DAYANANDA SAGAR COLLEGE OF ENGINEERING

Shavigemalleshwara Hills, Kumaraswamy Layout, Bengaluru-560111, Karnataka
(An Autonomous College affiliated to VTU Belgaum, accredited by NBA & NAAC)

Department of Electronics & Communication Engineering

IV SEM BE MINI PROJECT-1 (22EC49) REPORT
on

'DEVELOPMENT OF DHARANI ROVER'

Submitted in partial fulfillment of the requirement for the degree of

Bachelor of Engineering
in
Electronics & Communications Engineering - ECE
by

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2023-24

Certificate

Certified that the Mini project-1 **(Course Code : 22EC49)** entitled "**DEVELOPMENT OF DHARANI ROVER**" carried out by **BHUVAN GS** (1DS22EC050), HARSHINI R **(**1DS22EC082), **SHASHANK S** (1DS22EC205), **SHIVANI** (1DS22EC208) are bonafide students of the Department of ECE of Dayananda Sagar College of Engineering, Bangalore, Karnataka, India in partial fulfillment for the award of Bachelor of Engineering in Electronics & Communication Engineering of the Visvesvaraya Technological University, Belagavi, Karnataka for the I**V Semester course** during the academic year 2023-24. It is certified that all corrections / suggestions indicated for the Mini project-1 have been incorporated in the project report. This **IV semester mini project report** has been approved as it satisfies the academic requirement in respect of Mini project-1 prescribed for the said degree.

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Declaration

Certified that the Mini project-1 entitled, “DEVELOPMENT OF DHARANI ROVER” with the course code **22EC49** (2 Credits, CIE 100 Marks) is a bonafide work that was carried out by us in partial fulfillment for the award of degree of Bachelor of Engineering in Electronics & Communication Engg. of the Visvesvaraya Technological University, Belagavi, Karnataka during the academic year 2023-24 for the IV Semester Autonomous Course. We, the students of the IV sem Mini project-1 batch no 4MP-11 do hereby declare that the entire mini-project has been done on our own.

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Date: 13 / 07 /2024
Place: Bengaluru

Abstract

This project introduces a six-wheel rover equipped with a rocker-bogie suspension system and a versatile robotic arm designed for comprehensive environmental monitoring. The rover's rocker-bogie suspension enhances its ability to navigate rugged terrains by maintaining stability and ensuring continuous ground contact with its independently powered wheels. This robust design allows the rover to traverse a variety of landscapes, making it suitable for field research in challenging environments.

The robotic arm, controlled by precise servo and stepper motors, is outfitted with an array of sensors to measure critical environmental parameters such as soil moisture, rainfall, humidity, temperature, and air quality. An ESP32 microcontroller orchestrates data acquisition and processing from these sensors, ensuring efficient and accurate data collection. Additionally, the inclusion of an ESP32 camera module provides visual feedback and supports image-based analysis, further enhancing the rover's capabilities in environmental monitoring and assessment.

Wireless communication capabilities allow the rover to transmit data in real-time to remote servers or control stations, enabling continuous monitoring and timely data analysis. Powered by a rechargeable battery pack, the rover ensures extended operational periods, making it ideal for applications such as agricultural soil analysis, climate research, and air quality monitoring in inaccessible or hazardous locations. The combination of a robust mechanical design, comprehensive sensor suite, and advanced data transmission features provides researchers and environmental scientists with a powerful tool for detailed field data collection and analysis, enhancing our ability to understand and monitor environmental conditions in diverse settings.

Acknowledgement

It is our profound gratitude that we express our indebtedness to all who have guided us to complete this mini-project successfully. We extend our sincere thanks to the **management of DSCE**, for providing us with excellent infrastructure and facilities. We are thankful to our principal **Dr. B. G. Prasad**, for his encouragement and support. We are grateful to our HOD **Dr. Shobha K. R** for her valuable insights and guidance. We are thankful to our guide **Dr. T.C Manjunath** for his valuable guidance, exemplary support and timely suggestions throughout the journey of the mini project. We sincerely acknowledge the Mini Project-1 Convener **Dr. P. Vimala** for her help and constant support. We would like to thank our Mini-Project Coordinator **Dr. Manasa RK** for their support and coordination.

I also thank the teaching and non- teaching staff members of Department of Electronics and Communication Engineering and also, my family and friends for the help and support provided by them in successful completion of the mini project. We express our gratitude to the Almighty for guiding us throughout this journey.

Thank you all

SHASHANK S

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SHIVANI A

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Chapter-1

1.1 Introduction

Fig 1.1 Rover Prototype

The DHARANI ROVER is an innovative mini project designed to revolutionize soil analysis and environmental monitoring. This multifunctional rover is engineered to dig into the soil and measure various essential parameters, including temperature, air quality, moisture, and rainfall, providing a comprehensive overview of environmental conditions.

Equipped with advanced sensors, the DHARANI ROVER collects real-time data crucial for agricultural, environmental, and scientific research. The temperature sensor helps in monitoring soil and ambient temperatures, crucial for understanding climate patterns and their impact on soil health.

Soil moisture is a critical parameter for agriculture, and the DHARANI ROVER's moisture sensor accurately measures water content in the soil, helping farmers optimize irrigation and improve crop yields. The rainfall sensor quantifies precipitation levels, offering valuable insights into local weather patterns and aiding in water resource management.

The rover's mobility and ability to dig into the soil allow for on-site, in-depth analysis, making it a versatile tool for diverse applications. Its data collection capabilities are essential for precision agriculture, enabling farmers to make informed decisions based on real-time data, ultimately enhancing productivity and sustainability.

1.2 Problem statement

- In modern agriculture and environmental management, there is a pressing need for accurate and real-time data collection to optimize resource use, enhance productivity, and monitor ecological health.
- Traditional methods of soil and environmental analysis are often time-consuming, labour-intensive, and require stationary equipment that cannot provide comprehensive on-site data.
- This limitation hinders the ability to make timely and informed decisions critical for sustainable farming, environmental conservation, and scientific research.
- By using traditional methods there are very less chances of high margins which causes non profitability to farmers.
- Increase in population leads to increase in demand and supply which leads to ensure a constantly evolving production.

By addressing these challenges, the DHARANI ROVER aims to provide a practical and efficient solution for real-time environmental monitoring and soil analysis, ultimately contributing to the advancement of sustainable agricultural practices and environmental stewardship.

1.3 Objectives

The main objective of this project is to design and develop a versatile Bluetooth-controlled rover equipped with a robotic arm capable of digging soil and accurately measuring key environmental parameters, including temperature, air quality, soil moisture and other parameters.

The innovative solution aims to provide real-time, on-site data collection to support informed decision-making in agriculture and environmental management.

The specific objectives are

1. Design and development of the rover:

Construct a robust and mobile Bluetooth controlled car capable of navigating diverse terrains and ensure reliable remote-control functionality for precise manoeuvring and operation.

2. Integration of a robotic arm:

Design and implement a functional robotic arm capable of digging into different soil types.

3. Sensor incorporation and data collection:

Ensure sensors provide accurate and real time data for comprehensive environmental analysis.

4. User interface control:

Create a user-friendly interface for user for easy control of the rover and ensure the interface allows for real time monitoring of sensor data and rover status.

Chapter 2

Literature survey

REFERENCE PAPER	DISADVANTAGES OF THE PAPER	IDEAS IMPLEMENTED FROM THE PAPER
Designing and development of agricultural rovers for vegetable harvesting and soil analysis by Bristy Das, Tahmid Zarif Ul Hoq Sayor, Rubyat Jahan Nijhum, Mehnaz Tabassum Tishun, Taiyeb Hasan Sakib, Md. Ehsanul Karim, AFM Jamal Uddin, Aparna Islam, Abu S. M. Mohsin. Brac University, Dhaka, Bangladesh on June 21st 2024	The use of Arduino UNO and Mega along with Rasberry Pi Microprocessors, Human Automation, real time processing of data is complex.	Robustness of the rover for many terrains, multifunctionality with surveillance and increasing the overall real time data processing accuracy.
Robotics and AI for Precision Agriculture by Giulio Reina from Polytechnic University of Bari, Italy on April 20th 2024	This paper presented works only on the theoretical dataset trainings for better implementation of Robotics for real world Environments	Ideas on learning to develop systems for multiple environments and making it autonomous, with an idea on how to implement testing of the Unit.
Determining the optimal selective harvest strategy for mixed-crops stands with a transition matrix growth mode by Qingyu Hao, Fanrui Meng, Yuping Zhou & Jingxin Wang published on march/2021	This was just a theoretical approach for Selective harvesting. Number of data sets considered for training were less	How to determine the optimal harvesting strategy needed for uneven-aged mixed-crops
Application of IoT and Machine Learning in Agriculture by Aman Kumar Dewangan Department of Electrical Engineering National Institute of Technology Raipur, Chhattisgarh, India on July/2020 (IJERT)	Training and testing details was hidden. Compilation time was more.	increased productivity, proper crop distribution, Crop pattern suggestion, proper utilization of resources such as Fertilizers and manures using the technique of Automation and AI model.
Soil moisture and temperature measurement sensor network using Raspberry Pi and IoT.Mangesh Goswami, Naresh Ganesh, Bhupendra Bahadur Singh, Milind Mujumdar. Pimpri Chinchwad College of Engineering, Pune, 411044, India, Centre for Climate Change Research, Indian Institute of Tropical Meteorology (Ministry of Earth Sciences)- 2019	In this method test samples were not taken through the fields and it has accuracy of 93.7%. It can be increased by taking sample through the field and aggregating it in further.	Developed a network of low-cost soil moisture conductive sensors and temperature sensors using Raspberry Pi and IoT. This system measure soil parameter at different depth across one profile.

Chapter 3

Implementation

Conceptualization and Planning:

Define the project's scope, objectives, and requirements. Determined the specifications for the Rover including size, power source, and control mechanisms. Plan the integration of the mechanical arm and wireless communication components.

Mechanical Assembly:

Assembled the physical structure of the car, including attaching the wheels, motors, and chassis. Ensured the design supports the integration of the arm and provided space for electronics.

Electronics Integration:

Connect and integrate the Arduino along with motor drivers, Bluetooth transceivers. Wire the components according to the connections needed.

Wireless Communication Setup:

Configured the wireless communication system, established a reliable connection between the car and the remote-control device. Implemented appropriate protocols to ensure real-time data transmission and minimal latency.

Remote Control Interface Development:

For user interface for remote controlling the car we used application named Bluetooth RC car for controlling the movement of car. We used an application named Blynk IOT to view the output data fetched from the sensors.

Testing:

Thoroughly tested the car's functionality, including movement of mechanical arm and feasibility of wireless communication.

Demonstration and Validation:

Conducted a live demonstration to showcase the Rover capabilities, Validated its functionality in different terrains conditions and scenarios.

Project Presentation and Documentation:

Prepare a final project presentation that outlines the implementation process, challenges faced, solutions applied, and outcomes achieved. Compile all documentation for future reference and potential replication.

By following this implementation procedure, the "DHARANI ROVER" project is successfully created a functional tool capable of operating effectively.

3.1Methodology

System Integration and Control:

- Utilized an Arduino motor driver shields to control the rover's movement.
- Integrated an HC-Bluetooth module for remote control via a Bluetooth-enabled device.
- Programed the Arduino to handle motor operations and Bluetooth commands.

Sensor Deployment:

- Installed air quality sensor, rain sensor, and DHT11 sensor.
- Collect data on precipitation, air quality, temperature, and humidity.
- Connected the sensors to the Arduino for real-time data acquisition.

Data Transmission:

- Implemented a NodeMCU Wi-Fi module to transmit sensor data to the Blynk IoT application.
- Configured the NodeMCU to connect to Wi-Fi and ensure seamless data transfer to the cloud for remote monitoring.

Data Visualization and Remote Monitoring:

- The Blynk IoT application is set up to visualize sensor data in real-time.
- Enabled alerts and notifications for critical conditions to facilitate timely interventions.
- Ensures remote control capabilities through the Blynk app for efficient field operations.

3.2 Block diagram

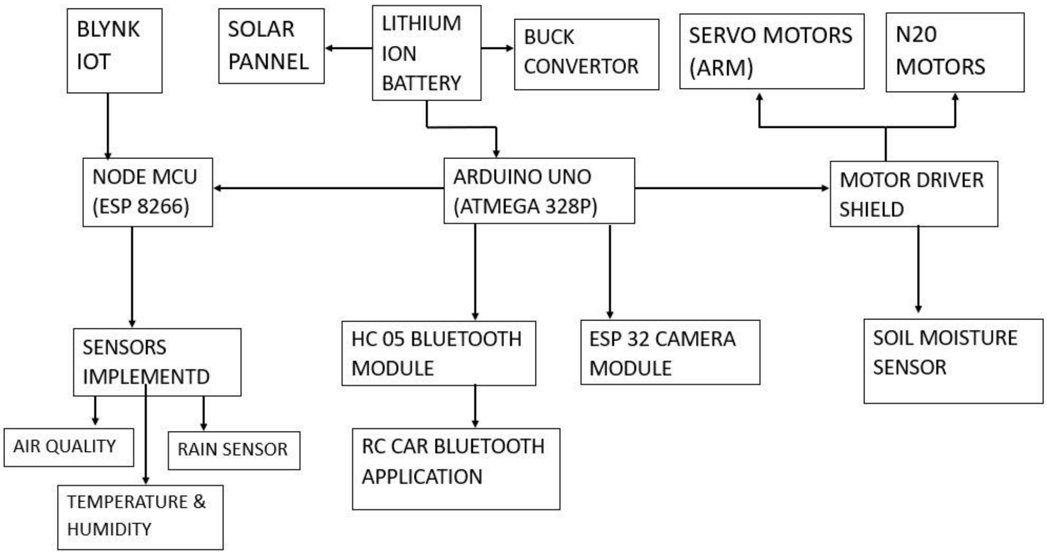

Fig.3.1 Dharani Rover Block Diagram

- Arduino UNO is the main central controller which is powered by Solar Panel and Lithium-Ion battery.
- The Arduino providing the main supply and ground for all Blocks is providing 5v Supply through Buck Converter to the NodeMCU ESP8266 which is connected to all sensors for direct data collection and monitoring.
- The main Rover movement is controlled by Bluetooth HC-05 Module through RC Bluetooth Car App which provides it manual control through mobile application.
- The sensor data is displayed in the Blynk IoT Application based on real time data collection.
- The ESP32 Camera Module mounted on a support using a servo motor provides extra 2Mega Pixel resolution of surveillance adding to the multi functionality .
- The Mechanical Arm which comprises of 4 servos is powered from the L293D Arduino Motor Driver shield which converts 9V to 5.7V to power the servos accordingly for customizable alignment which is controlled through the MIT Open Inventor App with the required buttons for control.
- The top of the mechanical arm is mounted with one N20 Motor and a soil Moisture Sensor which provides digging and soil moisture sensing data which is fetched by the Wi-Fi module and displayed in the Blynk IoT. The digging mechanism is through 270 angle shifts.

3.3 Hardware Used

1. HC-05 Bluetooth Transceiver:

Bluetooth module is a basic circuit set of chips which integrated Bluetooth functions and which can be used in wireless network transmission. Generally, the Bluetooth module can be divided into the following types: data transmission module, remote control module, etc. Usually, modules are the semi-finished products, which are processed on the basis of chips to make the next application easier.

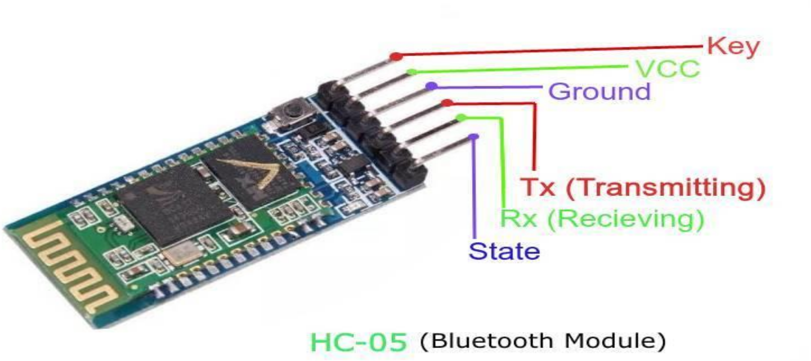

Fig.3.2 HC-05 Bluetooth Module Pin Configuration

2. L293D Motor driver:

L293D is a typical Motor driver or Motor Driver IC which allows DC motor to drive on either direction. L293D is a 16-pin IC which can control a set of two DC motors simultaneously in any direction. It means that you can control two DC motor with a single L293D IC.

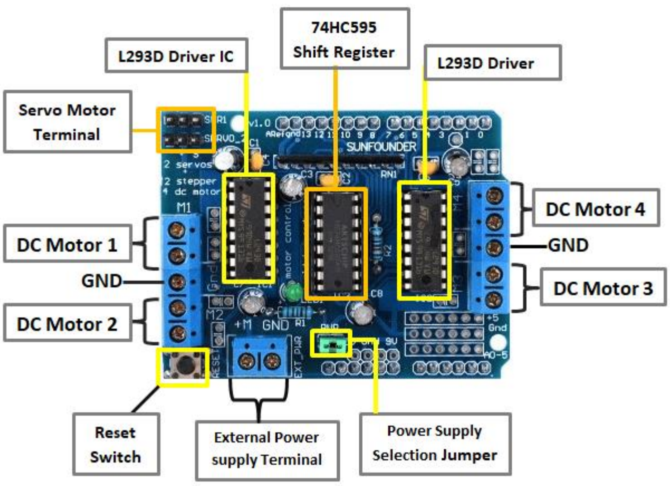

Fig.3.3 Arduino UNO Motor Driver Shield Pin Configuration

3. Arduino UNO:

The Arduino Uno is a microcontroller board based on the ATmega328. It has 20 digital input/output pins (of which 6 can be used as PWM outputs and 6 can be used as analog inputs), a 16 MHz resonator, a USB connection, a power jack, an in-circuit system programming (ICSP) header, and a reset button.

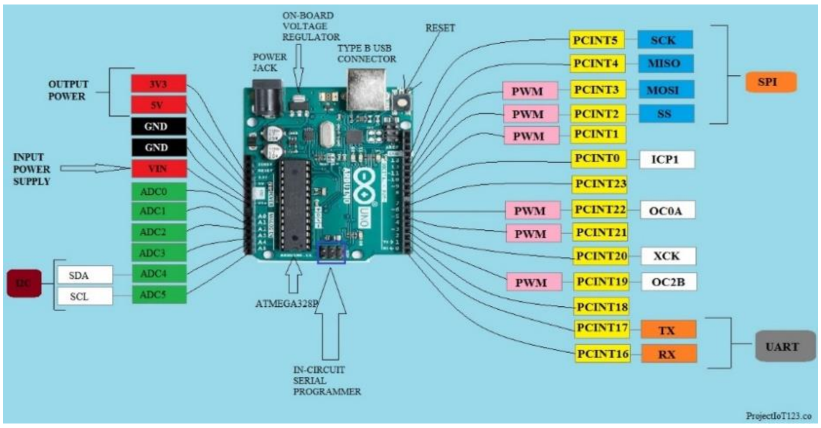

Fig.3.4: Arduino UNO Pin Configuration

4. NodeMCU ESP8266 WI-FI module:

   The ESP8266 WiFi module in our six-wheel rover enables seamless wireless communication, allowing real-time transmission of environmental data such as soil moisture, rainfall, humidity, temperature, and air quality to a remote server or mobile application.

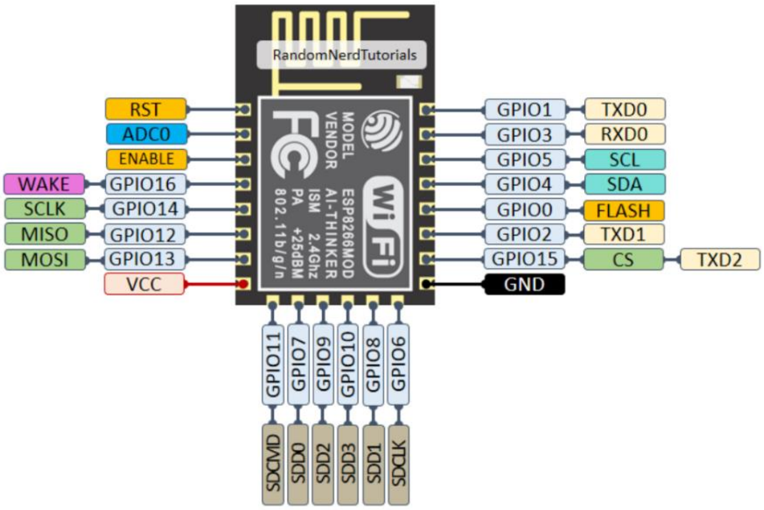

Fig.3.5 ESP8266 Wi-Fi Module Pin Configuration

Software Used

1. Blynk IoT:

Blynk IoT enhances our agricultural rover by enabling real-time remote monitoring and control through a user-friendly mobile app. It allows for custom interfaces to visualize and manage data such as soil moisture, rainfall, humidity, temperature, and air quality, facilitating efficient data analysis and decision-making.

2. Arduino IDE:

The Arduino Integrated Development Environment (IDE) is crucial for programming the microcontrollers in our agricultural rover. It offers a simple interface for writing, compiling, and uploading code to control the rover's sensors and robotic arm, making customization and development straightforward.

3. RC Bluetooth Car Module Controller App:

The RC Bluetooth Car Module Controller App provides wireless control of our agricultural rover via an intuitive interface. Using Bluetooth connectivity, users can command the rover's movements for precise and efficient field data collection.

4. MIT Open App Inventor:

MIT App Inventor is a visual programming platform that enables the easy creation of Android applications. It is used in our agricultural rover to control the orientation of the mechanical arms, providing an intuitive interface for precise manipulation and operation.

Chapter-4

4.1 Simulation Output

Code for RC Rover Model:

```
#include <Adafruit_BMP085.h>

#include <AFMotor.h>

//initial motors pin
AF_DCMotor motor1(1, MOTOR12_1KHZ);
AF_DCMotor motor2(2, MOTOR12_1KHZ);
AF_DCMotor motor3(3, MOTOR34_1KHZ);
AF_DCMotor motor4(4, MOTOR34_1KHZ);

char command;

void setup()
{
  Serial.begin(9600);
}

void loop(){
  if(Serial.available() > 0){
    command = Serial.read();
    Stop(); //initialize with motors stoped
    //Change pin mode only if new command is different from previous.
    //Serial.println(command);
    switch(command){
    case 'F':
      forward();
      break;
    case 'B':
       back();
      break;
    case 'L':
      left();
      break;
    case 'R':
      right();
      break;
    }
  }
}
```

```
void forward()
{
  motor1.setSpeed(255); //Define maximum velocity
  motor1.run(FORWARD); //rotate the motor clockwise
  motor2.setSpeed(255); //Define maximum velocity
  motor2.run(FORWARD); //rotate the motor clockwise
  motor3.setSpeed(255);//Define maximum velocity
  motor3.run(FORWARD); //rotate the motor clockwise
  motor4.setSpeed(255);//Define maximum velocity
  motor4.run(FORWARD); //rotate the motor clockwise
}

void back()
{
  motor1.setSpeed(255); //Define maximum velocity
  motor1.run(BACKWARD); //rotate the motor anti-clockwise
  motor2.setSpeed(255); //Define maximum velocity
  motor2.run(BACKWARD); //rotate the motor anti-clockwise
  motor3.setSpeed(255); //Define maximum velocity
  motor3.run(BACKWARD); //rotate the motor anti-clockwise
  motor4.setSpeed(255); //Define maximum velocity
  motor4.run(BACKWARD); //rotate the motor anti-clockwise
}

void left()
{
  motor1.setSpeed(255); //Define maximum velocity
  motor1.run(BACKWARD); //rotate the motor anti-clockwise
  motor2.setSpeed(255); //Define maximum velocity
  motor2.run(BACKWARD); //rotate the motor anti-clockwise
  motor3.setSpeed(255); //Define maximum velocity
  motor3.run(FORWARD);  //rotate the motor clockwise
  motor4.setSpeed(255); //Define maximum velocity
  motor4.run(FORWARD);  //rotate the motor clockwise
}
```

```
void right()
{
  motor1.setSpeed(255); //Define maximum velocity
  motor1.run(FORWARD); //rotate the motor clockwise
  motor2.setSpeed(255); //Define maximum velocity
  motor2.run(FORWARD); //rotate the motor clockwise
  motor3.setSpeed(255); //Define maximum velocity
  motor3.run(BACKWARD); //rotate the motor anti-clockwise
  motor4.setSpeed(255); //Define maximum velocity
  motor4.run(BACKWARD); //rotate the motor anti-clockwise
}

void Stop()
{
  motor1.setSpeed(0); //Define minimum velocity
  motor1.run(RELEASE); //stop the motor when release the button
  motor2.setSpeed(0); //Define minimum velocity
  motor2.run(RELEASE); //rotate the motor clockwise
  motor3.setSpeed(0); //Define minimum velocity
  motor3.run(RELEASE); //stop the motor when release the button
  motor4.setSpeed(0); //Define minimum velocity
  motor4.run(RELEASE); //stop the motor when release the button
}
```

Code for Sensor Implementation through NodeMCU:

```
#define BLYNK_TEMPLATE_ID "TMPL3IavJwNSa"
#define BLYNK_TEMPLATE_NAME "Temparature Humidity Monitoring System"
#define BLYNK_AUTH_TOKEN "4lh5DQhbDFQsVMaq5vPoKZ77XwX-6qSU"
#define BLYNK_PRINT Serial
#include <ESP8266WiFi.h>
#include <BlynkSimpleEsp8266.h>
#include <DHT.h>
#include <Wire.h>
char auth[] = "4lh5DQhbDFQsVMaq5vPoKZ77XwX-6qSU";
char ssid[] = "BGS";  //Enter your WIFI Name
char pass[] = "bhuvangs2026";  //Enter your WIFI Password
BlynkTimer timer;
int gas = A0;
int sensorThreshold = 10;
#define DHTPIN D2//Connect Out pin to D4 in NODE MCU
#define DHTTYPE DHT11
DHT dht(DHTPIN, DHTTYPE);
#define RAIN_SENSOR_PIN D1
void sendSensor()
{

  int rainDetected = digitalRead(RAIN_SENSOR_PIN);
  float h = dht.readHumidity();
  float t = dht.readTemperature();
     if (isnan(h) || isnan(t)) {
    Serial.println("Failed to read from DHT sensor!");
    return;
  }
  if (rainDetected == LOW) { // Assuming LOW indicates rain detected
    Serial.println("Rain detected!");
    //Blynk.notify("Rain detected!");
    Blynk.virtualWrite(V4, "Rain detected!");
  } else {
    Serial.println("No rain detected.");
    Blynk.virtualWrite(V4, "No rain detected.");
  }
   int analogSensor = analogRead(gas);
  Blynk.virtualWrite(V3, analogSensor);
  Serial.print("Airquality: ");
    Serial.println(analogSensor);
```

```
    Blynk.virtualWrite(V0, t);
    Blynk.virtualWrite(V1, h);
    Serial.print("Temperature : ");
    Serial.print(t);
    Serial.print("    Humidity : ");
    Serial.println(h);
}

void setup()
{
  Serial.begin(115200);

 //pinMode(gas, INPUT);
  Blynk.begin(auth, ssid, pass);
  dht.begin();
  timer.setInterval(1000L, sendSensor);
  }

void loop()
{
  Blynk.run();
  timer.run();
 }
```

Code for Mechanical Arm:

```
  if(val=='2' & i<180){
    i=i+10;
  }
  else if(val=='1' & i>0){
    i=i-10;
  }
  else if(val=='3' & j>0){
    j=j-10;
  }
  else if(val=='4' & j<180){
    j=j+10;
  }
    else if(val=='5' & k>0){
    k=k-10;
  }
  else if(val=='6' & k<180){
    k=k+10;
  }
    else if(val=='7' & l>0){
    l=l-10;
  }
  else if(val=='8' & l<180){
    l=l+10;
  }

  delay(00);
}
```

```
#include <Servo.h>
int servopin1=3;
Servo belbow;

int servopin2=9;
Servo bwrist;

int servopin3=10;
Servo selbow;

int servopin4=11;
Servo swrist;

int i=90;
int j=90;
int k=90;
int l=90;
char val;

void setup() {
  // put your setup code here, to run once:
  Serial.begin(9600);
  belbow.attach(servopin1);
  bwrist.attach(servopin2);
  selbow.attach(servopin3);
  swrist.attach(servopin4);

}
```

4.2 Results

- The Six wheeled Agricultural Rover is mounted with the multiple sensors such as rain, humidity, gas and temperature and real data acquired is interfaced with Blynk IoT Application.
- It is also mounted with a mechanical arm consisting of N20 Motor and Soil Moisture sensor for digging and soil moisture content data collection.
- A ESP32 camera module is also present on the rover with a 270-degree coverage of surveillance adding to the multiple functionalities of the rover.
- This Agricultural Rover provides multi- functionality making it the best option for agricultural environmental monitoring and soil analysis data collection for best produce output.

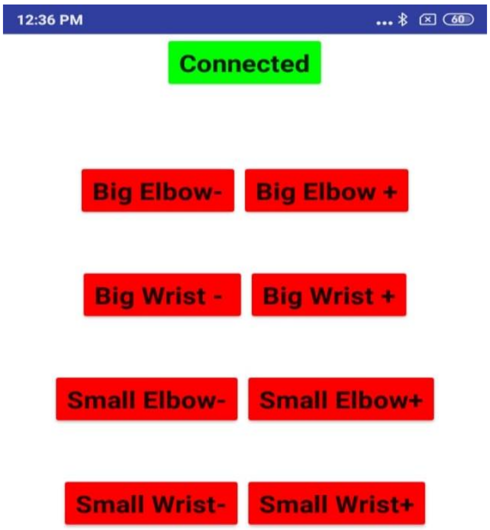

Fig. 4.1: MIT Open App Inventor Interface

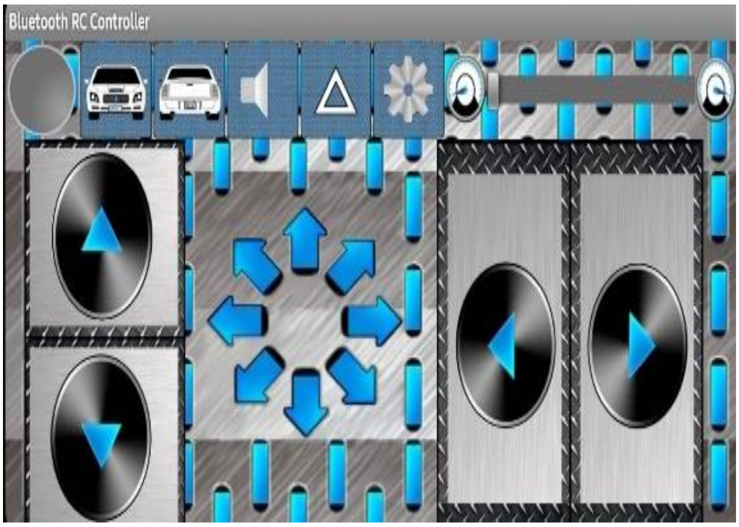

Fig. 4.2: RC bluetooth car control Application

Fig. 4.3: Dharani rover

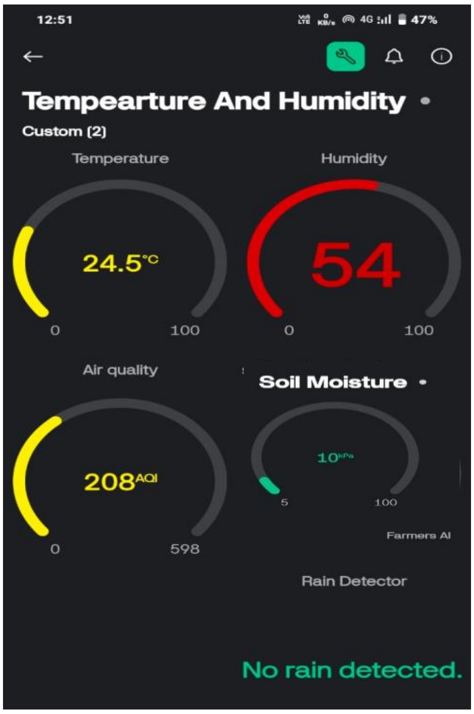

Fig. 4.4: Blynk IOT interface

4.3 Applications

The Darani rover has numerous practical applications across different aspects of agriculture:

1. Precision agriculture
    - Soil health monitoring: Regular measure of soil temperature, moisture and other parameters to optimize planting.
    - Crop management: Monitor environment conditions to predict and mitigate stress factors and sustainability.

2. Environmental science
    - Climate change studies: Collect data on temperature, air quality and rainfall to study the impacts of climate change on various ecosystems.
    - Pollution Monitoring: Assess air quality in different regions to take precautions for their crops.

3. Operate across different terrains
    - Dharani rover has an ability to operate across different land terrains as it has a rocker bogie suspension.

The DHARANI ROVER's ability to provide real-time, on-site data collection and analysis makes it a valuable asset in these diverse applications, contributing to improved decision-making and sustainable practices in agriculture, environmental management, research, and beyond.

Advantages

The Dharani rover offers following key advantages

1. Real time data collection

Provides immediate access to soil and environment data, enabling timely decision making

2. Mobility and versatility

Capable of navigating diverse terrains, including agricultural fields, and more, making it adaptable to various environments and application.

3. Comprehensive environmental monitoring

Integrates multiple sensors to measure essential parameters, offering a broad view of environmental conditions and soil health

4. Accessibility

Allowance of remote-controlled operation and data collection without need of physical presence, enhancing convenience and safety.

5. Efficiency and Time saving

Automates the process of soil and environmental monitoring, reducing the need for manual sampling and saving time and labor.

6. Enhanced productivity

Helps to optimize old practices through precise data leading to improved crop yields and efficiency.

7. User friendly interface

Designed with a user-friendly interface called BLYNK IOT for easy data visualization making it accessible.

Chapter-5

Conclusion

The six-wheel rover with a rocker-bogie suspension system represents a significant advancement in robotic exploration and environmental monitoring. The combination of mobility, stability, and multifunctional capabilities allows it to navigate challenging terrains while performing crucial measurements. By integrating sensors for soil moisture, rainfall, humidity, temperature, and air quality, the rover can provide comprehensive environmental data essential for various scientific and agricultural applications. This multi-sensor approach enables real-time monitoring and analysis, offering valuable insights into the local environment, which can inform decision-making processes in fields like precision agriculture, environmental conservation, and climate research.

The inclusion of a robotic arm further enhances the rover's functionality, allowing it to interact with its surroundings in a more dynamic and precise manner. This capability is particularly beneficial for tasks that require detailed sampling and manipulation, such as collecting soil samples or adjusting measurement instruments. As a result, the rover serves as a versatile platform that can be adapted to a wide range of missions, from planetary exploration to terrestrial research. Overall, the development of this rover marks a step forward in the integration of robotics and environmental sensing, providing a powerful tool for advancing our understanding of the natural world.

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Appendix

ARDUINO UNO DATASHEET:

Feature	Specification
Microcontroller	ATmega328P
Operating Voltage	5V
Input Voltage(recommended)	7-12V
Input Voltage(limit)	6-20V
Digital I/O Pins	14(of which 6 provide PWM output)
PWM Digital I/O Pins	6
Analog Input Pins	6
DC Current per I/o Pin	20mA
DC Current for 3.3V Pin	50mA
Flash Memory	32KB (0.5KB bootloader)
SRAM	2KB
EEPROM	1KB
Clock Speed	16MHz
LED_BUILTIN	13
Length	68.6mm
Width	53.4mm
Weight	25g

Table 1 Arduino UNO Datasheet

NODEMCU ESP8266 DATASHEET:

Feature	Specification
Microcontroller	Tensilica Xtensa LX6 dual-core (or single-core)
Operating Voltage	3.3V
Input Voltage	5V(via USB), 3.3V(via 3.3V pin), 7-12V(via Vin Pin)
Flash Memory	4MB(external Flash)
SRAM	520KB(on-chip),8KB(RTC)
Clock Speed	160MHz(up to 240MHz)
Wi-Fi	802.11b/g/n, dual-mode (2.4 GHz)
Bluetooth	V4.2 BR/EDR and BLE
GPIO Pins	36(multiplexed with various functions)
ADC Channels	18(12-bit SAR ADCs)
DAC Channels	2(8-bit DACs)
Touch Sensors	10
SPI Interfaces	4
I2C Interfaces	2
12S Interfaces	2
UART Interfaces	3
CAN Bus	1
PWM Channels	16
Hall Sensor	Yes
Temperature Sensors	Yes
Power Consumption	Active mode: ~160 mA, Deep Sleep: ~10 µA
Length	51.3mm
Width	25.7mm
Weight	7g

Table 2 NodeMCU ESP8266 Daatasheet

L293D ARDUINO MOTOR DRIVER SHIELD:

Features	Specifications
Motor Driver IC	L293D
Operating Voltage	5V(from Arduino)
Input Voltage(Vmotor)	4.5V-36V
Motor Current(per channel)	600mA continuous(1.2A peak)
Number of Channels	2
PWM Capability	Yes
Digital I/O Pins Used	8(for motor control and PWM)
Current Sense for Each Motor	Yes
Servo Motor Support	2 connectors for 5V servo motors
Output Enable Lines	Yes
Thermal Shutdown Protection	Yes
Internal ESD Protection	Yes
Dimensions	Standard Arduino shield size(68.6mm x 53.4mm)
Weight	~30g

Table 3 Arduino Motor Driver Datasheet