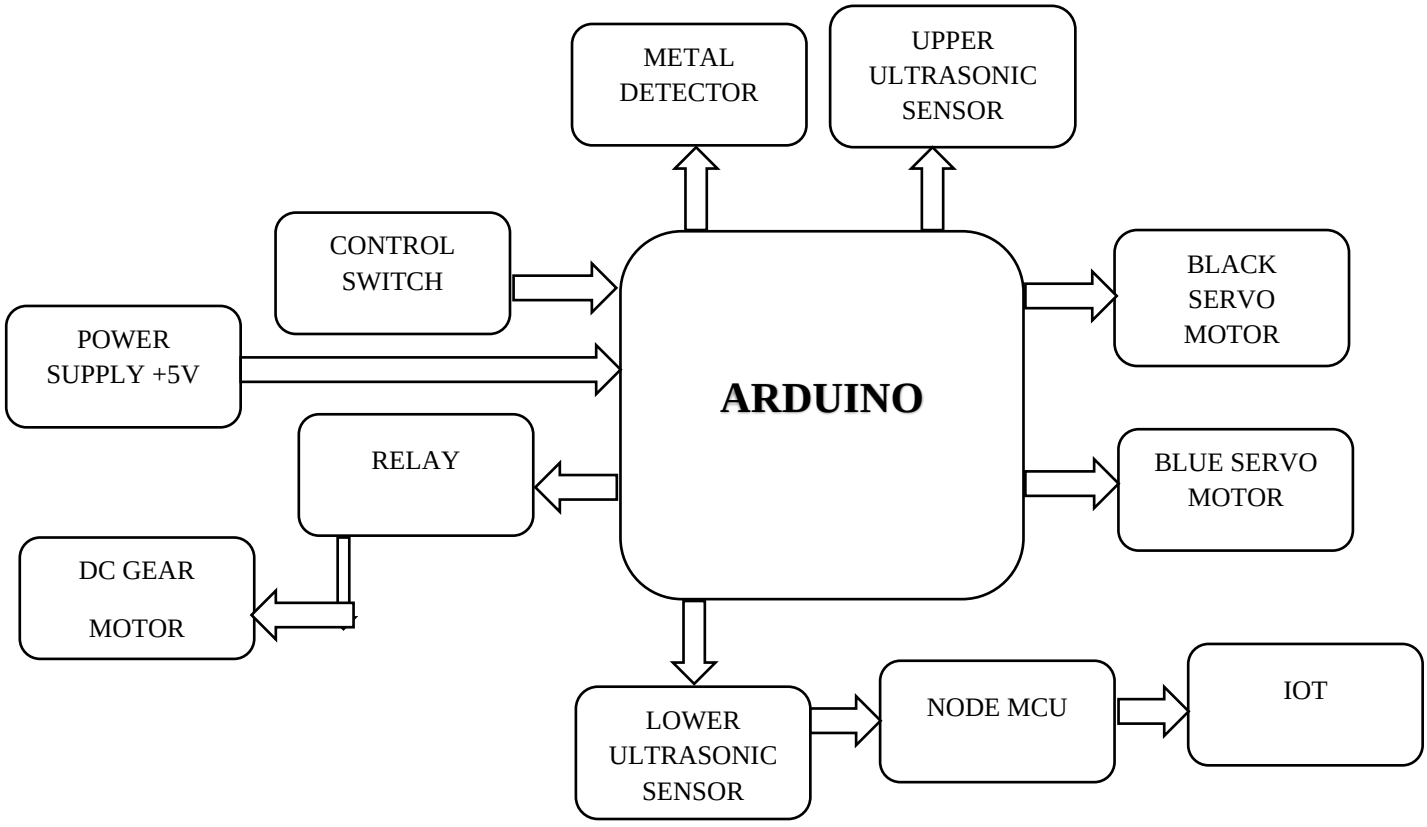

Fig 4.1 Main Block Diagram

Fig 4.1 Shows that the block diagram of proposed method and it consists of Metal Detector, Ultrasonic Sensors, Servo Motors, Arduino Board, Relay, DC Gear motor, Node MCU, Power Supply, Control Switch.

4.2 METHODOLOGY

4.2.1 ROBOT LOCOMOTION MODE

In manual mode robot can travel in the predetermined path by using combination of motors, drivers, and sensors connected to the Arduino. The ultrasonic sensors act as input to the Arduino. The motors are connected to the output of the Arduino through the drivers. The ultrasonic sensors detect the obstacles and the motors are made to rotate based on pre-programmed instructions in the Arduino.

In autonomous mode also robot locomotion mode involved and waste pickup without any human intervention. The trash detection is made possible using four ultrasonic sensors placed in 2 rows. The sensing range is limited about 30cm to avoid crosstalk's.

4.2.2 GARBAGE COLLECTION

The main aim is to collect garbage and segregate into metals and Non-metals. Metals like small metal trash cans etc… and Non-metals like plastic bottles, crushed papers etc.… The motors are mounted to two sides of the shaft and is connected to Arduino to perform its rotating mechanism. The collection mechanism is built is such a way as suit public places like gardens, bus stands, footpaths etc.…

4.3 CONNECTIONS

4.3.1 Relay Connection with Arduino.

Step 1: Relay input (vin1) is connected to D0.

Step 2: Relay input (vin2) is connected to D1.

Step 3: Relay input (vin3) is connected to D12

Step 4: Relay input (vin4) is connected to D13.

4.3.2 Ultrasonic Sensor Connection with Arduino

Step 1: Upper trigger pin of ultrasonic sensor is connected to D3.

Step 2: Upper echo pin of ultrasonic sensor is connected to D4.

Step 3: Lower trigger pin of ultrasonic sensor is connected to D7.

Step 4: Lower echo pin of ultrasonic sensor is connected to D8.

4.3.3 Servo Motor Connection with Arduino

Step 1: Upper left servo (Black) is connected to D9.

Step 2: Upper right servo (Black) is connected to D10.

Step 3: Lower left servo (Blue) is connected to D5.

Step 4: Lower right servo (Blue) is connected to D6.

4.3.4 Metal Detector Connection with Arduino

Step 1: Metal detector input is connected to D2

4.3.5 Node MCU connection with Arduino

Step 1: A0 is connected to robot switch control.

Step 2: A4 and A5 is connected to IoT.

Step 3: +5v is connected to Power supply.

Step 4: GND terminal is connected to Ground.

SUMMARY

The chapter describes about the Proposed method, Block diagram, Methodology and Connections of IOT based automatic waste segregation robot.

CHAPTER 5

HARDWARE DESCRIPTION

5.1 NODE MCU

Node MCU is an open source LUA based firmware developed for ESP8266 Wi-Fi chip. By exploring functionality with ESP8266, node MCU firmware comes with ESP8266 development board/kit i.e. Node MCU development board. Since node MCU is open source platform, their hardware design is open for edit/build.

Node MCU dev kit/board consist of ESP8266 Wi-Fi enabled chip. The ESP8266 is a low-cost Wi-Fi chip developed by Espressif systems with TCP/IP protocol. There is version2 (v2) available for node MCU dev kit i.e. Node MCU development board vl.0 (version 2), which usually comes in black colored PCB which is shown and pin configuration is shown.

Fig. 5.1 Node MCU board

5.1.1 PIN CONFIGURATION

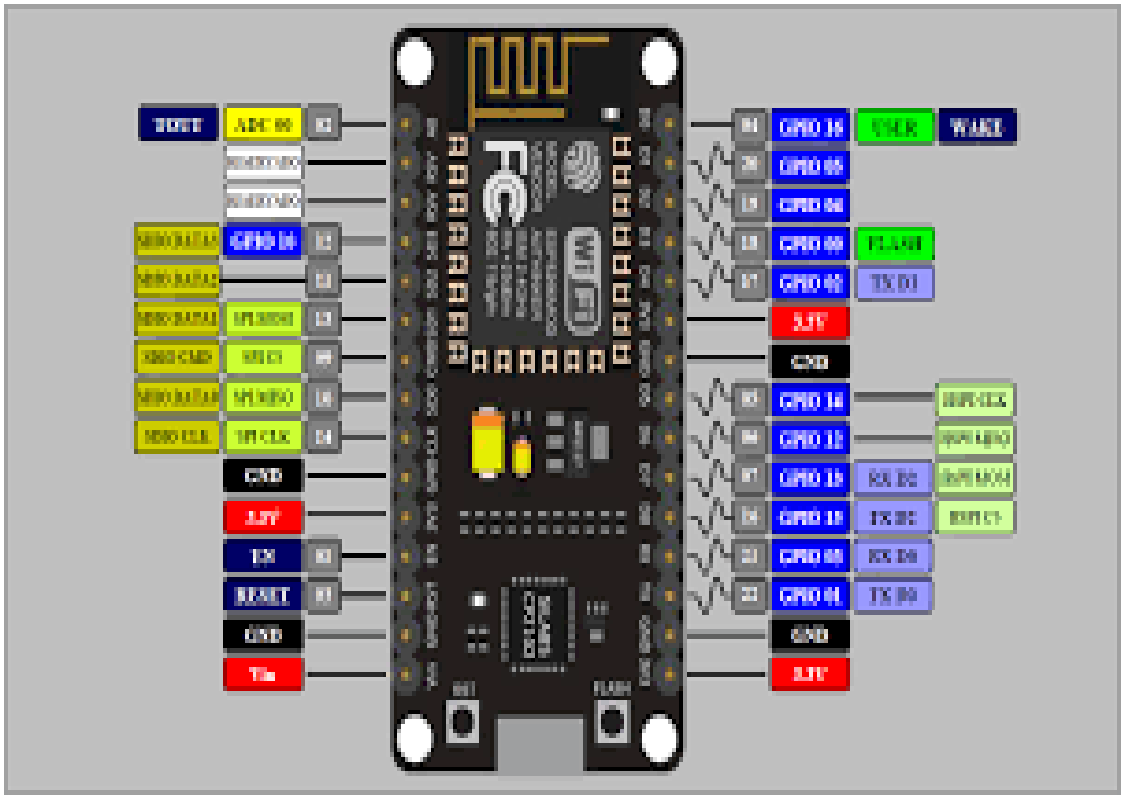

Fig. 5.1.1 Pin configuration of Node MCU

5.1.2 NODE MCU WITH ARDUINO IDE

Here is another way to developing node MCU with well-known Arduino IDE. We can also develop application on Node MCU using Arduino development environment. This makes easy for Arduino developers than learning new language and IDE for node MCU.

5.1.3 FEATURES OF NODE MCU

- Open-source
- Interactive
- Programmable
- Low cost.

5.1.4 NODE MCU SPECIFICATION

Table. 5.1.4 Node MCU Specification

Developer	ESP8266 open source community
Type	Single-board microcontroller
Operating system	XTOS
CPU	ESP8266
Memory	128kbytes
Storage	4Mbytes
Power by	USB
Power voltage	3v,5v (used with 3.3v regulator which inbuilt on-board pin VIN)
Code	Arduino Cpp.
IDE used	Arduino IDE
GPIO	10

5.1.5 ADVANTAGES

- Low energy consumption.
- Integrated support for WI-FI network.
- Reduced size of the board.
- Low cost.

5.1.5 DISADVANTAGES

- Need to learn a new language and IDE.
- Less pin out.

5.2 ARDUINO UNO

The Arduino Uno is an open source microcontroller board based on the microchip ATmega328p microcontroller and developed by Arduino.cc. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to varies expansion boards and other circuits.

The board is equipped with sets of digital and analog input/output (I/O) pins that may be interface to various expansion boards and other circuits. The board has 14 digital I/O pins,6 analog I/O pins, and is programming with the Arduino IDE, via a type B USB cable. It can be powered by the USB cable or by an external 9-volt battery, though it accepts voltage between 7 and 20 volts.

5.2.1 ARDUINO UNO PIN DIAGRAM

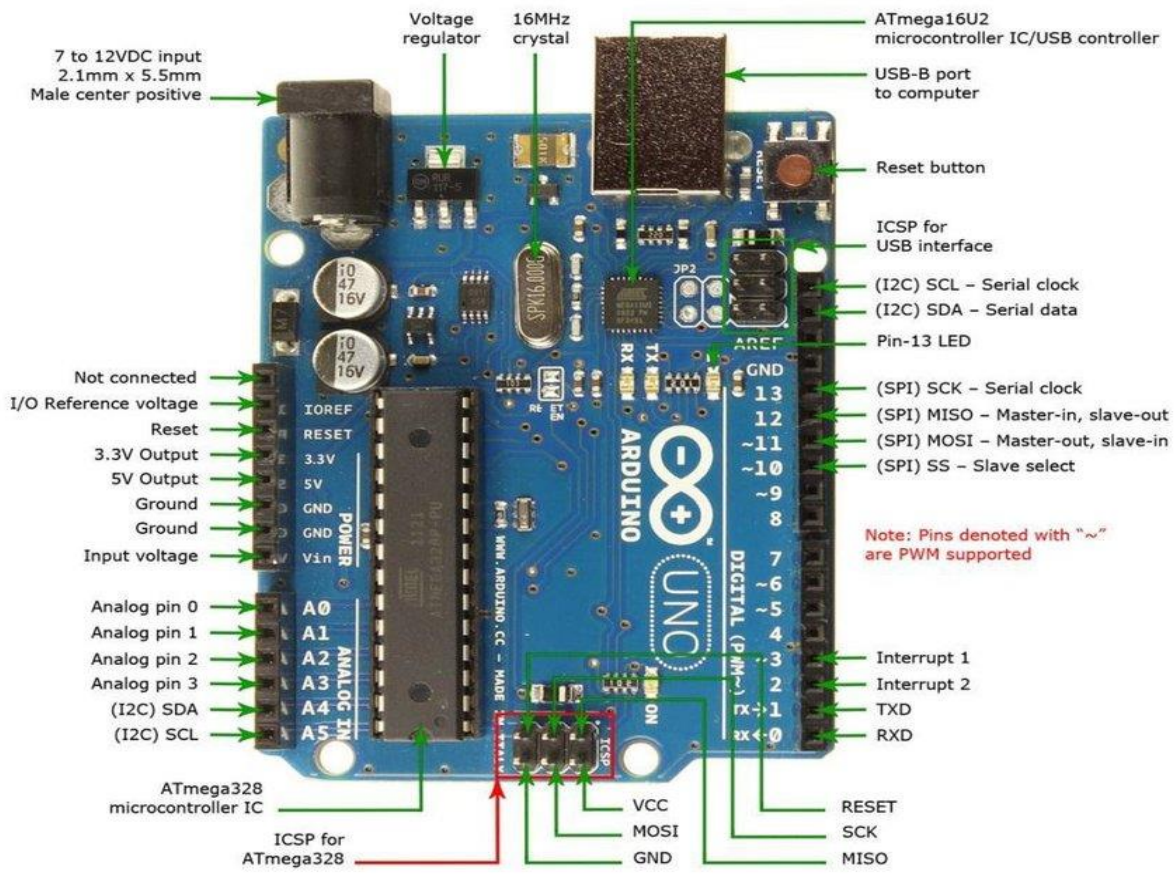

Fig. 5.2.1 Arduino Pin Diagram

5.2.2 PIN DESCRIPTION

Table. 5.2.2 Pin description

Pin category	pin name	Details
Power	Vin, 3.3v , 5v , GND	Vin: Input voltage to arduino when using an external power source . 5v: Regulated power supply used to microcontroller and

		other components on the board. GND: ground pins 3.3v: 3.3v supply generate by on-board voltage regulatior. Maximum current draw in 50mA.
Reset	Reset	Resets the microcontroller.
Analog pins	A0- A5	Used to provide analog input in the range of 0-5v.
Inputs/ouput pins 0-13	Digital pins 0-13	Can be used as input or ouputs pins.
Serial	0(RX), 1(TX)	Used to recevie and transmit TTL serial data.
External interputs	2,3	To triggers an interupt
PWM	3,5,6,8,11	Provides 8-bit PWM output.
SPI	10 (SS), 11 (MOSI), 12 (MISO) and 13	Used for SPI communication . To turn on tne inbulit LED.
Inbuilt LED	13	Used for TWI communicaion.
TWI	A4 (SDA), A5(SCA)	To provide reference voltage for input voltage.
AREF	AREF	

5.2.3 ARDUINO UNO TECHNICAL SPECIFICATIONS

Table. 5.2.3 Arduino Uno Technical specifications

Microcontroller	ATmega328p- 8 bit AVR family microcontroller
Operating voltage	5v
Recommended input voltage	7-12v
Input voltage limits	6-20v
Analog input pins	6(A0-A5)
Digital I/O pins	14
DC current on I/O pins	40mA
DC current on 3.3v pins	50 mA
Flash memory	32 KB
SRAM	2 KB
EEPROM	1 KB
Frequency	16 MHZ

5.2.4 FEATURES OF ARDUINO UNO BOARD

- Operating voltage is 5v.
- Recommended input voltage will range from 7v to 12v.

- The input voltage range from 6v to 20v.
- Digital input/output pins are 14 .
- Analog i/p pins are 6.
- DC current for each input/output pin is 40 Ma.
- DC current for 3.3v pins is 50 Ma.
- SRAM is 2Kb.
- EEPROM is a 1KB.
- Clk speed 16 MHZ.

5.2.5 APPLICATION OF ARDUINO UNO

- Arduino uno is used in Do-it-yoursself projects prototyping
- In devloping projects based on code-based control
- Devlopment of automation system
- Designing of basic crcuit designs.

5.3 ULTRASONIC SENSOR

An ultrasonic sensor is an instrument that measures the distances to an object using ultrasonic sound waves. An ultrasonic sensor uses a transducer pulses that relay black information about an object’s proximity.

Ultrasonic sensor works by emitting sound waves at a frequency too high for humans to hear. they then wait for the sound to be reflected back, calculating distance based on the time required this is similar to how radar measures the times it takes a radio wave to return after hitting an object.

Ultrasonic sensors can be used for many applications, including precise detection of objects and contactless monitoring of fill levels. They generate high frequency sound waves and evaluate the echo which is received back by the sensor.

The ultrasonic sensors can be works on the principle of sonar and radar system which is used to determine the distance to an object. an ultrasonic sensor generates the high-frequency sound (ultrasound) waves. When this ultrasound hits the object, it reflects as echo which is sensed by the receiver.

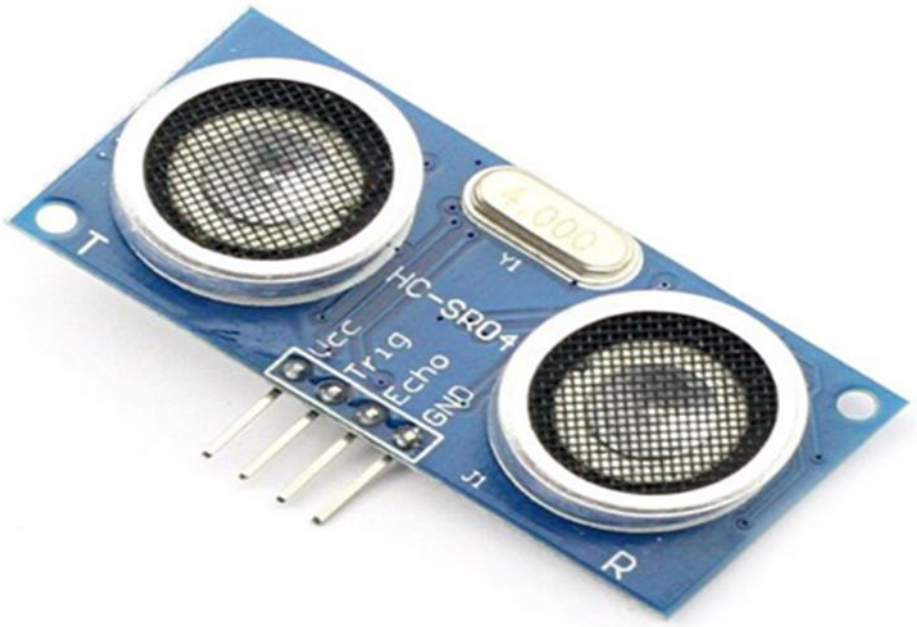

Fig. 5.3 Ultrasonic Sensor

VCC – +5v supply

TRIG – Trigger input of sensor. Microcontroller applies 10 us trigger pulse to the HC-SR04 ultrasonic module.

ECHO–Echo output of sensor. Microcontroller reads/monitors this pin to detect the obstacle or to find the distance.

GND – Ground

5.3.1 FEATURES

- High frequency
- High sensitivity

- High penetrating power
- It can easily detect the external or deep objects
- These sensors easily interface with microcontroller or any type of Controller
- These sensors could easily sense the nature, shape and orientation of that specific object
- person equipment or material.

5.3.2 ADVANTAGES

- The ultrasonic sensor has high frequency, high sensitivity and high penetrating power therefore it can easily detect the external or deep objects.
- These sensors easily interface with microcontroller or any type of controller
- These sensors could easily sense the nature, shape and orientation of that specific objects which is within the area of these sensors.
- There sensors are easy to use, not dangerous during operation for nearby objects, person, equipment or material

5.3.3 DISADVANTAGES

- When the sensors are interface with microcontroller or any Controller then experienced person or program is required.
- It is very sensitive to variation in the temperature.
- It has more difficulties in reflection from soft, curve, thin a small object.
- Measurement is not as accurate as other measurement techniques usually within 25 to 4% of the measure distance.

5.4 RELAY

Relays are switching that open and close circuits electromechanically or electronically. relays control one electrical circuits by opening and closing contact in another circuit. When a relay contact is Normally Closed (NC), there is a closed contact when the relay is not energized.

A relay is an electromagnetic switch operated by a relatively small electric current that can turn on or off a much larger electric current. the heart of a relay is an electromagnet.

Relay are used where it is necessary to control a circuit by an independent low power signal, or where several circuits must be controlled by one signal.

Relays were used extensively in telephone exchange and early computers to perform logical operations.

5.4.1 FOUR CHANNEL RELAY

The 4-channel relay driver module makes it simple and convenient to drive loads such as 12v relays from simple 5v digitals outputs of yours Arduino compatible board or another microcontroller. you can use any of the control channels independently, so simply leave any unused channels disconnected.

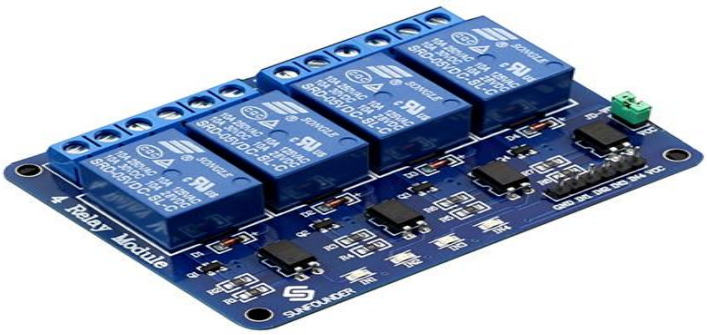

Fig. 5.4.1 Four Channel Relay

5.4.2 Pin digram of 4 channel relay

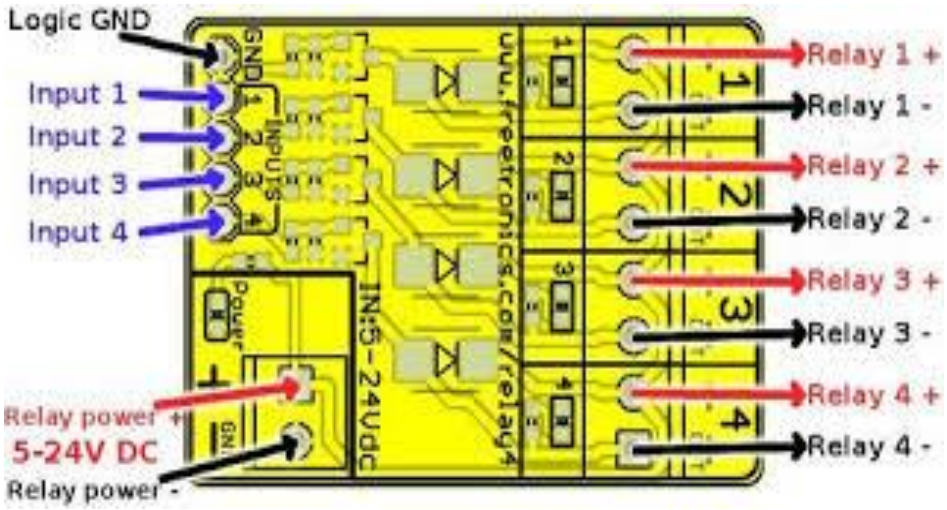

Fig. 5.4.2 Pin diagram of four channel relay

- **Logic GND:** connect to GND on your microcontroller.
- **Input 1:** connect to digital output from your microcontroller, or leave unconnected if channel not used.
- **Input 2**: connect to digital output from microcontroller, or leave unconnected if channels not used.
- **Input 3:** connect to digital output from microcontroller, or leave unconnected if channels not used
- **Input 4**: connect to digital output from microcontroller, or leave unconnected if Channels not used
- **Relay power +:** connect to the positive (+) lead of the power source for your relays. can be 5 to 24v dc.
- **Relay power -**: connect to the negative (-) lead of the power source for your relays.

- **Relay 1 +:** connect to the + side of the coil of yours first relay.
- **Relay 1 -**: connect to the – side of the coil of your relay.
- **Relay 2/3/4+:** As per Relay 1+
- **Relay 2/3/4 -**: As per Relay 1 –

The four channels relays module is a convenient board which can be used to control the high voltage, high current load such as motor, solenoid valves, lamps and AC load. It is designed to interface with microcontroller such as Arduino, PIC and etc.

The relays terminal (COM, NO and NC) is being brought out with screw terminal.

5.4.3 ADVANTAGES OF RELAY

- Relays have fast operation and fast reset.
- They can be used for both a. c and d. c system for protection of a. c and d. c equipment's.
- Relays operating speeds which has the ability to operate in millisecond are also can be possible.
- They have the properties such as simple, robust, compact and most reliable.
- These relays are almost instantaneous the operating time of the relay varies with the current. with extra arrangements like dashpot, copper rings etc.
- Slow operating times and reset can be possible

5.4.4 DISADVANTAGES OF RELAY

- High burden level instrument transformers are required such that CTs and PTs of high burden is required for operating the relays compared to static relays.
- The directional feature is absent in relays.
- Requires periodic maintenance and testing unlike static relays.

- Relay operation can be affected due to ageing of the components and dust, pollution resulting in spurious trips.
- Operation speed for a relay is limited by the mechanical inertia component.

5.5 ROBOTIC ARM

The robotic arm is moving an object from one place to other that is a pick and place robotic arm. Industrial robots are designed to do exactly is a controlled environment, over and over again. To each robot how to do its job, the programmer guides the arm through the motions using a handheld controller. The robot stores the exact sequence of movements in its memory, and does it again and again.

Manufacturing of robots are very important in the computer industry. It takes precise hand to put together in tiny micro strip.

ENLISTING THE ROBOTIC ARMS PARAMETERS:

- Number of axes
- Degree of freedom
- Working Freedom: The region of space a robot can reach.
- Speed: How fast the robot can position the end of its arm, angular linear speed of each axis or a compound speed.
- Acceleration: How quickly an axis can accelerate.
- Accuracy: How closely a robot can reach a commanded position.
- Power source.
- Drive: Some robots connect electric motors to the joints via gears, other connect to the motor to joint directly.
- Compliance.

The robotic arm it is controlled on servo motor,

5.5.1 SERVO MOTOR WORK

Servo motors have been around for a long time and are utilized in many applications. They are very energy efficient. It is used to operate remote controlled or radio- controlled toy cars, robots and airplanes. Servo motors are in industrial applications, in line manufacturing, pharmaceutics, and food services. The little motor is high efficiency and power.

5.5.2 SERVO MOTOR INSIDE

Inside there is a pretty simple setup: A small Dc motor, potentiometer, and a control circuit. The motor rotates is attached to gears to the control wheel. As the motor rotates, the potentiometer's resistance changes the control circuit and regulate the movement and which direction. The motor speed is proportional to the difference between actual position and desired position. So, the motor is desired position, it turns slowly, otherwise it turn fast. This is called proportional control.

5.5.3 SERVO MOTOR CONTROLLED

Servos are controlled by sending an electrical pulse of variable width, or pulse width modulation (PWM), through the control wire. A servo motor can usually only turn 90 degree in either direction for a total 180-degree movement. The motor's neutral position is defined as the position where the servo has same amount of potential rotation in both the clockwise and counter- clockwise direction.

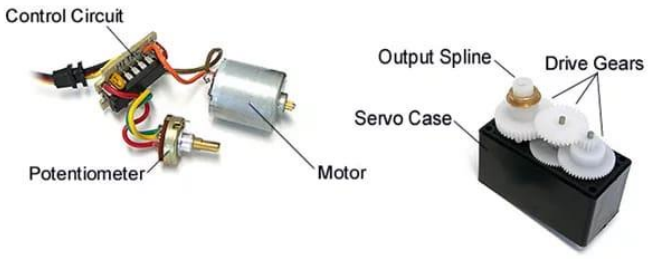

Fig. 5.5.3 Servo Controller

5.5.4 SERVO APPLICATIONS

- Servos are used in radio-controlled airplanes to position control surfaces like elevators, rudders, walking a robot, or operating grippers.
- Servo motors are small, have built in control circuitry have good power for their size.
- Servos are used in-line-manufacturing, when high repetition yet precise work is necessary.

5.6 METAL DETECTOR

A metal detector in an electronic instrument which detect the presence of metal nearby. Metal detectors are useful for finding metal inclusions hidden within objects, or metal objects buried under ground. They often consist of a handheld unit with a sensor probe which can be swept over the ground or other objects. if the sensors come near a piece of metal this is indicated by a changing tone in earphones, or a needle moving on an indicator. Usually the device gives some indication of distance; the closer the metal is, the higher the tone in the earphone or the higher the needle goes.

5.6.1 METAL DETECTOR USING IC 555

The circuit uses an IC555, which is used to detect the magnet and metals. when the magnet is near to the 10Mh choke, then the output frequency varies. The circuit can be powered from a power supply, which can give an o/p dc voltage between 6-12 volts. When a metal object is near to the LI coil, then it generates a change of output oscillation frequency and buzzer sound.

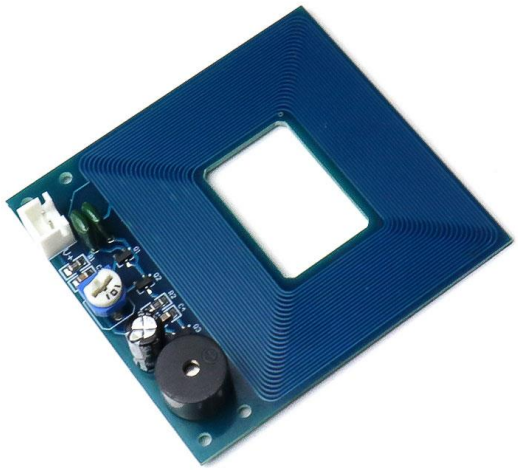

Fig. 5.6.1 Metal Detector

5.7 DC MOTOR AND WHEELS

The motors speed and torque (turning force) will play an important role in the final operation of your robot. A small motor with a low torque may not be able to able to drive a large wheel, but a small motor with a gearbox to change the velocity and torque of the output may be able to drive what an un-geared motor cannot. Also consider the speed of the motor and the circumference of your wheels so that your robot moves at the speed you desire.

The two drive wheels are used to propel and turn the robot (skid steering) and the one or two idler wheels to prevent the robot from falling forward or backwards. The “idler” wheels can be a caster, a ball or Omni wheel.

The texture, the width of the wheel and the type of terrain your robot is expected to cover, are also important factors, a very smooth wheel will have less traction than rough wheels like from wheels. Very thin wheels will turn easier than wide wheels. Omni-directions wheels are designed to roll forward but slides sideways with almost no friction, to changes direction. Some wheels are constructed with a flange, to allow mounting directly to a motor shaft. Other motors use aluminum hubs, which are available to fit a ranges of motors shafts from 4mm to 10mm diameters

Fig. 5.7 DC Motor and Wheels

5.7.1 MOTOR SPECIFICATIONS

- Standard 130 Type DC motor
- Operating Voltage: 4.5V to 9V
- Recommended/Rated Voltage: 6V
- Current at No load: 70mA (max)
- No- load Speed: 9000rpm.
- Loaded Current: 250mA (approx.)
- Rated Load: 10g*cm

- Motor Size: 27.5mm*20mm*15mms
- Weight: 17grams.

5.8 SERVO MOTOR

5.8.1 SERVO MOTOR OF MG995

MG995 is a micro servo motor with metal gear. This small and lightweight servo comes with high torque power, thus ideal for RC Airplane, Quad copter or Robotic Arms. Most of the servo motors operate from 4.8V to 6.5V, the higher the voltage higher the torque we can achieve, but most commonly they are operated at +5V. Almost all servo motors can rotate only 0 to 180 degree due to their gear arrangement so it can modify the motor to make a half circle. If can prefer 0 to 360-degree motor it can modify the motor to make a full circle. If your application requires stronger and long running motors you can go with metal gears or just stick with normal plastic gear.

Fig. 5.8.1 Towerpro-MG-995 Servo Motor

5.8.2 TOWERPRO-MG-995 FEATURES

- ✓ Operating Voltage: 4.8V to 7.2V
- ✓ Stall Torque: 13kg/cm (4.8V)
- ✓ Max Stall Torque: 15kg/cm(6V)

- ✓ Operating speed is 0.17s/60 Degree (4.8V)
- ✓ Gear Type: Metal
- ✓ Rotation: 0 Degree to 180Degree
- ✓ Weight of motor: 13.4gm
- ✓ Package includes gear horns and screws

5.8.3 SERVO MOTOR OF SG90

A Servo motor is rotary actuator or linear actuator that follows for precise control of angular or linear position, velocity and acceleration. It consists of a suitable motor coupled to a sensor for position feedback. It also requires a relatively sophisticated controller, often a dedicated module designed specifically for use with servomotors. Servomotors are not a specific class of motor although the term servomotor is often used to refer to a motor suitable for use in closed-loop control system.

Fig 5.8.3 TowerPro-SG90-Servo Motor

5.8.4 TOWER PRO-SG90 FEATURES

- ✓ Operating voltage is +5V typically
- ✓ Torque: 2.5kg/cm
- ✓ Operating speed is 0.1s/60 Degree
- ✓ Gear Type: Plastic
- ✓ Rotation: 0 Degree to 180 Degree

✓ Weight of motor: 9gm

5.8.5 WIRE DESCRIPTION

Table. 5.8.5 Wire Description

COLOUR	DESCRIPTION
• BROWN	Ground wire connected to the ground of system
• RED	Powers the motor typically +5v is used
• ORANGE	PWM signal is given through the wire to the motor.

5.8.6 APPLICATIONS

❖ Used as actuators in many robots like Biped Robot, Hexapod, robotic arm etc...
❖ Commonly used for steering system in RC toys
❖ Robots where position control is required without feedback
❖ Less weight hence used in multi DOF robots like humanoid robots.

5.9 WIRE

A wire is a single, usually cylindrical, flexible strand or rod of metal. Wires are used to bear mechanical loads or electricity and telecommunications signals. Wire is commonly formed by drawing the metal through a hole in a die or draw plate. Wire gauges come in various standard sizes, as expressed in terms of a gauge number. The term is also used loosely to refer to a bundle of such strands, as in “multi stranded wire”, which is more correctly termed a wire rope in mechanics, or a cable in electricity.

5.9.1 FEMALE TO FEMALE JUMPER WIRES

- Ideal for prototyping with ARDUINO, RASPBERRY PI, AVR, PIC, 8051, etc.
- Compatible With 2.54mm FEMALE Berg sticks
- COLORS: RED, BLACK, GREEN, YELLOW, BLUE, GREY (Selected as per availability)
- Pin pitch (End connector size): 2.54mm (standard female berg connector size)
- Gender: Female to Female (Both ends IP)
- Length:20cm to 30cm (Vary as per stock)

Fig 5.9.1 Female to Female Jumper Wires

5.9.2 Male TO Male Jumper Wires

- Ideal for prototyping with ARDUINO, RASPBERRY PI, AVR, PIC, 8051, etc.
- Compatible With 2.54mm FEMALE Berg sticks
- COLORS: RED, BLACK, GREEN, YELLOW, BLUE, GREY (Selected as per availability)

- Pin pitch (End connector size): 2.54mm (standard female berg connector size)
- Gender: Male to Male (Both ends IP)
- Length:20cm to 30cm (Vary as per stock)

Fig. 5.9.2 Male to Male Jumper Wires

5.9.3 FEMALE TO MALE JUMPER WIRES

- Ideal for prototyping with ARDUINO, RASPBERRY PI, AVR, PIC, 8051, etc.
- Compatible With 2.54mm FEMALE Berg sticks
- COLORS: RED, BLACK, GREEN, YELLOW, BLUE, GREY (Selected as per availability)
- Pin pitch (End connector size): 2.54mm (standard female berg connector size)
- Gender: Female to Male (Both ends IP)
- Length:20cm to 30cm (Vary as per stock)

Fig 5.9.3 Female to Male Jumper wires

5.9.4 FEATURES OF JUMPER WIRES

- Could be difficult to use depending on connector/part location; How it is connected into the circuit is critical; has the potential of damaging the circuit.
- Because of the potential for accidental short-to-grounds when using a jumper wire, be sure to follow the EWD and plan the placement of the jumper carefully, never by passing a load! If available, use a fused jumper wire.
- Never by-pass resistor in a circuit. Components, such as fuel injectors, can have a series resistor which limits current flow through the injector solenoid coils. Shunting around that resistor could cause significant damage.

5.10 BATTERIES

A battery is a device consisting of one or more electrochemical cells with external connections provided to power electrical devices such as flashlights, smart phones, and electric cars. When a battery is supplying electric power, its positive terminal is the cathode and its negative terminal it is anode. The terminal marked negative is the source of electrons that will flow through an external electric circuit to the positive terminal. When a battery is connected to an external electric load, a redox reaction converts high energy reactants to lower energy products, and the free energy difference is delivered to the external circuit as electrical energy. Historically the term “battery” specifically referred to advice

composed of multiple cells; however, the usage has evolved to include devices composed of a single cell.

Primary (single-use or “disposable”) batteries are used once and discarded; the electrode materials are irreversibly changed during discharge. Common examples are the alkaline battery used for flashlights and a multitude of portable electronic devices. Secondary (rechargeable) batteries can be discharged and recharged multiple times using an applied electric current; the original composition of the electrodes can be restored by reverse current. Example include the lead-acid batteries used in vehicles and lithium-ion batteries used for portable electronics such as laptops and smart phones.

Fig. 5.10 Rechargeable battery

SUMMARY:

The chapter describes about hardware description of the proposed system.

CHAPTER 6

SOFTWARE DESCRIPTION

6.1 ARDUINO IDE

The Arduino Integrated Development Environment (IDE) is a cross platform application (for Windows, MAC, Linux) that is written in functions from C and C++. It is used to write and upload programs to Arduino compatible boards, but also, with the help of third-party cores, other vendor development boards. The source code for the IDE is released under the GNU General Public License, version 2. The Arduino IDE supports the languages C and C++ using special rules of code structuring. The Arduino IDE supplies a software library from the Wiring project, which provides many common input and output procedures.'

Fig. 6.1 Arduino IDE

6.1.1 ADVANTAGES

- Inexpensive
- Cross-platform
- Simple, clear programming environment
- Open source and extensible software
- Effortless functions
- Large community

6.1.2 APPLICATIONS

- Arduino Uno is used in Do-it-Yourself projects prototyping.
- In developing projects based on code-based control
- Development of Automation System
- Designing of basic circuit designs.

6.2 Installation steps for Arduino IDE

Step 1 – Download Arduino IDE Software.

✓ Go to the Arduino download page and download the latest version of the Arduino software for Windows.

Step 2 – Launch Arduino IDE.

✓ After Arduino IDE software is downloaded, unzip the folder. Inside the folder, you can find the application icon with an infinity label (application.exe). Double-click the icon to start the IDE.

Step 3 – Power up the board.

✓ Power up the Arduino by connecting Arduino board to the computer with a USB cable. We should see an LED label ‘ON’ light up.

Step 4 – Open first file

- ✓ Once the software starts, two options given
- ✓ Create a new project.
- ✓ Open an existing project example.
- ✓ create a new project, select File → New
- ✓ open an existing project example, select File → Example → Basics → Blink.

Step 5 – Select the Arduino board.

- ✓ Select the correct Arduino board name, which matches with the board connected to the computer.
- ✓ Go to Tools → Board and select your board.

Step 6 – Select the serial port.

- ✓ Select the serial device of the Arduino board.
- ✓ Go to Tools → Serial Port menu.
- ✓ This is likely to be COM3 or higher (COM1 and COM2 are usually reserved for hardware serial ports).

Step 7 – Upload the program to the board.

6.3 BLYNK APPLICATION

Blynk is a new platform that allows us to quickly build interfaces for controlling and monitoring the hardware projects from our iOS and Android device which is shown in fig.6.3. After downloading the Blynk app, we can create a project dashboard and arrange buttons, sliders, graphs, and other widgets onto the screen. using the widgets, we can turn pins on and off or display data from sensors.

Create a Blynk project by following these steps.

- Click the “Create New Project” in the app to create a new Blynk app. Give it any name.

- Blynk works with hundreds of hardware models and connection types. Select the Hardware type. After this, select connection type. In this project we have select Wi Fi connectivity.
- To open the widget box, click in the project window to open. We are selecting a button to control Led connected with Node MCU.
- Click on Button.
- Give name to Button say led.
- Under OUTPUT tab- Click pin and select the pin to which led is connected to Node MCU, here it is digital pin 2, hence select digital and under pin D2. And Click continue.

Fig.6.3 Blynk application

SUMMARY

The Chapter describes about the software description of the proposed system.

CHAPTER 7

RESULT AND DISCUSSION

IoT based automatic waste segregation using robot, as the name suggests segregating the metal and non-metal waste into separate trash bins, and the various sensor information are delivered to cloud server. This way the system can be used for segregating the waste and also to avoid plastic and metal waste to presence in the system.

In this project we have designed IoT based automatic waste segregation robot using Node MCU and some other component which is various sensor, relay, motor, battery.

The system is controlled by Arduino Uno it is an open source electronic platform or board and the software used to program it. Arduino Uno is designed to make electronics is more accessible to artists, designers, hobbyists and anyone interested is creating interactive objects and environment.

Integrating of modern IoT technology has profoundly supply routers, information of the system at anytime and anywhere in the world. Use of cloud technology make this system a make demand product.

The Arduino platform has become quite popular with people just starting out with electronics, and for good reason. Unlike most previous programmable circuit boards, the Arduino does not need a separate piece of hardware (called a programmer) in order to load new code on to board you can simply use a USB Cable.

7.1 CIRCUIT DIAGRAM

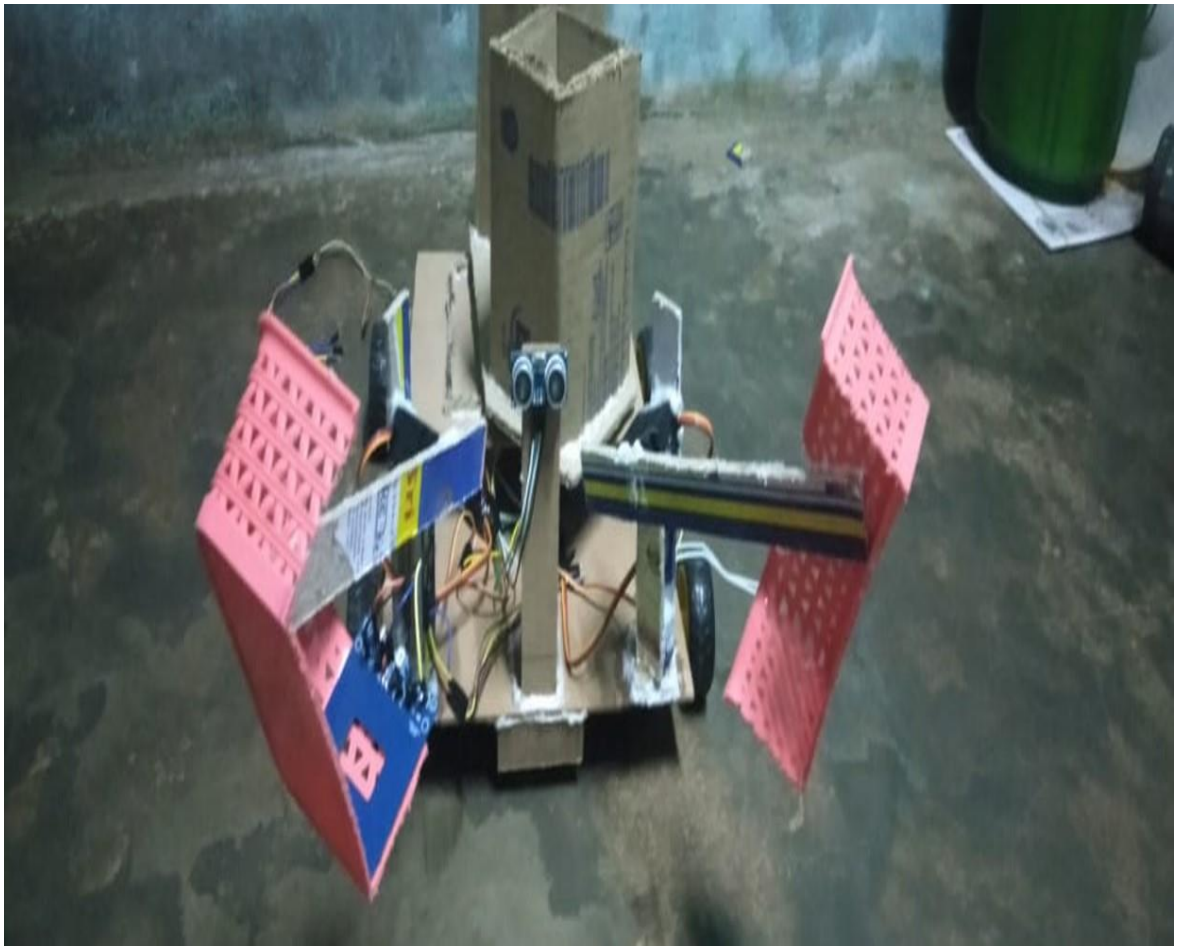

Fig. 7.1(a) Circuit diagram of Proposed System

Fig. 7.1 shows the hardware connection of proposed system and it consist of ultrasonic sensor, DC motor, metal detector, servo motor, relay, node MCU board, Arduino board, bread board and battery.

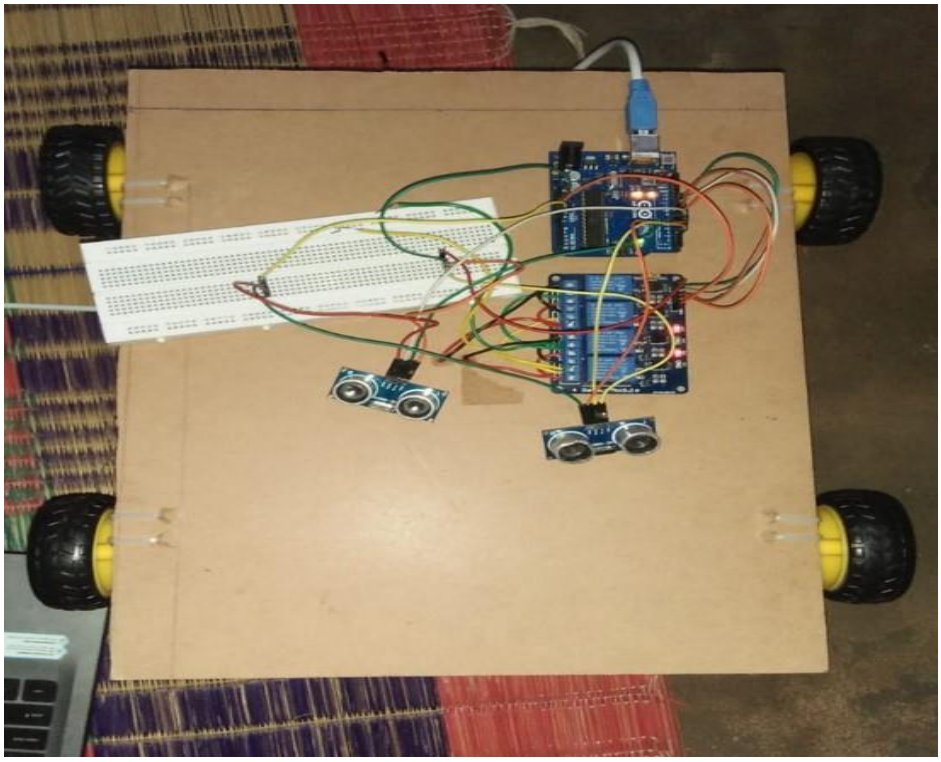

Fig.7.1(b) Relay connection of the proposed system

7.2 COMPONENTS REQUIRED

- Arduino Uno board
- Node MCU board
- DC motor
- Servo motor
- Ultrasonic sensor
- Metal detector
- Relay
- Robotic arm
- Robot Chassis
- Battery
- Bread board
- Connecting wires

7.3 RESULTS AND OUTPUTS OF THE PROPOSED SYSTEM

Once the power supply is switched on in the system, to identify the waste and obstacles avoid to segregate the separate trash bins. The system was controlled by Arduino Uno. The integration of modern IoT technology has profoundly supplied bounteous information of the system at anytime, anywhere in the world. One of the system identifies the waste segregating of various sensors to identify the waste and it is segregated into separate bins.

SUMMARY

The chapter describes about the Result and Discussion and output of the proposed system.

CHAPTER 8

CONCULSION

Waste is an unwanted resource in day to day life it affects human society. Waste is classified by source and composition. The waste materials in either liquid or solid form and their components may be either hazardous or inert in their effects on health and environment. The term waste is typically applied to solid sewage (waste water), hazardous waste and electronic waste. The project is designed to identify the metal and non-metallic waste to avoid obstacles and segregate into separate trash bins. The robot includes ultrasonic sensor for obstacle avoidance. The servo motor helps to rotating arm and pick up trash. To build an automatic waste segregation robot using node MCU collects the metals and plastic items automatically. Suppose if the trash bin gets filled, it will be detected then will receive the notification and trashes will be disposed. With this configuration system and handling procedures are easier to use instant notifications are possible. This way of robot can be used in industry, hospitals, gardens, footpaths and monitored at simultaneously.

APPENDIX

```
#include<Servo.h>


#define uptrigger 3

#define upecho 4

#define lowtrigger 7

#define lowecho 8

#define CW 0

#define CCW 1

#define CW1 12

#define CCW1 13


const int servoPin1 = 5;

const int servoPin2 = 6;

const int servoPin3 = 9;

const int servoPin4 = 10;

const int servoPin5 = 11;

const int metal = 2;
```

```
int distance,us,ls,pos1,pos2,con,angle;
long duration;
Servo lservol;
Servo lservor;
Servo uservol;
Servo uservor;
Servo rservo;
void setup ()
{
  //Setup runs once//
  Serial.begin(9600);
  pinMode(CW,OUTPUT);
  pinMode(CCW,OUTPUT);
  pinMode(CW1,OUTPUT);
  pinMode(CCW1,OUTPUT);
  pinMode(uptrigger,OUTPUT);
  pinMode(lowtrigger,OUTPUT);
  pinMode(upecho,INPUT);
  pinMode(lowecho,INPUT);
  lservol.attach(servoPin1);
```

```
  lservor.attach(servoPin2);
  uservol.attach(servoPin3);
  uservor.attach(servoPin4);
  rservo.attach(servoPin5);
}
void loop()
{
  /*sonar(uptrigger,upecho);
  us = distance;
  Serial.print("up Distance: ");
  Serial.println(us);
  delay (1000);
  sonar(lowtrigger,lowecho);
  ls = distance;
  Serial.print("low Distance: ");
  Serial.println(ls);
  delay (1000);

 if(us<20 && ls<=20)
  {
```

```
  backward ();
  delay (2000);
  stay ();
  delay (3000);
  left ();
  delay (10000);
}

else if (us<20 && ls>20)
{
  backward ();
  delay (2000);
  stay ();
  delay (3000);
  left ();
  delay (10000);
}
else if(us>=20 && ls<=20)
{
  backward ();
```

```
  delay (2000);
  stay ();
  delay (3000);
  servo2();
  delay (5000);
  servo3();
  delay (5000);
  servo4();
  delay (5000);
  servo5();
  delay (5000);
  servo1();
  delay (5000);
}
else if(us>=20 && ls>20)
{
  forward ();
  delay (1000);
}
else
```

```
  {
    stay ();
  }*/
  servo1();
  delay (2000);
  servo2a ();
  delay (2000);
  servo2b ();
  delay (2000);
  servo4();
  delay (2000);
  servo5();
  delay (2000);
}
void forward ()
{
  digitalWrite(CW,HIGH);
  digitalWrite(CCW,LOW);
  digitalWrite(CW1,HIGH);
  digitalWrite(CCW1,LOW);
```

```
  Serial.println("forward");
}
void backward ()
{
  digitalWrite(CW,LOW);
  digitalWrite(CCW,HIGH);
  digitalWrite(CW1,LOW);
  digitalWrite(CCW1,HIGH);
  Serial.println("backward");
}
void right ()
{
  digitalWrite(CW,HIGH);
  digitalWrite(CCW,LOW);
  digitalWrite(CW1,LOW);
  digitalWrite(CCW1,HIGH);
  Serial.println("right");
}
void left ()
{
```

```
  digitalWrite(CW,LOW);
  digitalWrite(CCW,HIGH);
  digitalWrite(CW1,HIGH);
  digitalWrite(CCW1,LOW);
  Serial.println("left");
}
void stay ()
{
  digitalWrite(CW,HIGH);
  digitalWrite(CCW,LOW);
  digitalWrite(CW1,HIGH);
  digitalWrite(CCW1,LOW);
  delay(500);
  digitalWrite(CW,LOW);
  digitalWrite(CCW,LOW);
  digitalWrite(CW1,LOW);
  digitalWrite(CCW1,LOW);
  Serial.println("stop");
}
void sonar (int trig,int echo)
```

```
{
digitalWrite(trig, LOW);
delayMicroseconds(2);
digitalWrite(trig, HIGH);
delayMicroseconds(10);
digitalWrite(trig, LOW);
duration = pulseIn(echo, HIGH);
distance= duration*0.034/2;
}
void servo1()
{
   lservor.write(0);
   delay (500);
   lservol.write(180);
   delay (500);
   uservor.write(50);
   delay (500);
   uservol.write(130);
   delay (500);
   Serial.println("Normal Position");
```

```
 }
void servo2a ()
{
   uservor.write(160);
   delay (1000);
   uservol.write(20);
   delay (1000);
   Serial.println("2a position");
}
void servo2b()
{
   lservor.write(90);
   delay (1000);
   lservol.write(90);
   delay (1000);
   Serial.println("2b position");
}
void servo3()
{
 if(digitalRead(metal)==HIGH)
```

```
    {
    for(angle = 0; angle < 200; angle += 1)//command to move from 0 degrees to
180 degrees
    {
    rservo.write(angle); //command to rotate the servo to the specified angle
    delay (15);
    }
    delay (1000);
    }
  else
   {
    for (angle = 200; angle >= 1; angle -= 1) //command to move from 180 degrees
to 0 degrees
    {
    rservo.write(angle);     //command to rotate the servo to the specified angle
    delay (15);
    }
    delay(1000);
   }
  Serial.println("Metal Check");
   }
```

```
void servo4()
{
  uservor.write(0);
  uservol.write(180);
  delay (500);
  }
void servo5()
{
    uservor.write(160);
    delay (100);
    uservol.write(20);
    delay (100);
    lservor.write(90);
    delay (500);
    lservol.write(90);
    delay (500);
    Serial.println("Picking Position");
```

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