VISVESVARAYA TECHNOLOGICAL UNIVERSITY
"Jnana Sangama", Machhe, Belagavi, Karnataka-590018

A Project Report
On

"GI ENABLED ROBOTIC VEHICLE FOR AGRICULTURAL APPLICATIONS"

Sponsored by

Karnataka State Council for Science and Technology [KSCST]
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Submitted in partial fulfillment of the requirements for the award of the degree of
Bachelor of Engineering
In
Electrical & Electronics Engineering

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DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING
(B.E (E&E) Program Accredited by NBA, New Delhi, Validity from 01.06.2021 to 30.06.2024)
GSSS INSTITUTE OF ENGINEERING & TECHNOLOGY FORWOMEN
(Affiliated to VTU, Belagavi, Approved by AICTE, New Delhi & Govt. of Karnataka)
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Accredited with Grade "A" by NAAC

2022

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GSSS INSTITUTE OF ENGINEERING & TECHNOLOGY FOR WOMEN

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CERTIFICATE

This is to certify that the 8th Semester Project titled **"GI Enabled Robotic Vehicle for Agricultural Applications**" is a bonafide work carried out by **NANDANA R (4GW18EE026), NAYANA G(4GW18EE027), NIHARIKA S(4GW18EE028) and SPOORTHI N (4GW18EE044)** in partial fulfilment for the award of degree of Bachelor of Engineering in **Electrical & Electronics Engineering** of the Visvesvaraya Technological University, Belagavi, during the year 2021-22. The Project report has been approved as it satisfies the academic requirements with respect to the project work prescribed for Bachelor of Engineering Degree.

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ABSTRACT

Agriculture monitoring is indeed a review of the processes and activities required to track the agricultural baseline. IoT are able to offer correct real time information on the surrounding to assist us to understand how we tend to have an effect on the agriculture and take actions to enhance quality. We proposed an automated vehicle that used for monitoring temperature, humidity, moisture content of the soil and rain detection. Visualization of environment can be obtained by camera through IoT gateway. The proposed robotic vehicle is controlled by an individual via android application. Latitude and Longitudes are obtained by Global position system mounted on the robotic vehicle. The robotic system is accomplished using a Raspberry-pi with android application.

Automation in agriculture evolved drastically in recent years. This project aims at designing an automatic robotic vehicle which detects the disease in crops just by simply capturing the image of leaves of crop plants. The captured image is then processed by using the convolutional neutral networks (CNN). This technique uses captured image, processing it by comparing it with the already available dataset. When the input image is matched or partially matched with any one of the existing images in the dataset, it will provide the result of the disease affected by crop and nutrient deficiency in terms of percentage. This result displayed in the LCD or system using IoT. This will reduce the labor force and the burden of farmers.

Keywords: Automation, IoT, CNN, GPS, Raspberry pi

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CHAPTER 1

INTRODUCTION

The continuously increasing population in the world is demanding for the rapid performance in food production technology. In recent times, technologies like big data, IOT, smart systems are being used in the agricultural domain. Over the years, it has been well established that Soil degradation is a major threat to food production. In this context, many laboratory methods are available for monitoring the soil parameters. These methods give test report after few days. In some of the developed countries, farmers are using automated systems for knowing a few agricultural parameters and the field suitability for feeding the suitable inputs like water, fertilizer, etc. Few precision agriculture systems embedded with image processing technologies are also available for monitoring different parameters.

In context to the agriculture system being followed in India and the extent of use of technology, the aforementioned technology is expected to play a major role. In order to adopt this system, soil moisture sensor and humidity sensor are interfaced in the prototype model. The soil moisture sensor is used to gauge the volumetric content of water with the soil. Humidity sensors are used to measure and monitor the amount of water present in the surrounding air. This work also involves implantation of Image processing to monitor the plant during its growth period as well as the time of harvest. Finally, IOT data collection process is followed to track the condition crop growth. Based on the image processing, it is also possible to identify the crop decease and thereby robotic vehicle act as a pesticide sprayer. Through IoT we can monitor and measure data in real-time.

In the developing world, technologies play a vital role in all sectors. Human survival mainly depends on Agriculture. we are still using traditional methods in the agricultural practices. Identifying nutrient deficiency in crops and plant disease is still difficult for farmers. If we are using ancient methods to identify crop disease and deficiency in crops, it will take consume more time, work and cost. If identified wrongly, product yield, money and time will tend to lose.

In general, this kind of nutrient deficiencies is identified through agricultural laboratories and experienced people(farmers). The predictions on nutrient deficiencies manually may go wrong due to several environmental conditions. The nutrient deficiency in crops can appear in their leaves, stem, flowers, fruits, etc. we are using the leaf for identifying the disease in crops and also color changing

in the leaves helps to identify different disease of the plant. A plant should need almost twelve nutrients for its efficient growth. They are Nitrogen, Phosphorous, Potassium, Magnesium, Sulphur, Molybdenum, Zinc, Boron, Copper, Calcium, Iron, Chloride. These nutrients are divided into micronutrients and macronutrients. The micronutrients are Molybdenum, Zinc, Boron, Chloride, Copper, and Iron. The macronutrients are Nitrogen, Phosphorous, Potassium, Sulphur, Calcium, and Magnesium. The deficiency in these nutrients will cause many diseases in the crops. This will indirectly affect the yield rate. Generally, the nutrient deficiencies are identified in the leaves of the crop plants by the symptoms like reduction in leaf size, distorted edges, necrosis, blackspots and color change in the leaves etc., The farmer needs to uproot the entire plant and test the defected plant in the corresponding laboratory to identify the appropriate disease.

1.1 Literature Survey

S. Nithya, R. Krishnaranjani, V. Kirubakaran, R. Madhu vaishnavi" have proposed GPS Controlled Robotic Vehicle for Environmental Impact Analysis" [1]. This paper presents a design and implementation of the robotic vehicle with android application along with GPS. This paper includes monitoring the environmental impacts along with this it uses some sensors to detect temperature, Humidity, Air pressure and Radiation of the environment to detect the pollution. All this information is processed through IoT.

M. Rahman Laskar et al. displayed a paper on climate gauging utilizing Arduino and Cube-Sat.[2] This proposed framework employments temperature and moistness sensor (DHT11), weight and elevation sensor (BMP180) and accelerometer (ADXL-335). The information handling unit Arduino Uno is utilized. Shape satellite is utilized to give data of climate from any place without utilizing organization. A gas inflatable is utilized to hold and convey the Cube satellite. This framework is easy to develop, versatile, cost-productive, low power devouring and dependable. In any case, there are a few confinements, for example, the gadget may not impart at long separation without amazing handset area, at higher height record of information with the assistance of gas inflatable might be an issue and parts may be harmed by a downpour or long-time use.

Amirtha T, Gokulalakshmi T, Umamaheswari P, T Rajasekar" have discussed about Machine Learning Based Nutrient Deficiency Detection in Crops".[3] This paper presents the detection of nutrient deficiency in plants using Machine learning. The nutrient deficiencies are identified in the leaves of the crop plants by the symptoms like reduction in leaf size, distorted edges, necrosis, blackspots. The capture image is processed through image processing and send data stored in Iot and the identified disease in LCD.

Piyush Chaudhary et al. proposed an algorithm for disease spot segmentation using image processing techniques in plant leaves. [4] In this paper, a comparison of the effect of CIELAB, HSI and YCbCr color space in the process of disease spot detection is done. The median filter is used for image smoothing. Finally, the threshold can be calculated by applying the Otsu method on the color component to detect the disease spot color was developed and experiments were carried out on different “monocot” and “dicot” family plant leaves with both, noise-free and noisy backgrounds.

Pavit Noinongyao, Chaiwat Wattanapaiboonsuk, Puriwat Khantiviriya, Sutsawat Duangsrisai have discussed about “Identification of Plant Nutrient Deficiencies Using Convolutional Neural Networks” [5] for identifying nutrient deficiencies in plants-based on its leaf using Convolutional Neural Networks with the set of black gram (Vigna mungo) plants, grown under nutrient controlled environments. In this paper, they have studied five types of nutrient deficiencies. They are Ca, Fe, K, Mg and N deficiencies, and a group of healthy plants. A dataset of 3,000 leaf images was collected and have used for experimentation. This result indicates the superiority of the proposed method over trained humans in nutrient deficiency identification.

“Detection of Air Temperature, Humidity and Soil pH by Using DHT22 and pH Sensor Based Arduino Nano Microcontroller” is presented in [6]. This paper presents the detection of Air temperature, Humidity and moisture of the soil using sensors interfaced with Arduino.

Komal Bodake et.al presented a system to develop a soil-based fertilizer recommendations system which can be used for regional soil analysis which in turn helps the farmer can understand it easily[7].

S. A. Miller, F. D. Beed, C. L. Harmon have discussed about “Plant Disease Diagnostic Capabilities and Networks” [8]. They have published in Annual Review of pathology to improve the speed and accuracy of disease diagnostics and pathogen detection. Emerging, re-emerging and endemic plant pathogens continue to challenge the ability to safeguard plant health worldwide. The spread of invasive plant pathogen is increased due to combination of globalization, weather changes, human mobility demands, pathogen, and vector evolution. Accurate diagnoses, pathogen surveillance on local, regional and global scales are necessary to predict outbreaks allow time for development and application of mitigation strategies. Plant disease diagnostic networks have developed worldwide to address the problems of efficient and effective disease diagnosis and pathogen detection, engendering cooperation of institutions and experts within countries.

Amrutha A, Lekha R, Sreedevi A have presented paper on “Automatic Soil Nutrient Detection and Fertilizer Dispensary System”. [9] The proposed research aims at restoring the levels of Nitrogen, phosphorous, potassium in the soil by the measuring the nutrients present in it. Chemical processes have done for determining the presence of nutrients and they are quantified using sensors. An automated system has been developed for controlled addition of fertilizers in order to avoid excess/ deficient fertilizers in the soil. The working of the system comprises three steps: Soil sample preparation, Estimation of results from it and Dispensing estimated amount of fertilizers to the soil. The results are obtained within 30 minutes in the proposed system. The results, thus obtained from soil tests are given to sensors and the results are analysed using a microcontroller, which in turn needs a few seconds. Hence, the whole process of soil testing for all measurements of the macronutrients requires a maximum of 30-40 minutes after which the field can be fertilized.

1.2 Problem Statement

This project aims to implement the robotic vehicle with Global Positioning System (GPS) to monitor the activities related to agriculture. The robotic vehicle helps in sensing moisture level of the soil, temperature, humidity of the surrounding air and rain detection using sensors to take precautions to reduce the disease of the crop, which in turn reduces the time and cost of the farmers.

Live capturing of the image of the crop leaves to identify the disease affected by plat through image processing and the processed image is stored and analyzed using IoT enabled data gathering system. This minimizes the labor force, time. Cost and farmers burden.

1.3 Aim and Objectives

- To implement the GI Enabled robotic vehicle for Agricultural Applications.
- Design and implementation of GPS robotic vehicle.
- Detection of temperature, humidity and moisture of the soil.
- Rain Detection.
- Capturing the image of the Maize crop.
- Detection of the crop disease using Image processing.
- Processing and storing data using IoT.
- Design and implementation of communication between the robotic vehicle and the user.

1.4 Proposed System

The robotic system is designed in a way to provide autonomous movement. The autonomous movement can be controlled by the mobile application. The intuitive user interfaces within the App and Autonomous movement after getting instruction from the user. Crop visualization is transmitted to System through IoT gateway which is obtained by the camera mounted on the robotic vehicle. Robotic system monitors environmental parameters like temperature, humidity, moisture of the soil and rain detection. Latitude and longitude coordinates are obtained by Global Position System mounted on the robotic vehicle. The robotic system is accomplished using a cost-efficient Raspberry pi that communicates through a wireless network to the Internet of things platform, where data are stored, processed and can be accessed using a smart device. Data are collected and transmitted to phone or displayed in the LCD through IoT. The stored data will be used for further analysis of the reduction of disease, detection of crop quality and measure that can be taken to prevent disease.

1.5 Organization of the Report

Chapter 1 consists of a brief introduction of the whole project. It gives the literature survey, problem statement, aim and objectives of the project.

Chapter 2 consists of methodology, about the maize crop, block diagram and hardware details.

Chapter 3 describes the hardware and software implementation with circuit diagrams and necessary flow charts to understand the work and working of the system.

Chapter 4 gives the results, discussion and future scope.

CHAPTER 2

METHODOLOGY AND HARDWARE DETAILS

2.1 Methodology

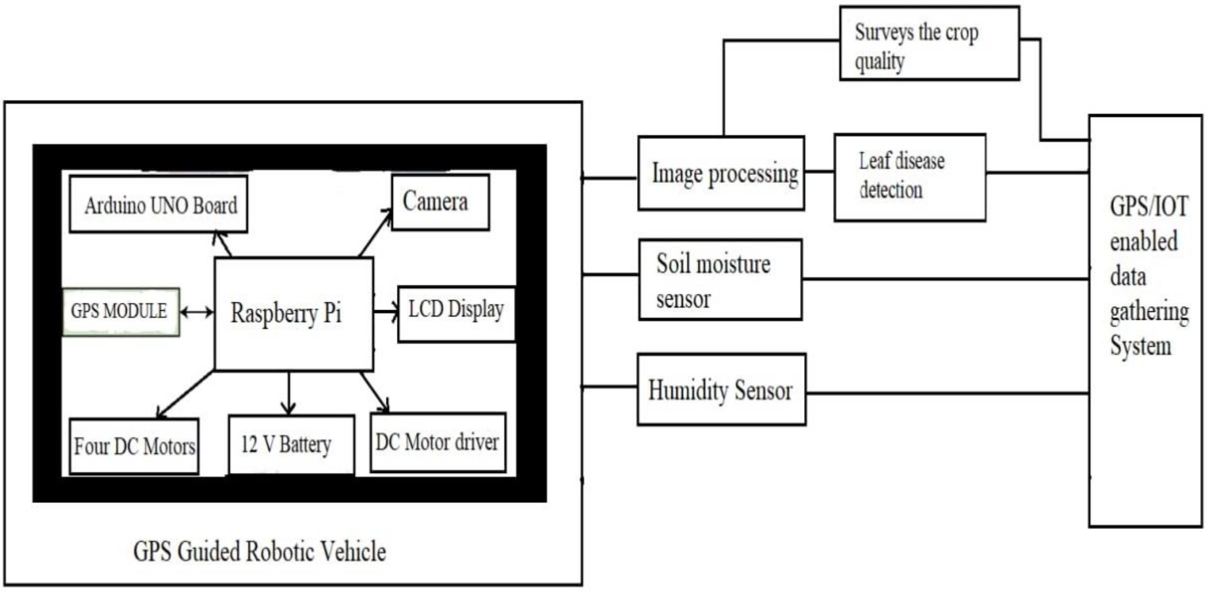

Figure 2.1: Block diagram of methodology

Figure 2.1 shows the main components and methodology of the project. It uses Raspberry pi which is a very cheap computer also provides a set of general purpose input/output pins allowing to control electronic components for physical computing and explore the internet of things (IoT).

Robotic vehicle is enabled with GPS module to track the location of the vehicle, which gives the longitude and latitude coordinates interfaced with raspberry pi.

L298N DC motor is used to move the robotic vehicle. Two L298N DC motors is used which is a high power motor driver module for driving DC motors.

Four DC motors are used which is of 12 volts and 60 rpm. One DC motor driver can control two DC motors with directional speed and control.

The motor driver is interfaced with Raspberry pi. Robotic vehicle can navigate using Blue dot android application.

DHT22 sensor is directly interfaced with Raspberry pi to detect the temperature and humidity of the surrounding.

Arduino UNO used to convert Analog signals to digital signals. Soil moisture sensor and rain detection sensor are connected to Arduino which converts analog to digital signal. Then converted digital signal is interfaced with Raspberry pi.

16X2 LCD display used to display the information.

Camera is mounted on robotic vehicle to capture the images of the crop and then it is processed by image processing to detect the leaf disease and give the information regarding crop health.

Finally, all this information is processed and stored by IoT enabled data gathering system.

2.2 Maize Crop

In this project to identify the crop disease, particularly we have used maize crop. It is helpful to show different variations in the maize crop. The determination of soil nutrient deficiency can be done based on Color changes in the leaf.

2.3 Hardware Details

2.3.1 Raspberry pi

The Raspberry Pi is a low cost, credit-card sized computer that plugs into a computer monitor or TV, and uses a standard keyboard and mouse. It is a capable little device that enables people of all ages to explore computing, and to learn how to program in languages like Scratch and Python. It was established by the Raspberry pi foundation from the UK. It has been ready for public consumption since 2012 with the idea of making a low-cost educational microcomputer for students and children. The main purpose of designing the raspberry pi board is, to encourage learning, experimentation and innovation for school level students. Maximum of the raspberry pi computers is used in mobile phones. In the 20th century, the growth of mobile computing technologies is very high, a huge segment of this being driven by the mobile industries. The 98% of the mobile phones were using ARM technology.

2.3.2 Raspberry Pi Technology:

The raspberry pi comes in two models, they are model A and model B. The main difference between model A and model B is USB port. Model A board will consume less power and that does not include an Ethernet port. But, the model B board includes an Ethernet port and designed in China. The raspberry pi comes with a set of open source technologies, i.e. communication and multimedia web technologies. In the year 2014, the foundation of the raspberry pi board launched the computer module, that packages a model B raspberry pi board into module for use as a part of embedded systems, to encourage their use.

2.3.3 Raspberry Pi Hardware Specifications:

The raspberry pi board comprises a program memory (RAM), processor and graphics chip, CPU, GPU, Ethernet port, GPIO pins, Xbee socket, UART, power source connector. And various interfaces for other external devices. It also requires mass storage, for that we use an SD flash memory card. So that raspberry pi board will boot from this SD card similarly as a PC boots up into windows from its hard disk.

Essential hardware specifications of raspberry pi board mainly include SD card containing Linux OS, US keyboard, monitor, power supply and video cable. Optional hardware specifications include USB mouse, powered USB hub, case, internet connection, the Model A or B: USB Wi-Fi adaptor is used and internet connection to Model B is LAN cable.

2.3.4 Memory:

The raspberry pi model Aboard is designed with 256MB of SDRAM and model B is designed with 51MB.Raspberry pi is a small size PC compare with other PCs. The normal PCs RAM memory is available in gigabytes. But in raspberry pi board, the RAM memory is available more than 256MB or 512MB.

2.3.5 CPU (Central Processing Unit):

The Central processing unit is the brain of the raspberry pi board and that is responsible for carrying out the instructions of the computer through logical and mathematical operations. The raspberry pi uses ARM11 series processor.

2.3.6 Applications of Raspberry pi:

- Retro Gaming Machine
- Robot Controller
- Stop Motion Camera

Figure 2.2: Raspberry pi Module

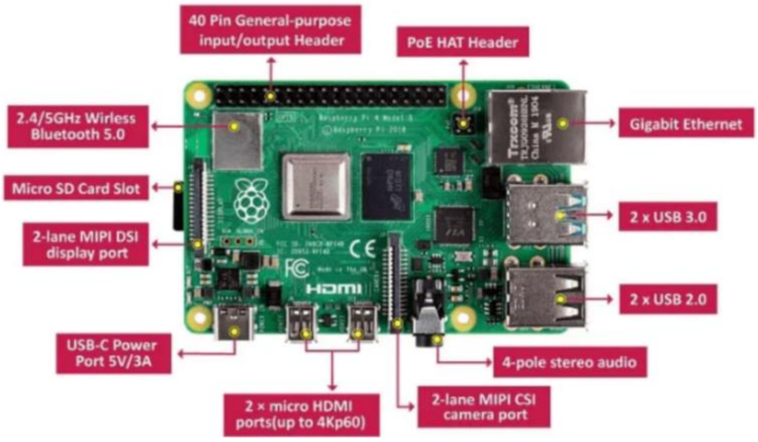

Figure 2.3: Labels of Raspberry pi

PIN	NAME	NAME	PIN
01	3.3V DC Power	5V DC Power	02
03	GPIO02 (SDA1,I²C)	5V DC Power	04
05	GPIO03 (SDL1,I²C)	Ground	06
07	GPIO04 (GPCLK0)	GPIO14 (TXD0, UART)	08
09	Ground	GPIO15 (RXD0, UART)	10
11	GPIO17	GPIO18(PWM0)	12
13	GPIO27	Ground	14
15	GPIO22	GPIO23	16
17	3.3V DC Power	GPIO24	18
19	GPIO10 (SP10_MOSI)	Ground	20
21	GPIO09 (SP10_MISO)	GPIO25	22
23	GPIO11 (SP10_CLK)	GPIO08 (SPI0_CE0_N)	24
25	Ground	GPIO07 (SPI0_CE1_N)	26
27	GPIO00 (SDA0, I²C)	GPIO07 (SCL0, I²C)	28
29	GPIO05	Ground	30
31	GPIO06	GPIO12 (PWM0)	32
33	GPIO13 (PWM1)	Ground	34
35	GPIO19	GPIO16	36
37	GPIO26	GPIO20	38
39	Ground	GPIO21	40

Figure 2.4: General purpose input and output pin diagram

2.4 Arduino UNO

The Arduino Uno is a type of Arduino board that is provided as an open-source board that uses an ATmega328p microcontroller in the board. The Arduino Uno contains a set of analog and digital pins that are input and output pins which are used to connect the board to other components. There are a total of fourteen I/O pins placed inboard in which six are analog input pins. The board has a USB connection that can be used to a power supply to the board. The board is used for electronics projects and used to design the circuit.

2.4.1 Advantages of using Arduino UNO

- Inexpensive
- Cross Platform
- Simple clear programming Environment
- Open source and Extensible software
- Open source and extensible hardware

2.4.2 Application of Arduino UNO

- Weighing Machines.
- Traffic Light Count Down Timer.
- Parking Lot Counter.
- Embedded systems.
- Home Automation.
- Industrial Automation.
- Medical Instrument.
- Emergency Light for Railways.

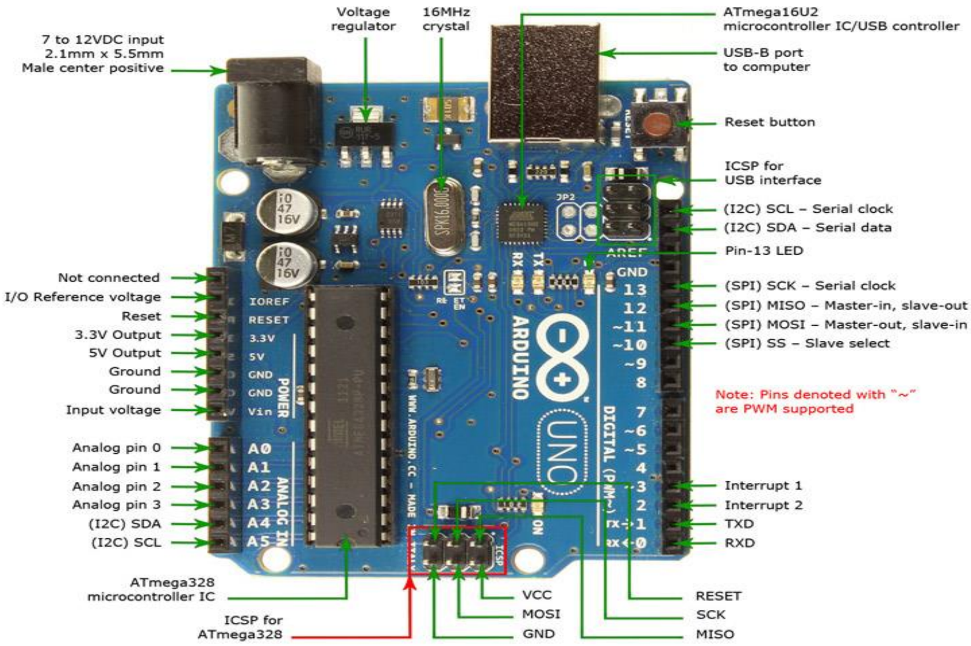

Figure 2.5: Arduino UNO

2.5 Soil Moisture Sensor

The soil moisture sensor is one kind of sensor used to gauge the volumetric content of water within the soil. As the straight gravimetric dimension of soil moisture needs eliminating, drying, as well as sample weighting. These sensors measure the volumetric water content not directly with the help of some other rules of soil like dielectric constant, electrical resistance, otherwise interaction with neutrons, and replacement of the moisture content.

The relation among the calculated property as well as moisture of soil should be adjusted & may change based on ecological factors like temperature, type of soil, otherwise electric conductivity. The microwave emission which is reflected can be influenced by the moisture of soil as well as mainly used in agriculture and remote sensing within hydrology.

These sensors normally used to check volumetric water content, and another group of sensors calculates a new property of moisture within soils named water potential. Generally, these sensors are named as soil water potential sensors which include gypsum blocks and tensiometer.

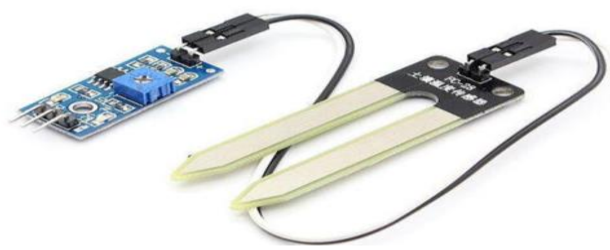

Figure 2.6: Soil moisture sensor

The FC-28 soil moisture sensor includes 4-pins

- VCC pin is used for power
- A0 pin is an analog output
- D0 pin is a digital output
- GND pin is a Ground

This module also includes a potentiometer that will fix the threshold value, & the value can be evaluated by the comparator-LM393. The LED will turn on/off based on the threshold value.

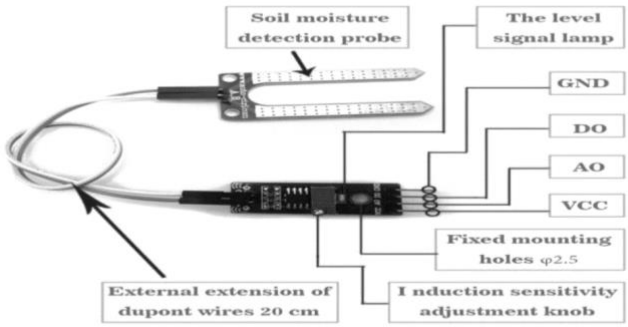

Figure 2.7: Pin diagram of soil moisture sensor

2.5.1 How the Sensor Works

The Soil Moisture Sensor uses capacitance to measure dielectric permittivity of the surrounding medium. In soil, dielectric permittivity is a function of the water content. The sensor creates a voltage proportional to the dielectric permittivity, and therefore the water content of the soil.
The sensor averages the water content over the entire length of the sensor. There is a 2 cm zone of influence with respect to the flat surface of the sensor, but it has little or no sensitivity at the extreme edges. The figure above shows the electromagnetic field lines along a cross-section of the sensor, illustrating the 2 cm zone of influence.

2.5.2 Working Principle

This sensor mainly utilizes capacitance to gauge the water content of the soil (dielectric permittivity). The working of this sensor can be done by inserting this sensor into the earth and the status of the water content in the soil can be reported in the form of a percent.

This sensor makes it perfect to execute experiments within science courses like environmental science, agricultural science, biology, soil science, botany, and horticulture.

2.5.3 Specifications

- The required voltage for working is 5V
- The required current for working is <20mA
- Type of interface is analogue
- The required working temperature of this sensor is 10°C~30°C

2.5.4 Soil Moisture Sensor Applications

- Agriculture
- Landscape irrigation
- Research
- Simple sensors for gardeners

2.6 DHT22 Sensor

The **DHT22** is a commonly used Temperature and humidity sensor. The sensor comes with a dedicated NTC to measure temperature and an 8-bit microcontroller to output the values of temperature and humidity as serial data. The sensor is also factory calibrated and hence easy to interface with other microcontrollers. The sensor can measure temperature from **-40°C to 80°C** and humidity from **0% to 100%** with an accuracy of ±1°C and ±1%.

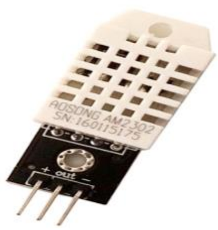

Figure 2.8: DHT22 Sensor

Table 2.1: DHT22 Sensor pin table

DHT22 Sensor		
1	Vcc	Power supply 3.5V to 5.5V
2	Data	Outputs both Temperature and Humidity through serial Data
3	NC	No Connection and hence not used
4	Ground	Connected to the ground of the circuit

2.6.1 DHT22 Specifications

- Operating Voltage: 3.5V to 5.5V
- Operating current: 0.3mA (measuring) 60uA (standby)
- Output: Serial data
- Temperature Range: -40°C to 80°C
- Humidity Range: 0% to 100%
- Resolution: Temperature and Humidity both are 16-bit
- Accuracy: ±0.5°C and ±1%

2.6.2 Applications

- Measure temperature and humidity
- Local Weather station
- Automatic climate control
- Environment monitoring

2.7 Rain Detection Sensor

A rain sensor is one kind of switching device which is used to detect the rainfall. It works like a switch and the working principle of this sensor is, whenever there is rain, the switch will be normally closed.

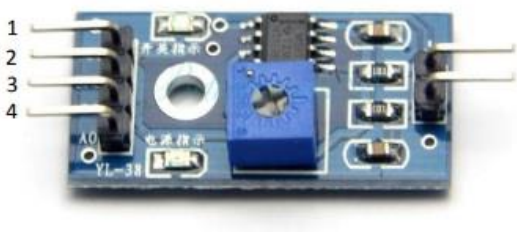

Figure 2.9: Rain sensor module

This board includes nickel coated lines and it works on the resistance principle. This sensor module permits to gauge moisture through analog output pins & it gives a digital output while moisture threshold surpasses. This module is similar to the LM393_IC because it includes the electronic module as well as a PCB. Here PCB is used to collect the raindrops. When the rain falls on the board, then it creates a parallel resistance path to calculate through the operational_amplifier. This sensor is a resistive dipole, and based on the moisture only it shows the resistance. For example, it shows more resistance when it is dry and shows less resistance when it is wet.

2.7.1 Pin Configuration

The pin configuration of this sensor is shown in fig 2.9. This sensor includes four pins which include the following.

- Pin1 (VCC): It is a 5V DC pin
- Pin2 (GND): it is a GND (ground) pin
- Pin3 (DO): It is a low/ high output pin
- Pin4 (AO): It is an analog output pin

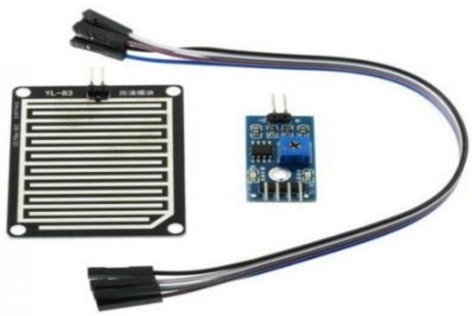

Figure 2.10: Rain detection sensor

- This sensor module uses good quality of double-sided material.
- Anti-conductivity & oxidation with long time use.
- The area of this sensor includes 5cm x 4cm and can be built with a nickel plate on the side.

- The sensitivity can be adjusted by a potentiometer.
- The required voltage is 5V.
- The size of the small PCB is 3.2cm x 1.4cm.
- For easy installation, it uses bolt holes.
- It uses an LM393 comparator with wide voltage.
- The output of the comparator is a clean waveform and driving capacity is above 15mA.

2.7.2 Applications

- This sensor is used as a water preservation device and this is connected to the irrigation system to shut down the system in the event of rainfall.
- This sensor is used to guard the internal parts of an automobile against the rainfall as well as to support the regular windscreen wiper's mode.
- This sensor is used in specialized satellite communications aerials for activating a rain blower over the opening of the aerial feed, to get rid of water droplets from the mylar wrap to keep pressurized as well as dry air within the waveguides.

2.8 L298N DC Motor driver

L298N Motor Driver Module is a high power motor driver module for driving DC and Stepper Motors. This module consists of an L298 motor driver IC and a 78M05 5V regulator. L298N Module can control up to 4 DC motors, or 2 DC motors with directional and speed control.

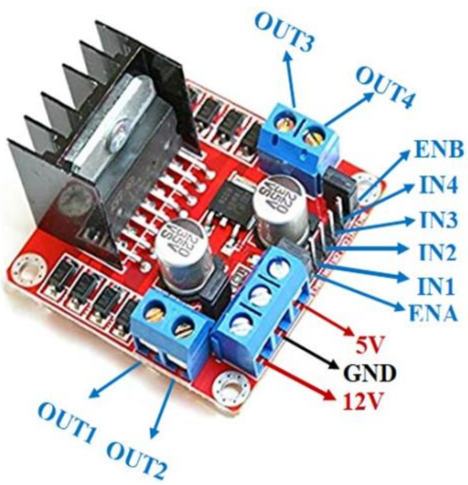

Figure 2.11: L298N DC motor driver

2.8.1 L298N Module Pinout Configuration

Table 2.2: L298N module pin configuration

Pin Name	Description
IN1 & IN2	Motor A input pins. Used to control the spinning direction of Motor A
IN3 & IN4	Motor B input pins. Used to control the spinning direction of Motor B
ENA	Enables PWM signal for Motor A
ENB	Enables PWM signal for Motor B
OUT1 & OUT2	Output pins of Motor A
OUT3 & OUT4	Output pins of Motor B
12V	12V input from DC power Source
5V	Supplies power for the switching logic circuitry inside L298N IC
GND	Ground pin

2.8.2 Features & Specifications

- Driver Model: L298N 2A
- Driver Chip: Double H Bridge L298N
- Motor Supply Voltage (Maximum): 46V
- Motor Supply Current (Maximum): 2A
- Logic Voltage: 5V

- Driver Voltage: 5-35V
- Driver Current:2A
- Logical Current:0-36mA
- Maximum Power (W): 25W
- Current Sense for each motor
- Heatsink for better performance
- Power-On LED indicator

2.8.3 Brief about L298N Module

The L298N Motor Driver module consists of an L298 Motor Driver IC, 78M05 Voltage Regulator, resistors, capacitor, Power LED, 5V jumper in an integrated circuit.

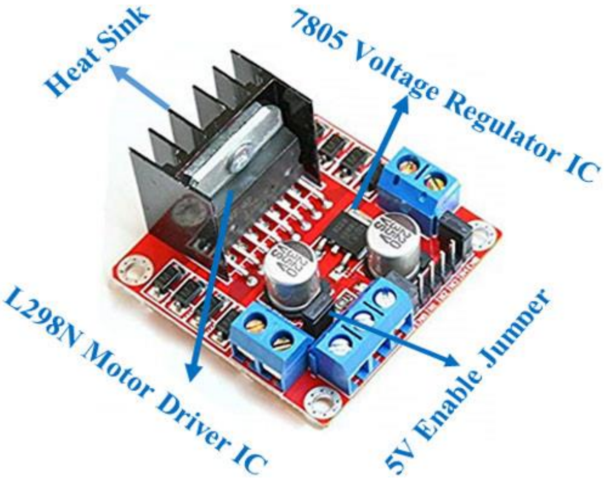

Figure 2.12: L298N Motor driver

78M05 Voltage regulator will be enabled only when the jumper is placed. When the power supply is less than or equal to 12V, then the internal circuitry will be powered by the voltage regulator and the 5V pin can be used as an output pin to power the microcontroller. The jumper should not be placed when the power supply is greater than 12V and separate 5V should be given through 5V terminal to power the internal circuitry.

ENA & ENB pins are speed control pins for Motor A and Motor B while IN1& IN2 and IN3 & IN4 are direction control pins for Motor A and Motor B.

Internal circuit diagram of L298N Motor Driver module is given in the fig 2.12:

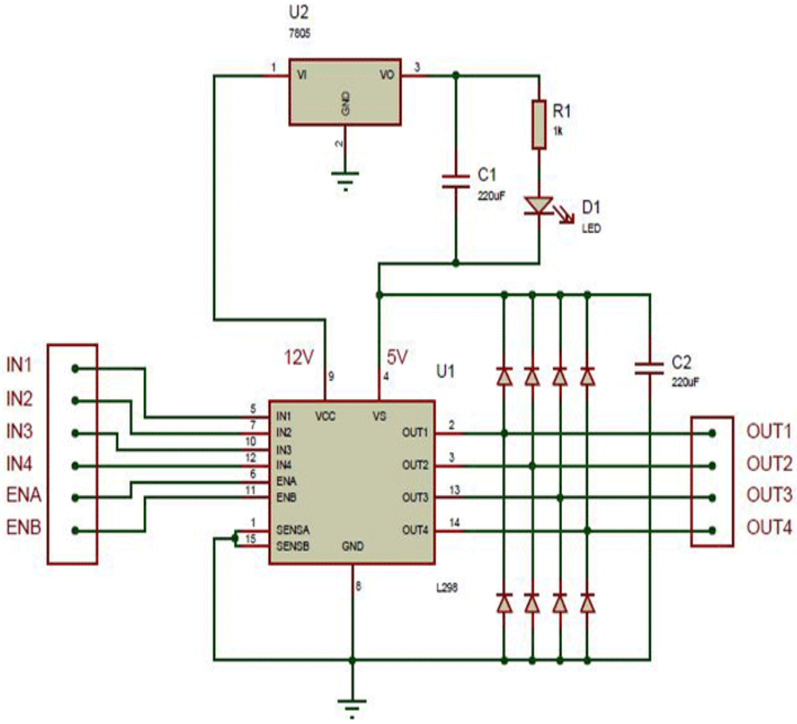

Figure 2.13: Circuit diagram of L298N Motor driver

2.8.4 Applications

- Drive DC motors.
- Drive stepping motors
- In Robotics

2.9 DC Motors

The DC Motor – 60RPM – 12Volts can be used in all-terrain robots and a variety of robotic applications. These motors have a 3 mm threaded drill hole in the middle of the shaft thus making it simple to connect it to the wheels or any other mechanical assembly.

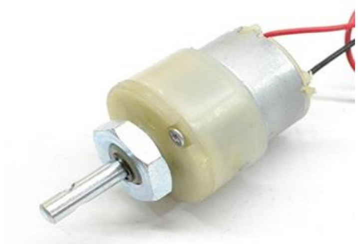

Figure 2.14: DC Motor

2.10 HD Webcam

Figure 2.15: HD Webcam

2.11 LCD Display

The term LCD stands for liquid crystal display. It is one kind of electronic display module used in an extensive range of applications like various circuits & devices like mobile phones, calculators, computers, TV sets, etc. These displays are mainly preferred for multi-segment light-emitting diodes and seven segments. The main benefits of using this module are inexpensive; simply programmable, animations, and there are no limitations for displaying custom characters, special and even animations, etc.

2.11.1 LCD 16×2 Pin Diagram

The 16x2 LCD display screen with i2c interface is as shown in the figure .2.16, is able to display 16x2 characters on two lines. The advantage of an I2C LCD is that the wiring is very simple. You only need two data pins to control the LCD. Standard LCDs typically require around 12 connections, which can be a problem if you do not have many GPIO pins available. Another alternate option is i2c 20x4 Arduino LCD display module if more characters is required.

Specification:

- Compatible with Arduino/Genuino UNO
- I2C Address: 0x20-0x27 (0x20default)
- Supply Voltage :5v
- Adjustable Contrast

16X2 LCD display is used to display the readings of multiple sensors and the on going operation of wheelchair system.

Figure 2.16: LCD Display

2.12 GY-NEO6MV2 GPS Module

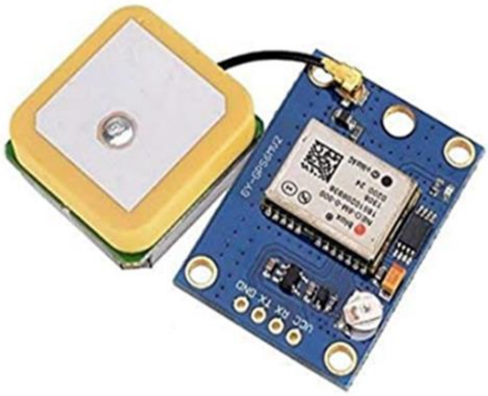

Figure 2.17: GPS module

The NEO-6 module series is a family of stand-alone GPS receivers featuring the high performance u-blox 6 positioning engine. These flexible and cost effective receivers offer numerous connectivity options in a miniature 16 x 12.2 x 2.4 mm package. Their compact architecture and power and memory options make NEO-6 modules ideal for battery operated mobile devices with very strict cost and space constraints. The 50-channel u-blox 6 positioning engine boasts a Time-To-First-Fix0(TTFF) of under 1 second. The dedicated acquisition engine, with 2 million correlators, is capable of massive parallel time/frequency space searches, enabling it to find satellites instantly. Innovative design and technology suppresses jamming sources and mitigates multipath effects, giving NEO-6 GPS receivers excellent navigation performance even in the most challenging environments.

1. **Supply Voltage**: 2.7 to 3.6V
2. **Supply current**: 67 mA
3. **Antenna gain**: 50 dB
4. **Operating temperature:** -40 to 85°C

5. **Antenna Type:** Passive and active antenna

6. **Interfaces**: UART, USB, SPI, DDC

7. **Sensitivity-**

- **Tracking & Navigation:**-160 dBm
- **Reacquisition:**-160 dBm
- **Cold Start (Autonomous):**-146 dBm

2.13. Power Bank- 5 V:

Figure 2.18. Lithium-Ion battery

The Lithium-Ion battery which is used to power up the Raspberry Pi comes with a mammoth battery capacity of 10,000 mAh which provides multiple charges for your device on a single charge. It also supports three USB ports just in case you need to charge three devices simultaneously on the go. Battery had kept safety as a priority while designing this power bank and that's why it comes with precise IC protection. IC protection assures the safety of your power bank as it avoids situations like over-charging, over-discharging and a short circuit.

CHAPTER 3

SOFTWARE AND HARDWARE IMPLEMENTATION

In this chapter we have described about the implementation details of the project. Proposed system has been implemented into two parts i.e. Hardware implementation and Software implementation in Hardware implementation we described how circuit connection is made based on the block diagram and we have explained each component working in the prototype. In Software implementation part we have explained workflow of the proposed system.

3.1 HARDWARE IMPLEMENTATION

The hardware design implementation that is basically the circuit diagram of the GI Enabled Robotic Vehicle for Agricultural Applications system is as shown in the Figure 3.1.

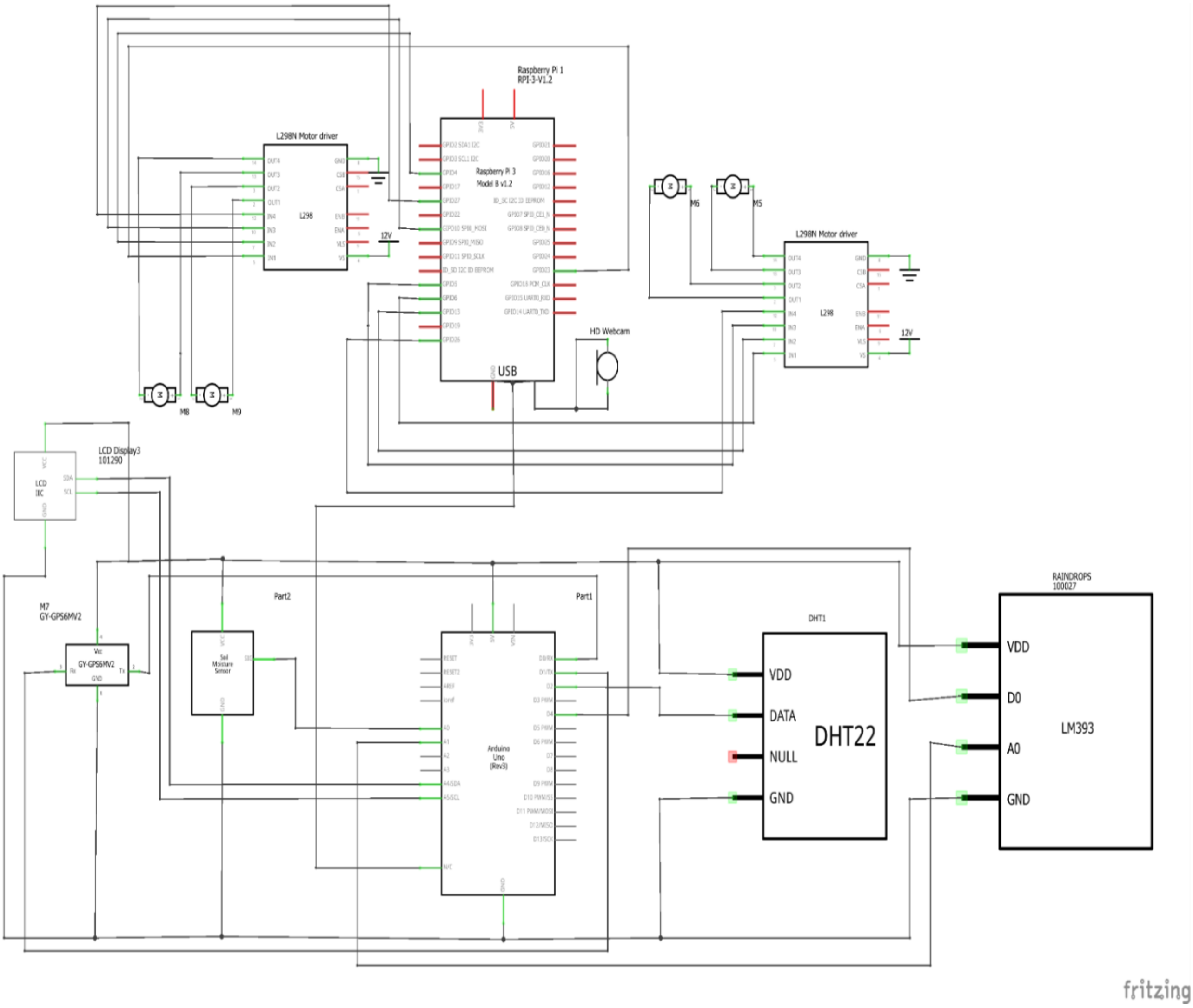

Figure 3.1: Circuit diagram of proposed system.

The design of the Raspberry Pi & L298N Motor Driver Interface Circuit is shown in the above figure. First connect 12V Power Supply to L298N Motor Driver Module. Then, make the GND terminals of Raspberry Pi and L298N Motor Driver Module common (connect them together). To control the movement of robot, four12V DC motors are used which are controlled by a pair of L298N H-Bridges. The HD- webcam which is used for live streaming is connected to USB port of the Raspberry Pi.

The Hardware Implementation of the circuit to move the robotic vehicle and track the location of the vehicle using Global Positioning System (GPS). The robotic vehicle consists of DHT22 temperature sensor, FC-28 Soil moisture sensor and rain detection module. Camera is mounted on the vehicle to capture the images and for live streaming. Each wheel is equipped with a DC motor which helps in desired movement of the vehicle. The connection is given for Raspberry pi and we are connecting temperature, soil moisture sensor and web camera for live streaming. Motor drivers in order to control DC motor. Where one motor driver can control two DC motors. There is a serial communication between the Arduino and raspberry pi where DHT22 and rain detection sensor is connected to Arduino board for conversion of analog to digital signal. Here we are using wheels to move robot. Those Wheels are controlled by using Blue dot application. The Blue dot is used to move robot forward, backward, left and right.

Robot is constructed with a pair of H-bridges. The forward and backward pins for the H-bridge of the left wheel are 17 and 18 respectively, and the forward and backward pins for H-bridge of the right wheel are 22 and 23 respectively. We can change the robot to use variable speeds, so the further towards the edge you press the Blue Dot, the faster the robot will go. Python 3.7 is used for implementation of this operation.

Table 3.1: Truth table of DC motor control.

DC Motor truth table			
EN	**IN1**	**IN2**	**Description**
0	N/A	N/A	Motor is off
1	0	0	Motor is stopped (brakes)
1	0	1	Motor is on and turning backwards
1	1	0	Motor is on and turning forwards
1	1	1	Motor is stopped (brakes)

IN1, IN2, IN3, IN4 of L298N of back wheels are connected to GPIO16, GPIO19, GPIO 26 and GPIO 20, IN1, IN2, IN3, IN4 of L298N of front wheels are connected to GPIO17, GPIO18, GPIO 22 and GPIO 23. Arduino UNO is interfaced with raspberry pi using USB port. The connection details are as follows:

L298N-1	**Raspberry Pi 4**
IN1	GPIO23
IN2	GPIO22
IN3	GPIO17
IN4	GPIO18

L298N-2	**Raspberry Pi 4**
IN1	GPIO16
IN2	GPIO19
IN3	GPIO26
IN4	GPIO20

LCD with i2c	**Arduino UNO**
VIN	5V
GND	GND
SCL	SCL
SDA	SDA

NEO 6M GPS MODULE	**Arduino UNO**
VCC	5V
GND	GND
TX	RX
RX	TX

DHT22	**Arduino UNO**
VCC	5V
GND	GND

DATA	8

Soil Moisture sensor	**Arduino UNO**
VCC	5V
GND	GND
A0	A1

Raindrops detector	**Arduino UNO**
VCC	5V
GND	GND
Digital	4
Analog	A0

3.2 SOFTWARE IMPLEMENTATION

3.2.1 Raspberry Pi Operating System

Raspberry Pi OS (formerly Raspbian) is a Debian-based operating system for Raspberry Pi. Since 2015, it has been officially provided by the Raspberry Pi Foundation as the primary operating system for the Raspberry Pi family of compact single-board computers. The first version of Raspbian was created by Mike Thompson and Peter Green as an independent project. The initial build was completed in June 2012.

Raspberry Pi OS is highly optimized for the Raspberry Pi line of compact single-board computers with ARM CPUs. It runs on every Raspberry Pi except the Pico microcontroller. Raspberry Pi OS uses a modified LXDE as its desktop environment with the Open box stacking window manager, along with a unique theme. The distribution is shipped with a copy of the algebra program Wolfram Mathematica and a version of Minecraft called Minecraft: Pi Edition, as well as a lightweight version of the Chromium web browser.

3.2.2 User Interface

Raspberry Pi OS looks similar to many common desktops, such as MacOS and Microsoft Windows. The menu bar is positioned at the top and contains an application menu and shortcuts to Terminal, Chromium, and File Manager. On the right is a Bluetooth menu, a Wi-Fi menu, volume control, and

A digital clock.

Figure 3.2: Raspberry Pi OS

3.3 Python 3

Python is a powerful programming language ideal for scripting and rapid application development. It is used in web development (like: Django and Bottle), scientific and mathematical computing (Orange, SciPy, NumPy) to desktop graphical user Interfaces (Pygame, Panda3D). Python is designed to be highly readable. It uses English keywords frequently where as the other languages use punctuations. It has fewer syntactical constructions than other languages.

- **Python is Interpreted** − Python is processed at runtime by the interpreter. You do not need to compile your program before executing it. This is similar to PERL and PHP.
- **Python is Interactive** − You can actually sit at a Python prompt and interact with the interpreter directly to write your programs.
- **Python is Object-Oriented** − Python supports Object-Oriented style or technique of programming that encapsulates code within objects.
- **Python is a Beginner's Language** − Python is a great language for the beginner-level programmers and supports the development of a wide range of applications from simple text processing to WWW browsers to games.

Figure 3.3: Python software

Python's features include −

- **Easy-to-learn −** Python has few keywords, simple structure, and a clearly defined syntax. This allows a student to pick up the language quickly.
- **Easy-to-read −** Python code is more clearly defined and visible to the eyes.
- **Easy-to-maintain −** Python's source code is fairly easy-to-maintain.
- **A broad standard library −** Python's bulk of the library is very portable and cross-platform compatible on UNIX, Windows, and Mac into sh.
- **Interactive Mode−**Python has support for an interactive mode which allows interactive testing and debugging of snippets of code.
- **Portable −** Python can run on a wide variety of hardware platforms and has the same interface on all platforms.
- **Extendable−**YoucanaddIow-levelmodulestothePythoninterpreter.Thesemodules enable programmers to add to or customize their tools to be more efficient.
- **Databases −** Python provides interfaces to all major commercial databases.
- **GUI Programming−**Python supports GUI applications that can be created and ported to many system calls, libraries and windows systems, such as Windows MFC, Macintosh, and the X Window system of Unix.

Scalable−Python provides a better structure and support for large programs than shell scripting.

3.4 ARDUINO IDE

The Arduino integrate development environment is across-platform application for Windows, macOS and Linux that is written in the programming language Java. It is used to write and upload programs to Arduino compatible boards, but also with help of third party cores, other vendor development boards. The Arduino IDE supports the languages C, C++ and C# using special rules of code structuring.

Figure 3.4: Arduino IDE

The Arduino [IDE] contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the Arduino and Genuino hardware to upload programs and communicate with them. Programs written using Arduino Software (IDE) are called sketches. These sketches are written in the text editor and are saved with the file extension ".ino". The editor has features for cutting/pasting and for searching/replacing text. The message area gives feedback while saving and exporting and also displays errors. The console displays text output by the Arduino IDE, including complete error messages and other information. The bottom right-hand corner of the window displays the configured board and serial port. The toolbar buttons allow you to verify and upload programs, create, open, and save sketches, and open the serial monitor.

3.5 Blue Dot Application

Blue Dot allows us to control our Raspberry pi projects wirelessly, it is a blue tooth remote and zero boiler plate (super simple to use), python library. blue dot should be installed on the operator device to monitor the patient conditions regularly. Blue dot also should be included in the library of the programming language.

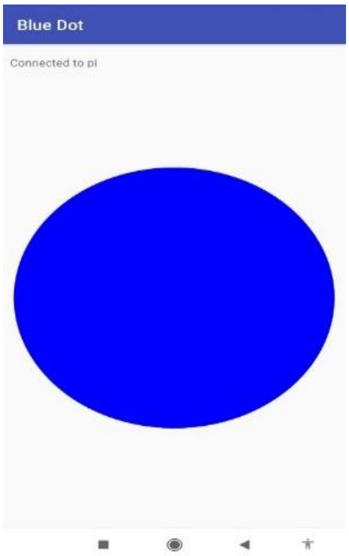

Figure 3.5: Blue Dot Application

3.6 Internet of Things

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

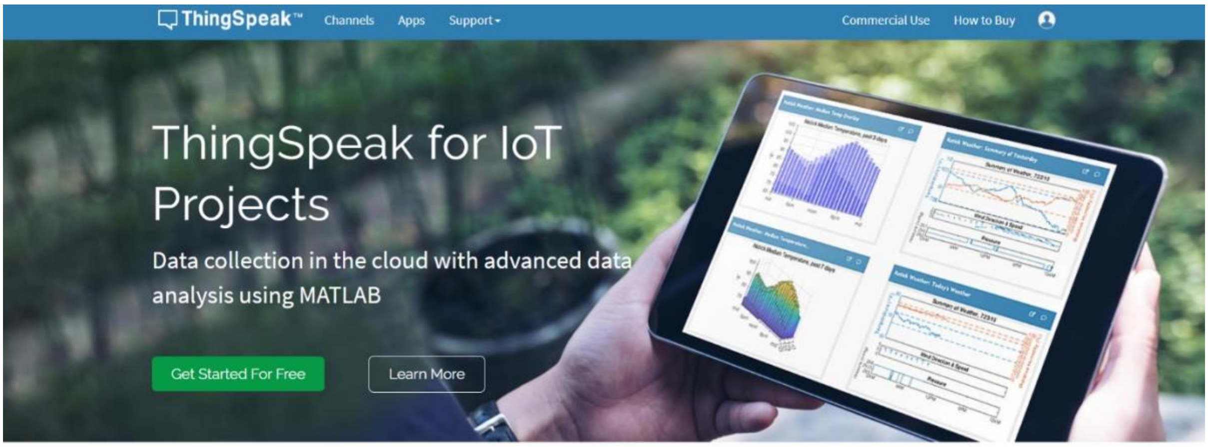

Figure 3.6: Thingspeak

A thing in the internet of things can be a person with a heart monitor implant, a farm animal with a biochip transponder, an automobile that has built-in sensors to alert the driver when tire pressure is low or any other natural or man-made object that can be assigned an Internet Protocol (IP) address and is able to transfer data over a network.

Increasingly, organizations in a variety of industries are using IoT to operate more efficiently, better understand customers to deliver enhanced customer service, improve decision-making and increase the value of the business.

ThingSpeak is IoT Cloud platform where it can send sensor data to the cloud. It can also analyze and visualize your data with MATLAB or other software, including making your own applications.

The ThingSpeak service is operated by MathWorks. In order to sign up for ThingSpeak, you must create a new MathWorks Account or log in to your existing MathWorks Account.

ThingSpeak is free for small non-commercial projects.

ThingSpeak includes a Web Service (REST API) that lets you collect and store sensor data in the cloud and develop Internet of Things applications. It works with Arduino, Raspberry Pi and

MATLAB (premade libraries and APIs exists) But it should work with all kind of Programming Languages, since it uses a REST API and HTTP.

3.7 Image Processing

Digital image processing is the use of a digital computer to process digital images through an algorithm. As a subcategory or field of digital signal processing, digital image processing has many advantages over analog image processing. It allows a much wider range of algorithms to be applied to the input data and can avoid problems such as the build-up of noise and distortion during processing. Since images are defined over two dimensions (perhaps more) digital image processing may be modeled in the form of multidimensional systems. The generation and development of digital image processing are mainly affected by three factors: first, the development of computers; second, the development of mathematics (especially the creation and improvement of discrete mathematics theory); third, the demand for a wide range of applications in environment, agriculture, military, industry and medical science has increased.

3.8 Hardware Implementation

The Hardware Implementation of the circuit to move the robotic vehicle and track the location of the vehicle using Global Positioning System(GPS).

The robotic vehicle consists of DHT22 temperature sensor, FC-28 Soil moisture sensor and rain detection module. Camera is mounted on the vehicle to capture the images and for live streaming.

Each wheel is equipped with a DC motor which helps in desired movement of the vehicle. The connection is given for Raspberry pi and we are connecting temperature, soil moisture sensor and web camera for live streaming. Motor drivers in order to control DC motor. Where one motor driver can control two DC motors. There is a serial communication between the Arduino and raspberry pi where DHT22 and rain detection sensor is connected to Arduino board for conversion of analog to digital signal. Here we are using wheels to move robot. Those Wheels are controlled by using Blue dot application. The Blue dot is used to move robot forward, backward, left and right.

3.9 Software Implementation

3.9.1 Software implementation of the blue dot for the robotic vehicle

Software Program**:**

```
from bluedot import BlueDot
from gpiozero import Robot
from signal import pause

bd = BlueDot()
robot = Robot(left=(23,22), right=(17,18))
robot1 = Robot(left=(16,19), right=(26,20))

def move(pos):
        if pos.top:
              robot.forward(pos.distance)
              robot1.forward(pos.distance)
         elif pos.bottom:
               robot.backward(pos.detachment)
               robot1.backward(pos.distance)
         elif pos.left:
                robot.left(pos.distance)
                robot1.left(pos.distance)
          elif pos.right:
                robot.right(pos.distance)
                robot1.right(pos.distance)
def stop():
           robot.stop()
           robot1.stop()

bd.when_pressed = move
bd.when_moved = move
bd.when_released = stop

pause()
```

3.9.2 Flowchart

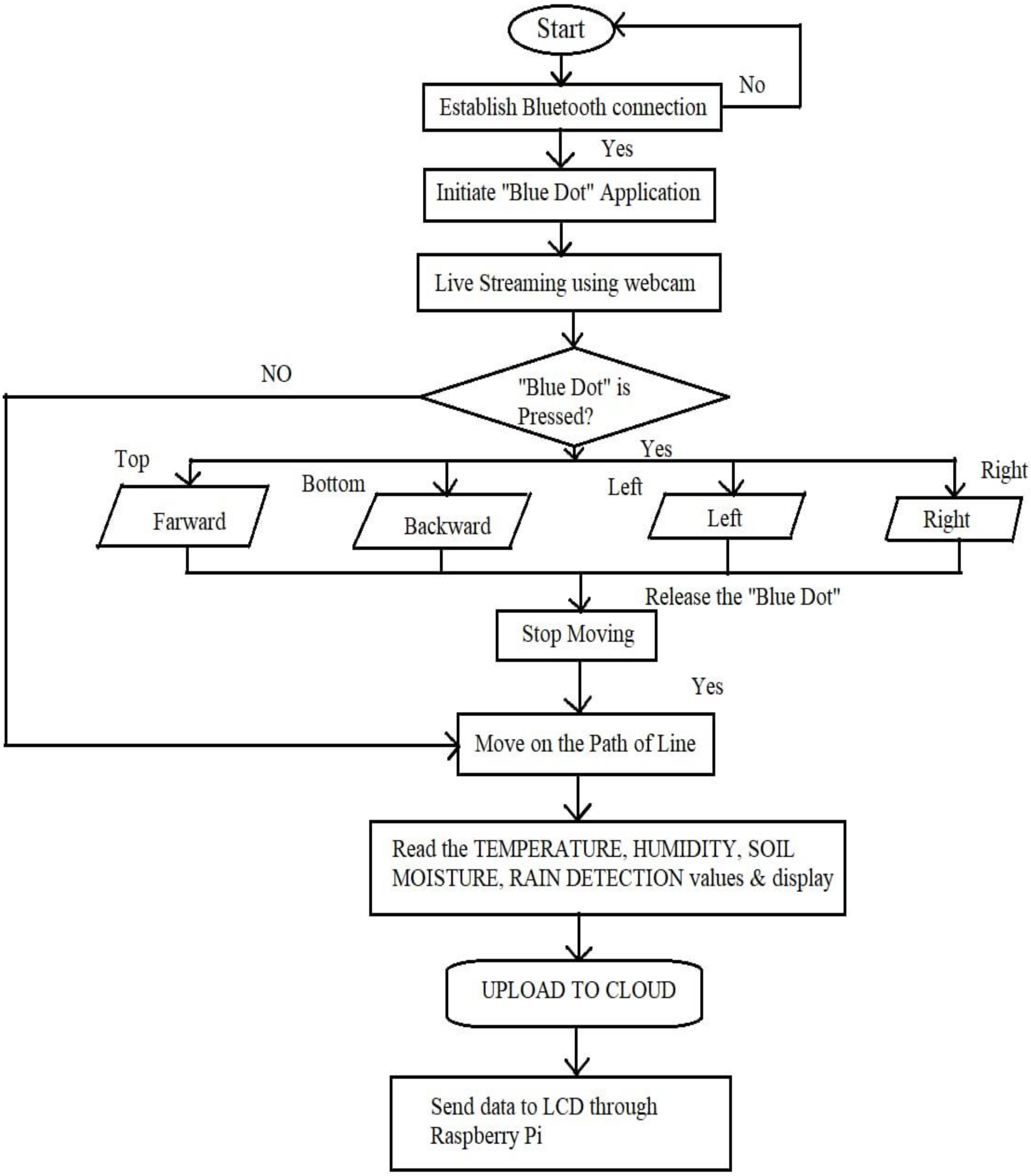

Figure 3.7: Flowchart of the proposed robotic Vehicle

The working principle of our project is illustrated in the above flowchart, Raspberry PI module which is coded with respect to Blue Dot application, where the robot is initiated Bluetooth connection is established between the Raspberry PI and Android app. The live capturing of surroundings is done by using Webcam. As the line following robots only move forward or backward directions, in order to move the robot left and right we are using Blue Dot application. This Blue Dot application is mainly used to control the wheel's movement and once we release the Blue Dot the entire movement of Robot wheels will pause and it will move on the path of line automatically in forward direction after sometime as we programmed with time delay.

These readings are uploaded to the cloud where the massive network that supports network devices.

3.9.3 Software Implementation for Image Processing

Program:

```
import numpy as np
import matplotlib.pyplot as plt
from keras.models import load_model

model = load_model('saved_model/my_model')
model.compile(optimizer='adam', loss='categorical_crossentropy' ,metrics=['accuracy'])
from keras.preprocessing import image
def prepare(img_path):
    img = image.load_img(img_path, target_size=(260,260))
    x = image.img_to_array(img)
    x = x/255
    return np.expand_dims(x, axis=0)

path = 'F:/project/disease_detection_code/Corn_Common_Rusts.jpg'

result = model.predict([prepare(path)])
d=image.load_img(path)
plt.imshow(d)
x=np.argmax(result,axis=1)
print(x)
print(result)

if x[0]==0:
    print("Disease is corn_blight")
elif x[0]==1:
    print("Disease is common_rust")
elif x[0]==2:
    print('Disease is green_leaf_spot')
elif x[0]==3:
    print('Disease is healthy')
```

3.9.4 Flowchart

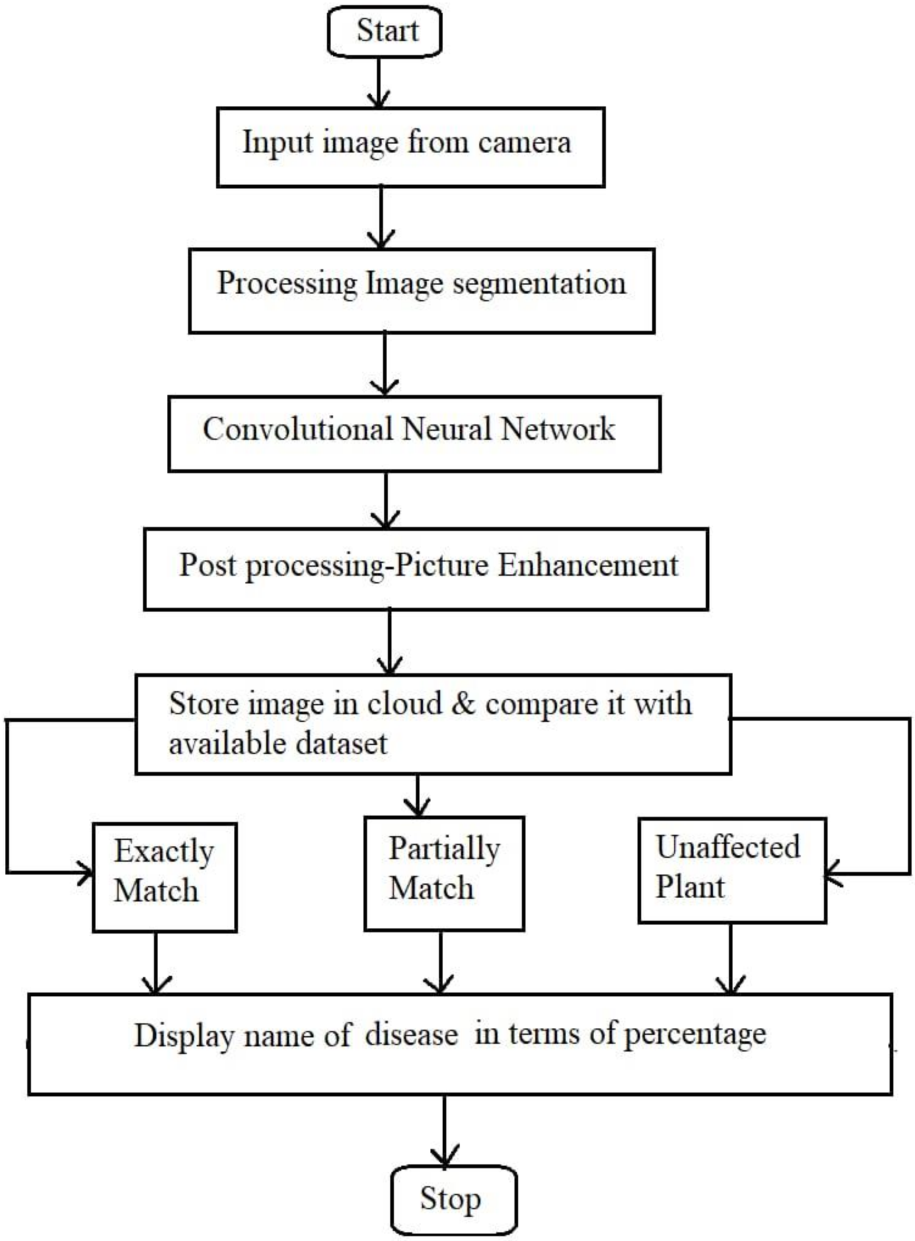

Figure 3.8: Flowchart for the proposed image processing

The methodologies used for the final result of disease detection in the crops are:

i) Image Pre-processing

ii) Image segmentation

iii) Convolutional Neural Networks

iv) Post Processing-Image enhancement

v) Matching techniques

The edges and corners are used mostly in image processing for differentiating an image from another image Initially, the features from images in the trained dataset are extracted to find the sample threshold values. These features are used to train the system to identify the various disease affected by crop.

The various disease that can identify by the image processing in this project are:

- Blight
- Common rust
- Gray leaf spot
- And healthy system

Keras and Tensarflow models are used to train the data sets. The result is processed using above software program and the result is displayed by mentioning the disease of the crop and display it in percentage.

CHAPTER 4

RESULT, DISCUSSION AND CONCLUSION

This project presents the design methodology and implementation of a robotic vehicle along with Global positioning system (GPS) to track the location of the robot. Along with the GPS enabled robotic vehicle, this work implements image processing for use in the agriculture sector. Image processing is used to capture the image of the crop and processed to detect the disease affected by the plant. Soil moisture sensing, determination of the humidity and temperature of the atmosphere and rain detection are enabled with robotic vehicle for sensing the assigned parameters. Finally, all the information is gathered using IoT enabled data system.

4.1: Module 1

Movement of robot is controlled using Blue dot app with Live streaming

In order to make the Robot available for the monitoring and capturing the images of the crop it should move towards the plant which is made possible by wheels attached to the Robot and controlled by Blue Dot application. By controlling the entire Robotic System, the system can reach destination point for performing desired objectives. The system is also integrated with Pi camera in order to get the livestreaming of the crop/leaves/plant to detect the leaf disease. Through which the monitoring person can get in touch with the user virtually.

4.2 Module 2

Implementation of robotic vehicle with GPS:

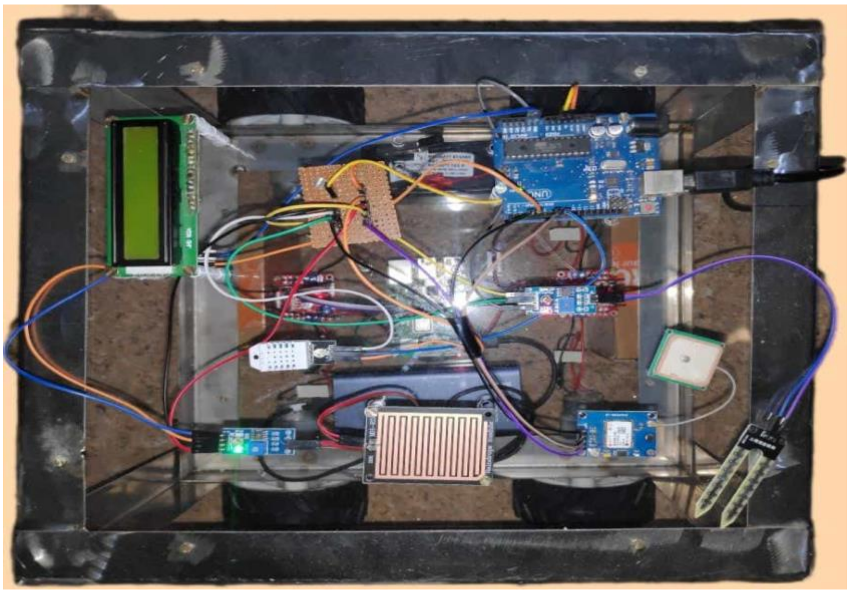

Figure 4.1: Image of the robotic vehicle

Robotic vehicle is implemented with Global positioning system(GPS). GPS is mounted on the vehicle to track the location of the vehicle.

https://maps.google.com/?q=12.361924,76.628646- This link provides the location of the robotic vehicle in the google map.

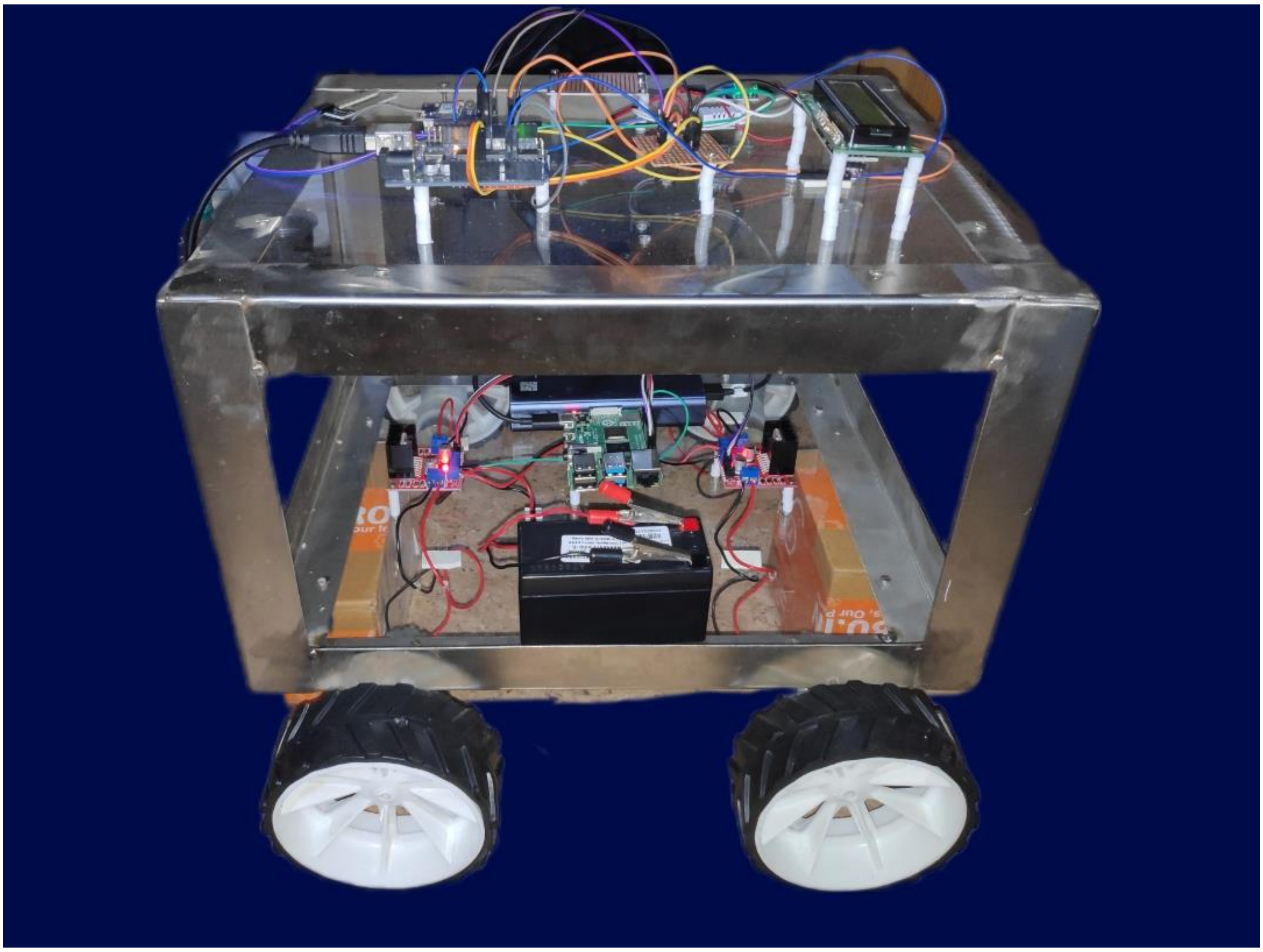

Figure 4.2: Developed Robotic vehicle for Agricultural Applications.

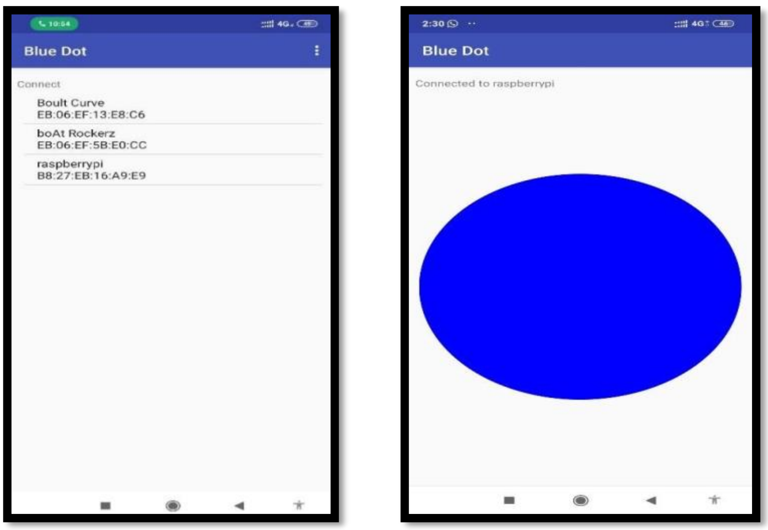

Figure 4.3: Bluedot connection between android and Raspberry Pi

The movement of the robotic vehicle is controlled using "Bluedot" android application, Bluetooth will be enabled in both raspberry Pi and Android phone, after establishing the connection between android and raspberry Pi, a blue colored circle will be displayed on android phone. The movement of the robot is based on the region which is pressed. If the top region of the circle is touched then it will move in forward direction, similarly if left, right and bottom regions are pressed, the robot will move that direction. The speed of the robot can be controlled by pressing inward regions and speed can be increased by pressing at the edges of the circle.

Figure 4.4: Sensor Readings on LCD Display.

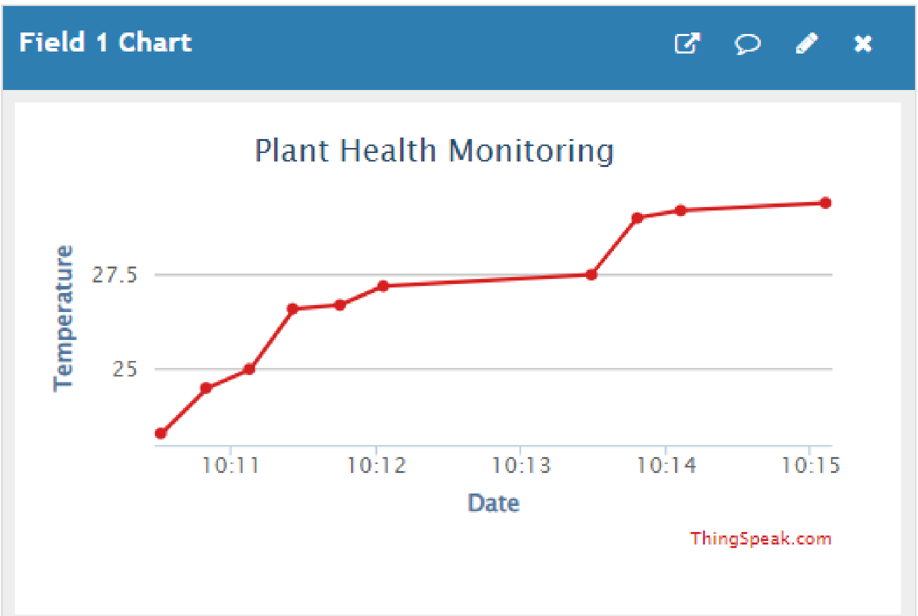

Figure 4.5: Temperature Visualization on ThingSpeak

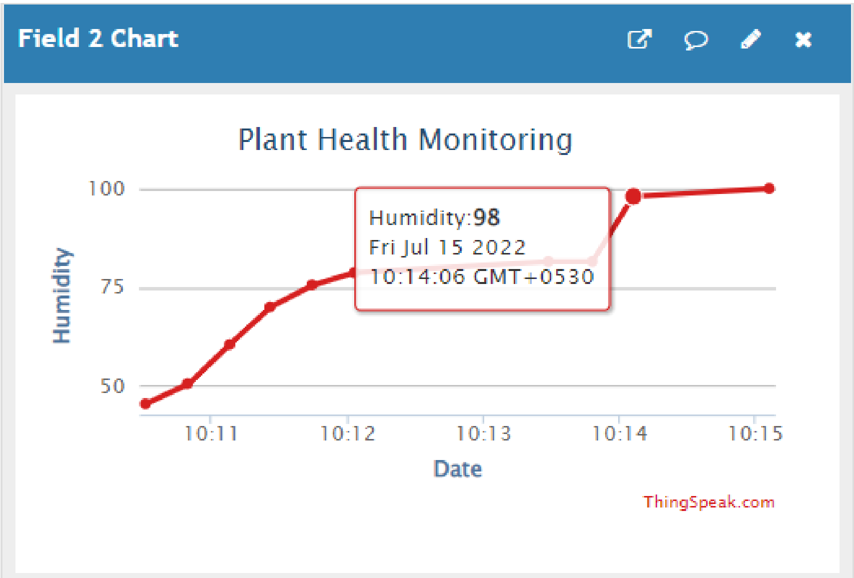

Figure 4.6: Humidity values uploaded to ThingSpeak

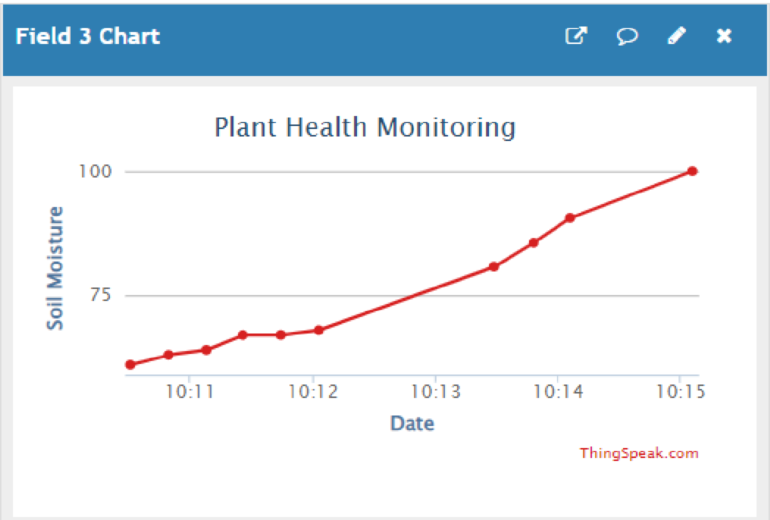

Figure 4.7: Soil Moisture data uploaded on ThingSpeak

The uploaded data to ThingSpeak is shown in above figure. Three separate fields are created for temperature, humidity and Soil Moisture. The accurate readings of temperature, humidity and Soil moisture are displayed using the digital meters shown in the fields. These data can be accessed anytime for analysis of agriculture environment.

4.3 Module 3

Implementation of image processing to identify the crop disease

Implementation of image processing in the project to detect the disease of the maize crop. There are three types of disease identified and healthy crop. The three types of disease identified are corn blight, common rust, grey leaf spot.

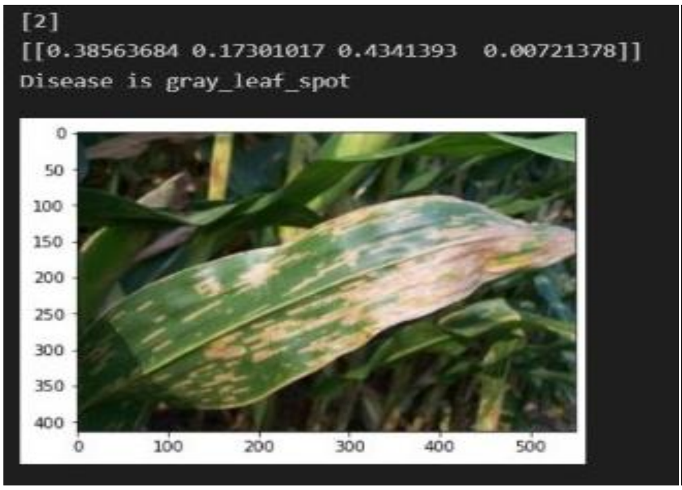

Figure (a)

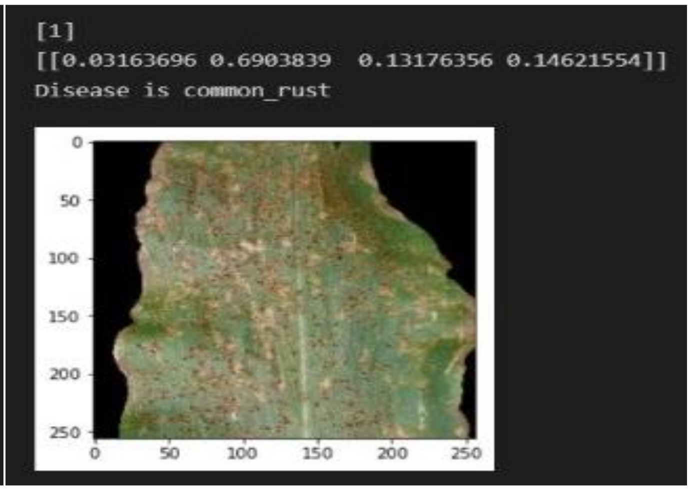

Figure (b)

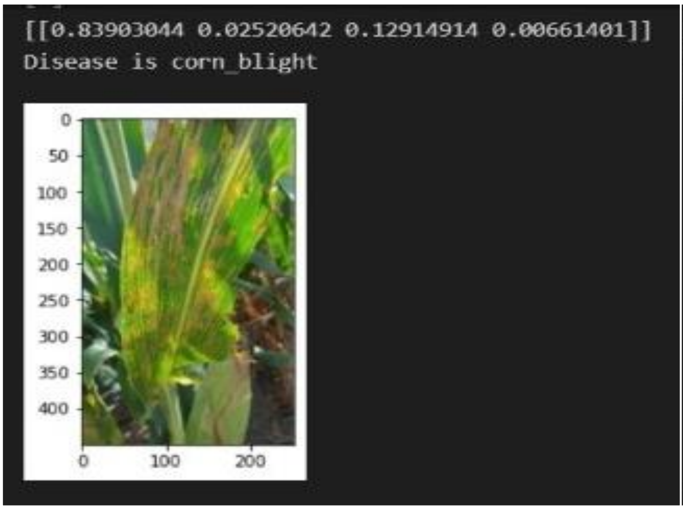

Figure (c)

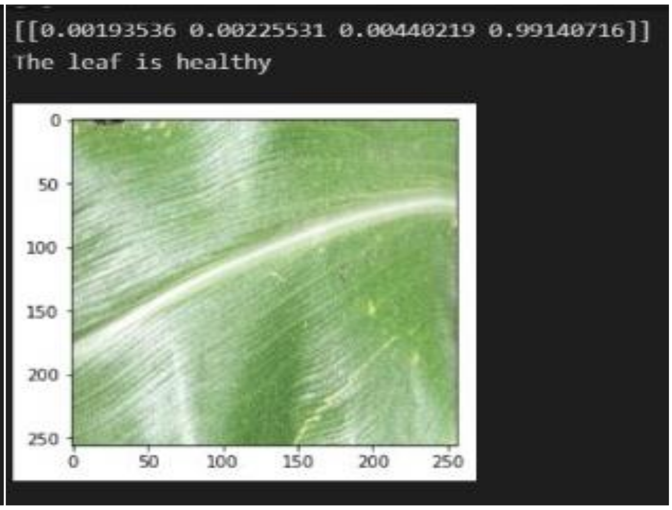

Figure (d)

Figure 4.8: Screenshots of the image processing

Figure 4.2(a) gives the identification of gray leaf spot disease. Where it consists 38% of corn blight,17% of common rust, 43% of gray leaf spot and 7% healthy.

Figure 4.2(b) gives the identification of common rust disease. It consists of 3.1% of corn blight, 68% of common rust ,13% of gray leaf disease and 14% is healthy.

Figure 4.2(c) gives the identification of corn blight disease. It consists of 83% of corn blight, 2.5% of common rust, 1.2% of gray leaf spot and 0.6% healthy.

Figure 4.2(d) identifies the crop as healthy. Where the crop is 99% healthy.

CONCLUSION

This project proposes a GPS controlled robotic vehicle for monitoring the environmental conditions such as temperature, humidity, air quality, air pressure. Image processing is used to monitor and capture the images of crops, determine soil moisture sensing, determine the humidity of the atmosphere with IOT enabled data gathering system. Sensors sense the data from the environment and transmit it to the cloud server using wireless communication. The proposed robotic vehicle work effectively in remote places to collect data and t is easy to implement. Instead of visiting the farm and uploading the images of crop, the proposed GPS and IOT enabled robotic vehicle acts as aid in resource to the farmers. With the proposed prototype, location of the robotic vehicle can be traced out and vehicle can be operated to place at desired locations. It is possible to fetch the details of humidity by DHT22, examining the moisture of the soil by the sensor and quality of the crop through image processing. It will be helpful to get a good yield.

FUTURE SCOPE

This work lies in developing a prototype useful for farmers. A mechanism to facilitate farmers about crop health, preventive measures based on GPS and IOT. The project involves image identification and symptom based diagnosis to help farmers to arrive at good crop yield. As an effort towards sustainable agriculture system, the important contributions can be made by using emerging technologies. With the proposed prototype it may be possible to reduce errors in the farming and can increase crop yield so as to achieve economically sustainable agriculture.

GPS used in precision agriculture for many purposes including farm planning, field mapping, oil sampling and yield mapping. This project presents the robotic vehicle with the sensors to sense the soil moisture, humidity of the atmosphere and rain detection. With reference to the agricentral application, the image is captured in the farm manually and then it is processed by image processing and gives the information regarding crop health

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