A

PROJECT REPORT

ON

"DESIGN AND IMPLEMENTATION OF AI BASED AGRI ROBOT"

SUBMITTED BY

CHETAN GUJARATHI (B190133024)

NANDAN KASAT (B190133032)

PRAJWAL NIKAM (B190133049)

Under the Guidance of

Prof. Dr. S.S. MORADE

DEPARTMENT OF ELECTRONICS & TELECOMMUNICATION ENGINEERING

K. K. WAGH INSTITUTE OF ENGINEERING EDUCATION & RESEARCH, NASHIK.

SAVITRIBAI PHULE PUNE UNIVERSITY

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<u>Dissertation Approval Sheet</u>

This is to certify that the project work titled "**Design and Implementation of AI Based Agri Robot."**, has been submitted in partial fulfilment of the Bachelor's degree in Electronics and Telecommunication during the academic year of 2021-2022 by following students:

Chetan Dipak Gujarathi (B190133024)
Nandan Shailesh Kasat (B190133032)
Prajwal Subhash Nikam (B190133049)

This project confirms to the standards laid down by the Savirtibai Phule Pune University and has been completed in satisfactory manner as a partial fulfilment for the Bachelor's degree in Electronics and Telecommunication Engineering.

External Examiner	Internal Guide	Head of Department
	Prof.Dr. S.S.Morade	**Prof. Dr. D. M. Chandwadkar**

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1. Chetan Dipak Gujarathi
2. Nandan Shailesh Kasat
3. Prajwal Subhash Nikam

ABSTRACT

Agriculture is the backbone of the Indian economy. Presently a number of researchers are being done to increase the application of robotics in agriculture. So, we have an idea to make an intelligent Agri Robot to detect grass density, sense obstacles, spray herbicides on unwanted grass etc.

Consequently, it is anticipated that Agri Robot usage would increase and eventually replace present laborers. The crucial part of agriculture production, especially for fertigation farms, is the control of pest insects or unwanted grass. Therefore, it is challenging and costly to identify unwanted grass before using herbicides.

The objective of this project is to build a robot capable of performing activities, like herbicide spraying. A mobile-operated robot works on the principle that someone can use an app to remotely or wireless control a robot without having to be physically present. The robot then keeps on its initial path using a smartphone application on Android.

An app is used for controlling the robot, and the camera is utilized to monitor weeds and unwanted grass. When the camera detects a weed, the controller will instruct the relay so as to spray herbicide on it.

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ABBREVIATIONS

AI	Artificial Intelligence
GPIO	General Purpose Input Output
DC	Direct Current
HDMI	High-Definition Multimedia Interface
GPS	Global Positioning System
GMM	Gaussian Mixture Model
EM	Expectation-Maximization
CNN	Convolutional Neural Network
AV	Audio-Video
BMS	Battery Management System
PWM	Pulse Width Modulation
USB	Universal Serial Bus
GPM	Gallons Per Minute
AC	Alternating Current
MP	Mega Pixel
DBMS	Database Management System
EDA	Electronic Design Automation
HTML	Hyper Text Markup Language
HTTP	Hyper Text Transfer Protocol
URL	Uniform Resource Locator
LCD	Liquid Crystal Display
IR	Infra-Red
PCB	Printed Circuit Board

CHAPTER-1

INTRODUCTION

1.1 Introduction:

In recent years, technological innovation in the field of agriculture has advanced dramatically, and a new scientific field has emerged that effectively utilizes data to improve accuracy and agricultural productivity and minimize environmental impact. Farmers are increasingly turning to technology to address many pressing agribusiness issues, including growing global shortage of food, and dwindling agricultural workforce. Surprisingly, agriculture, despite being the least digitalized, is showing momentum in agricultural technology development and commercialization.

The backbone of the Indian economy is undoubtedly agriculture since sixty-four percent of our population is dependent on agricultural activities for their living. About half of our country's total population chooses agriculture as their main occupation. It all started due to the impact of the “Green Revolution" by which farmers came to know about the various techniques involved in farming and the advantages in it. Farmers still follow traditional methods to spray herbicide in the grapes farm on the unwanted weeds such that they do not harm the plants. Initially farmers had to manually sprinkle herbicide on the grape and later a hanging spraying machine was introduced where the farmers must hang it on their shoulders to spray herbicide to kill the weed.

Artificial Intelligence (AI) is starting to play a significant role in our daily lives, expanding our perceptions and our ability to change the environment around us. AI is a new technology in agriculture. AI-based devices and machines have taken today's agricultural systems to another level. The technology has improved crop production and improved real-time monitoring, harvesting, processing, and marketing. The latest technology in automation systems using agricultural robots and drones has made a significant contribution to the agriculture-based sector. Various high-tech computer systems have been developed to determine a variety of important parameters such as weed detection, yield detection, crop quality and many other techniques. Image processing is categorized as signal processing and is commonly used to make multiple modifications to an image to enhance it or extract desired data or information from the acquired image. The process is straightforward, starting with a camera capturing an image, then using an image processing system such as deep learning to process the captured image and derive the required information from it.

Image processing is done using the steps given below:

I. Image acquisition through image acquiring tools.

II. Detect and edit captured images.

III. Output of the same can be a modified image or extracted information from it.

The aim of this research is to develop a low-cost agricultural robot for spraying herbicides on farmland and recording their paths. To keep costs as low as possible, the herbicide spray robot prototype was assembled from simple, inexpensive, off-the-shelf components.

The agricultural robot developed for this study focuses on four applications:

I. Intelligent Robot to spray Herbicides.

II. Sense the grass density based on the decision of nozzle adjustment.

III. Sense the obstacles in front of it and make decisions.

IV. Memorize/record the path.

1.2 Need of Project:

Weeds are the unwanted plants that grow near crops or on farm boundaries. Weed control is an important consideration as weeds reduce yields, increase production costs, affect yields, and reduce crop quality. The project is imperative to identify and remove weeds so that they do not damage crops.

The goal of agricultural robotics is to support the sector in process efficiency and profitability. In other words, mobile robotics are working in the agricultural sector to improve productivity, professionalism, and environmental sustainability. Incorporating robotics into agriculture sectors will improve both productivity and working conditions for farmers and workers in the farm. Intelligent systems are becoming the ideal solution for advancing precision agriculture. Today, many farms already operate autonomously.

Labour shortages, rising consumer demand, and high production costs are some of the factors driving automation in this sector to reduce costs and optimize yields. Identification of crop conditions and appropriate chemical application, application or harvest as required for fruit or plants. Robots move autonomously in the field to inspect crops and collect data from the field via integrated sensor systems.

1.3 Target Community of Project:

The target community for weed detection can vary depending on the specific application and context. Here are some examples of communities that may benefit from weed detection technology:

Farmers: Weed detection technology can help farmers identify and remove weeds from their crops, which can increase crop yield and reduce the use of herbicides.

Landscapers: Weed detection technology can be useful for landscapers to identify and remove weeds from lawns and gardens.

Conservationists: Weed detection technology can help conservationists identify invasive plant species and take measures to control their spread.

Researchers: Researchers studying plant ecology and weed biology may use weed detection technology to identify and monitor the distribution and growth of various plant species.

Government agencies: Government agencies responsible for managing public lands may use weed detection technology to identify and control invasive plant species that can harm native ecosystems.

1.4 Scope of Project:

The scope of weed detection includes various methods and technologies used to identify and differentiate unwanted plants (weeds) from desired plants in agricultural fields, gardens, lawns, and other areas where vegetation management is necessary. The detection of weeds is essential for effective weed control, as it allows farmers, gardeners, and other land managers to implement targeted weed management strategies.

Weed detection methods can range from visual observation to advanced technologies such as hyper spectral imaging, machine learning, and robotics. The goal of weed detection is to identify and manage the weeds effectively, minimizing their impact on crop yield and overall plant health.

1.5 Objective of Project:

i. To make an intelligent robot to spray Herbicides: To create an intelligent robot for spraying herbicides, several components and technologies can be integrated.
ii. To sense the grass density: To sense the grass density and adjust the nozzle accordingly, the intelligent robot can utilize a combination of sensors and decision-making algorithms.
iii. To sense weed and based on the type of weed spray herbicides: To sense weed and based on the type of weed spray herbicides on it , an intelligent robot will detect the weed and based on the type of weed it will detect it will spray the herbicides on it.
iv. To memorize/record the path: To memorize or record the path, an intelligent robot can utilize various techniques and algorithms such as Localization and Mapping, Path Planning and Navigation, Path Recording, Data Storage, Path Retrieval and Playback.

1.6 Gantt Chart:

Fig. 1.1: Gantt Chart for Project Completion

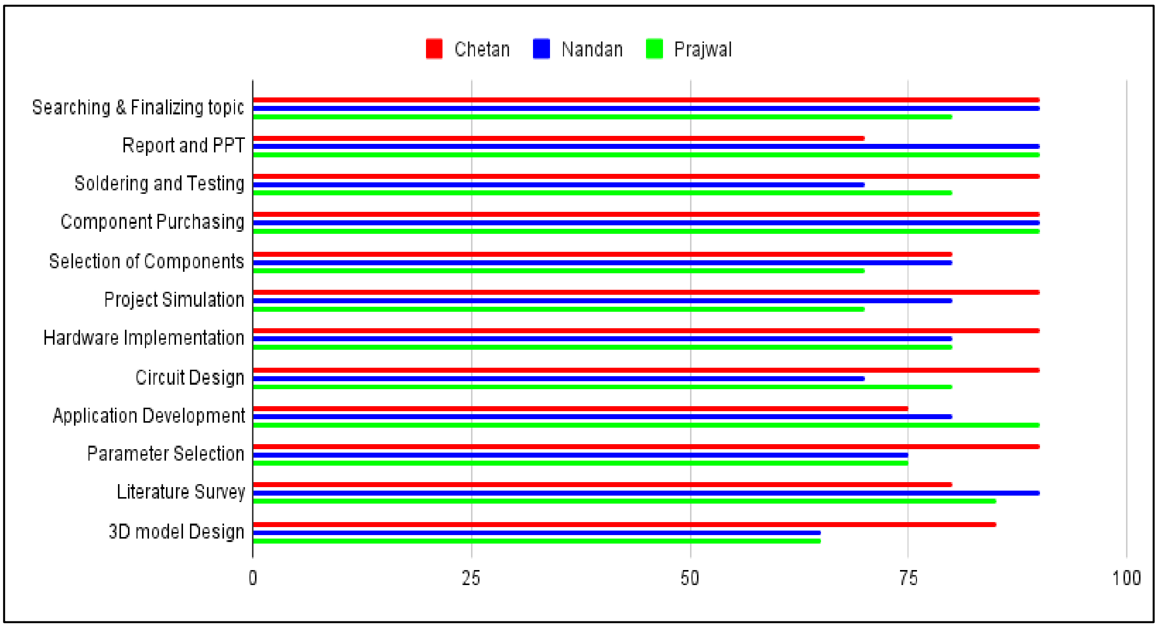


Fig. 1.2: Gantt Chart for Member Contribution

CHAPTER-2

LITERATURE REVIEW

Prajwal B et al. [1] describes a system build and modeling an autonomous spraying system using AI. For the navigation system they used controller board, GPS, Compass module for retrieving GPS coordinates and heading data, motor driver and motors. For spraying they take input from the image processing system. Image processing is done using the yolo algorithm. yolo is an object detection model that is dynamic and compact and provides high performance considering its size and it has been continually improving. Object detection makes use of an object detector model that takes input images and extracts the features of train images subsequently feeding it to the prediction system to detect necessary objects of required classes. There are two classes considered: Healthy plants and weeds. The trained model can detect healthy plants as well as weeds. The features are bounded by colored boxes. The yolo employs an end-to-end differential network to predict the boxes bounding the object and labeling them accordingly.

Mitul Raval et al. [2] the development and automation of a robot with a spraying mechanism for agricultural applications as a promising solution to address the challenges of increasing agricultural productivity while minimizing labor costs and environmental impact. Mitul Raval, Aniket Dhandhukia, and Supath Mohile's work focuses on designing a robot that can autonomously navigate through crop fields and spray pesticides or fertilizers on crops. The robot is equipped with a spraying mechanism that can be controlled remotely. The robot's movement is based on GPS and is guided by an operator through a remote-control system. The system includes a camera and sensors that help the operator detect obstacles in the robot's path and avoid them. The robot's spraying mechanism can be adjusted to the type of crop and the desired quantity of the chemical being sprayed.

Palash Patil et al. [3] the work focuses on designing a robot that can autonomously navigate through crop fields and spray pesticides or fertilizers on crops. The robot's automation offers several advantages over traditional agricultural methods. It can reduce labor costs and increase productivity by working autonomously and covering large areas of farmland quickly. It can also reduce the environmental impact of agriculture by minimizing chemical use and reducing the risk of chemical exposure to workers.

Ajinkya Paikekari et al. [4] weed detection using image processing as a technique that uses computer vision algorithms to identify and distinguish between crops and weeds in agricultural fields. The system works by capturing images of the crops using cameras or drones and processing them using image processing techniques. The system involves several steps, including image acquisition, image pre-processing, feature extraction, and classification. In the image acquisition step, images of the crops are captured using cameras or drones, and these images are pre-processed to remove any noise or unwanted elements.

Amrutha A. Aware et al. [5] used crop and weed detection based on texture and size features and automatic spraying of herbicides is an innovative technology that uses computer vision and machine learning algorithms to identify crops and weeds in agricultural fields and selectively spray herbicides to control weed growth. The system works by using cameras or drones to capture images of the crops and weeds in the field, which are then processed using image processing techniques to extract texture and size features. The extracted features are used to train machine learning algorithms, such as SVM or Random Forest, to classify the crops and weeds accurately.

Rincy Johnson et al. [6] proposed weed detection and removal based on image processing is an area of research that is becoming increasingly important in agriculture and environmental management. The technology involves the use of digital images of a field or other environment, which are processed using computer vision algorithms to identify and classify weeds based on their visual characteristics, such as color, texture, and shape. Once the weeds have been identified, various methods can be used to remove them, such as targeted herbicide spraying or mechanical weed removal. The removal method depends on the type of weed, the size of the infestation, and the resources available.

G.Y. Rajaa Vikhram et al. [7] describes the automatic weed detection and smart herbicide sprayer robot as a technology that uses computer vision and robotics to detect and eliminate weeds in agricultural fields. The system works by deploying a robot equipped with sensors and cameras that can move through the crop fields and detect the presence of weeds. The system consists of two main parts: the weed detection system and the smart herbicide sprayer. The weed detection system uses computer vision algorithms to process images captured by the robot's cameras and identify the presence of weeds in the field. In Fig 2.1 the author describes the three different images which show the original image with the grayscale scale and the HSV Making of the original image.

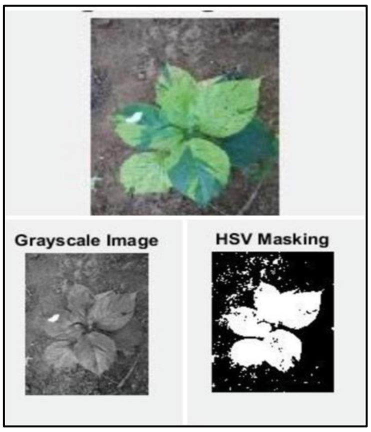


Fig. 2.1: Different stages of image processing of weed plant

Filippo Bonaccorso et al. [8] proposed the algorithm uses scan matching, which involves aligning successive laser scans to a map of the environment to determine the robot's position and orientation. The algorithm employs a Gaussian Mixture Model (GMM) to model the range measurements and uses the Expectation-Maximization (EM) algorithm to estimate the GMM parameters. The algorithm is tested on a mobile robot in a real indoor environment and is compared with other popular scan matching algorithms. The results show that the proposed algorithm outperforms the other methods in terms of accuracy and robustness.

T. Grift et al. [9] discusses the potential benefits of using autonomous robots in agriculture, including increased efficiency, reduced labor costs, and improved crop yields. It then describes the various types of robots used in agriculture, such as ground-based robots, aerial robots, and underwater robots.

Mario Cunha et al. [10] describes the methodology used to evaluate the software, which involves spraying water-sensitive papers placed at different distances and angles from the nozzle, capturing images of the papers, and analyzing the images using the software.

The advances in image processing technology have led to the development of different experimental or commercial software applications that produce indicators related to the spray quality based on the image processing of scanned WSP. Reviews of some of these programs have been published, and their limiting factors investigated. This literature has revealed that there are still difficulties for these software tools in situations of high spray coverage with overlapping stains. Image processing techniques based on mathematical morphology have been used for granulometry studies and these have been adapted to develop a software application with low sensitivity to high coverage and overlapping stains software applications based on image processing of scanned WSPs is the lack of standard images that can be used to obtain absolute accurate measurements of the stain characteristics and number.

Amir H. Kargar B et al. [11] the author describes the development of an automatic weed detection system that uses image processing techniques to identify weeds in the corn field. The system uses a camera mounted on a mobile platform to capture images of the field, which are then analyzed by a computer vision algorithm to identify and locate weeds. Once weeds are identified, the system triggers a smart herbicide sprayer robot that is capable of precisely targeting and spraying herbicide only on the weed, while avoiding the corn plants. The robot is equipped with a nozzle and a pump, and can move autonomously through the field, guided by GPS and computer vision algorithms.

Adrian Salazar-Gomez et al. [12] the author first reviewed the current state of the art in object detection for weed spraying, highlighting the challenges in applying these techniques in practical farming scenarios. They then propose a new method that combines a deep neural network with a simple thresholding algorithm to achieve high accuracy in weed detection while minimizing computational complexity.

The proposed method was tested on a dataset of images of corn plants and weeds, captured using a camera mounted on a mobile platform. The authors report that the method achieved an accuracy of 92% in detecting weeds, while also being computationally efficient and practical for deployment in a real-world farming environment.

Mansoor Alam et al. [13] the author first describes the current challenges in weed control in agriculture, including the overuse of herbicides and the development of herbicide-resistant weeds. They then propose a system that uses a camera mounted on a mobile platform to capture images of the field, which are then processed in real-time by a machine learning algorithm to detect and classify crops and weeds.

The machine learning algorithm is trained on a dataset of images of crops and weeds and can recognize a wide range of weed species. The authors report that their system achieved an accuracy of 95% in crop/weed detection and classification and was able to trigger variable-rate spraying to apply herbicide only where needed.

S. Ganesh Sundaram et al. [14] the author first discusses the negative impact of weeds on crop yield and the environment, and the challenges in manually identifying and removing weeds in large fields. They then propose a system that uses a camera mounted on a mobile platform to capture images of the field, which are processed by a machine learning algorithm to detect and classify weeds.

The machine learning algorithm is trained on a dataset of images of crops and weeds and uses a combination of feature extraction and classification techniques to accurately identify weeds. The authors report that their system achieved an accuracy of 91.5% in weed detection and classification.

Victor Partel et al. [15] the authors explain that current weed management practices are often inefficient and can have negative environmental impacts. To address this, they developed a system that uses AI and computer vision to detect and identify weeds in real-time, allowing for targeted herbicide application.

The system consists of a camera mounted on a mobile platform that is driven over a field. The camera captures images of the field, which are analyzed by an AI algorithm to detect and identify weeds. The system then controls an herbicide applicator to apply the herbicide only to the identified weeds. The authors tested the system in a cornfield and found that it was able to accurately detect and identify weeds with a high level of precision. They also found that the system reduced herbicide use by up to 90% compared to traditional broadcast spraying methods. In Fig 2.2 the author shows the tiny YOLOv3 containing pictures of the weed portulaca as targets and the Pepper plants and the weed sedge as non-targets. Only the portulaca weeds in Fig 2.3 a) were considered as the target in order to evaluate the smart sprayer in a more complex environment, the smart sprayer had to spray only on a specific weed and not on anything else (non-target includes pepper plants, Fig 2.3c), and sedge weeds, Fig 2.3 b).

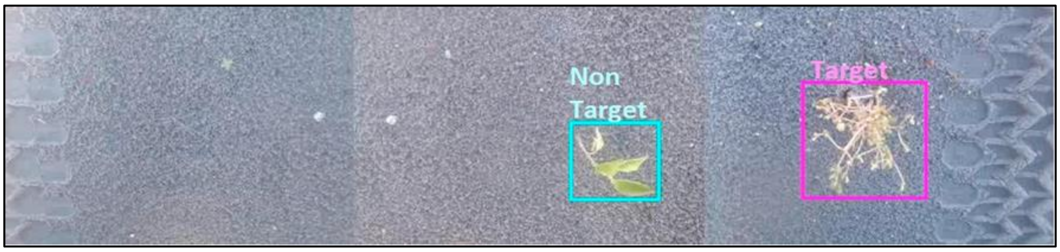


Fig. 2.2: Smart sprayer detection on weed portulaca as target and pepper as non-target.

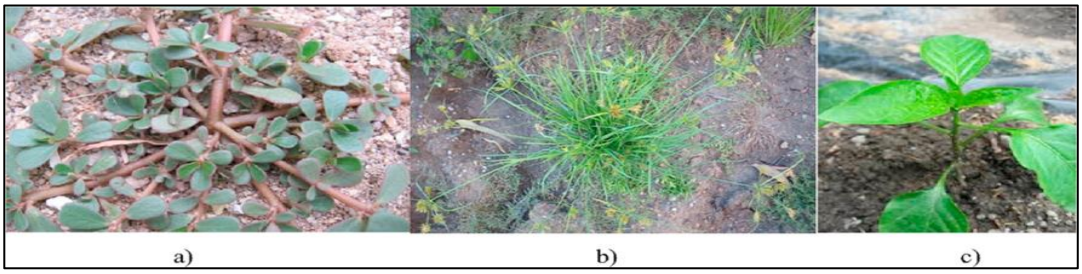


Fig. 2.3: Images showing: **(a)** portulaca (target weed); **(b)** sedge (non-target weed); **(c)** and pepper plant (non-target).

David Reiser et al. [16] the system consists of an electric-powered robot equipped with a camera and a computer vision system that can detect and identify weeds growing in between the vine rows. Once the weeds are detected, the robot uses a mechanical weeding tool to remove them. The authors conclude that the use of autonomous robots for intra-row weeding in vineyards has the potential to increase efficiency and reduce labor costs, while also reducing the need for herbicides and other chemical treatments. They suggest that further research is needed to optimize the design and performance of such systems, as well as to explore the potential of other autonomous technologies in the agricultural industry.

For each treatment, the power consumption and the accuracy of the processing procedure were evaluated estimating the treated and the non-treated area. The better control method tested in the indoor laboratory was evaluated at the vineyard of

Hohenheim University (48.710115 N, 9.212913 E) on 9 October 2018 (see Fig 2.4). The following figure shows the two different test areas for the autonomous weeding robot.

Fig. 2.4: The two test environments– **(A)** indoor laboratory, **(B)** outdoor vineyard.

Peteinatos, G. G et al. [17] the article discusses the potential use of round-based sensor technologies for weed detection in agriculture. It begins by providing an overview of the challenges associated with weed control in agriculture, including the development of herbicide-resistant weeds and the high cost of manual labor for weed control.

The article then describes several types of ground-based sensor technologies that have been developed for weed detection, including optical sensors, electromagnetic sensors, and ultrasonic sensors. The authors discuss the advantages and limitations of each type of sensor technology and provide examples of how they have been used in weed detection applications.[17]

Van Der Weide.R.Y et al. [18] the article discusses the use of mechanical weed control in crop rows as an alternative to chemical weed control. The authors argue that mechanical weed control can be an effective way to reduce weed populations and improve crop yields, while also reducing the use of herbicides and the potential for environmental damage.

The article reviews various types of mechanical weed control, such as inter-row cultivation, intra-row hoeing, and precision weed control using cameras and sensors. The authors also discuss the importance of proper equipment maintenance and the need for training and education for farmers to use these tools effectively.

BajwaA.A et al. [19] the article provides a comprehensive review of various non-conventional weed management strategies that can be used in modern agriculture.

These strategies include physical, cultural, and biological control methods, as well as the use of allelopathic crops and crop rotation.

The authors discuss the advantages and limitations of each strategy and highlight the importance of integrated weed management approaches that combine multiple methods. They also discuss the need for further research to develop and optimize these strategies for different cropping systems and weed species.

CHAPTER-3

DESIGN METHODOLOGY

3.1 System requirement :

Here is an overview of the system design for AI Based Agri Robot:

i. Moving System: The first component of the system is a moving system, which will move the robot along an agriculture field. This can be done by using the drivers.

ii. Vision System: Next, there will be a vision system that uses cameras to capture images of the crops and weeds. This is the system in which the camera detects the difference between the crops and weed and when it will detect the weed it will spray herbicides.

iii. Spraying System: In the spraying system the nozzle is used to spray the herbicides using the AI. When the weeds are detected, the herbicides are sprayed on it.

In a project Designing and Implementation of AI Based Agri Robot system we are using Raspberry Pi as a controller of a system. Thonny and Geany IDE is used for programming Raspberry Pi in python language. The Raspberry Pi is a small and affordable microcontroller that can be an excellent choice fora wide range of projects, including those aimed at sorting and grading of fruits. With its versatile input/output capabilities, powerful processor, and ample memory, the controller can be used to collect, process, and transmit data from a variety of sensors and devices. Python programming that can be used to program Raspberry Pi Pico microcontrollers. Thonny is an easy-to-use and beginner-friendly IDE that features a simple and user- friendly interface, and debugging tools. One of the key benefits of using Thonny for programming Raspberry Pi Pico is that it simplifies the process of writing, running, and debugging code. Thonny provides an intuitive interface that makes it easy to write and execute code, and its debugging tools allow developers to easily identify and fix errors in their code. Developers can write and execute Python code directly on the Pico without having to install and configure additional software or libraries.

3.2 System Specifications:

As per the requirements for the robot the specifications used that the system will need are Raspberry Pi 4 Module B, Cytron MD10C R3 Motor Driver, Lead Acid Battery, Monitor, HDMI to HDMI Cable, HDMI to AV Converter, Submersible Pump, Wheels, Chassis, Johnson Geared DC Motor, 5V Dual Channel Relay Module and Webcam. Below are the specifications of the components:

3.2.1 Raspberry Pi 4 Module B:

Specification	Details
Processor	Broadcom BCM2711, quad-core Cortex-A72 (ARM v8) 64-bit SoC @ 1.5GHz
RAM	2GB, 4GB, or 8GB LPDDR4-3200 SDRAM (depending on model)
GPIO	Standard 40-pin GPIO header (fully backwards-compatible with previous boards)

Table 3.1: Raspberry Pi 4 Module B

3.2.2 Cytron MD10C R3 Motor Driver:

Specification	Details
Microcontroller	Atmel SAM3X8E ARM Cortex-M3
Input Voltage	7V - 30V DC
Output Current	Up to 10A continuous, 30A peak
PWM Frequency	Adjustable up to 20kHz
Control Interface	PWM, Analog, UART

Table 3.2: Cytron MD10 R3

3.2.3 Lead Acid Battery:

Specification	**Details**
Battery Type	Sealed Lead Acid (SLA)
Nominal Voltage	12V
Capacity	8Ah
Dimensions	151mm x 65mm x 94mm

Table 3.3: Lead Acid Battery

3.2.4 Monitor:

Specification	**Details**
Screen Size	43 inches
Display Type	Tft, LCD
2-Channel Video Input	V1/V2 (Auto Switching)

Table 3.4: Monitor

3.2.5 HDMI to HDMI Cable:

Specification	**Details**
Cable Type	HDMI to HDMI
Connector Type	HDMI Type A Male to HDMI Type A Male
Data Transfer Rate	Up to 18 Gbps

Table 3.5: HDMI to HDMI Cable

3.2.6 HDMI to AV Converter:

Specification	Details
Input	HDMI Type A Female
Output	Composite AV (RCA) and/or S-Video
Supported Input Resolutions	Up to 1080p (1920 x 1080 pixels)

Table 3.6: HDMI to AV Converter

3.2.7 Submersible Pump:

Specification	Details
Pump Type	Submersible
Power Source	Electric
Maximum Flow Rate	10 gallons per minute (GPM)
Maximum Head Height	100 feet
Voltage	110-120 volts

Table 3.7: Submersible Pump

3.2.8 Wheels and Chassis:

Wheels employed in this mechanism are created from solid rubber with a nylon center that is anti-corrosive and has high impact strength. Wheel is used for driving the chassis and chassis which contain all components of Agri Robot.

3.2.9 Johnson Geared DC Motor:

Specification	Details
Motor Type	DC Brushed
Operating Voltage	12-24V
Rated Load Speed	11,000 RPM
Rated Load Current	5A

Table 3.8: Johnson Geared DC Motor

3.2.10 5V Dual Channel Relay Module:

Specification	Details
Input Voltage	5V DC
Number of Channels	2
Maximum Switching Voltage	30VDC / 250VAC

Table 3.9: 5V Dual Channel Relay Module

3.2.11 Webcam:

Specification	Details
Connectivity	USB
Frame Rate	30 fps
Still Image Sensor Resolution	720 MP

Table 3.10: Webcam

3.3 Block Diagram and description:

Description of Block Diagram of Agri Robot System:

i. BMS: Battery Management system is used to manage rechargeable batteries and ensure their optimal performance and safety. A BMS monitors various aspects of the battery, such as temperature, state of charge, and state of health, to prevent overcharging, over-discharging, and overheating. The two 12V 8 Amps batteries are connected in series so it will totally give the power of 24V 18 Amps DC supply to the Agri Robot.

ii. LM7805: It converts the 12V DC supply from Battery into 5V which gives it to the raspberry pi.

iii. Raspberry PI: The main parameter of the robot is the Raspberry Pi controller. The input and output parameters of the robot are worked through the controller. Upon receiving power from the battery controller, the controller begins accepting inputs and issuing outputs to the appropriate parameters.

iv. APP: The App is used to control the movements of Agri Robot and give the commands to spray the herbicides. It is connected through the API which is generated when we select the controller into the app, so the app directly generates the API link and is processed on the cloud. Some of the commands executed are - forward, backward, right, left, stop, spray and relay.

v. Webcam: The main function of Webcam in Agri Robot is to record the path of the agriculture field and will memorize it. After the path recording it will perform a function of image and video processing and will capture the images of the weed. It will differentiate between weed and crops and provide the feedback to the controller so that the nozzle will come into the function and a spraying mechanism on weeds will take place.

vi. Display: The function of display is to connect with the Raspberry pi through the HDMI to AV connector. When the camera detects the weed or crops it shows the live video of the field, etc.

vii. Drivers: The main function of Drivers in Agri Robot is to control the mechanism of the Sprayer Motor and the Wheels of the Robot. It will give the instructions based on the inputs gained from the controller. To move the robot flexibly four drivers are used, and each driver is connected to the wheels of the Robot. The drivers are connected to the controller as they will get the PWM signal and direction signal from it.

viii. Relay: The sprayer pump and led are connected to the relay as it functions for the spraying of the herbicides and acts as a switch. The relay is connected to the controller so that when the any command from the controller is given to the relay the relay acts as a switch and then it will on the Water pump.

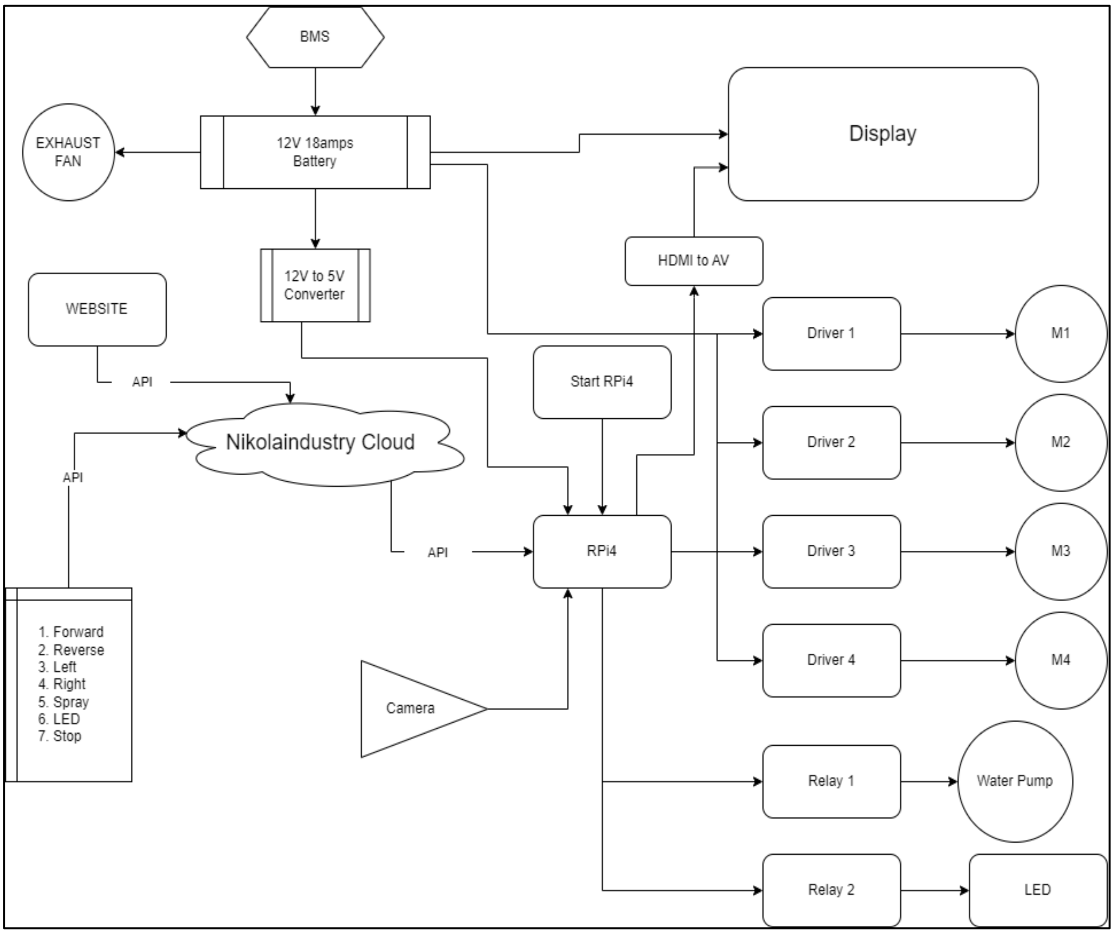


Fig. 3.1: Block Diagram of Agri Robot

3.4 Hardware design:

3.4.1 Mechanical Implementation:

3.4.1.1 2-D Model:

The 2-D Model of the Agri Robot is designed in AutoCAD software and it consists of the Lidar, Sprayer Pump, Camera, Flash, Nozzle, Tank, and the wheel.

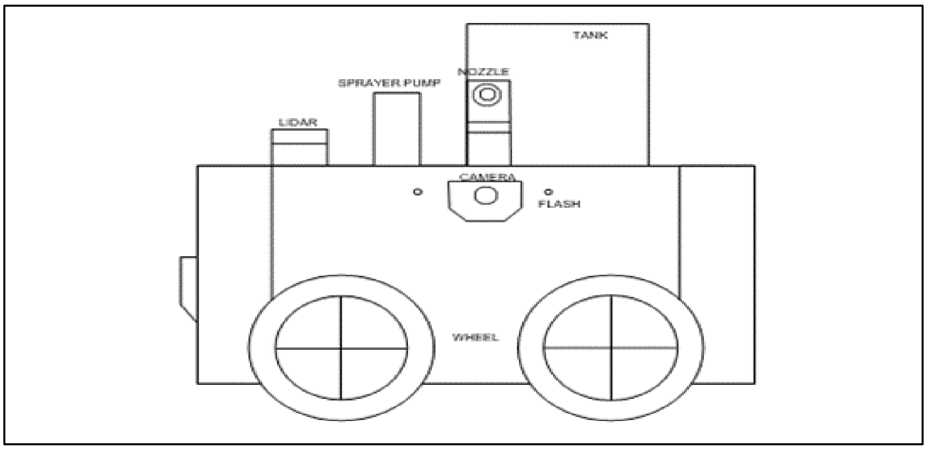


Fig. 3.2: 2-D Model of Agri Robot

3.4.1.2 3-D Model:

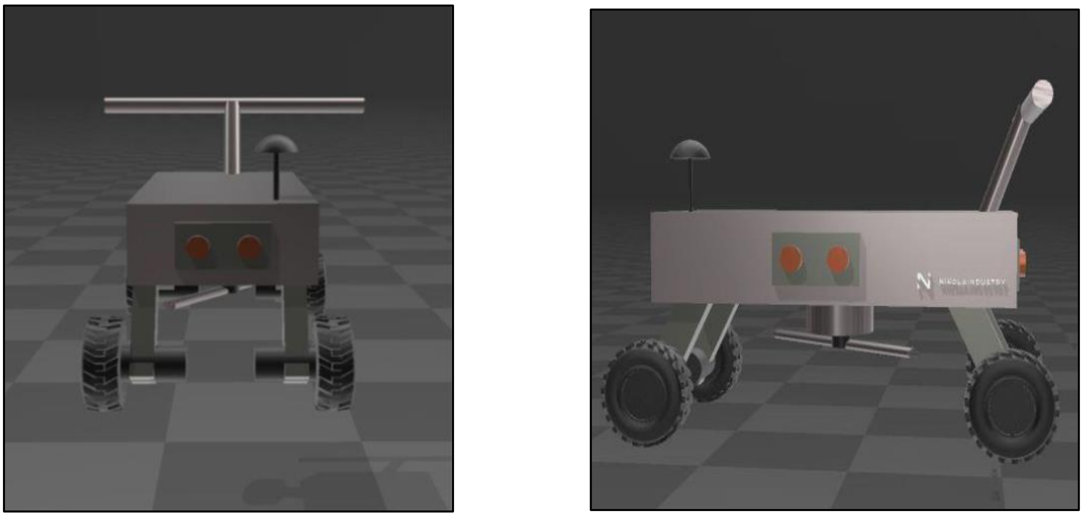


Fig. 3.3: 3-D Model

I. Chassis:

Length	1515 mm
Width	1090 mm
Height	1105 mm
Weight	100 kg

Table 3.11: Chassis

II. Hose Pipe:

Inner Diameter	8 mm
Outer Diameter	12 mm
Maximum Pressure	220 kgf/cm^2
Material	Plastic

Table 3.12: Hose Pipe

III. Water Tank:

Length	720 mm
Width	490 mm
Height	730 mm
Weight	10 Ltr

Table 3.13: Water Tank

IV. Herbicides DC Pump:

Weight of Motor	800g
Liquid Discharge	4.8lit/min
Power Required	10 W
Operating Current	0.8 A
Motor Speed	1500 RPM

Table 3.14: Herbicides DC Pump

V. Fogging Sprayer Nozzle:

Length	250 mm
Width	210 mm
Height	420 mm
Weight	5g
Max Sprayer Width	12 m

Table 3.15: Fogging Sprayer Nozzle

VI. Wheel Specification:

Wheel Diameter	15 in
Wheel Width	4.5 in
For Axle Diameter	0.143 in
Style	Tubeless

Table 3.16: Wheel Specification

3.4.1.3 Technical Drawing:

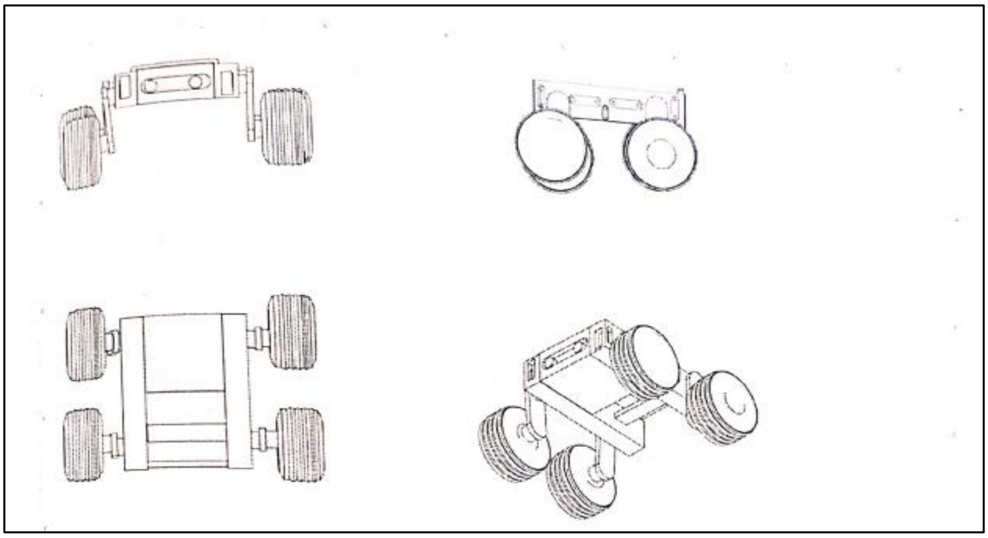


Fig. 3.4: Chassis Model Prepared in Solid-Works

3.4.2 Electrical Implementation:

In the implementation of Agri Robot we are using Raspberry Pi 4 controller in which we give PWM signal to controller so we have assigned the following pin no's 13,19,20,21 which are GPIO PWM pins and connected to the motor driver which are used to drive the robot. For the direction pins we have assigned GPIO 23,24,25,26 pins which are connected to the motor driver. We have also assigned GPIO 3 and 4 for the spray and led.

3.4.2.1 Raspberry Pi 4 Module B:

i. Processor: Broadcom BCM2711, Quad-core Cortex-A72 (ARMv8)64-bit SoC, running at 1.5GHz.
ii. RAM: Options available with 2GB, 4GB, or 8GB LPDDR4-3200 SDRAM.
iii. GPU: Video Core VI graphics, supporting OpenGL ES 3.x.
iv. Storage: MicroSD card slot for operating system and data storage.

v. Connectivity:

  2 × USB 3.0 ports.

  2 × USB 2.0 ports.

vi. Gigabit Ethernet port (RJ45).

vii. Dual-band 2.4GHz and 5GHz IEEE 802.11b/g/n/ac wireless LAN.

viii. Bluetooth 5.0.

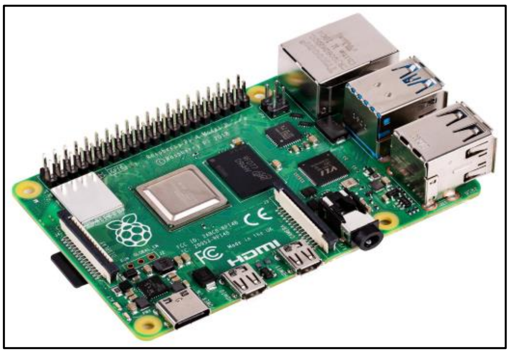


Fig. 3.5: Raspberry Pi 4 Module B

3.4.2.2 Cytron MD10C R3 Motor Driver:

i. Supports brushed DC motors.

ii. Operating voltage: 5V to 30V DC.

iii. Maximum continuous current: 10A.

iv. PWM control signal: 20 kHz frequency.

v. Supports both analog (0-5V) and digital (PWM) control inputs.

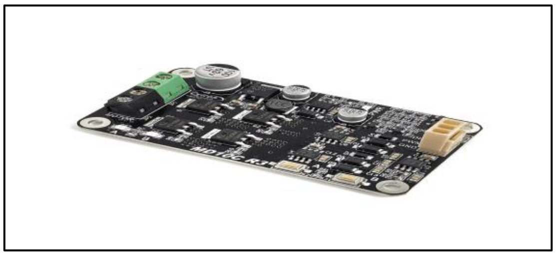


Fig. 3.6: Cytron MD10 R3 Motor Driver

3.4.2.3 Lead Acid Battery:

i. Battery Type: Sealed Lead Acid (SLA)

ii. Nominal Voltage: 12V

iii. Capacity: 8Ah.

iv. Dimensions: 151mm x 65mm x 94mm

Fig. 3.7: Lead Acid Battery

3.4.2.4 Monitor:

i. Screen Size: 43 inches.

ii. Display Type: Tft, LCD.

iii. 2-Channel Video Input: V1/V2 (Auto Switching).

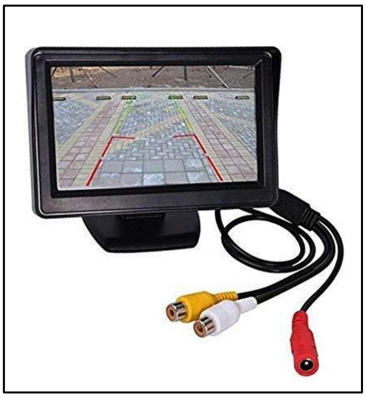


Fig.3.8: Monitor

3.4.2.5 HDMI to HDMI Cable:

i. Cable Type: HDMI to HDMI.

ii. Connector Type: HDMI Type A Male to HDMI Type A Male.

iii. Data Transfer Rate: Up to 18 Gbps.

Fig. 3.9: HDMI to HDMI Cable

3.4.2.6 HDMI to AV Converter:

i. Input: HDMI Type A Female.

ii. Output: Composite AV (RCA) and/or S-Video.

iii. Supported Input Resolutions: Up to 1080p (1920 x 1080 pixels).

Fig. 3.10: HDMI to AV Converter

3.4.2.7 Submersible Pump:

i. Pump Type: Submersible.

ii. Power Source: Electric.

iii. Maximum Flow Rate: 10 gallons per minute (GPM).

iv. Maximum Head Height: 100 feet.

v. Voltage: 110-120 volts.

Fig. 3.11: Submersible Pump

3.4.2.8 Wheels and Chassis:

i. Diameter: 10cm.

ii. Width: 2cm.

iii. Shaft Bore: 6mm.

iv. Dimensions: 4 X 18 x 11 cm.

Fig. 3.12: Wheels

3.4.2.9 Johnson Geared DC Motor:

i. Motor Type: DC Geared.

ii. Operating Voltage: 6-18V.

iii. Rated Load Speed: 500 RPM.

iv. Rated Load Current: 1.2A.

v. Torque: 3.6 kg-cm.

Fig. 3.13: Johnson Geared DC Motor

3.4.2.10 5V Dual Channel Relay Module:

i. Input Voltage: 5V DC.

ii. Number of Channels: 2.

iii. Maximum Switching Voltage: 30VDC / 250VAC.

iv. Input Control: 3.3V or 5V.

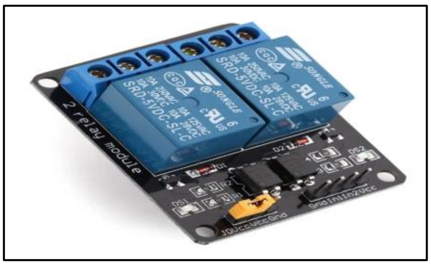


Fig. 3.14: 5V Dual Channel Relay Module

3.4.2.11 Webcam:

i. Connectivity: USB.

ii. Frame Rate: 30 fps.

iii. Still Image Sensor Resolution: 720 MP.

Fig. 3.15: Webcam

3.4.3 Circuit Schematic:

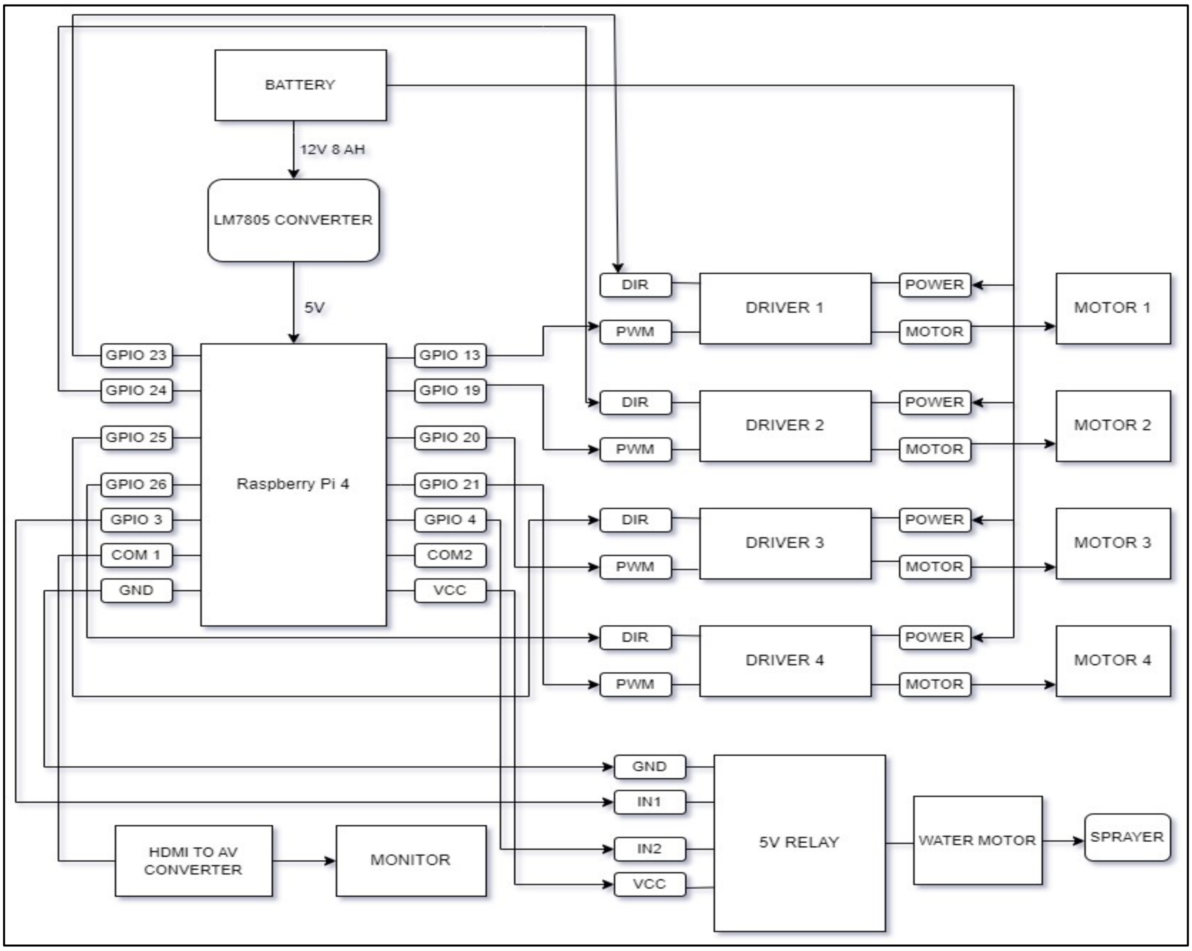


Fig. 3.16: Circuit Schematic

3.5 Software Design:

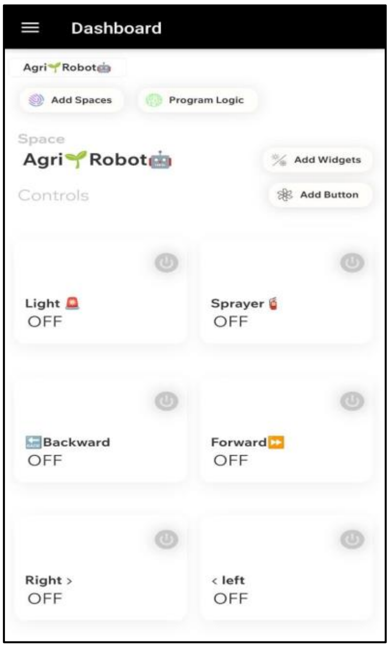


Fig. 3.17: Dashboard

Database:

To generate the AI sequence in the project we have collected the 100 samples of each crop and weed in the database and made their classes .The samples of the weed collected are of 5-6 different types which are in the database. Using the html programming we have generate the AI implementation and the robot could detect whether it is crop or the weed present. The AI will work in two logic such as logic 1 or logic 0. The database will simplify the crop and weed class and based on it will give the instruction to the controller to spray.

Photo 3.1: Images of the Crops and Weed taken from the Agriculture field

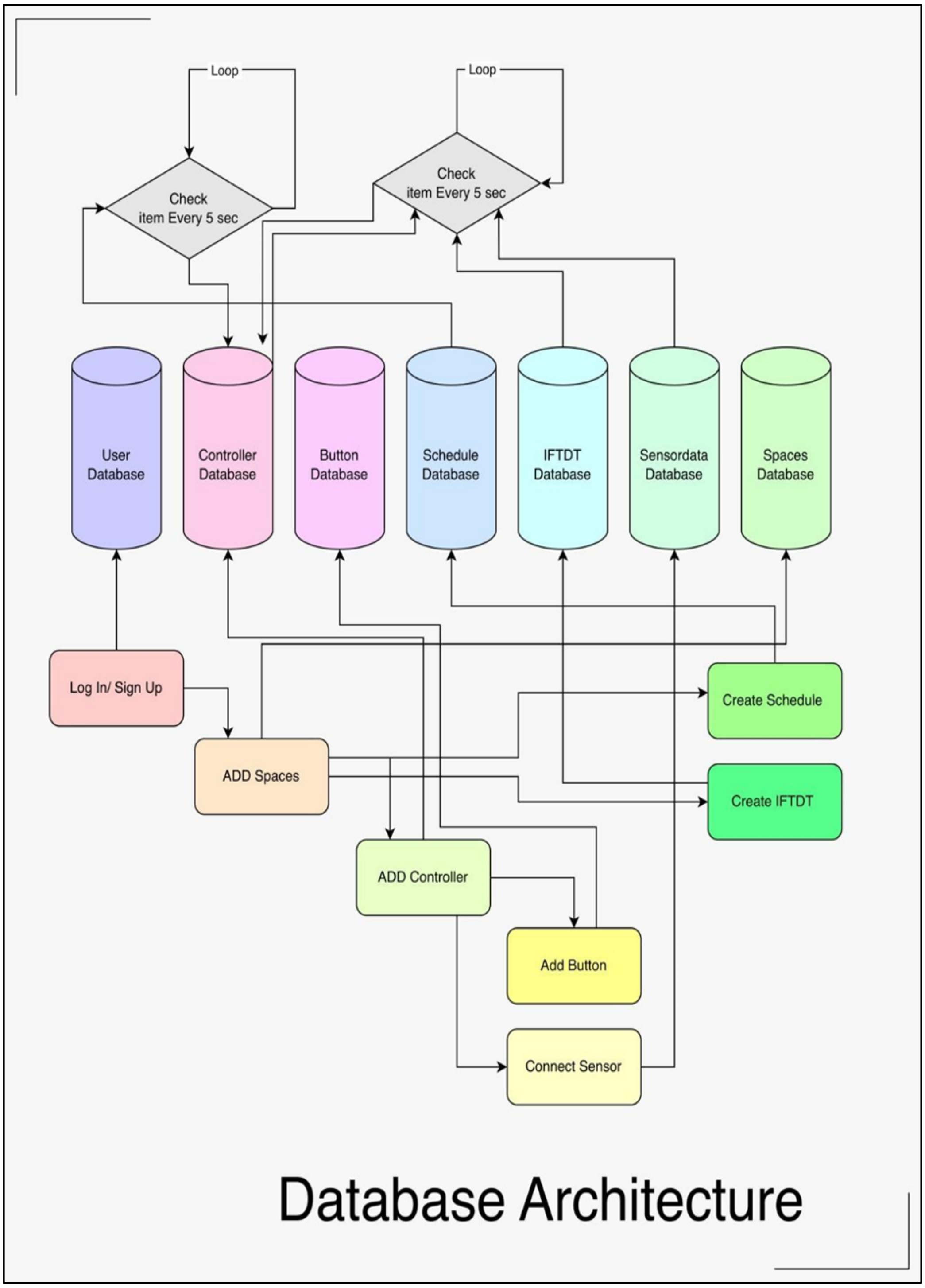


Fig. 3.18: Database Architecture

3.5.1 Modern tools used:

i. Thonny and Geany IDE: Thonny is an integrated development environment (IDE) specifically designed for beginners and students learning to program. Thonny supports several programming languages, including Python and Micro Python, and offers features that help users write, test, and debug their code.

ii. Keil IDE: Keil MDK (Microcontroller Development Kit) is a popular integrated development environment (IDE) specifically designed for embedded systems development. It is developed by ARM and provides a comprehensive toolset for programming and debugging microcontrollers based on ARM architecture.

iii. Proteus: Proteus is a powerful software suite designed for electronic circuit design, simulation, and PCB (Printed Circuit Board) layout. It is widely used by engineers, designers, and hobbyists for developing and testing electronic systems before they are physically built. Proteus provides an integrated environment that combines schematic capture, simulation, and PCB design tools, allowing users to design, validate, and optimize electronic circuits.

iv. DBMS: Nikola Industry DBMS, you can easily create new databases, write, and update data, and read data from your databases with just a few simple API calls. Plus, our platform is designed to be highly scalable and reliable, so you can trust that your data will always be safe and accessible.

v. Codux: It is "Build functional applications, develop components in isolation, and edit existing projects— all based on source code and with real-time rendering."

vi. EasyEDA: EasyEDA is a web-based EDA tool suite that enables hardware engineers to design, simulate, share - publicly and privately - and discuss schematics, simulations, and printed circuit boards.

vii. Visual studio code: Visual Studio Code, also commonly referred to as VS Code, is a source-code editor made by Microsoft with the Electron Framework, for Windows, Linux and macOS. Features include support for debugging, syntax highlighting, intelligent code completion, snippets, code refactoring, and embedded Git.

viii. Fusion 360 (3D Design): Fusion 360 is a computer-aided design (CAD) and computer-aided manufacturing (CAM) software developed by Autodesk. It provides a comprehensive set of tools for designing, engineering, and manufacturing 3D models and prototypes. Here is a brief description of Fusion 360.

ix. Auto CAD (2D Design): AutoCAD is a computer-aided design (CAD) software developed by Autodesk. It is one of the most widely used and established CAD programs in the industry, known for its extensive functionality and versatility. Here is a brief description of AutoCAD.

x. Convolutional Neural Network (CNN) : A Convolutional Neural Network (CNN) is a type of deep learning algorithm that is particularly well-suited for image recognition and processing tasks. It is made up of multiple layers, including convolutional layers, pooling layers, and fully connected layers. The convolutional layers are the key component of a CNN, where filters are applied to the input image to extract features such as edges, textures, and shapes. The output of the convolutional layers is then passed through pooling layers, which are used to down-sample the feature maps, reducing the spatial dimensions while retaining the most important information. The output of the pooling layers is then passed through one or more fully connected layers, which are used to make a prediction or classify the image.

3.5.2 Algorithm:

A. Movement of Agri Robot:

I. Import the necessary libraries: Import the "requests" library for making HTTP requests and the "RPi.GPIO" library for controlling the Raspberry Pi's GPIO pins. Also, import the "time" library for adding delays in the code.

II. Define the URL: Set the URL variable to the endpoint where the data will be fetched.

III. Set up GPIO pins: Initialize the GPIO pins that will be used for motor control, PWM (Pulse Width Modulation) output, spray control, and LED control.

IV. Set initial states: Set the initial states of the GPIO pins for motor control and PWM output to LOW.

V. Set up PWM: Initialize PWM on the specified PWM pins using the GPIO.PWM() function. Set the PWM frequency to 1000 Hz and start with a duty cycle of 0.

VI. Define the set_speed() function: Create a function to set the motor speed by changing the duty cycle of the PWM pin.

VII. Start an infinite loop: Enter an infinite loop to continuously retrieve data from the specified URL.

VIII. Make an HTTP GET request: Use the requests.get() function to make an HTTP GET request to the specified URL.

IX. Check the response status code: Verify if the response status code is 200 (indicating a successful request).

X. Parse the JSON response: If the response is successful, parse the JSON response and extract the required data values.

XI. Process the data: Based on the received data, control the GPIO pins and perform the desired actions such as motor movement, spray control, and LED control.

XII. Handle different conditions: Implement conditional statements to handle various combinations of input values and control the motor movement and other actions accordingly.

XIII. Add delay: Pause the program execution for 1 second using the time.sleep() function to introduce a delay between successive iterations of the loop.

XIV. Clean up GPIO: After exiting the infinite loop, clean up the GPIO by calling the gpio.cleanup() function.

B. Weed Detection Using Image Processing

I. Create an HTML page with a title, a "Start" button, and container elements for displaying the webcam feed and prediction labels.

II. Include the TensorFlow.js library and the Teachable Machine image model library in the HTML page.

III. Define the URL of the Teachable Machine model to be used for image classification.

IV. Declare variables for the model, webcam, label container, and maximum number of predictions.

V. Implement an init() function to initialize the image model and set up the webcam.

VI. Inside the init() function, load the model and metadata files using the provided URLs.

VII. Set up the webcam by creating a new Webcam object, specifying the dimensions and whether to flip the feed.

VIII. Append the webcam canvas element and create child elements within the label container for each class label.

IX. Implement a loop() function that updates the webcam feed, calls the predict() function, and schedules the next loop iteration.

X. Inside the predict() function, use the image model to predict the class probabilities for the current webcam frame.

XI. Iterate over the predictions and update the label container with the class names and probabilities.

XII. Extract the probability values for the "weeds" and "crops" classes.

XIII. Compare the probabilities and perform an action based on the higher probability:

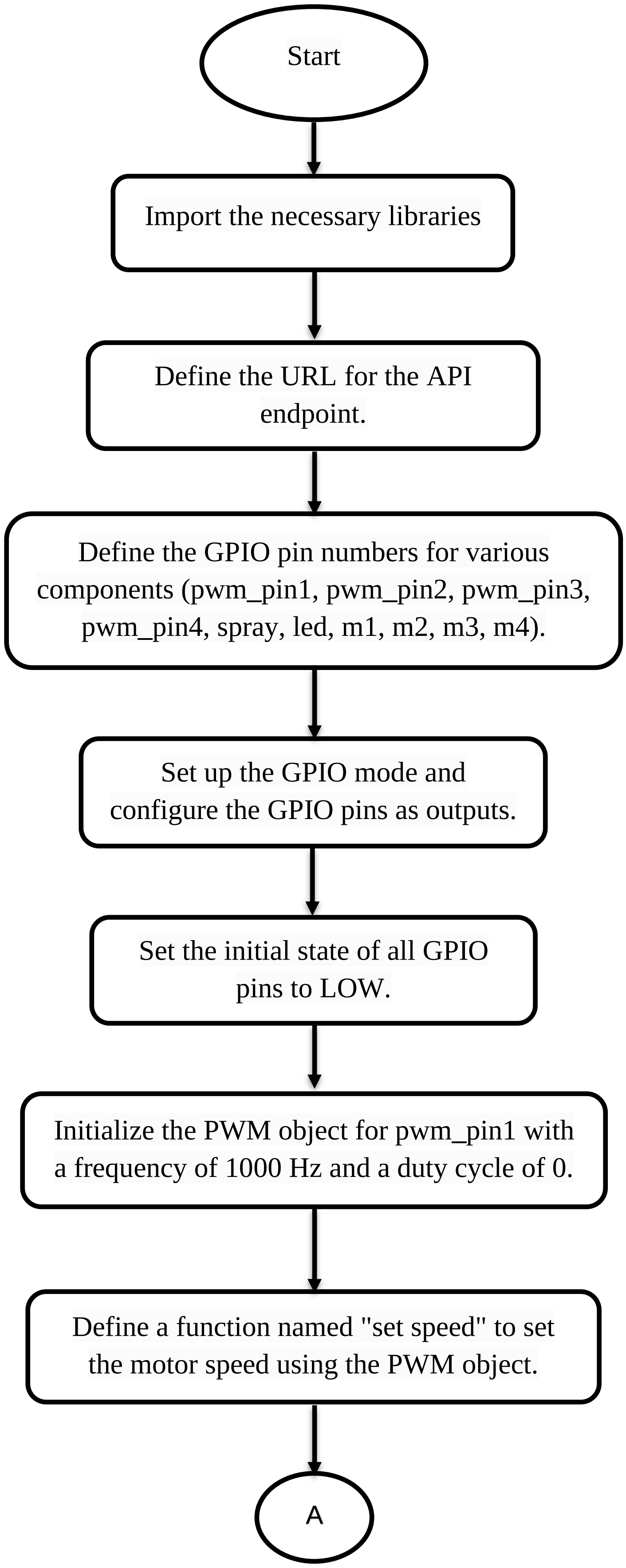
XIV. a. If "weeds" have a higher probability, send a GET request to a specified URL to update the "ch6" channel value to 255.

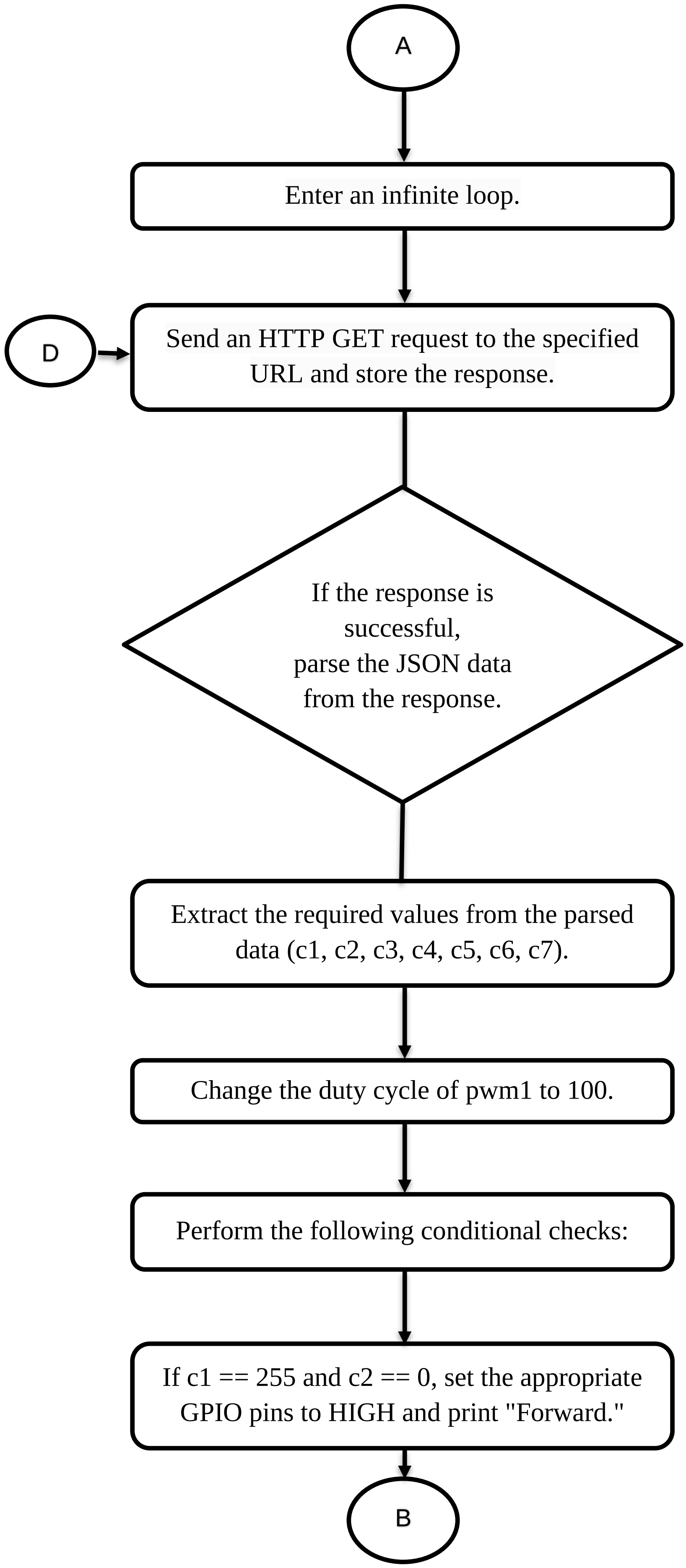
XV. b. If "crops" have a higher probability, send a GET request to a specified URL to update the "ch6" channel value to 0.

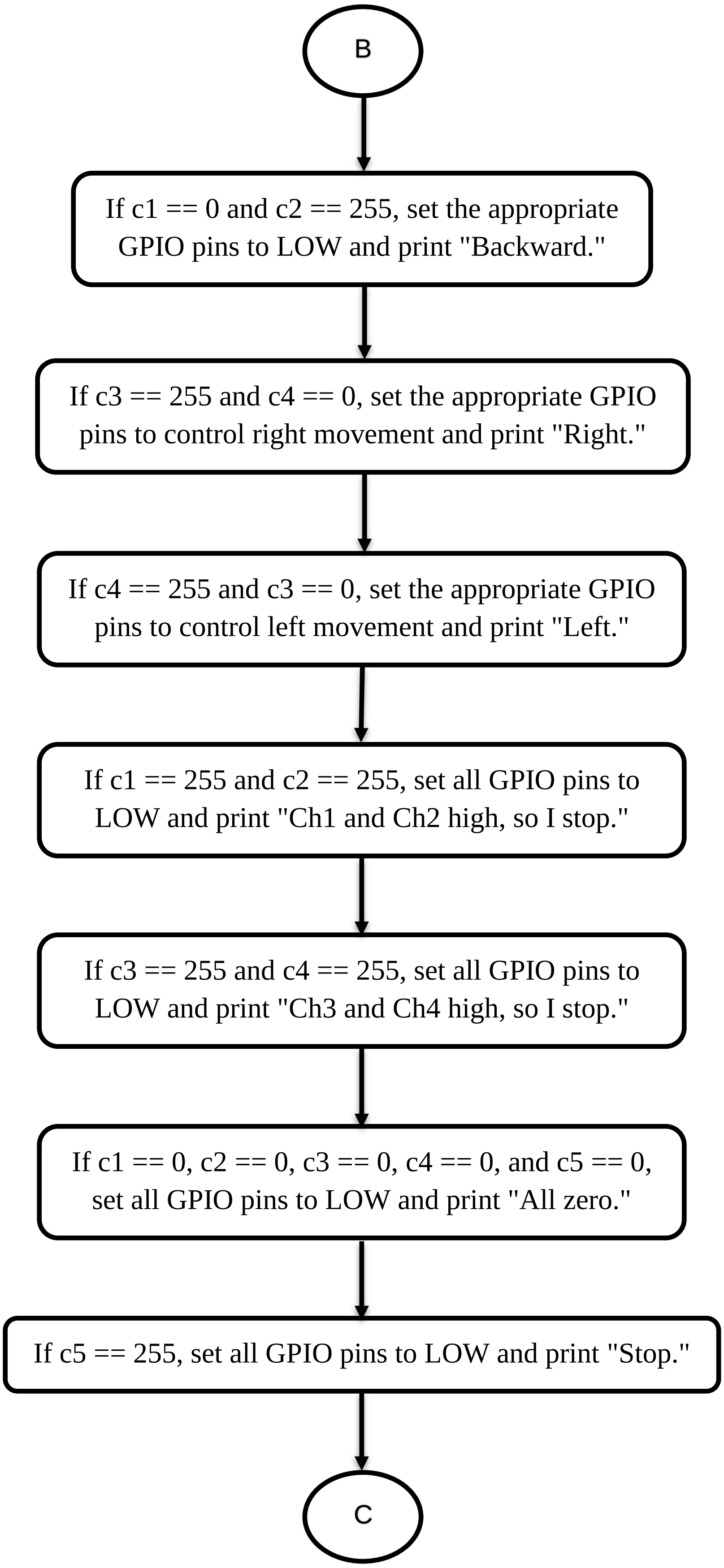
XVI. Uncomment and modify the code if you need to handle additional classes or perform different actions based on the predictions.

XVII. Save the HTML file and open it in a web browser to run the AI algorithm.

3.5.3 Flowchart:




A
Enter an infinite loop.
D
Send an HTTP GET request to the specified URL and store the response.
If the response is successful,
parse the JSON data from the response.
Extract the required values from the parsed data (c1, c2, c3, c4, c5, c6, c7).
Change the duty cycle of pwm1 to 100.
Perform the following conditional checks:
If c1 == 255 and c2 == 0, set the appropriate GPIO pins to HIGH and print "Forward."
B


B
If c1 == 0 and c2 == 255, set the appropriate GPIO pins to LOW and print "Backward."
If c3 == 255 and c4 == 0, set the appropriate GPIO pins to control right movement and print "Right."
If c4 == 255 and c3 == 0, set the appropriate GPIO pins to control left movement and print "Left."
If c1 == 255 and c2 == 255, set all GPIO pins to LOW and print "Ch1 and Ch2 high, so I stop."
If c3 == 255 and c4 == 255, set all GPIO pins to LOW and print "Ch3 and Ch4 high, so I stop."
If c1 == 0, c2 == 0, c3 == 0, c4 == 0, and c5 == 0, set all GPIO pins to LOW and print "All zero."
If c5 == 255, set all GPIO pins to LOW and print "Stop."
C

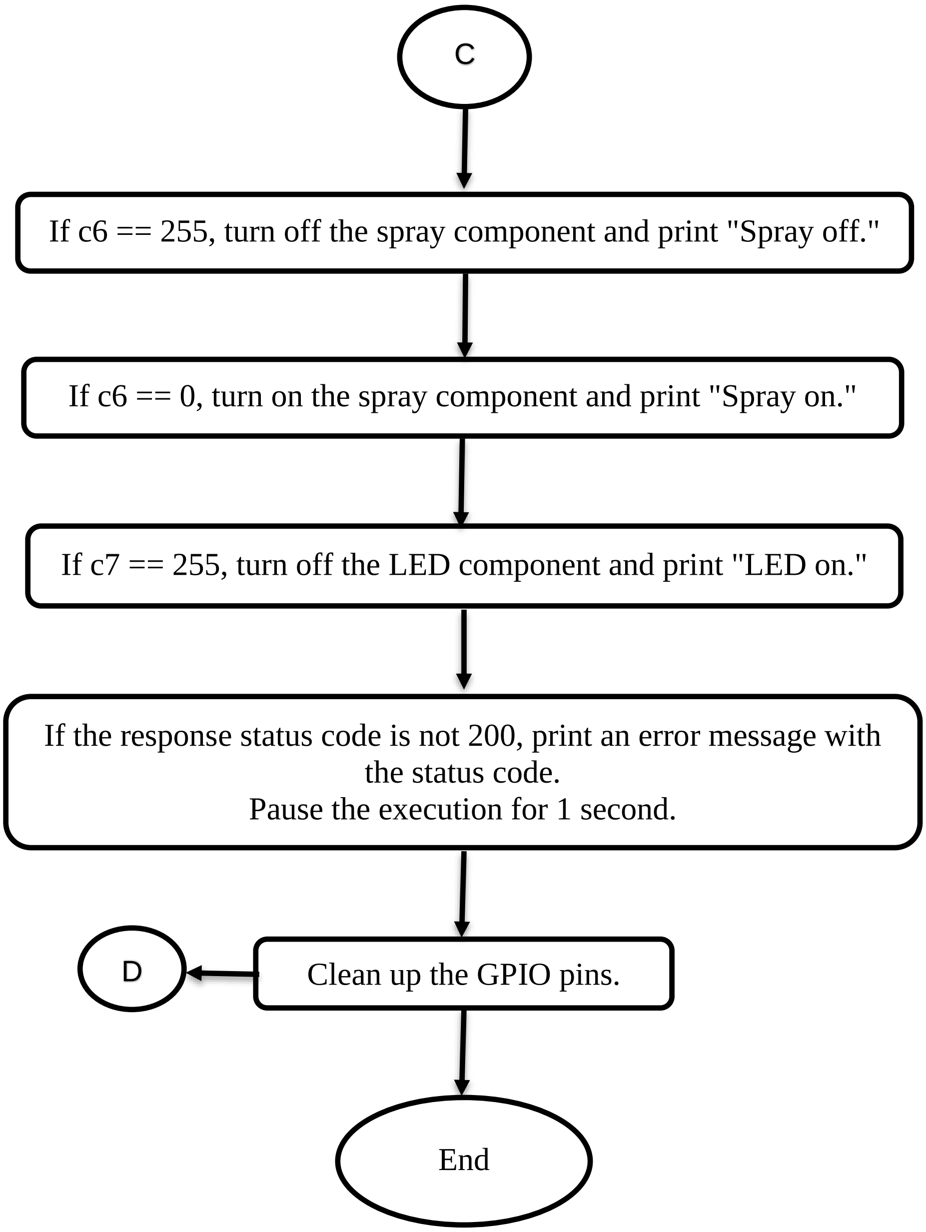


Fig. 3.19: Flowchart

3.5.4 Circuit Simulation:

Description:

A circuit diagram is a simplified representation of the components of an electrical circuit using either the images of the distinct parts or standard symbols. It shows the relative positions of all the elements and their connections to one another. It is often used to visually represent the circuit of an Agri robot obstacle Detection. The following figure shows a simple circuit diagram. This circuit diagram shows the simulation of an obstacle detection robot using 8051 microcontroller and Analog IR Sensor. This robot is an automatic robot i.e., no manual control is required for the operation of the robot. We are connecting ports of the 8051 microcontrollers to the various components as shown in fig. We were assigned port 2 from an 8051 microcontroller which is connected to an LCD display, to display the obstacle detection Agri Robot, Robot is moving, Obstacle detected and so on. After that we were assigned port 1 which is connected to the IR Sensor which helps to detect the obstacle and one Logic stat component is connected to IR Sensor. Logic State is nothing but tests pin where we test the logic. And also, we assigned port 0 and port 3 for the L293D motor driver. Because the microcontroller sends the control signal to the DC motor driver Integrated Circuit (L293D) of the robot to move the robot in forward, left, or right direction. There are 4 wheels which are connected to the L293D motor. They work when the microcontroller sends the control signal to the motor. As we mentioned Logic State is connected to the IR Sensor to detect obstacles and after detection to display in LCD. So first we test Logic 0, applying the logic 0 which means Robot is Moving in forward direction. And when we apply logic 1 which means Obstacle Detected and the Robot gets stopped. As per the logic operation wheels are worked either they move in forward direction or get stopped. As applying all the operations during simulation, the result is as shown below.

Results:

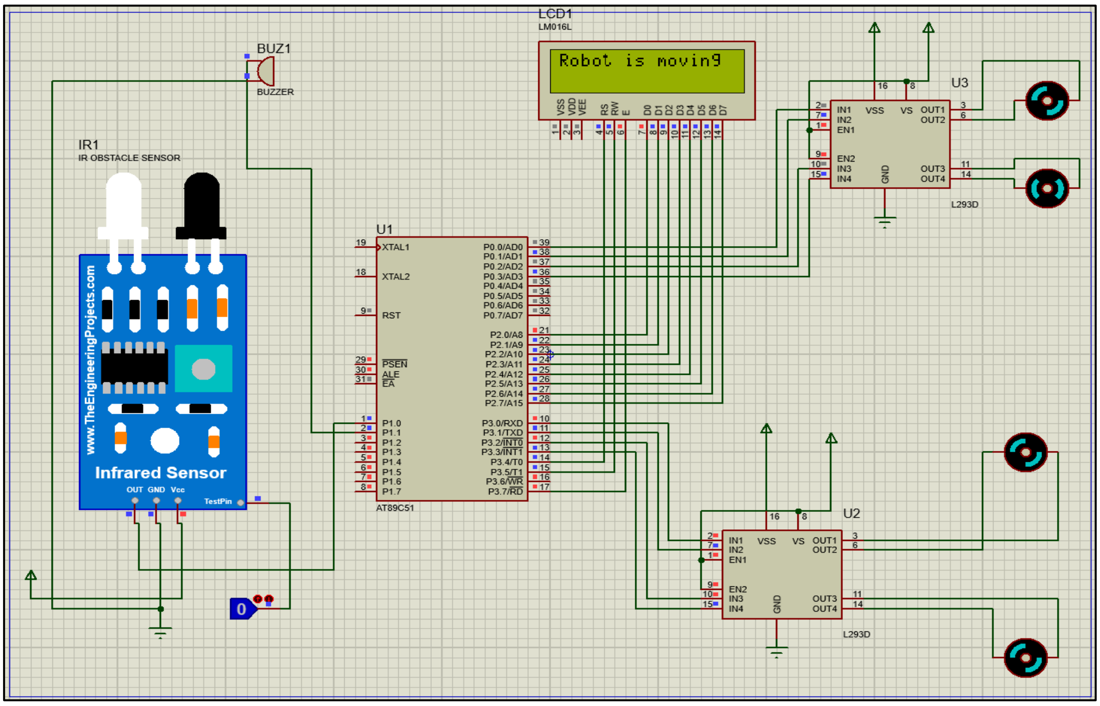


Fig. 3.20: a) Logic 0 Robot is Moving.

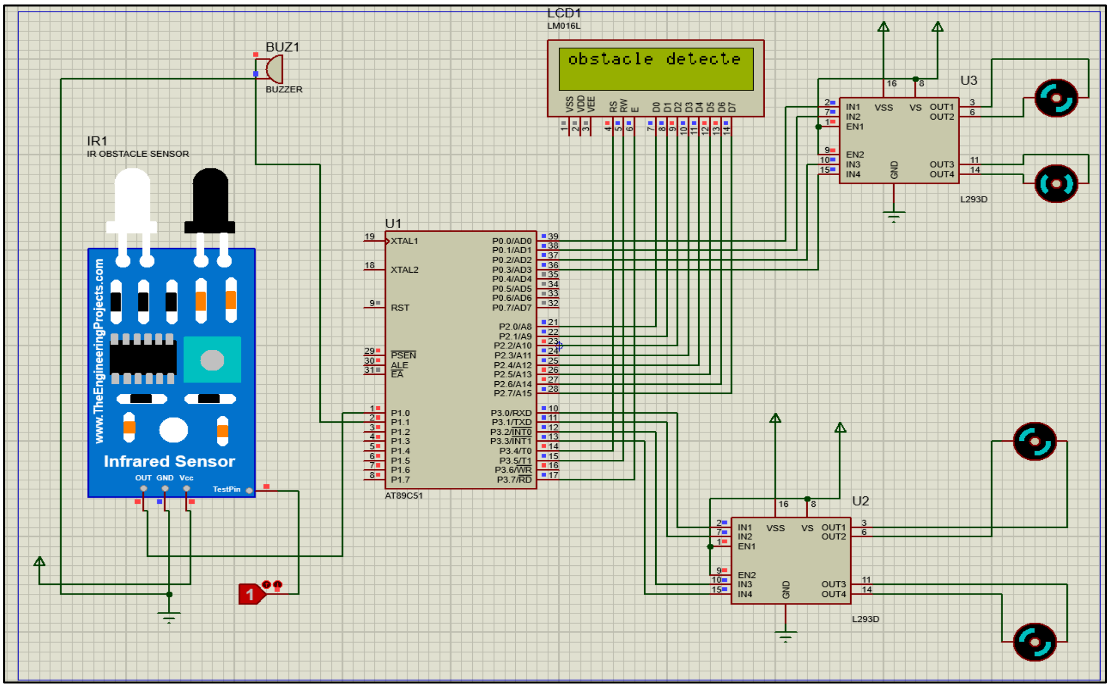


Fig. 3.20: b) Logic 1 Obstacle detected.

3.6: PCB Design and Layout

Designing and laying out printed circuit boards (PCBs) is an essential step in creating electronic products. Any electronic device's performance, dependability, and manufacturability are all governed by the PCB, which is the device's skeleton. Making a schematic, placing components, and routing traces to connect the components are all parts of PCB design and layout. Careful planning, attention to detail, and familiarity with PCB design guidelines are necessary for good PCB design. The objective of PCB design and layout is to produce a small, dependable, and affordable board that satisfies the product's performance and manufacturing needs. Let us take a closer look at the various facets of PCB design and layout in this context.

1. Developing the Idea for a PCB Design

Step 1: Identify the purpose of the PCB. This step involves understanding the problem that the PCB will solve and defining the goals of the project.
Step 2: Research existing designs and technologies. This step involves examining similar projects and technologies to identify best practices and potential challenges.
Step 3: Define the requirements and constraints for the design. This step involves outlining the specific design requirements and constraints such as size, power consumption, and performance criteria.
Step 4: Brainstorm potential solutions and design concepts. This step involves developing multiple potential solutions to the problem at hand and assessing their feasibility.
Step 5: Select the most promising design concept and move on to the next stage. This step involves evaluating the different design concepts and selecting the most promising one to move forward with.

2.Creating a Block Diagram of the Circuit

Step 1: Identify the major components and subsystems of the circuit. This step involves understanding the different components and subsystems that will make up the final circuit.

Step 2: Determine the connections and relationships between the components. This step involves identifying the different connections and relationships between the different components and subsystems.

Step 3: Sketch out a rough block diagram of the circuit. This step involves creating a rough sketch of the different components and subsystems and how they will connect.

Step 4: Refine the block diagram, adding details and making adjustments as necessary. This step involves adding details and refining the block diagram to ensure it accurately reflects the final design.

Step 5: Review and finalize the block diagram before moving on to the next stage. This step involves reviewing the block diagram and ensuring it meets all design requirements before moving on to the next stage.

2]Developing a Schematic of the Circuit

Step 1: Transfer the block diagram to a schematic editor. This step involves transferring the block diagram to a schematic editor to begin creating the schematic.

Step 2: Add individual components and connections to the schematic. This step involves adding the individual components and connections to the schematic editor.

Step 3: Ensure that the schematic reflects the block diagram accurately. This step involves ensuring that the schematic accurately reflects the block diagram created in the previous step.

Step 4: Verify the schematic against the design requirements and constraints. This step involves verifying the schematic against the design requirements and constraints outlined earlier in the design process.

Step 5: Refine the schematic and finalize it for the next stage. This step involves refining the schematic as necessary and finalizing it for the next stage of the design process.

1.Creating a Layout of the PCB

Step 1: Transfer the schematic to a PCB layout editor. This step involves transferring the schematic to a PCB layout editor to begin designing the layout.

Step 2: Place the components on the board, taking into account spacing and placement rules. This step involves placing the individual components on the board, taking into account any spacing and placement rules.

Step 3: Route the connections between components, ensuring signal integrity and minimizing noise. This step involves routing the connections between the components on the board, taking into account signal integrity and noise considerations.
Step 4: Add ground and power planes, as necessary. This step involves adding ground and power planes to the board as necessary to ensure the proper operation of the final circuit.
Step 5: Verify the layout against the schematic and design requirements and refine as necessary. This step involves verifying the layout against the schematic and design requirements and making any necessary refinements.

2.Printing and Manufacturing the PCB

Step 1: Generate the manufacturing files from the PCB layout editor. This step involves generating the necessary manufacturing files from
Step 2: Generate Gerber Files. The Gerber file is a standard file format used by PCB manufacturers to produce the board. It contains all the information needed to create the layers, drill holes, and place the copper traces on the board. Once the layout is complete, the Gerber files are generated using PCB design software.
Step 3: With the Gerber files generated, the next step is to order the PCB from a manufacturer. There are many PCB manufacturers available online that offer fast, affordable, and high-quality PCB fabrication. The Gerber files are uploaded to the manufacturer's website, and the order is placed.
Step 4: Once the PCBs are delivered, the next step is to assemble the components onto the board. This involves soldering the components onto the PCB using a soldering iron or a reflow oven.
Step 5: The final step is to test the PCB to ensure that it works as expected. This involves checking the circuit for any errors, checking for short circuits, and verifying that all the components are correctly installed.

CHAPTER-4

TEST PROCEDURE AND RESULT

4.1 Test Procedure:

4.1.1 Step 1: Forward Condition

The Below Image Indicates that when we press forward button then the robot moves in forward direction.

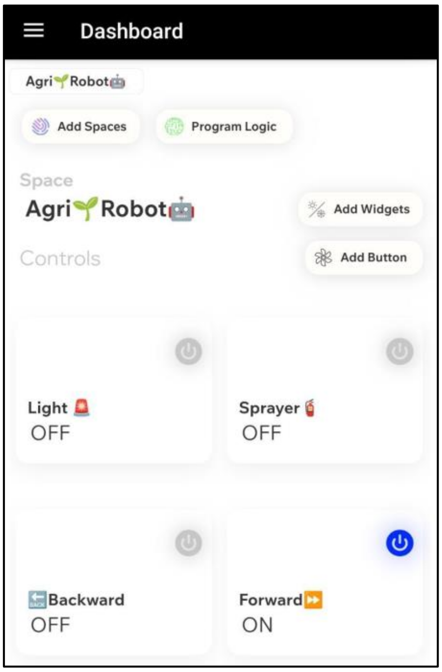


Fig. 4.1: Forward Condition

Output:

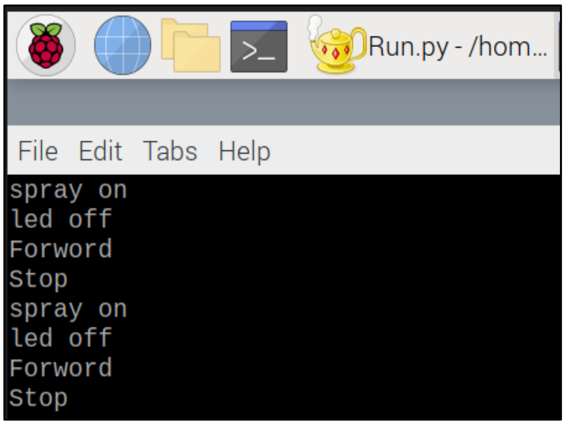


Fig. 4.2: Forward Condition Output

4.1.2 Step 2: Backward Condition

The Below Image Indicates that when we press Backward button then the robot moves in backward direction.

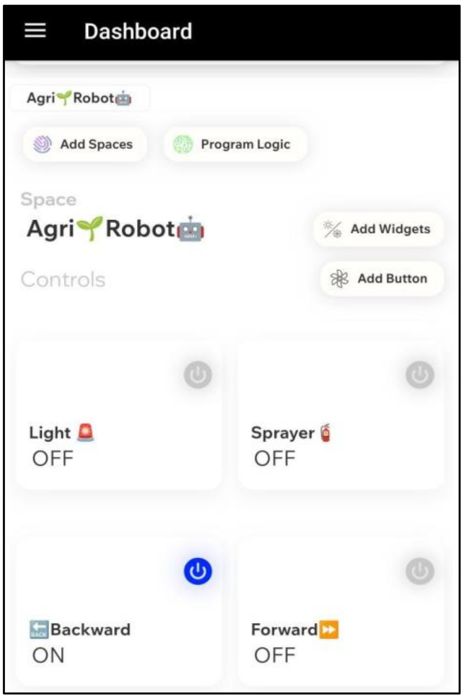


Fig. 4.3: Backward Condition

Output:

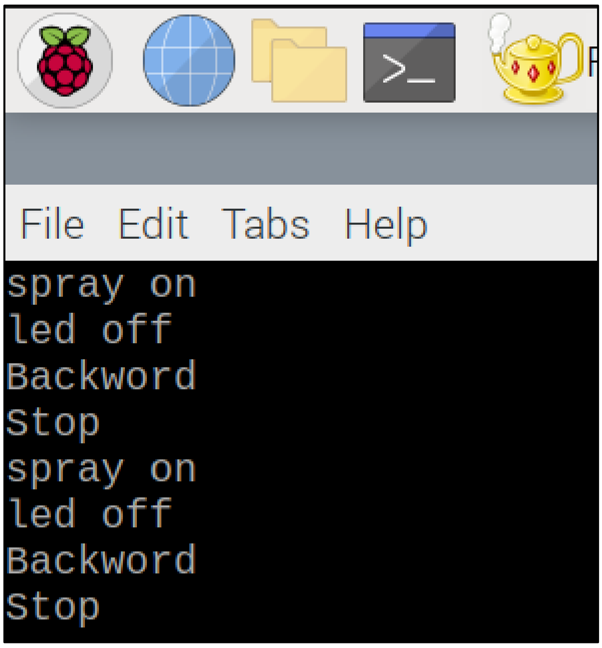


Fig. 4.4: Backward Condition Output

4.1.3 Step 3: Right Condition

The Below Image Indicates that when we press Right button then the robot moves in right direction.

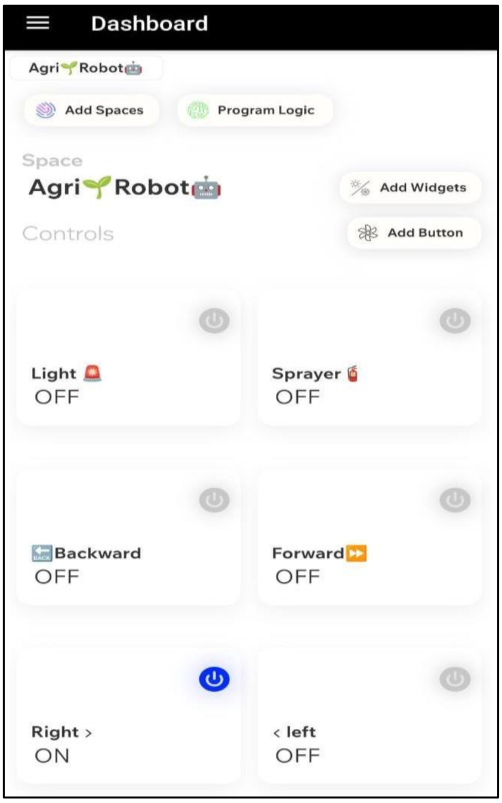


Fig. 4.5: Right Condition

Output:

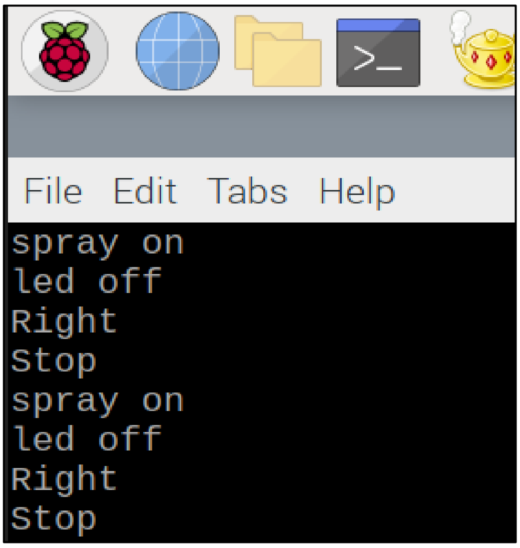


Fig. 4.6: Right Condition Output

4.1.4 Step 4: Left Condition

The Below Image Indicates that when we press Left button then the robot moves in left direction.

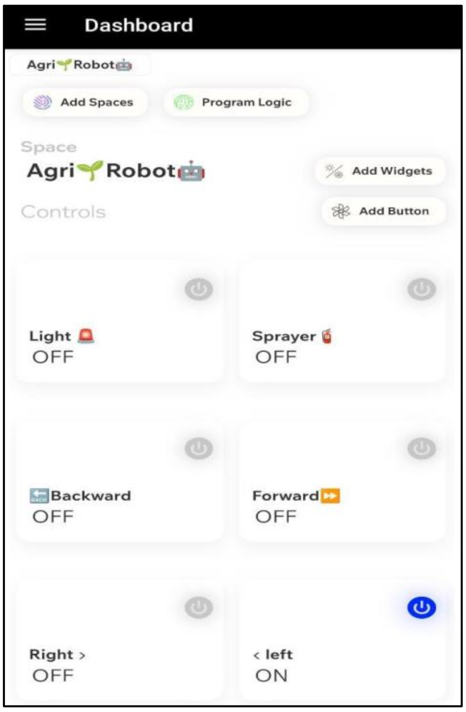


Fig. 4.7: Left Condition

Output:

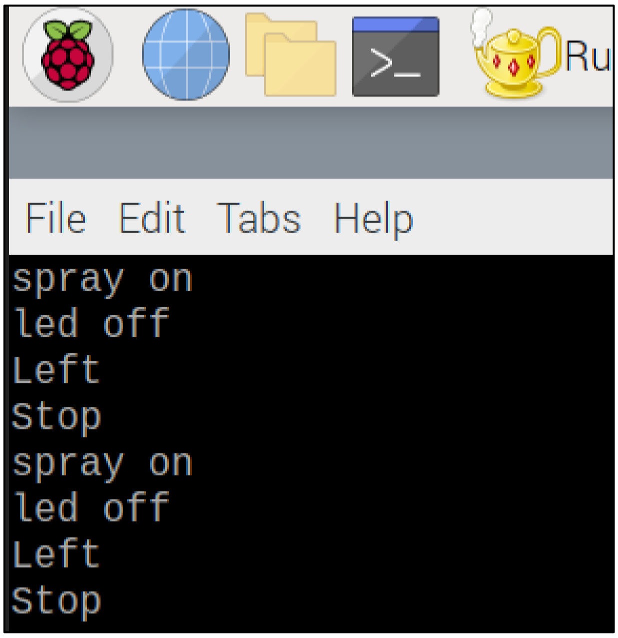


Fig. 4.8: Left Condition Output

4.1.5 Step 5: Sprayer Condition

The Below Image Indicates that when we press Sprayer button then the robot should start the spraying herbicides.

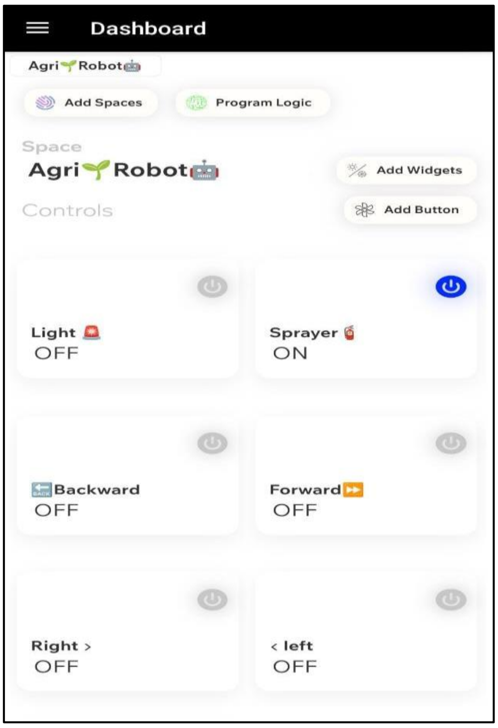


Fig. 4.9: Sprayer Condition

Output:

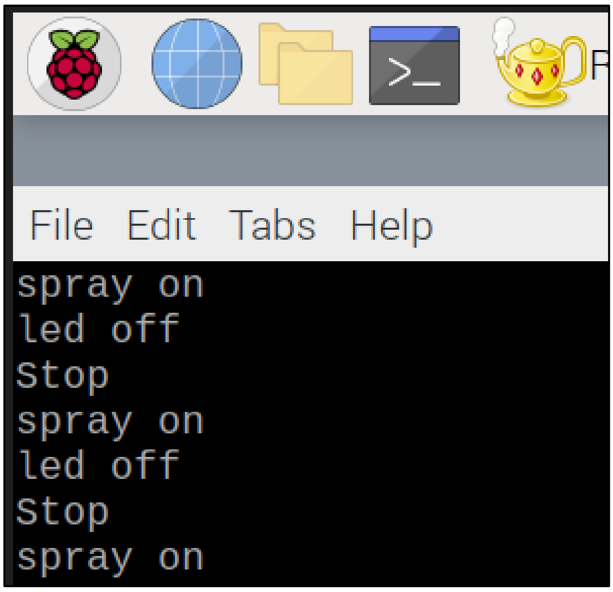


Fig. 4.10: Sprayer Condition Output

4.1.6 Step 6: Default Conditions

The Below Image Indicates that when we press All button then the robot gets stop because the output shows that Channel 1 and Channel 2 gets high. So ultimately Robot gets stop at this stage.

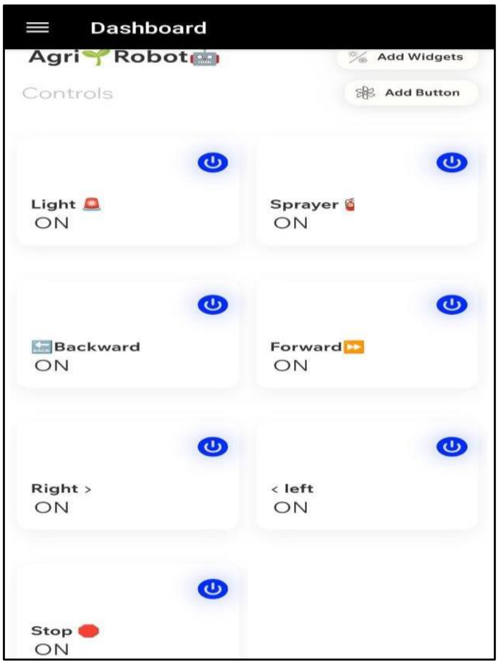


Fig. 4.11: Default Condition

Output:

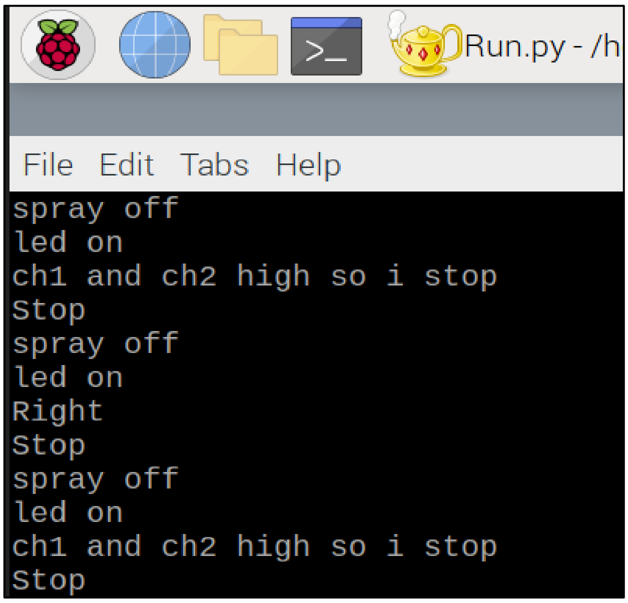


Fig. 4.12: Default Condition Output

4.1.7 Step 7: Crop Detection

The Below Image Indicates that when the robot detect crop, then the AI shows Logic 1 at crops and Logic 0 at weeds. Which means that the robot should stop spraying herbicides on crops.

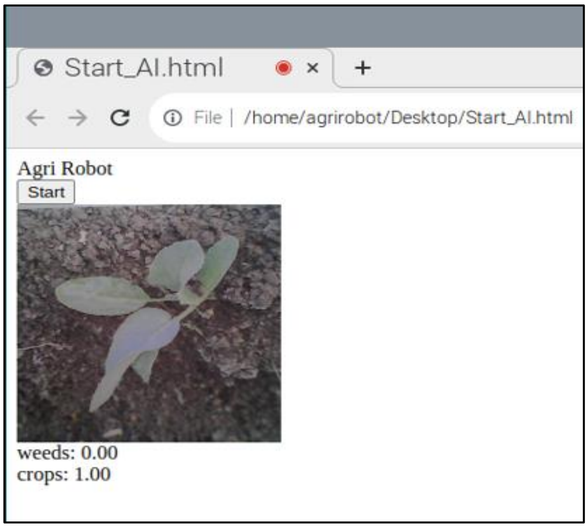


Fig. 4.13: Crop Detection

4.1.8 Step 8: Weed Detection

The Below Image Indicates that when the robot detect Weeds, then the AI shows Logic 0 at crops and Logic 1 at weeds. Which means that the robot should start spraying herbicides on weeds.

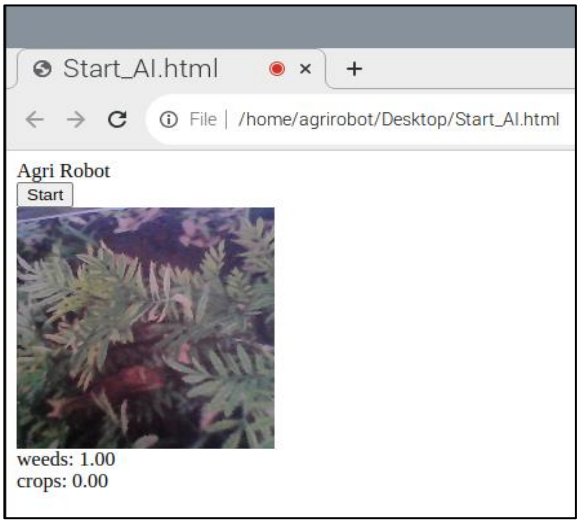


Fig.4.14: Weed Detection

4.2 Results

The Final Results shows the working of Agri Robot. In this we used Raspberry Pi 4 as a controller, to connect all the parameters of robot from this controller, like Cytron motor driver, web camera, monitor, sprayer, Submersible pump, Relay etc. We used battery as a supply here. The most important thing is that Agri Robot should be control by the Android App. In this app there are a lot of operations present, like the functions for movement of robot in Forward, Reverse, Right, Left directions as well as Spraying and Led.

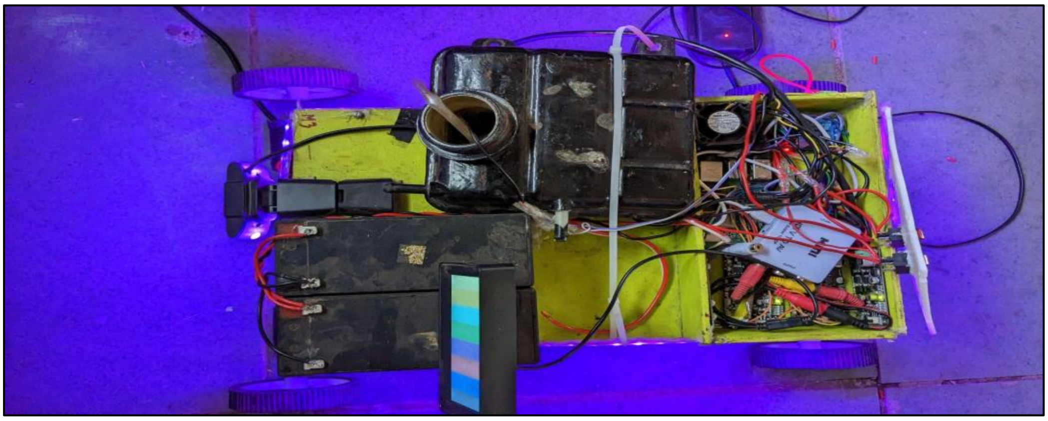


Photo 4.1: Circuit Implementation of Agri Robot

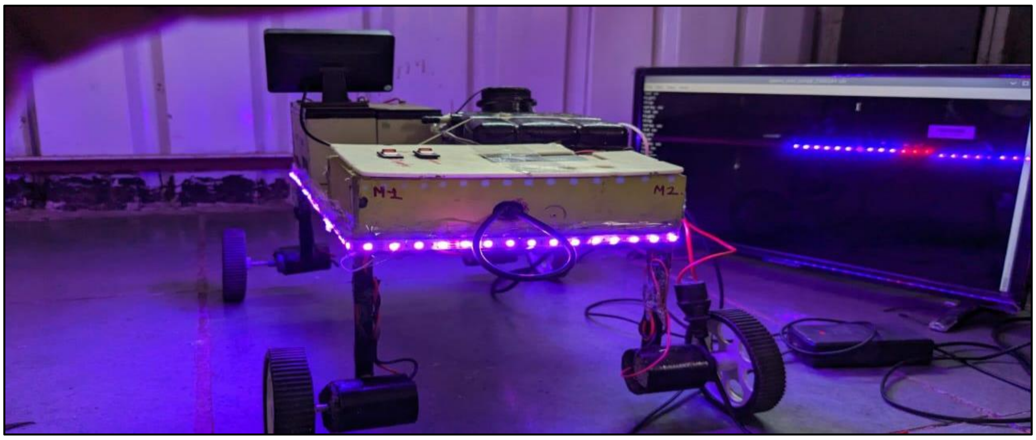


Photo 4.2: Final Implementation of Agri Robot

CHAPTER-5

CONCLUSION AND FUTURE SCOPE

5.1 Conclusion:

The Agrirobot automates the process of spraying herbicides, significantly reducing the time and effort required by farmers. It can cover large areas of farmland quickly and accurately, leading to increased efficiency in weed control. With AI technology, the Agrirobot can accurately detect and differentiate between weeds and crops. It can precisely target and spray herbicides only on the unwanted vegetation, minimizing the risk of damage to the crops. This level of precision ensures that herbicides are used efficiently, reducing costs and environmental impact. Traditional manual spraying methods often involve indiscriminate herbicide application, leading to excessive use and potential negative effects on the environment. By employing an AI-based Agrirobot, farmers can reduce the overall herbicide usage. The robot's ability to identify and target specific weeds results in targeted herbicide application, minimizing chemical exposure for crops and reducing environmental contamination.

By optimizing herbicide usage and reducing labor requirements, the AI-based Agrirobot can lead to cost savings for farmers. With increased efficiency and precise spraying, farmers can minimize wastage, save on herbicide expenses, and potentially reduce the need for additional labor. The use of an android app to control the movement of the Agrirobot adds a layer of scalability and adaptability. Farmers can easily program the robot to navigate their specific fields, adjusting the route and spray patterns as needed. This flexibility enables the Agrirobot to cater to different field sizes and crop layouts, making it a versatile tool for farmers. Automating the spraying process with an Agrirobot enhances safety for farmers. By reducing human exposure to potentially harmful chemicals, the risk of health hazards is minimized. Additionally, the robot's ability to detect crops and halt spraying ensures that the agricultural produce remains uncontaminated.

5.2 Future Scope:

i. Integration with AI and Machine Learning: Agri Robots can be integrated with AI and machine learning algorithms to improve their accuracy in detecting weeds and distinguishing them from crops. This will help reduce herbicide use and minimize crop damage.

ii. Navigation: Incorporating navigation systems into Agri Robots can improve their accuracy in targeting specific areas for herbicide application. This will reduce herbicide drift and minimize the risk of environmental contamination.

iii. Multi-Tasking Capabilities: Agri Robots can be designed to perform multiple tasks such as planting, harvesting, and pruning, in addition to herbicide spraying. This will increase their overall utility and provide greater value to farmers.

iv. Modular Design: Modular design can allow farmers to customize Agri Robots to suit their specific needs, such as changing the size and type of herbicide spray nozzles or adding additional sensors.

v. Autonomous Operations: Autonomous Agri Robots can operate without human intervention, improving efficiency and reducing labor costs. This will be achieved by the development of advanced sensing and machine learning technologies.

vi. Reduced Costs: As the technology continues to develop and become more accessible, the cost of Agri Robots equipped with herbicide spraying technology will reduce, making it more affordable for small and medium-sized farmers.

vii. Sustainable Agriculture: Agri Robots can be a key tool in promoting sustainable agriculture by reducing the use of herbicides and improving efficiency. This will help to protect the environment, increase crop yields, and improve food security.

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APPENDIX – A

(Course Detail Sheet for Project)

Department of Electronics and Telecommunication Engineering
K. K. Wagh Institute of Engineering Education and Research
Hirabai Haridas Vidyanagari, Amrut Dham, Panchavati, Nashik-422003

Course Detail Sheet

Programme: 2019			Class: B.E(E&TC)				AY 2022-23 Sem. I&II	
Course Code: 404188 & 404197			Course Project Phase-I and Project Phase-II					
Course Teacher: Project Guides			Department: Electronics and Telecommunication Engineering					
Teaching Scheme			Examination Scheme					
Theory	Practical	Tutorial	Theory			Lab		
(hrs/week)	(hrs/week)	(hrs/week)	~~Online~~/ Insem	Endsem	Sessional	Term Work	Practical	Oral
----	----	2+6 hrs	---	---	---	100	---	50+50

Abstract: By learning this subject students will be able to Identify complex problem and define the methodology to solve the problem. Construct, analyze and approach problem solution as a team, plan, and co-ordinate and control the complex and diverse activities in project. Design appropriately using a modular construction approach to solve the problem as per specifications and implement the selected methodology to solve the problem by selecting the correct hardware according to specifications and software for simulation and programming and develop leadership skills by aligning with the objective of the project and lead the team towards its goal

Prerequisite: All Subjects of E&TC Engineering

Delivery Methods (DM)

Chalk & Talk	ICT Tools	Group Discussion	Industrial/ Field Visit	Expert Talk	Survey	Mini project	Lab
--	√	--	--	--	√	--	--

Course Outcomes (COs)

Course Outcome	**After successful completion of course students will be able to**
CO1	Define, analyze and solve complex real life problem.
CO2	Work in collaborative team as a member or leader.
CO3	Apply project management techniques.
CO4	Identify and apply appropriate tools.
CO5	Communicate effectively in verbal and written form.
CO6	Imbibe ethical practices.

Learning objective for CO1 **Students will be able to:**	
1	Identify specification of the problem.
2	Structure the problem.
3	Identify the appropriate methodology to solve the problem.
4	Define the methodology to solve the problem.
Learning objective for CO2 **Students will be able to:**	
1	Adapt the vital skills of compromise and collaboration.
2	Construct , analyzes and approach problem solution as a team
3	Fully understand the role of each individual in a group to accomplish the goal.
4	Develop leadership skills by aligning with the objective of the project and lead the team towards its goal.
Learning objective for CO3 **Students will be able to**	
1	Plan, co-ordinate and control the complex and diverse activities in project
2	Predict any problems and find solution for it
3	Plan the progress to result in total completion of the project.
Learning objective for CO4 **Students will be able to**	
1	Design appropriately using a modular construction approach to solve the problem as per specifications.
2	Implement the selected methodology to solve the problem.
3	Select the correct hardware according to specifications.
4	Select the correct software for simulation and programming.
5	Validate the result and draw conclusion.
Learning objective for CO5 **Students will be able to**	
1	Present the work done by proper documentation
2	Present paper in national / international conferences, project exhibitions & competitions
Learning objective for CO6 **Students will**	
1	Develop professional practice.
2	Recognize how *to do the project to its best.*
3	Develop ethical Practices.

Mapping of Course Objectives to Course Outcomes:

Course Objective	Course Outcomes					
	1.	2.	3.	4.	5.	6.
C-I	●					
C-II		●				
C-III			●			
C-IV				●		
C-V					●	
C-VI						●

Program Outcomes (POs):

Engineering Graduates will be able to:

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2. **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one’s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes (PSO):

1. Analyze and design electronic systems for hybrid engineering application.

2. Implement functional blocks of hardware, software or hardware-software co-design for signal processing and communication applications.

Mapping of Course Outcome (CO) with
Program Outcome (PO) and Program Specific Outcome (PSO)
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)
If there is no correlation, put **"-"**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO404188.1 & CO404195.1	3	3	3	3	-	3	3	-	-	-	-	-	3	3
CO404188.2 & CO404195.2	-	-	-	-	-	-	-	-	3	-	2	-	-	-
CO404188.3 & CO404195.3	-	-	-	-	-	-	-	-	-	-	3	2	-	-
CO404188.4 & CO404195.4	2	2	-	3	3	-	-	-	-	-	-	2	-	-
CO404188.5 & CO404195.5	-	-	-	-	-	-	-	-	-	3	-	-	-	-
CO404188.6 & CO404195.6	-	-	-	-	-	-	-	3	-	-	-	-	-	-
Average	2.5	2.5	3	3	3	3	3	3	3	3	2.5	2	3	3

Course-PO matrix

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
404188 & 404197	2.5	2.5	3	3	3	3	3	3	3	3	2.5	2	3	3

APPENDIX – B

(Program)

Program -

Code for Movement -

```
import requests
import RPi.GPIO as GPIO
import time
url = "https://www.hyperwisor.com/_functions/state?apikey=IvDmFKo4MuUj5xU"
pwm_pin1 = 13
pwm_pin2 = 19
pwm_pin3 = 20
pwm_pin4 = 21
sprey = 3
led = 4

m1 = 23
m2 = 24
m3 = 25
m4 = 26

GPIO.setmode(GPIO.BCM)
GPIO.setup(m1, GPIO.OUT)
GPIO.setup(m2, GPIO.OUT)
GPIO.setup(m3, GPIO.OUT)
GPIO.setup(m4, GPIO.OUT)

GPIO.setup(pwm_pin1, GPIO.OUT)
GPIO.setup(pwm_pin2, GPIO.OUT)
GPIO.setup(pwm_pin3, GPIO.OUT)
GPIO.setup(pwm_pin4, GPIO.OUT)
GPIO.setup(sprey, GPIO.OUT)
GPIO.setup(led, GPIO.OUT)

GPIO.output(m1, GPIO.LOW)
GPIO.output(m2, GPIO.LOW)
```

```
GPIO.output(m3, GPIO.LOW)
GPIO.output(m4, GPIO.LOW)

GPIO.output(pwm_pin1, GPIO.LOW)
GPIO.output(pwm_pin2, GPIO.LOW)
GPIO.output(pwm_pin3, GPIO.LOW)
GPIO.output(pwm_pin4, GPIO.LOW)

pwm1 = GPIO.PWM(pwm_pin1, 1000)
pwm1.start(0)
# define a function to set the motor speed
def set_speed(speed):
    pwm1.changedutycycle(speed)
while True:
    response = requests.get(url)

    if response.status_code == 200:
        data = response.json()
        espdata = data["espdata"]
        c1 = espdata["cH1"]
        c2 = espdata["c2"]
        c3 = espdata["c3"]
        c4 = espdata["c4"]
        c5 = espdata["c5"]
        c6 = espdata["c6"]
        c7 = espdata["cH7"]
        c8 = espdata["c8"]
        c9 = espdata["c9"]
        ch10 = espdata["cH10"]
        c11 = espdata["c11"]
        c12 = espdata["c12"]
        pppp = espdata["pppp"]
        delay = espdata["delay"]
        deviceid = espdata["deviceid"]
```

```
INBUILT = espdata["INBUILT"]
pwm1.ChangeDutyCycle(100)

if  c1 == 255 and c2 == 0:
    GPIO.output(m1, GPIO.HIGH)
    GPIO.output(m4, GPIO.HIGH)
    GPIO.output(m2, GPIO.HIGH)
    GPIO.output(m3, GPIO.HIGH)
    GPIO.output(pwm_pin1, GPIO.HIGH)
    GPIO.output(pwm_pin2, GPIO.HIGH)
    GPIO.output(pwm_pin3, GPIO.HIGH)
    GPIO.output(pwm_pin4, GPIO.HIGH)
    print("Forword")
elif c1 == 0 and c2 == 255:
    GPIO.output(m1, GPIO.LOW)
    GPIO.output(m4, GPIO.LOW)
    GPIO.output(m2, GPIO.LOW)
    GPIO.output(m3, GPIO.LOW)
    GPIO.output(pwm_pin1, GPIO.HIGH)
    GPIO.output(pwm_pin2, GPIO.HIGH)
    GPIO.output(pwm_pin3, GPIO.HIGH)
    GPIO.output(pwm_pin4, GPIO.HIGH)
    print("Backword")
elif c3 == 255 and c4 == 0:
    GPIO.output(m1, GPIO.HIGH)
    GPIO.output(m4, GPIO.HIGH)
    GPIO.output(m2, GPIO.LOW)
    GPIO.output(m3, GPIO.LOW)
    GPIO.output(pwm_pin1, GPIO.HIGH)
    GPIO.output(pwm_pin2, GPIO.HIGH)
    GPIO.output(pwm_pin3, GPIO.HIGH)
    GPIO.output(pwm_pin4, GPIO.HIGH)
    print("Right")
elif c4 == 255 and c3 == 0:
```

```
    GPIO.output(m1, GPIO.LOW)
    GPIO.output(m4, GPIO.LOW)
    GPIO.output(m2, GPIO.HIGH)
    GPIO.output(m3, GPIO.HIGH)
    GPIO.output(pwm_pin1, GPIO.HIGH)
    GPIO.output(pwm_pin2, GPIO.HIGH)
    GPIO.output(pwm_pin3, GPIO.HIGH)
    GPIO.output(pwm_pin4, GPIO.HIGH)
    print("Left")
elif c1 == 255 and c2 == 255:
    GPIO.output(m1, GPIO.LOW)
    GPIO.output(m4, GPIO.LOW)
    GPIO.output(m2, GPIO.LOW)
    GPIO.output(m3, GPIO.LOW)
    GPIO.output(pwm_pin1, GPIO.LOW)
    GPIO.output(pwm_pin2, GPIO.LOW)
    GPIO.output(pwm_pin3, GPIO.LOW)
    GPIO.output(pwm_pin4, GPIO.LOW)
    print("ch1 and ch2 high so i stop")
elif c3 == 255 and c4 == 255:
    GPIO.output(m1, GPIO.LOW)
    GPIO.output(m4, GPIO.LOW)
    GPIO.output(m2, GPIO.LOW)
    GPIO.output(m3, GPIO.LOW)
    GPIO.output(pwm_pin1, GPIO.LOW)
    GPIO.output(pwm_pin2, GPIO.LOW)
    GPIO.output(pwm_pin3, GPIO.LOW)
    GPIO.output(pwm_pin4, GPIO.LOW)
    print("ch3 and ch4 high so i stop")
elif c1 == 0 and c2 == 0 and c3 == 0 and c4 == 0 and c5 == 0:
    GPIO.output(m1, GPIO.LOW)
    GPIO.output(m4, GPIO.LOW)
    GPIO.output(m2, GPIO.LOW)
    GPIO.output(m3, GPIO.LOW)
```

```
            GPIO.output(pwm_pin1, GPIO.LOW)
            GPIO.output(pwm_pin2, GPIO.LOW)
            GPIO.output(pwm_pin3, GPIO.LOW)
            GPIO.output(pwm_pin4, GPIO.LOW)
            print("ALL ZERO")
        if c5 == 255:
            GPIO.output(m1, GPIO.LOW)
            GPIO.output(m4, GPIO.LOW)
            GPIO.output(m2, GPIO.LOW)
            GPIO.output(m3, GPIO.LOW)
            GPIO.output(pwm_pin1, GPIO.LOW)
            GPIO.output(pwm_pin2, GPIO.LOW)
            GPIO.output(pwm_pin3, GPIO.LOW)
            GPIO.output(pwm_pin4, GPIO.LOW)
            print("Stop")
        if c6 == 255:
            GPIO.output(sprey, GPIO.LOW)
            print("spray off")
        elif c6 == 0:
            GPIO.output(sprey, GPIO.HIGH)
            print("spray on")
        if c7 == 255:
            GPIO.output(led, GPIO.LOW)
            print("led on")
        elif c7 == 0:
            GPIO.output(led, GPIO.HIGH)
            print("led off")
    else:
        print("error calling api:", response.status_code)

    time.sleep(1)

gpio.cleanup()
```

Code for AI -

```
<div>Agri Robot</div>
<button type="button" onclick="init()">Start</button>
<div id="webcam-container"></div>
<div id="label-container"></div>
<script src="https://cdn.jsdelivr.net/npm/@tensorflow/tfjs@latest/dist/tf.min.js"></script>
<script src="https://cdn.jsdelivr.net/npm/@teachablemachine/image@latest/dist/teachablemachine-image.min.js"></script>
<script type="text/javascript">
  // More API functions here:
  // https://github.com/googlecreativelab/teachablemachinecommunity/tree/master/libraries/image
  // the link to your model provided by Teachable Machine export panel
  const URL = "https://teachablemachine.withgoogle.com/models/_BDRBT2ud/";
  let model, webcam, labelContainer, maxPredictions;
  // Load the image model and setup the webcam
  async function init() {
    const modelURL = URL + "model.json";
    const metadataURL = URL + "metadata.json";
    // load the model and metadata
    // Refer to tmImage.loadFromFiles() in the API to support files from a file picker
    // or files from your local hard drive
    // Note: the pose library adds "tmImage" object to your window (window.tmImage)
    model = await tmImage.load(modelURL, metadataURL);
    maxPredictions = model.getTotalClasses();
    // Convenience function to setup a webcam
    const flip = false; // whether to flip the webcam
    webcam = new tmImage.Webcam(200, 200, flip); // width, height, flip
    await webcam.setup(); // request access to the webcam
    await webcam.play();
```

```
      window.requestAnimationFrame(loop);
      // append elements to the DOM
      document.getElementById("webcam-container").appendChild(webcam.canvas);
      labelContainer = document.getElementById("label-container");
      for (let i = 0; i < maxPredictions; i++) { // and class labels
        labelContainer.appendChild(document.createElement("div"));
      }
    }
    async function loop() {
      webcam.update(); // update the webcam frame
      await predict();
      setTimeout(() => {
        window.requestAnimationFrame(loop);
      }, 1000);
    }
    let weeds = 0
    let crops = 0
    // run the webcam image through the image model
    async function predict() {
      // predict can take in an image, video or canvas html element
      const prediction = await model.predict(webcam.canvas);
      for (let i = 0; i < maxPredictions; i++) {
        const classPrediction =
          prediction[i].className + ": " + prediction[i].probability.toFixed(2);
        labelContainer.childNodes[i].innerHTML = classPrediction;
        if (i == 0) {
          weeds = prediction[0].probability.toFixed(2)
        } else if (i == 1) {
          crops = prediction[1].probability.toFixed(2)
          if (weeds > crops) { let link =
"https://www.hyperwisor.com/_functions/updatech?apikey=IvDmFKo4MuUj5xU&chnumber=ch6&value=255";
            console.log('weeds');
            fetch(link, {
```

```
                method: 'GET',
                mode: "no-cors"
            })
                .then(result => {
                    console.log('Prediction sent:', result);
                })
                .catch(error => {
                    console.error('Error sending prediction:', error);
                });
        }else{
            let link =
"https://www.hyperwisor.com/_functions/updatech?apikey=IvDmFKo4MuUj5xU&chnumber=ch6&value=0";
            console.log('crops');
            fetch(link, {
                method: 'GET',
                mode: "no-cors"
            })
                .then(result => {
                    console.log('Prediction sent:', result);
                })
                .catch(error => {
                    console.error('Error sending prediction:', error);
                });
        }
    }
  }
}
// async function predict() {
//     // predict can take in an image, video or canvas html element
//     const prediction = await model.predict(webcam.canvas);
//     for (let i = 0; i < maxPredictions; i++) {
//         const classPrediction =
//             prediction[i].className + ": " + prediction[i].probability.toFixed(2);
```

```
//          labelContainer.childNodes[i].innerHTML = classPrediction;
//          // Send prediction to API
//          if (i == 0) {
//              class30 = prediction[0].probability.toFixed(2)
//          } else if (i == 1) {
//              class40 = prediction[1].probability.toFixed(2)
//          } else if (i == 2) {
//              class80 = prediction[2].probability.toFixed(2)
//          }
//          if (i == 2) {
//              if (class30 > class40 && class30 > class80) {
//                  needtospeed = 30
//              } else if (class40 > class30 && class40 > class80) {
//                  needtospeed = 40
//              } else {
//                  needtospeed = 80
//              }
//        let link =
"https://www.nikolaindustry.com/_functions/updatedata?databasekey=CnHqXcMhWpxWtNV&userid=mayurtechnologys16@gmail.com&itemid=mbTO5&speed="+needtospeed ;
//              fetch(link, {
//                  method: 'POST',
//                  mode: "no-cors"
//              })
//                  .then(result => {
//                      console.log('Prediction sent:', result);
//                  })
//                  .catch(error => {
//                      console.error('Error sending prediction:', error);
//                  });
//          }
//      } // }
</script>
```

APPENDIX – C

(Bill of Material)

Sr. No.	Component Name	Qty.	Cost
1	Raspberry Pi 4 Module B 2GB RAM	1	8496/-
2	Cytron Enhanced DC Motor Driver MD10C	4	4689/-
3	Raspberry Pi 4 Power Adapter	1	790/-
4	Lead Acid Battery	2	1500/-
5	Webcam	1	702/-
6	Auto Smart Look Car Monitor Display	1	1295/-
7	HDMI to AV Converter	1	450/-
8	HDMI to HDMI Cable and Micro HDMI	1	150/-
9	Relay Switch	1	138/-
10	Charger	1	220/-
11	Johnson Geared Motor	4	1300/-
12	Mechanical Design	1	7000/-
	Total Cost		**26730/-**

APPENDIX – D

(Paper presented in journals /conference)

"DESIGN AND IMPLEMENTATION OF AI BASED AGRI ROBOT"

Prof.Dr. S.S. Morade, Chetan Gujarathi, Nandan Kasat, Prajwal Nikam

Department of Electronics and Telecommunication Engineering K. K. Wagh Institute of Engineering Education and Research, Nashik 422003

Email ID: **ssmorade@kkwagh.edu.in**, **chetangujarathi08528@gmail.com**, **nandankasat05@gmail.com**, **pn476964@gmail.com**

Abstract

This project strives to develop a robot which is capable of performing operations to detect weed and remove weed by spraying(chemical) and mechanical methods. The mobile operated ROBOT is a concept where a human being can control a ROBOT by an android app by remote or wireless operation, without physical intervention of human being. The motion of the robot will be controlled by remote buttons and voice commands in the android app. After that Robot remembers the route that is trained using android app. Density of grass is sensed by robot and based on that decision is taken to apply method of removing weed. Boundary areas of field are provided to robot using android app. The main controller is the microcontroller (Rasberi Pi 4B) that supervises the entire process. Farmer can utilize this robot to decrease the labour and increase yield of crops so that the profit and efficiency will be higher and also water and soil pollution will be less. This method is the best solution to remove weed and save environment.

Introduction

Agriculture is the backbone of the Indian economy. Presently a number of researches are being done to increase the application of robotics in agriculture. Farmers cultivate vegetables with manual farming technologies. But obviously, weeding removal is also manual. Farmers use a tractor for removing weeds if distance between plant is large which involves direct involvement of human. The inhalation of pesticides sprayed earlier causes permanent damage to the lung tissues in recent years, the development of autonomous vehicles in agriculture has experienced an increased interest. This robot is a multipurpose application robot that will automate the slow, repetitive, and dull tasks for the farmers. Replaces the manual removing weed method by an automated one is thereby reducing use of harmful chemical on humans. System provides an additional feature of grass sensing using image sensing by camera for detection of type of grass and its density for removing mechanically.

G. Kavitha et.all,[1] done work on weed removal using robotic arm by using image processing.
Xiaolong Wu et al.,[2] proposed a robotic weed control system using multiple cameras. In their work, they utilized both mechanical and chemical methods for weeding. Victor Partel et al. [4] conducted an experiment on smart weed management using artificial and real plants. They tested two types of GPU cards for image processing and found that one of the cards was better. The aim of the experiment was to reduce the cost of weeding and improve precision weeding. Rekha Rajaa et al. [5] developed a weed-crop classification system using crop signalling techniques. They achieved a sprayer weed detection accuracy of 98.11% using a micro jet nozzle for spraying. This technique could potentially address labor problems in countries like the US. David Reiser et al. [7] worked on an autonomous robot used for intra-row weeding in vineyards. The robot was tested in the inner field and then in the outer field, and it uses terrain wheels for this purpose. Wedding is a labour-intensive task and is often done manually which can be time consuming and costly. Robotics method has the potential to improve efficiency and accuracy of wedding. This system is useful in rainy season.

Proposed Methodology

Fig 1is block diagram of proposed system. The proposed system is specially designed for detecting weed and spraying herbicide based on detection and can also be used for removal wedding on different crops such as onion and fruit farm. Camera is interface to the system using microcontroller. Motors are interfaced to port of microcontroller. (Raspberry Pi 4 B). Development of software to detect weed in python. Analysis of grass and its density using image processing and based on that activate the spraying pump using relay. Wireless interface is required to perform remote activity. The spraying path coordinate are stored for doing routine work. Mechanical assembly is prepared to carry 10 lit drum to carry herbicide Testing is done indoor. Latter on it can be checked outer field.

Tem and humidity is sensed through ADC interface. Based on tem and humidity herbicide solution is prepared

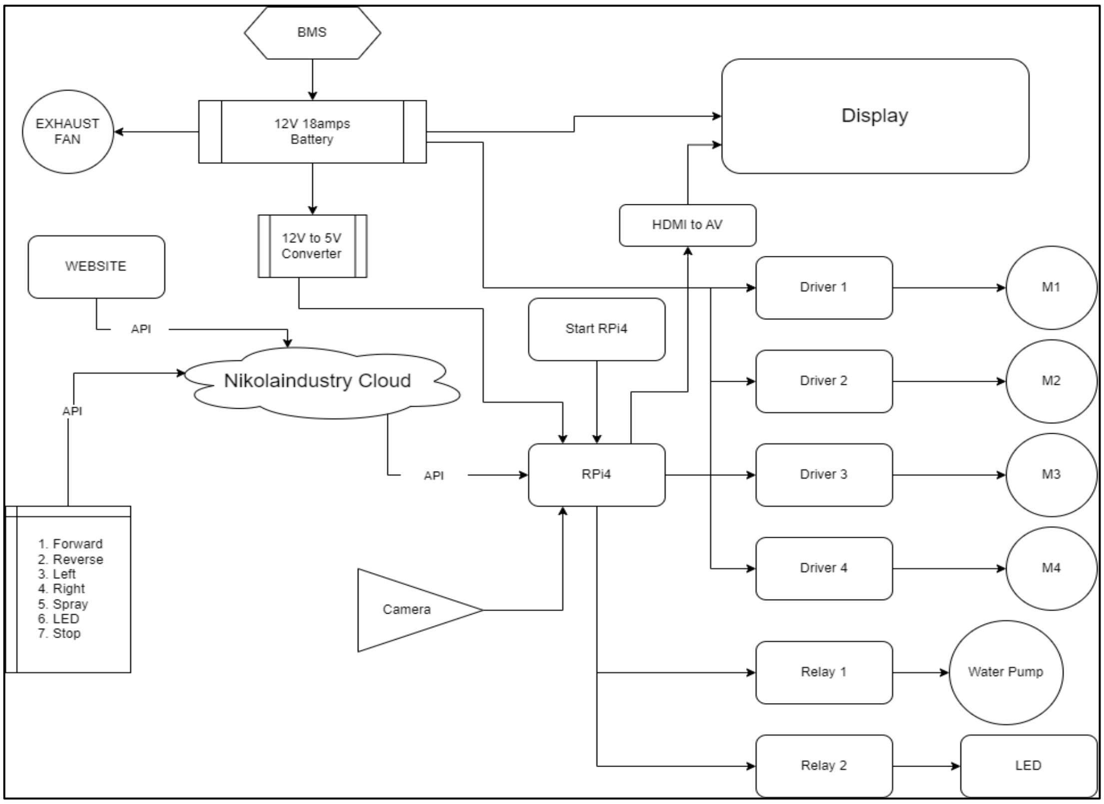

Fig 1. Block Diagram of Agri-Robot System

Detect the weed:

Steps to detect the weed

1. Read the image

2. Convert image into a gray image

3. Mask green part of the image

4. Obtain eroded or dilated image

5. Summation of white pixel

6. If Sum greater than threshold weed detected otherwise no weed

7. Process is repeated for next detection

Experimental Result

Fig 2 shows android app by wireless operation. Right, left, forward and backward operation possible by using 4 motor. Pump can be ON or OFF by using front display. Fig 4 shows detection of weds with camera. Here it is greater than the threshold value. Yellow dot indicate presence of weed. Fig 5 is shows Prototype of aggrirobot.

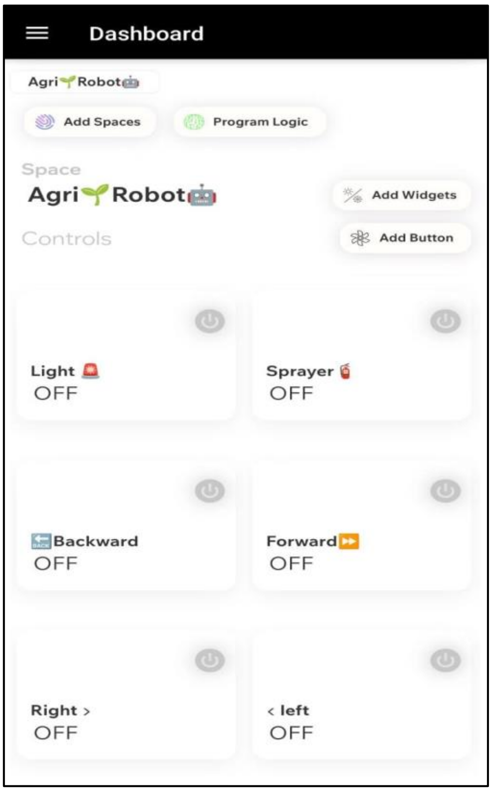

Fig.2: Android Design

Weed as Grass	After Weed detection
	

Fig 4. Detection as grass in grape wine yard (Yellow dots indicate detection of weed)

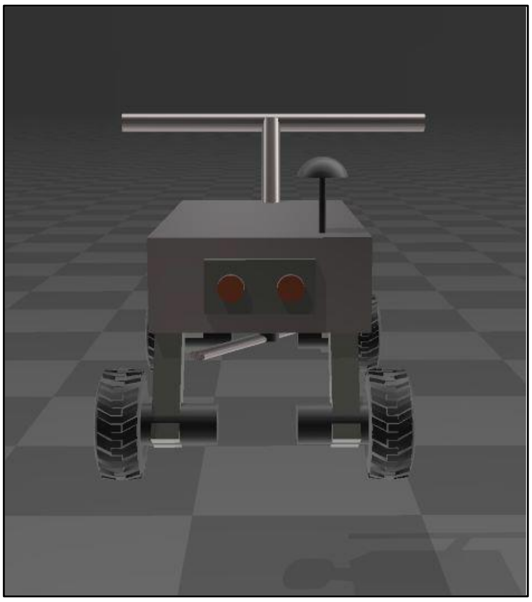

Fig. 5 Agri robot 3-D model

Conclusion

This robot works effectively and efficiently to control weeds while minimizing harm to the environment. This experiment will be useful in determining the effectiveness of weed control in agriculture. A real-time robot is needed for effective herbicide spraying in all seasons.

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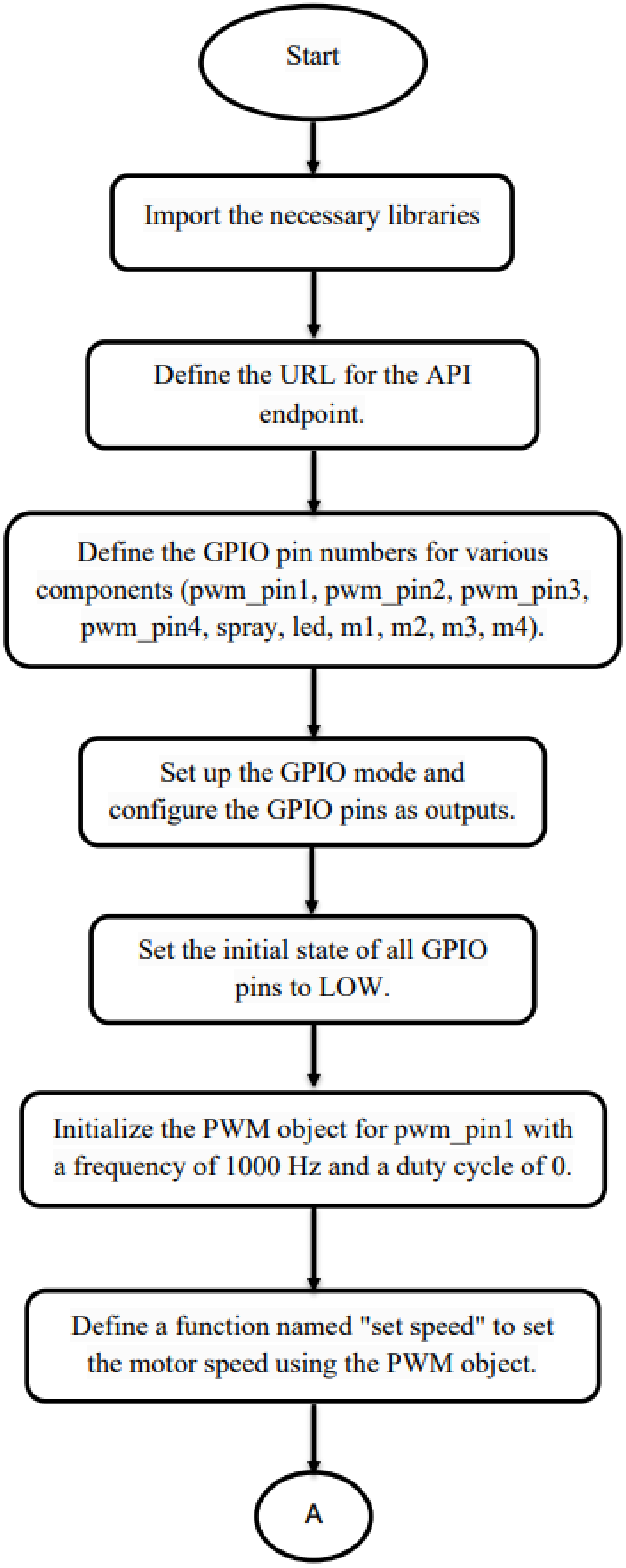
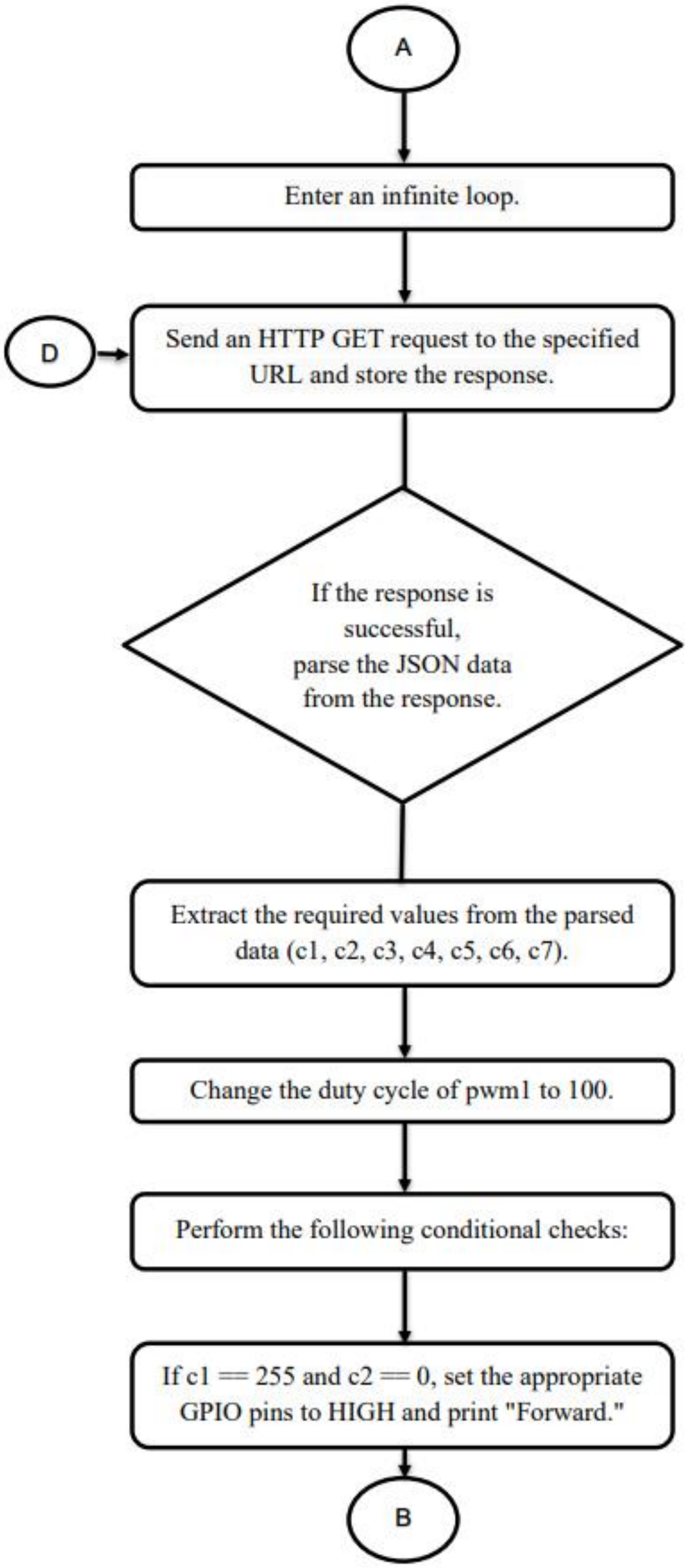
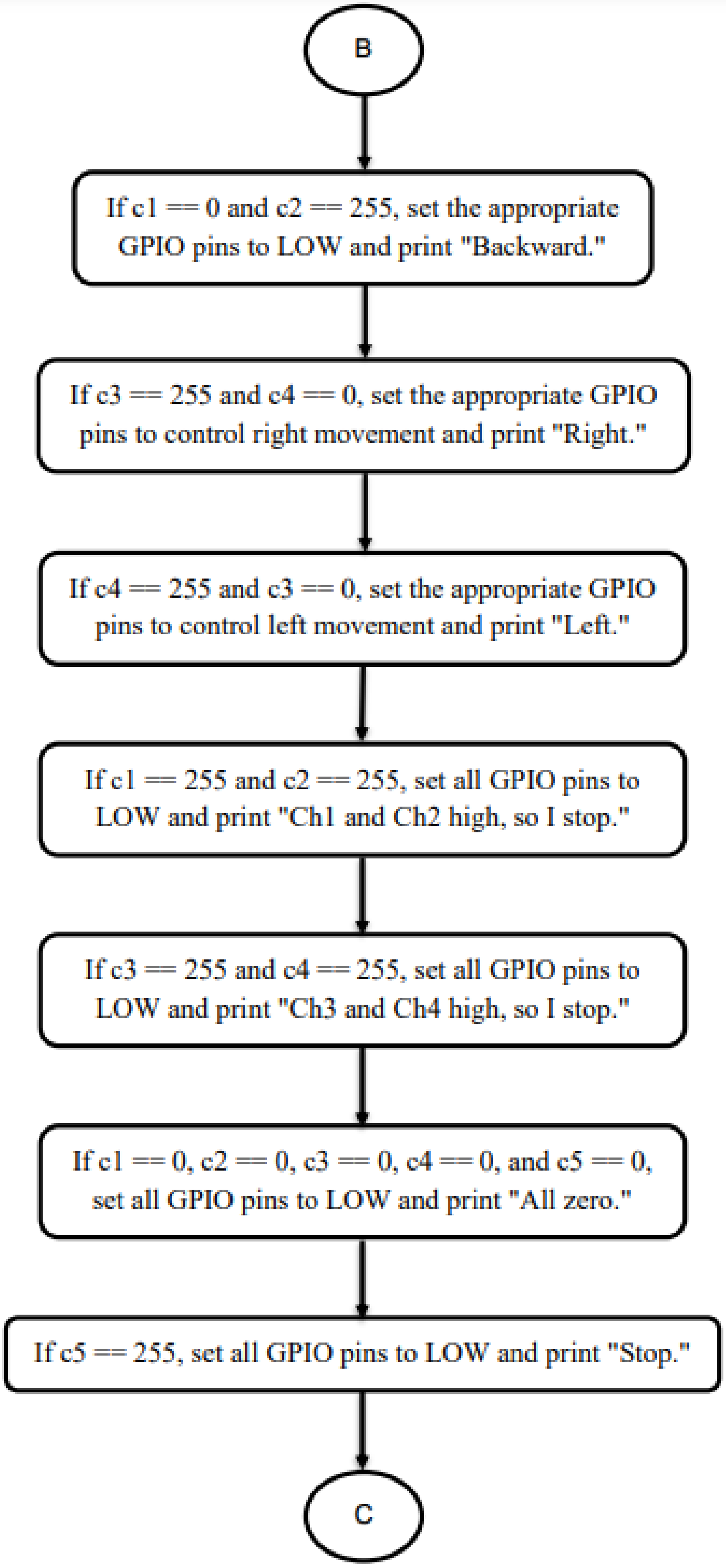
[10] Crop and Weed Detection Based on Texture and Size Features and Automatic Spraying of Herbicides - Amrutha A. Aware, Kavitha Joshi.

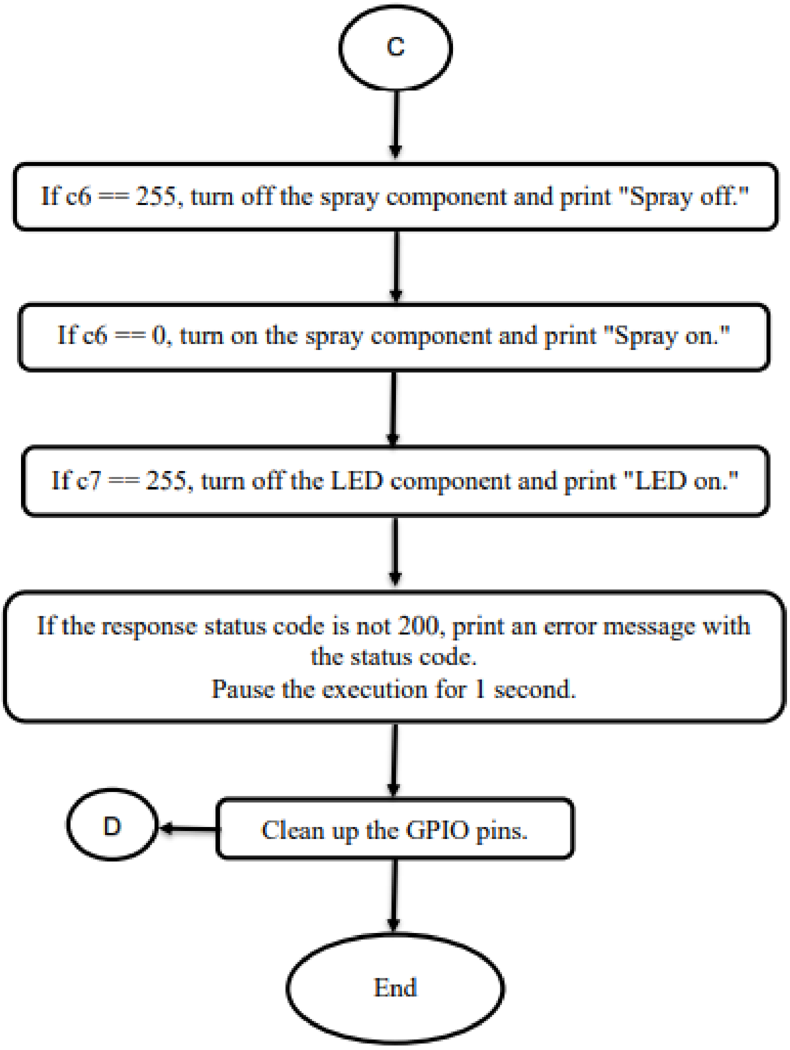
Development and Automation of Robot with Spraying Mechanism for Agricultural Applications

Flowchart:


Start
Import the necessary libraries
Define the URL for the API endpoint.
Define the GPIO pin numbers for various components (pwm_pin1, pwm_pin2, pwm_pin3, pwm_pin4, spray, led, m1, m2, m3, m4).
Set up the GPIO mode and configure the GPIO pins as outputs.
Set the initial state of all GPIO pins to LOW.
Initialize the PWM object for pwm_pin1 with a frequency of 1000 Hz and a duty cycle of 0.
Define a function named "set speed" to set the motor speed using the PWM object.
A


A
Enter an infinite loop.
D
Send an HTTP GET request to the specified URL and store the response.
If the response is successful, parse the JSON data from the response.
Extract the required values from the parsed data (c1, c2, c3, c4, c5, c6, c7).
Change the duty cycle of pwm1 to 100.
Perform the following conditional checks:
If c1 == 255 and c2 == 0, set the appropriate GPIO pins to HIGH and print "Forward."
B


B
If c1 == 0 and c2 == 255, set the appropriate GPIO pins to LOW and print "Backward."
If c3 == 255 and c4 == 0, set the appropriate GPIO pins to control right movement and print "Right."
If c4 == 255 and c3 == 0, set the appropriate GPIO pins to control left movement and print "Left."
If c1 == 255 and c2 == 255, set all GPIO pins to LOW and print "Ch1 and Ch2 high, so I stop."
If c3 == 255 and c4 == 255, set all GPIO pins to LOW and print "Ch3 and Ch4 high, so I stop."
If c1 == 0, c2 == 0, c3 == 0, c4 == 0, and c5 == 0, set all GPIO pins to LOW and print "All zero."
If c5 == 255, set all GPIO pins to LOW and print "Stop."
C


C
If c6 == 255, turn off the spray component and print "Spray off."
If c6 == 0, turn on the spray component and print "Spray on."
If c7 == 255, turn off the LED component and print "LED on."
If the response status code is not 200, print an error message with the status code.
Pause the execution for 1 second.
D
Clean up the GPIO pins.
End

APPENDIX - E

(Certificate of Paper Presentation/Project Competition)

IRJIET

IJNRD
International Research Journal
Research Through Innovation

IJRAT
International Journal of Research in Advent Technology

ICRTET - 2023

Certificate

Chaudhari Attarsingh Yadav Memorial Education Trust's

SIDDHANT COLLEGE OF ENGINEERING

This is to certified that Mr./Ms. Chetan Gujarathi *has actively and significantly Participated /Presented Paper /Reviewed Paper / Chaired Session/ Co-ordinated / Volunteered in* ***INTERNATIONAL CONFERENCE ON RECENT TRENDS IN ENGINEERING & TECHNOLOGY ICRTET-2023*** *Organized by Siddhant College Of Engineering, Sudumbare, Pune during 18th & 19th April 2023.*

Dr. P. A. Makasare	**Dr. U. V. Shinde**	**Dr. L. V. Kamble**
Convener	**Convener**	**Principal**

Certificate

Chaudhari Attarsingh Yadav Memorial Education Trust's

SIDDHANT COLLEGE OF ENGINEERING

This is to certified that Mr./~~M~~s. Nandan Kasat *has actively and significantly Participated /Presented Paper /Reviewed Paper / Chaired Session/ Co-ordinated / Volunteered in* ***INTERNATIONAL CONFERENCE ON RECENT TRENDS IN ENGINEERING & TECHNOLOGY ICRTET-2023*** *Organized by Siddhant College Of Engineering, Sudumbare, Pune during 18th & 19th April 2023.*

Dr. P. A. Makasare	**Dr. U. V. Shinde**	**Dr. L. V. Kamble**
Convener	**Convener**	**Principal**

IRJIET

International Research Journal IJNRD Research Through Innovation

IJRAT International Journal of Research in Advent Technology

ICRTET - 2023

Certificate

Chaudhari Attarsingh Yadav Memorial Education Trust's

SIDDHANT COLLEGE OF ENGINEERING

This is to certified that Mr./~~Ms.~~ Prajwal Nikam has actively and significantly Participated /Presented Paper /Reviewed Paper / Chaired Session/ Co-ordinated / Volunteered in ***INTERNATIONAL CONFERENCE ON RECENT TRENDS IN ENGINEERING & TECHNOLOGY ICRTET-2023*** *Organized by Siddhant College Of Engineering, Sudumbare, Pune during 18th & 19th April 2023.*

Dr. P. A. Makasare	**Dr. U. V. Shinde**	**Dr. L. V. Kamble**
Convener	**Convener**	**Principal**

K. K. Wagh Education Society's

K. K. Wagh Institute of Engineering Education and Research, Nashik

Website: www.engg.kkwagh.edu.in

(Affiliated to Savitribai Phule Pune University and Approved by AICTE, New Delhi)

(An autonomous institute from A.Y.2022-23)

Department of Electronics & Telecommunication Engineering
in collaboration with IETE organizes

"Telekinesis 2k23 – Project Competition"

Certificate

This is to certify that, Mr. / Ms. ______________________ *of* BE E&TC, KKWIEER

has secured ___—___ *position in Project competition held in the event* ***Telekinesis 2023*** *organized by E&TC department on 20th May, 2023 at K. K. Wagh Institute of Engineering and Research, Nashik*

Dr. S. A. Patil (Ugale)	**Dr. D. M. Chandwadkar**	**Dr. K. N. Nandurkar**
U.G. Co-ordinator	Dean Student Affairs, HOD, E&TC Engg.	Principal

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Maratha Vidya Prasarak Samaj's

Karmaveer Adv Baburao Ganpatrao Thakare College of Engineering, Nashik

Permanently Affiliated to Savitribai Phule Pune University, Pune and Approved by AICTE, New Delhi

CERTIFICATE

OF EXCELLENCE

IS PRESENTED TO :

CHETAN GUJARATHI

Has participated in the **Project Hunt** competition in
MVP ELICIT 2K23

Organized by
Progressive Association of Electronics and Telecommunication Engineering Students (PAES)MVPS's KBT College of Engineering, Nashik

Mr. V. R. Sonawane PAES COORDINATOR	**Dr. Vijay Birari** HOD (E&TC DEPARTMENT)	**Dr. Vijay Birari** VICE PRINCIPAL	**Dr. S. R. Devane** PRINCIPAL

Maratha Vidya Prasarak Samaj's

Karmaveer Adv Baburao Ganpatrao Thakare College of Engineering, Nashik

Permanently Affiliated to Savitribai Phule Pune University, Pune and Approved by AICTE, New Delhi

KBTCOE

CERTIFICATE

OF EXCELLENCE

IS PRESENTED TO :

NANDAN KASAT

Has participated in the **Project Hunt** competition in

MVP ELICIT 2K23

Organized by

Progressive Association of Electronics and Telecommunication Engineering Students

(PAES)MVPS's KBT College of Engineering, Nashik

Sonawane			
Mr. V. R. Sonawane PAES COORDINATOR	**Dr. Vijay Birari** HOD (E&TC DEPARTMENT)	**Dr. Vijay Birari** VICE PRINCIPAL	**Dr. S. R. Devane** PRINCIPAL

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CERTIFICATE

OF EXCELLENCE

IS PRESENTED TO :

PRAJWAL NIKAM

Has participated in the **Project Hunt** competition in
MVP ELICIT 2K23

Organized by
Progressive Association of Electronics and Telecommunication Engineering Students
(PAES)MVPS's KBT College of Engineering, Nashik

Mr. V. R. Sonawane	**Dr. Vijay Birari**	**Dr. Vijay Birari**	**Dr. S. R. Devane**
PAES COORDINATOR	HOD (E&TC DEPARTMENT)	VICE PRINCIPAL	PRINCIPAL

APPENDIX - F

(Certificate and Report for Plagiarism Check)

Plagiarism Certificate

This is to certify that the project work titled "Design and Implementation of AI Based Agri Robot", is a part of project work carried out by "Chetan Dipak Gujarathi, Nandan Shailesh Kasat, Prajwal Subhash Nikam" under the guidance of Prof. Dr. S. S. Morade at K. K. Wagh Institute of Engineering Education and Research, Nashik, in the partial fulfillment of the requirements for Bachelor's degree in Electronics and Telecommunication Engineering.

To the best of our knowledge, the work included in this report is an original work carried out by us independently. The percentage of plagiarism is 1%. The results of the project work in part or whole have not been submitted to any other Institute/University for the award of any degree.

1. Chetan Dipak Gujarathi
2. Nandan Shailesh Kasat
3. Prajwal Subhash Nikam

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Sources included in the report

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SA	**3555.pdf** Document 3555.pdf (D142327474)	2

APPENDIX - G

(Data sheets)

DATASHEET

Raspberry Pi 4 Model B

Release 1

June 2019

Table 1: Release History

Release	Date	Description
1	21/06/2019	First release

The latest release of this document can be found at `https://www.raspberrypi.org`

1 Introduction

The Raspberry Pi 4 Model B (Pi4B) is the first of a new generation of Raspberry Pi computers supporting more RAM and with siginficantly enhanced CPU, GPU and I/O performance; all within a similar form factor, power envelope and cost as the previous generation Raspberry Pi 3B+.

The Pi4B is avaiable with either 1, 2 and 4 Gigabytes of LPDDR4 SDRAM.

2 Features

2.1 Hardware

- Quad core 64-bit ARM-Cortex A72 running at 1.5GHz
- 1, 2 and 4 Gigabyte LPDDR4 RAM options
- H.265 (HEVC) hardware decode (up to 4Kp60)
- H.264 hardware decode (up to 1080p60)
- VideoCore VI 3D Graphics
- Supports dual HDMI display output up to 4Kp60

2.2 Interfaces

- 802.11 b/g/n/ac Wireless LAN
- Bluetooth 5.0 with BLE
- 1x SD Card
- 2x micro-HDMI ports supporting dual displays up to 4Kp60 resolution
- 2x USB2 ports
- 2x USB3 ports
- 1x Gigabit Ethernet port (supports PoE with add-on PoE HAT)
- 1x Raspberry Pi camera port (2-lane MIPI CSI)
- 1x Raspberry Pi display port (2-lane MIPI DSI)
- 28x user GPIO supporting various interface options:
  - Up to 6x UART
  - Up to 6x I2C
  - Up to 5x SPI
  - 1x SDIO interface
  - 1x DPI (Parallel RGB Display)
  - 1x PCM

- Up to 2x PWM channels
- Up to 3x GPCLK outputs

2.3 Software

- ARMv8 Instruction Set
- Mature Linux software stack
- Actively developed and maintained
  - Recent Linux kernel support
  - Many drivers upstreamed
  - Stable and well supported userland
  - Availability of GPU functions using standard APIs

3 Mechanical Specification

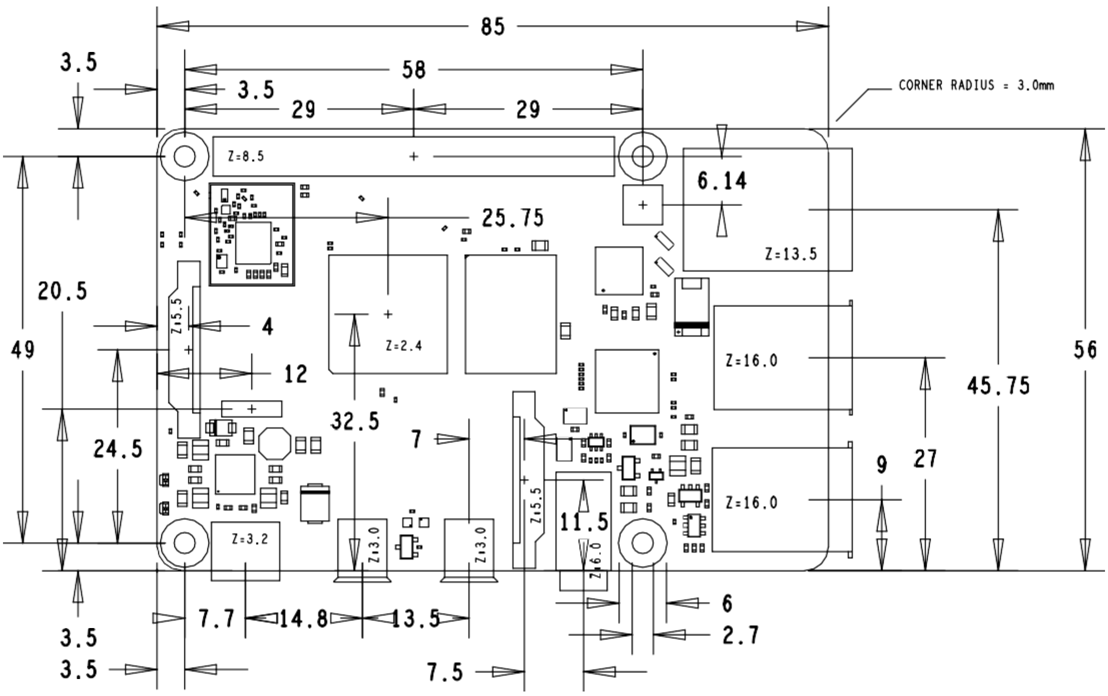


Figure 1: Mechanical Dimensions

4 Electrical Specification

Caution! Stresses above those listed in Table 2 may cause permanent damage to the device. This is a stress rating only; functional operation of the device under these or any other conditions above those listed in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Symbol	Parameter	Minimum	Maximum	Unit
VIN	5V Input Voltage	-0.5	6.0	V

Table 2: Absolute Maximum Ratings

Please note that VDD_IO is the GPIO bank voltage which is tied to the on-board 3.3V supply rail.

Symbol	Parameter	Conditions	Minimum	Typical	Maximum	Unit
V_{IL}	Input low voltage[a]	VDD_IO = 3.3V	-	-	TBD	V
V_{IH}	Input high voltage[a]	VDD_IO = 3.3V	TBD	-	-	V
I_{IL}	Input leakage current	TA = +85°C	-	-	TBD	μA
C_{IN}	Input capacitance	-	-	TBD	-	pF
V_{OL}	Output low voltage[b]	VDD_IO = 3.3V, IOL = -2mA	-	-	TBD	V
V_{OH}	Output high voltage[b]	VDD IO = 3.3V, IOH = 2mA	TBD	-	-	V
I_{OL}	Output low current[c]	VDD IO = 3.3V, VO = 0.4V	TBD	-	-	mA
I_{OH}	Output high current[c]	VDD_IO = 3.3V, VO = 2.3V	TBD	-	-	mA
R_{PU}	Pullup resistor	-	TBD	-	TBD	kΩ
R_{PD}	Pulldown resistor	-	TBD	-	TBD	kΩ

[a] Hysteresis enabled
[b] Default drive strength (8mA)
[c] Maximum drive strength (16mA)

Table 3: DC Characteristics

Pin Name	Symbol	Parameter	Minimum	Typical	Maximum	Unit
Digital outputs	t_{rise}	10-90% rise time[a]	-	TBD	-	ns
Digital outputs	t_{fall}	90-10% fall time[a]	-	TBD	-	ns

[a] Default drive strength, CL = 5pF, VDD_IO = 3.3V

Table 4: Digital I/O Pin AC Characteristics

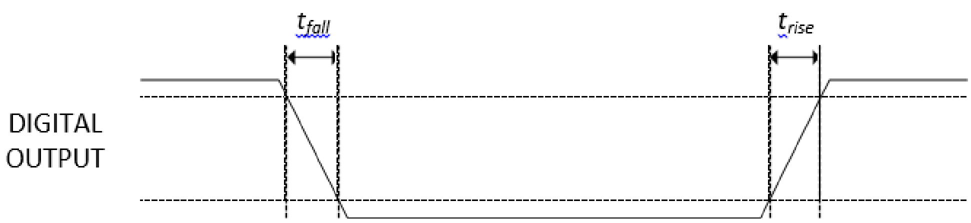


Figure 2: Digital IO Characteristics

1.1 Power Requirements

The Pi4B requires a good quality USB-C power supply capable of delivering 5V at 3A. If attached downstream USB devices consume less than 500mA, a 5V, 2.5A supply may be used.

2 Peripherals

2.1 GPIO Interface

The Pi4B makes 28 BCM2711 GPIOs available via a standard Raspberry Pi 40-pin header. This header is backwards compatible with all previous Raspberry Pi boards with a 40-way header.

5.1.1 GPIO Pin Assignments

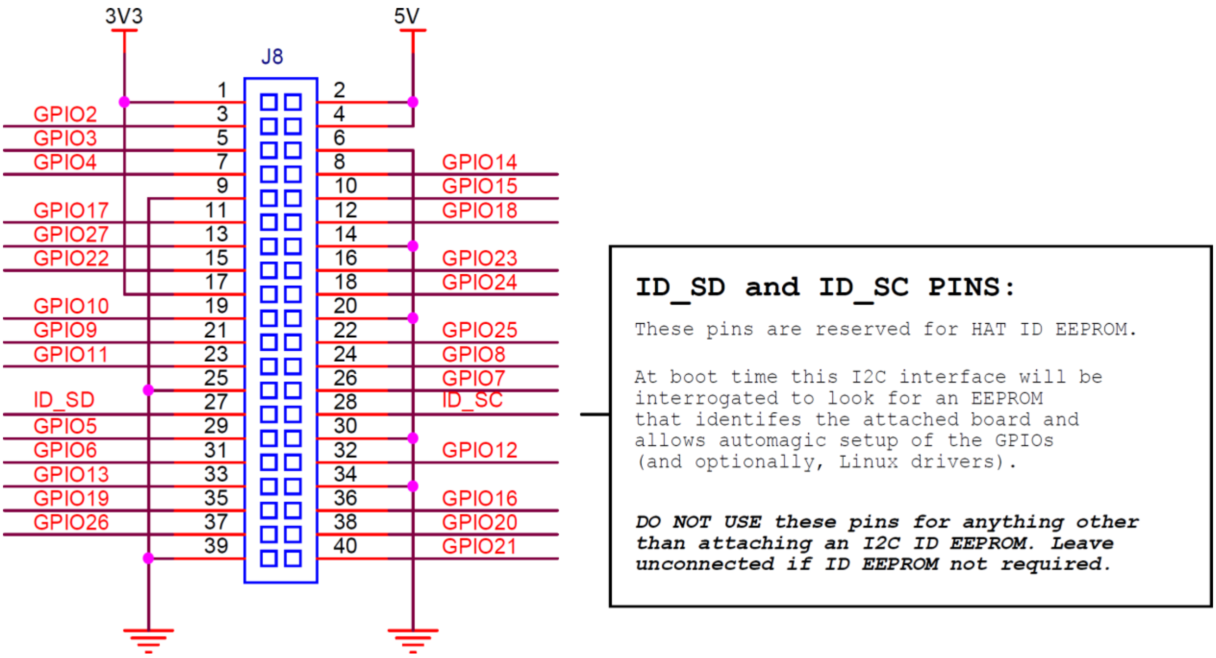


Figure 3: GPIO Connector Pinout

As well as being able to be used as straightforward software controlled input and output (with programmable pulls), GPIO pins can be switched (multiplexed) into various other modes backed by dedicated peripheral blocks such as I2C, UART and SPI.

In addition to the standard peripheral options found on legacy Pis, extra I2C, UART and SPI peripherals have been added to the BCM2711 chip and are available as further mux options on the Pi4. This gives users much more flexibility when attaching add-on hardware as compared to older models.

5.1.2 GPIO Alternate Functions

GPIO	Default Pull	ALT0	ALT1	ALT2	ALT3	ALT4	ALT5
0	High	SDA0	SA5	PCLK	SPI3_CE0_N	TXD2	SDA6
1	High	SCL0	SA4	DE	SPI3_MISO	RXD2	SCL6
2	High	SDA1	SA3	LCD_VSYNC	SPI3_MOSI	CTS2	SDA3
3	High	SCL1	SA2	LCD_HSYNC	SPI3_SCLK	RTS2	SCL3
4	High	GPCLK0	SA1	DPI_D0	SPI4_CE0_N	TXD3	SDA3
5	High	GPCLK1	SA0	DPI_D1	SPI4_MISO	RXD3	SCL3
6	High	GPCLK2	SOE_N	DPI_D2	SPI4_MOSI	CTS3	SDA4
7	High	SPI0_CE1_N	SWE_N	DPI_D3	SPI4_SCLK	RTS3	SCL4
8	High	SPI0_CE0_N	SD0	DPI_D4	-	TXD4	SDA4
9	Low	SPI0_MISO	SD1	DPI_D5	-	RXD4	SCL4
10	Low	SPI0_MOSI	SD2	DPI_D6	-	CTS4	SDA5
11	Low	SPI0_SCLK	SD3	DPI_D7	-	RTS4	SCL5
12	Low	PWM0	SD4	DPI_D8	SPI5_CE0_N	TXD5	SDA5
13	Low	PWM1	SD5	DPI_D9	SPI5_MISO	RXD5	SCL5
14	Low	TXD0	SD6	DPI_D10	SPI5_MOSI	CTS5	TXD1
15	Low	RXD0	SD7	DPI_D11	SPI5_SCLK	RTS5	RXD1
16	Low	FL0	SD8	DPI_D12	CTS0	SPI1_CE2_N	CTS1
17	Low	FL1	SD9	DPI_D13	RTS0	SPI1_CE1_N	RTS1
18	Low	PCM_CLK	SD10	DPI_D14	SPI6_CE0_N	SPI1_CE0_N	PWM0
19	Low	PCM_FS	SD11	DPI_D15	SPI6_MISO	SPI1_MISO	PWM1
20	Low	PCM_DIN	SD12	DPI_D16	SPI6_MOSI	SPI1_MOSI	GPCLK0
21	Low	PCM_DOUT	SD13	DPI_D17	SPI6_SCLK	SPI1_SCLK	GPCLK1
22	Low	SD0_CLK	SD14	DPI_D18	SD1_CLK	ARM_TRST	SDA6
23	Low	SD0_CMD	SD15	DPI_D19	SD1_CMD	ARM_RTCK	SCL6
24	Low	SD0_DAT0	SD16	DPI_D20	SD1_DAT0	ARM_TDO	SPI3_CE1_N
25	Low	SD0_DAT1	SD17	DPI_D21	SD1_DAT1	ARM_TCK	SPI4_CE1_N
26	Low	SD0_DAT2	TE0	DPI_D22	SD1_DAT2	ARM_TDI	SPI5_CE1_N
27	Low	SD0_DAT3	TE1	DPI_D23	SD1_DAT3	ARM_TMS	SPI6_CE1_N

Table 5: Raspberry Pi 4 GPIO Alternate Functions

MD10C R3.0
10Amp
DC Motor Driver

User's Manual Rev3.0

V1.0

Aug 2018

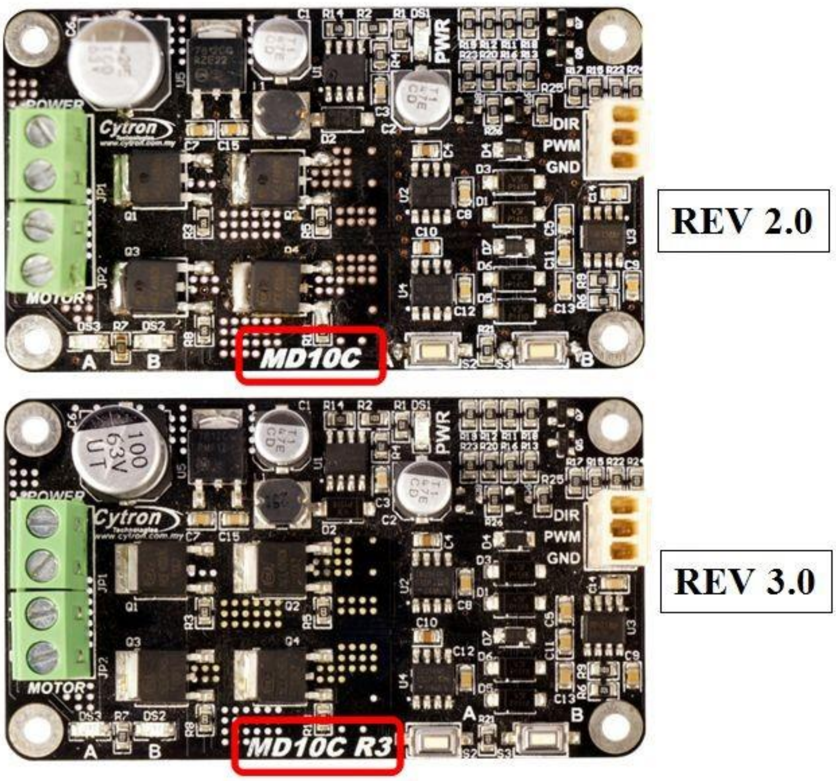
1. INTRODUCTION/OVERVIEW

MD10C is another version of the MD10B(Launched in 2008, uses mechanical relays) which is designed to drive high current brushed DC motor up to 13A continuously. It offers several enhancements over the MD10B such as support for both locked-antiphase and sign-magnitude PWM signal as well as using full solid state components which result in faster response time and eliminate the wear and tear of the mechanical relay.

The MD10C has been designed with the capabilities and features of:

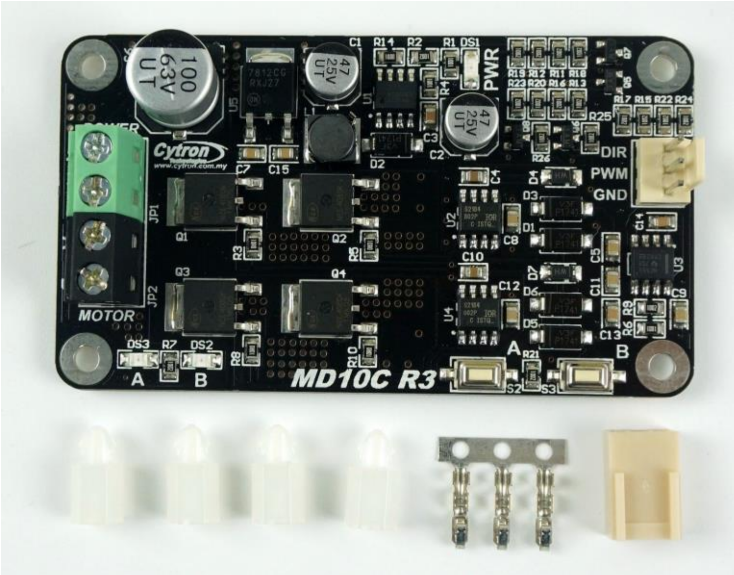
- Bi-directional control for one DC Brushed motor, single channel.
- Support motor voltage ranges from 5V to 30V.
- Maximum current up to 13A continuous and 30A peak (10 second).
- 3.3V and 5V logic level input, which support signal from Arduino, Raspberry Pi and any controller that can produces PWM or logic signal of that voltage, 3.3V or 5.0.
- Solid state components provide faster response time and eliminate the wear and tear of mechanical relay.
- Full NMOS H-Bridge for better efficiency and no heat sink is required.
- Speed control PWM frequency up to 20KHz (output frequency is same as input frequency).
- Support both Locked-Antiphase and Sign-Magnitude PWM operation.
- The new MD10C should be powered from a single power source, the Vmotor only. No additional Vin is required.
- Support TTL PWM from microcontroller, **not PWM from RC receiver**.
- **Dimension:**75mm x 43mm

***MD10C is now Revision 3.0**.

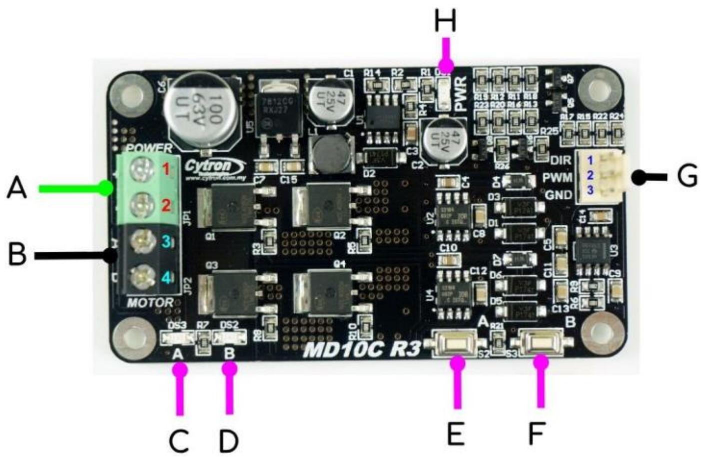


2. PACKING LIST

Please check the parts and components according to the packing list. If there are any parts missing, please contact us at sales@cytron.io immediately.



- 1 x MD10C R3.0 10A DC Motor Driver
- 1x 2510 PCB Connector - 3 Ways (Female)
- 3 x 2510 Terminal Pin
- 4 x plastic spacer (~7mm)
- User's manual can be downloa ded from https://www.cytron.io



A. Terminal Block (**GREEN**) - For Vmotor, should be connected to power source example battery with voltage ranging from 5V to 30VDC. Please ensure the **voltage polarity (Positive and Negative) is correctly connected** before applying power. MD10C does not come with Reverse Polarity Protection.

Pin No.	Pin Name	Description
1	V motor Power +	Positive Supply (5V to 30VDC)
2	V motor Power -	Negative Supply or Ground terminal

B. Terminal Block (Black) - Connect to DC brushed motor, or load.

Pin No.	Pin Name	Description
3	Motor Output A	Connect to motor terminal A
4	Motor Output B	Connect to motor terminal B

C. Red LED A – Turns on when the output A is high and output B is low. Indicates the current flows from output A to B.

D. Red LED B – Turns on when the output A is low and output B is high. Indicates the current flows from output B to A.

3. BOARD LAYOUT AND SPECIFICATION

E. Test Button A – When this button is pressed, current flows from output A to B and motor will turn CW (or CCW depending on the motor connection).

F. Test Button B – When this button is pressed, current flows from output B to A and motor will turn CCW (or CW depending on the connection).

G. Control Input Signal Pin

Pin No.	Pin Name	Description
1	GND	Logic ground.
2	*PWM	PWM input for speed control, support upto 20KHz
3	DIR	Direction control.

*Note that it is not for RC PWM operation

The truth table for the control logic is as follow:

Pin 2 (PWM)	Pin 3 (DIR)	Output A	Output B	Operation
Low	X (Don't care)	Low	Low	Brake Low
High	Low	High	Low	Forward
High	High	Low	High	Reserve

H. Green LED – Power LED. Should be illuminate when the board is powered on.

Absolute Maximum Rating

No.	Parameters	Min	Typical	Max	Unit
1	Power Input Voltage	5	-	30	V
2	I_{MAX} (Maximum Continuous Motor Current)*	-	-	13	A
3	I_{PEAK} – (Peak Motor Current) **	-	-	30	A
4	V_{IOH} (Logic Input – High Level)	3	-	5.5	V
5	V_{IOL} (Logic Input – Low Level)	0	0	0.5	V
6	Maximum PWM Frequency ***	-	-	20	KHz

**** Tested under 25℃ (room temperature) environment, without airflow and heatsink.***
***** Must not exceed 10 seconds.***
****** Actual output frequency is same as input frequency.***

4. BOARD LAYOUT AND SPECIFICATION

I. Test Button A – When this button is pressed, current flows from output A to B and motor will turn CW (or CCW depending on the motor connection).

J. Test Button B – When this button is pressed, current flows from output B to A and motor will turn CCW (or CW depending on the connection).

K. Control Input Signal Pin

Pin No.	Pin Name	Description
1	GND	Logic ground.
2	*PWM	PWM input for speed control, support upto 20KHz
3	DIR	Direction control.

*Note that it is not for RC PWM operation

The truth table for the control logic is as follow:

Pin 2 (PWM)	Pin 3 (DIR)	Output A	Output B	Operation
Low	X (Don't care)	Low	Low	Brake Low
High	Low	High	Low	Forward
High	High	Low	High	Reserve

L. Green LED – Power LED. Should be illuminate when the board is powered on.

Absolute Maximum Rating

No.	Parameters	Min	Typical	Max	Unit
1	Power Input Voltage	5	-	30	V
2	I_{MAX} (Maximum Continuous Motor Current)*	-	-	13	A
3	I_{PEAK} – (Peak Motor Current) **	-	-	30	A
4	V_{IOH} (Logic Input – High Level)	3	-	5.5	V
5	V_{IOL} (Logic Input – Low Level)	0	0	0.5	V
6	Maximum PWM Frequency ***	-	-	20	KHz

**** Tested under 25℃ (room temperature) environment, without airflow and heatsink.***
***** Must not exceed 10 seconds.***
****** Actual output frequency is same as input frequency.***

User Guide

2 Channel 5V Optical Isolated Relay Module

This is a LOW Level 5V 2-channel relay interface board, and each channel needs a 15-20mA driver current. It can be used to control various appliances and equipment with large current. It is equipped with high-current relays that work under AC250V 10A or DC30V 10A. It has a standard interface that can be controlled directly by microcontroller. This module is optically isolated from high voltage side for safety requirement and also prevent ground loop when interface to microcontroller.

Brief Data:

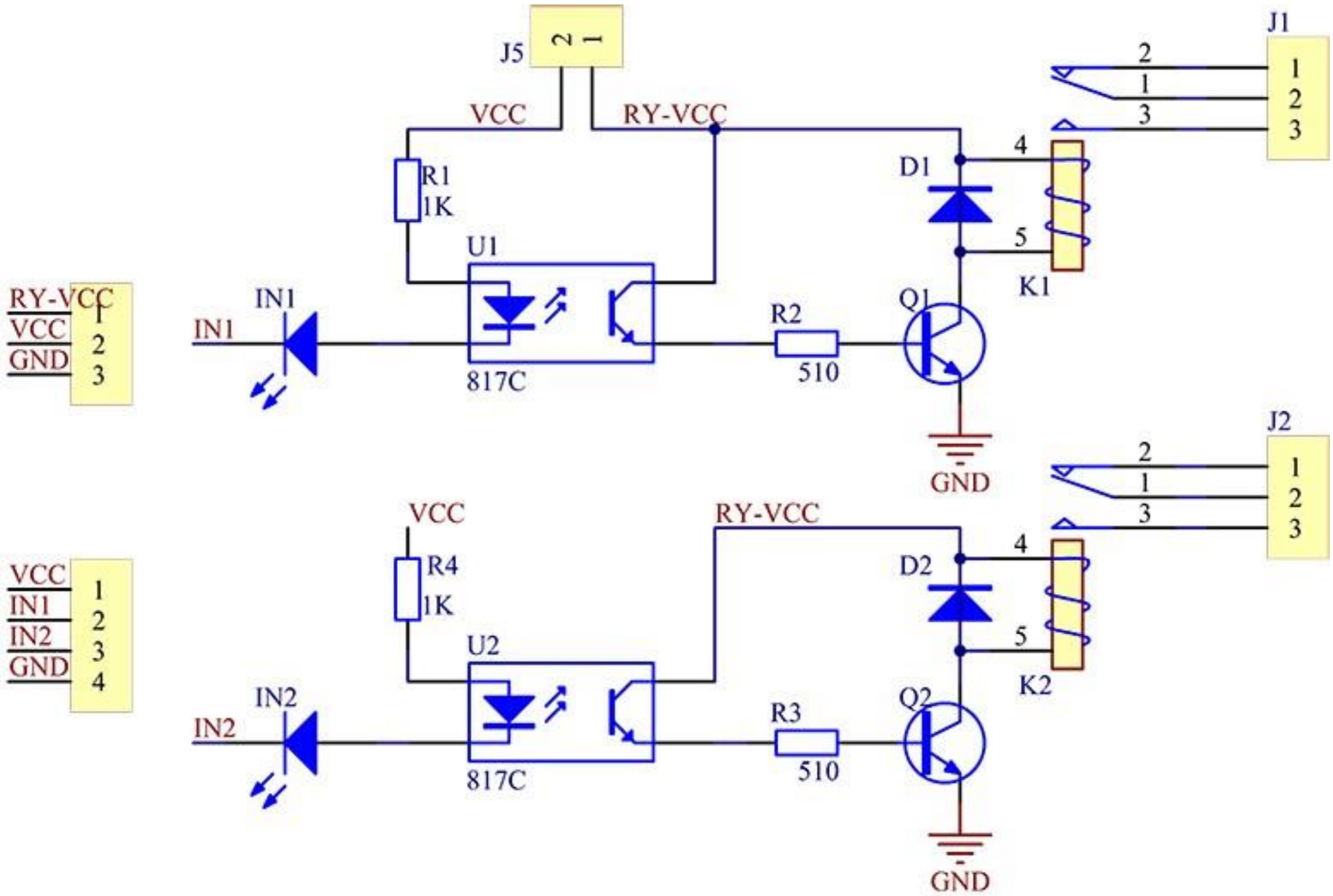
- Relay Maximum output: DC 30V/10A, AC 250V/10A.
- 2 Channel Relay Module with Opto-coupler. LOW Level Trigger expansion board, which is compatible with Arduino control board.
- Standard interface that can be controlled directly by microcontroller (8051, AVR, *PIC, DSP, ARM, ARM, MSP430, TTL logic).
- Relay of high quality low noise relays SPDT. A common terminal, a normally open, one normally closed terminal.
- Opto-Coupler isolation, for high voltage safety and prevent ground loop with microcontroller.

Schematic:

VCC and RY-VCC are also the power supply of the relay module. When you need to drive a large power load, you can take the jumper cap off and connect an extra power to RY-VCC to supply the relay; connect VCC to 5V of the MCU board to supply input signals.

NOTES: If you want complete optical isolation, connect "Vcc" to Arduino +5 volts but do NOT connect Arduino Ground. Remove the Vcc to JD-Vcc jumper. Connect a separate +5 supply to "JD-Vcc" and board Gnd. This will supply power to the transistor drivers and relay coils.

If relay isolation is enough for your application, connect Arduino +5 and Gnd, and leave Vcc to JD-Vcc jumper in place.

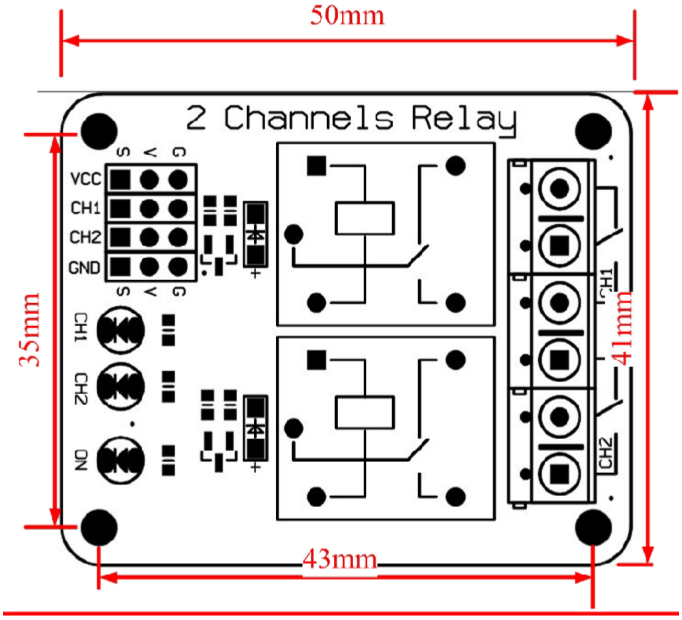


It is sometimes possible to use this relay boards with 3.3V signals, if the JD-VCC (Relay Power) is provided from a +5V supply and the VCC to JD-VCC jumper is removed. That 5V relay supply could be totally isolated from the 3.3V device, or have a common ground if opto-isolation is not needed. If used with isolated 3.3V signals, VCC (To the input of the opto-isolator, next to the IN pins) should be connected to the 3.3V device's +3.3V supply.

NOTE: Some Raspberry-Pi users have found that some relays are reliable and others do not actuate sometimes. It may be necessary to change the value of R1 from 1000 ohms to something like 220 ohms, or supply +5V to the VCC connection.

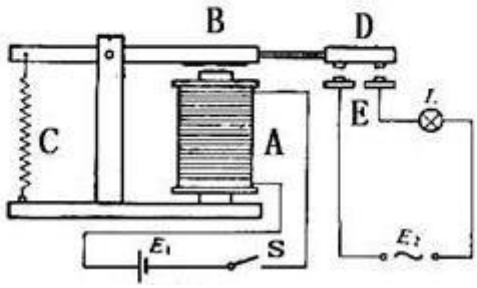
NOTE: The digital input s from Arduino are Active LOW: The relay actuates and LED lights when the input pin is LOW, and turns off on HIGH.

Module Layout:



Operating Principle:

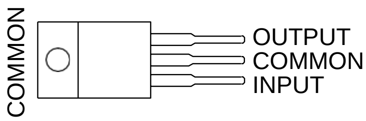
See the picture below: A is an electromagnet, B armature, C spring, D moving contact, and E fixed contacts. There are two fixed contacts, a normally closed one and a normally open one. When the coil is not energized, the normally open contact is the one that is off, while the normally closed one is the other that is on.



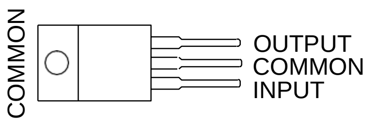
Supply voltage to the coil and some currents will pass through the coil thus generating the electromagnetic effect. So the armature overcomes the tension of the spring and is attracted to the core, thus closing the moving contact of the armature and the normally open (NO) contact or you may say releasing the former and the normally closed (NC) contact. After the coil is de-energized, the electromagnetic force disappears and the armature moves back to the original position, releasing the moving contact and normally closed contact. The closing and releasing of the contacts results in power on and off of the circuit.

- 3-Terminal Regulators
- Output Current up to 1.5 A
- Internal Thermal-Overload Protection
- High Power-Dissipation Capability
- Internal Short-Circuit Current Limiting
- Output Transistor Safe-Area Compensation

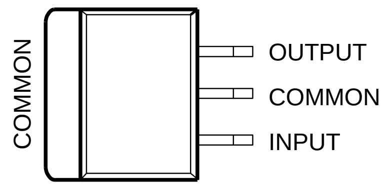
KC (TO-220) PACKAGE
(TOP VIEW)



KCS (TO-220) PACKAGE
(TOP VIEW)



KTE PACKAGE
(TOP VIEW)



description/ordering information

This series of fixed-voltage integrated-circuit voltage regulators is designed for a wide range of applications. These applications include on-card regulation for elimination of noise and distribution problems associated with single-point regulation. Each of these regulators can deliver up to 1.5 A of output current. The internal current-limiting and thermal-shutdown features of these regulators essentially make them immune to overload. In addition to use as fixed-voltage regulators, these devices can be used with external components to obtain adjustable output voltages and currents, and also can be used as the power-pass element in precision regulators.

ORDERING INFORMATION

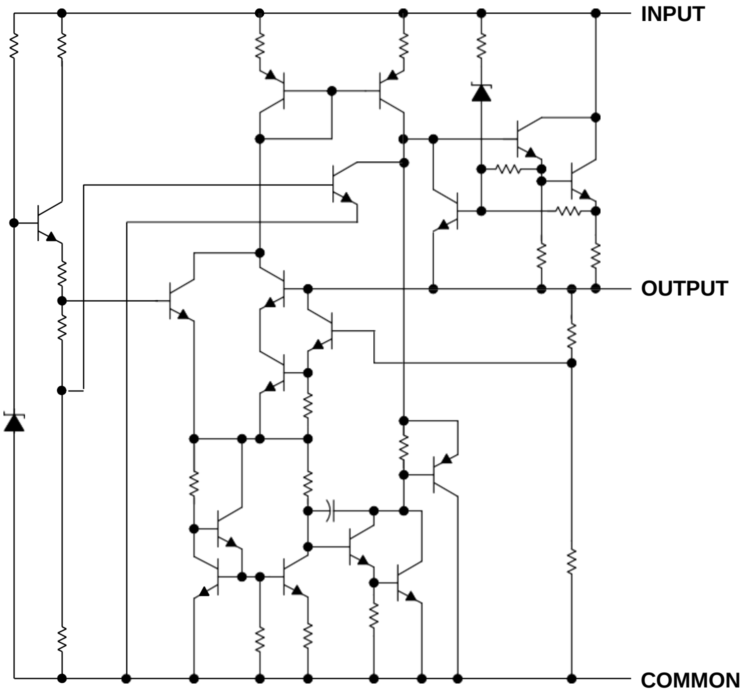
T_J	$V_{O(NOM)}$ (V)	PACKAGE†		ORDERABLE PART NUMBER	TOP-SIDE MARKING
0°C to 125°C	5	POWER-FLEX (KTE)	Reel of 2000	μA7805CKTER	μA7805C
		TO-220 (KC)	Tube of 50	μA7805CKC	μA7805C
		TO-220, short shoulder (KCS)	Tube of 20	μA7805CKCS	
	8	POWER-FLEX (KTE)	Reel of 2000	μA7808CKTER	μA7808C
		TO-220 (KC)	Tube of 50	μA7808CKC	μA7808C
		TO-220, short shoulder (KCS)	Tube of 20	μA7808CKCS	
	10	POWER-FLEX (KTE)	Reel of 2000	μA7810CKTER	μA7810C
		TO-220 (KC)	Tube of 50	μA7810CKC	μA7810C
	12	POWER-FLEX (KTE)	Reel of 2000	μA7812CKTER	μA7812C
		TO-220 (KC)	Tube of 50	μA7812CKC	μA7812C
		TO-220, short shoulder (KCS)	Tube of 20	μA7812CKCS	
	15	POWER-FLEX (KTE)	Reel of 2000	μA7815CKTER	μA7815C
		TO-220 (KC)	Tube of 50	μA7815CKC	μA7815C
		TO-220, short shoulder (KCS)	Tube of 20	μA7815CKCS	
	24	POWER-FLEX (KTE)	Reel of 2000	μA7824CKTER	μA7824C
		TO-220 (KC)	Tube of 50	μA7824CKC	μA7824C

† Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at www.ti.com/sc/package.

Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

standard warranty. Production processing does not necessarily include testing of all parameters.

schematic



absolute maximum ratings over virtual junction temperature range (unless otherwise noted)†

Input voltage, V_I: μA7824C . . . . 40 V
All others . . . . 35 V
Operating virtual junction temperature, T_J . . . . 150°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds . . . . 260°C
Storage temperature range, T_{stg} . . . . 65°C to 150°C

† Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

package thermal data (see Note 1)

PACKAGE	BOARD	θ_{JC}	θ_{JA}
POWER-FLEX (KTE)	High K, JESD 51-5	3°C/W	23°C/W
TO-220 (KC/KCS)	High K, JESD 51-5	3°C/W	19°C/W

NOTE 1: Maximum power dissipation is a function of T_J(max), θ_{JA}, and T_A. The maximum allowable power dissipation at any allowable ambient temperature is $P_D = (T_J(max) - T_A)/\theta_{JA}$. Operating at the absolute maximum T_J of 150°C can affect reliability.

APPENDIX - H

(Rubrics for Project Phase-I and Phase-II)

Rubrics

Rubrics for Project Phase-II

Maximum Marks: 150

Review –III

Sr.No.	Criterion	**Excellent**	**Good**	**Beginner**
1	Revised Final Design (10)	Final Design is correct (10-8)	Final Design is somewhat correct (8-5)	Design is incorrect, to be revised again (5-0)
2	Tools and Techniques Used (10)	Appropriate tools and techniques used(10-8)	Tools and techniques to some extent only used (8-5)	Tools and techniques not used(5-0)
3	Partial Implementation (15)	Project is partially implemented (15-12)	Project implementation is just started. (12-7)	Project implementation is not yet started. (7-0)
4	Partial Results (15)	Partial Results are correct. (15-12)	Partial results are somewhat correct. (12-8)	Results not obtained. (8-0)
	Total (50)	(50-40)	(40-25)	(25-0)

Review –IV

Sr.No.	Criterion	**Excellent**	**Good**	**Beginner**
1	Implementation Status (10)	Project implementation is complete. (10-8)	Project implementation is partially completed. (8-5)	Project implementation is incomplete. (5-0)
2	Modular Testing (10)	Modular testing is correct (10-8)	Modular testing is somewhat correct(8-5)	Modular testing is incorrect. (5-0)
3	Intermediate Results (15)	Desired results are shown (15-12)	Results are partially shown. (12-8)	Results are not obtained. (8-0)
4	Conclusion and Future Scope (10)	Conclusion and future scope are clearly stated (10-8)	Conclusion and future scope are somewhat clearly stated (8-5)	Conclusion and future scope are not clear. (5-0)
5	Cost Analysis (5)	Cost analysis is correct. (5-4)	Cost analysis is somewhat done (4-2)	Cost analysis not done.(2-0)
	Total (50)	(50-40)	(40-25)	(25-0)

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Department of Electronics and Telecommunication Engineering

Rubrics

Rubrics for Project Phase-II

Maximum Marks: 150

Stage-II Documentation

Sr.No.	Criterion for (Project Stage-II)	**Excellent**	**Good**	**Poor**
1	Documentation (50)	All Contents are covered with the given format and well organized report. (50- 40)	Content are covered but the format is not proper and somewhat organized report. (40-20)	Content are not covered, format is not proper and report not organized. (<20)

Sr.No.	Criterion
1	Project Review 3 (50)
2	Project Review 4 (50)
3	Documentation (Project Stage-II Report) (50)
	Total of Review-3, Review-4 and Documentation stage is taken for 150 marks Evaluation