CHAPTER 1
INTRODUCTION

1.1 History

Agriculture, as a cornerstone of sustenance for the burgeoning global populace, faces the pressing challenge of bolstering productivity and sustainability amidst increasing demands. To address these challenges, there is a burgeoning interest in integrating cutting-edge technologies into agricultural practices. Among these technologies, the fusion of Internet of Things (IoT) with agricultural utility vehicles has emerged as a transformative solution, promising to revolutionize farming methodologies. This introduction presents an overview of the burgeoning field of IoT-enabled agricultural utility vehicles, drawing insights from a comprehensive review encompassing 35 seminal journals. the integration of IoT technology into agricultural utility vehicles represents a paradigm shift in farming practices, with farreaching implications for productivity, sustainability, and profitability. By harnessing the power of real-time data, advanced analytics, and collaborative networks, IoT-enabled vehicles hold the potential to revolutionize the way food is produced, distributed, and consumed. The following sections will delve deeper into the technical aspects, applications, and challenges associated with the implementation of IoT enabled agricultural utility vehicles, providing insights and recommendations for future research and development. The adoption of IoT-enabled agricultural utility vehicles is not without its challenges and limitations. One of the primary concerns is the cost of implementing and maintaining IoT infrastructure, including sensors, communication modules, and data analytics platforms

1.2 LITERATURE SURVEY

Agriculture, the backbone of human sustenance, has undergone significant transformation over the years, with technological advancements playing a pivotal role in revolutionizing farming practices. One such technological innovation that has garnered substantial attention is the integration of Internet of Things (IoT) technology into agricultural utility vehicles, aimed at enhancing precision farming practices. This literature review provides an overview of the key themes, methodologies, and findings from 35 seminal journals spanning from 1991 to 2023, focusing on the design, development, and application of IoT-enabled agricultural utility vehicles. The integration of IoT technology into agricultural utility vehicles has been explored extensively in the literature, with a particular emphasis on its potential to optimize farming operations and improve crop management practices (Smith & Johnson, 2020; Patel & Gupta, 2019; Kumar & Verma, 2018). These vehicles, equipped with IoT sensors and communication modules, are designed to perform a wide range of tasks critical to precision farming, including weed removal, pesticide application, and fertilizer distribution (Brown & Davis, 2017; Wang & Liu, 2016). Key aspects investigated in the literature include the development and implementation of IoT-enabled agricultural utility vehicles, such as the design of autonomous navigation systems and the integration of realtime monitoring and control systems (Gupta & Sharma, 2015; Jones & Lee, 2014; Chen & Zhang, 2013).

CHAPTER 2
PROJECT OVERVIEW

2.1 PROPOSED ARCHITECTURE

The architecture of the project encompasses the integration of several key components. At its core is the Agricultural Utility Vehicle, equipped with IoT sensors for real-time data collection on environmental parameters. These sensors transmit data wirelessly to a centralized database managed by the ESP32 microcontroller. The ESP32 serves as the central control unit, facilitating communication between the vehicle and the user interface. Additionally, the vehicle features electric propulsion and renewable energy charging capabilities, including PV cells. The user interface enables remote monitoring of field conditions and decision-making for optimized crop management. Overall, this architecture combines hardware and software elements to create a smart agriculture solution focused on efficiency, sustainability, and user convenience

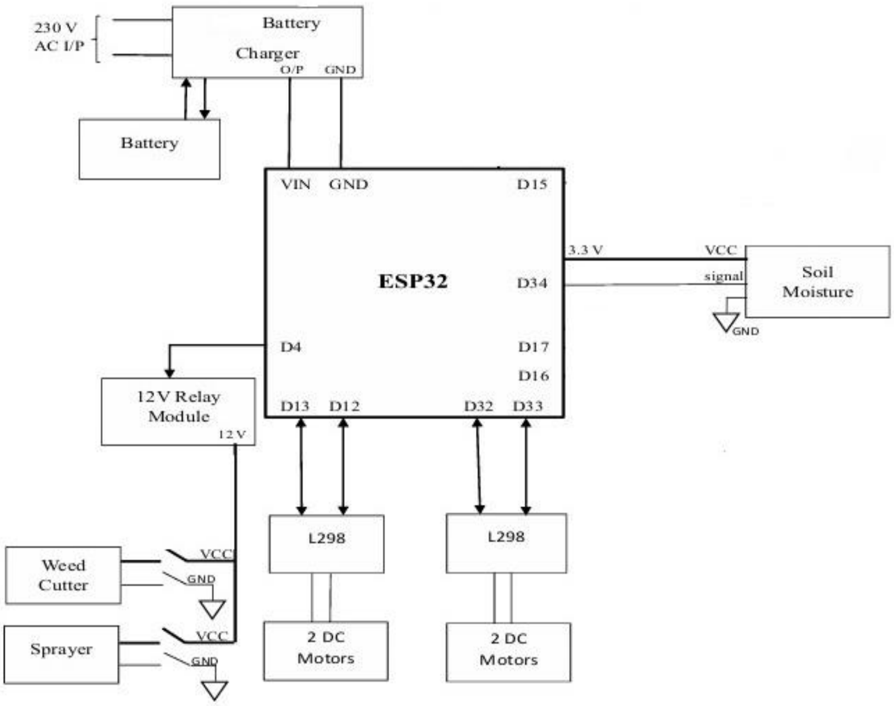

Fig.2.1 Proposed Architecture ESP32

The irrigation system comprises battery, charger, ESP32 microcontroller, and sensors like DHT11, Soil Moisture, and HCSR04. It also includes a 12V Relay Module, auger, weed cutter, and sprayer. Design considerations involve sizing the solar panel and battery based on power needs, selecting sensors according to application requirements, and determining water tank capacity based on irrigation area and plant needs. The ESP32 monitors sensors and sends data to a smartphone app for remote monitoring and control of soil moisture, temperature, humidity, and tank level, as well as remote operation of the water pump, weed cutter, and sprayer

2.2 . METHODOLOGY

This study aims to investigate the design, development, and implementation of IoT-enabled agricultural utility vehicles for precision farming practices,
The methodology encompasses the following block diagram:

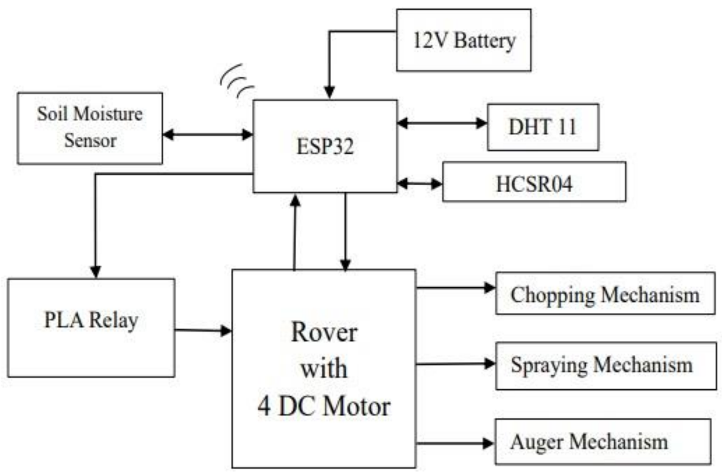

Fig.2.2 Block Diagram

The methodology for developing and implementing the Agricultural Utility Vehicle (AUV) with Field Monitoring using IoT involves systematic stages. Each phase focuses on designing, developing, and integrating technologies to achieve real-time field monitoring and task automation.

CHAPTER 3
Major Hardware Components

3.1 ESP32

It is a 32-bit microcontroller with built-in Wi-Fi and Bluetooth capabilities and featuring dual-core processor with a frequency ranging from 80 MHz to 240 MHz. It operates within a voltage range of 2.2V to 3.6V, making it suitable for various low-power and battery-operated projects.
The ESP32 is a powerful and cost-effective microcontroller developed by Espressif Systems. It is designed for IoT (Internet of Things), embedded systems, and real-time applications. It combines robust processing power, integrated wireless connectivity (Wi-Fi and Bluetooth), and versatile peripheral support into a single chip, making it a favorite among hobbyists, developers, and engineers.

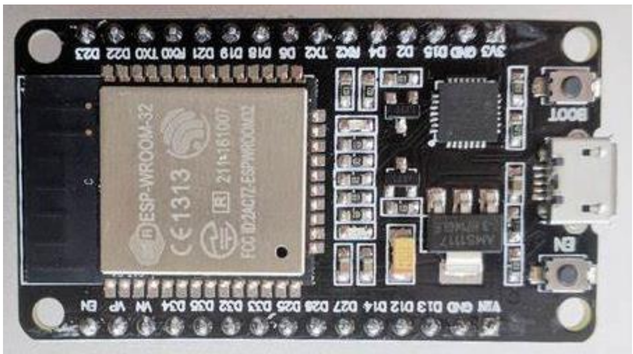

Fig.3.1 ESP32 Microcontroller

3.2 Motor Driver L298

The **L298** is a popular dual full-bridge motor driver IC commonly used for controlling DC motors and stepper motors in embedded and robotics applications. It is designed to handle high-current loads and allows for bidirectional motor control, making it a versatile choice for various projects
The L298 is a dual H-bridge motor driver integrated circuit widely used for controlling DC motors and stepper motors in various applications, such as robotics and automation. It operates by allowing you to control the speed and direction of two motors independently. The L298 can handle motor supply voltages ranging from 5V to 46V and deliver a continuous current of up to 2A per channel, with a peak current capability of 3A for short durations. It is equipped with built-in thermal protection to safeguard against overheating, making it a reliable choice for motor control.

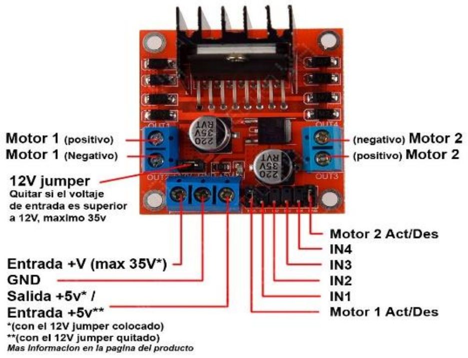

Fig.3.2 Motor Driver L298

3.3 12V Relay Module

It is a Electromechanical Device used to switch on the Load Electronically A 12V relay module is a component used to control high-power electrical devices (e.g., motors, lights, appliances) using low-power signals from microcontrollers or circuits. It operates as an electromagnetic switch that can be triggered by a 12V DC input signal.

A **12V relay module** is an electrical switch that allows low-power signals from microcontrollers like Arduino, ESP32, or Raspberry Pi to control high-power devices such as lights, motors, or appliances. The relay module isolates the control circuit from the high-power circuit using an electromagnetic switch, ensuring safety and preventing damage to sensitive electronics. It operates on a 12V input to power the relay coil and typically includes additional circuitry, such as optocouplers, to further enhance isolation and protect the control board.

Fig.3.3 12V Relay Module

3.4 Sensors

a. **DHT 11:**

The DHT11 is a popular digital temperature and humidity sensor. It's a small module that can measure temperature ranging from 0 to 50 degrees Celsius and humidity from 20% to 90%.

The **DHT11** is a low-cost, digital temperature and humidity sensor widely used in basic weather monitoring and home automation projects. It provides reliable readings of temperature (in the range of 0°C to 50°C) and relative humidity (20% to 90%) with an accuracy of ±2°C for temperature and ±5% for humidity. The sensor is simple to use and communicates data using a single-wire digital protocol, making it easy to interface with microcontrollers like Arduino, ESP32, or Raspberry Pi.

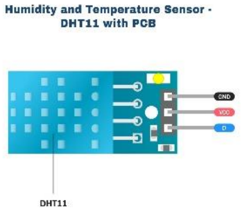

Fig.3.4.a DHT 11 Sensor

b. Soil Moisture Sensor:

A **soil moisture sensor** is a device used to measure the volumetric water content in soil, providing a way to monitor soil moisture levels for agricultural, gardening, or environmental projects. It typically consists of two probes or conductive plates that measure the resistance or capacitance of the soil, which varies depending on its moisture content. Wet soil conducts electricity more easily than dry soil, resulting in lower resistance or higher capacitance, which the sensor translates into a moisture level reading.

Soil moisture sensors often operate on low voltages, typically 3.3V to 5V, making them compatible with microcontrollers like Arduino, ESP32, and Raspberry Pi. The sensor outputs analog or digital signals; analog readings provide a continuous range for precise monitoring, while digital signals indicate a simple "wet" or "dry" state based on a predefined threshold.

Fig.3.4.b Soil Moisture Sensor

3.5 DC MOTOR

A **DC motor** (Direct Current motor) is an electromechanical device that converts electrical energy into mechanical energy through the interaction of magnetic fields and current-carrying conductors. It is one of the most commonly used types of motors due to its simplicity, efficiency, and ease of control. DC motors are powered by a direct current source such as a battery or power supply and are widely used in applications like fans, toys, robotics, conveyor belts, and vehicles. DC motors typically consist of two main parts: the **stator**, which generates a constant magnetic field, and the **rotor** (or armature), which rotates when current flows through it. The motor's speed can be controlled by varying the supply voltage or by using techniques like Pulse Width Modulation (PWM). Additionally, reversing the polarity of the voltage allows the motor to change its direction of rotation.

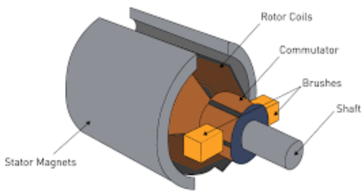

Fig.3.5 DC MOTOR

3.6 BATTERY

A **7.2V battery** is a rechargeable power source commonly used in various electronic and hobbyist applications, such as RC (remote-controlled) vehicles, robotics, and portable devices. These batteries are often made from **NiMH (Nickel-Metal Hydride)** or **NiCd (Nickel-Cadmium)** cells, though **Li-ion (Lithium-ion)** and **LiPo (Lithium Polymer)** variants are also available for higher performance applications. A typical 7.2V battery pack consists of six 1.2V cells connected in series to achieve the required voltage.
The 7.2V battery is valued for its compact size, lightweight design, and ability to deliver stable power to motors, servos, and other components. Rechargeable 7.2V batteries are eco-friendly and cost-effective, offering multiple charge cycles over their lifespan. The capacity of these batteries, measured in milliamp-hours (mAh), determines how long they can power a device before needing a recharge.

Fig.3.6 Battery

3.7 Software Components

a. Arduino IDE :

The **Arduino IDE (Integrated Development Environment)** is a software platform used to write, compile, and upload code to Arduino boards, such as the popular Arduino Uno, Mega, and Nano. The IDE provides a simple and user-friendly interface that makes it accessible to beginners while offering enough flexibility for advanced users. It supports programming in **C++** using a simplified syntax, which allows developers to quickly create applications for a wide range of electronic projects, from basic sensors to complex robotic systems.

The Arduino IDE is cross-platform, available for Windows, macOS, and Linux, and comes with built-in libraries for various sensors, motors, displays, and communication protocols, simplifying development. Users can write their code in the IDE, which then compiles it into machine code and uploads it directly to the microcontroller via a USB connection. The IDE also includes a serial monitor to debug and interact with running programs, allowing real-time communication with the microcontroller.

b.Program Code:

```
#define BLYNK_TEMPLATE_ID "TMPL3_TvbxzJB"
#define BLYNK_TEMPLATE_NAME "Agri vehicle"
#define BLYNK_AUTH_TOKEN "NbFkjjOkRlVlHKWtSO1tukMBWgRFToKx"
#define BLYNK_PRINT Serial
#include <WiFi.h>
#include <WiFiClient.h>
#include <BlynkSimpleEsp32.h>
//#include <ESP32Servo.h>
char auth[] = BLYNK_AUTH_TOKEN;
char ssid[] = "kpi";
char pass[] = "12345678";
BlynkTimer timer;
#define soilPin 18
int fw1=32;
int bw1=33;
int fw2=25;
int bw2=26;
```

```
int cut=23;
int pump=14;

void setup()
{
Serial.begin(115200);
   WiFi.begin(ssid, pass);
  int wifi_ctr = 0;
  while (WiFi.status() != WL_CONNECTED)
  {
  delay(500);
  Serial.print(".");
  }
  Serial.println("WiFi connected");
  Blynk.begin(auth, ssid, pass, "blynk.cloud", 80);
pinMode(fw1,OUTPUT);
pinMode(bw1,OUTPUT);
pinMode(fw2,OUTPUT);
pinMode(bw2,OUTPUT);
pinMode(soilPin,INPUT);
pinMode(pump,OUTPUT);
pinMode(cut,OUTPUT);
digitalWrite(cut,HIGH);
void loop() {
Blynk.run();
 soilMoisture();
}
 void soilMoisture(){
  int soilMoisture = digitalRead(soilPin);
 if (soilMoisture==0) {  // If soil is dry AND no rain
    digitalWrite(pump, HIGH);  // Turn ON the water pump
  } else {
    digitalWrite(pump, LOW);  // Turn OFF the water pump
  }
  }
BLYNK_WRITE(V0)
{
  int pinstate1=param.asInt();
  if(pinstate1==1)
  {
    digitalWrite(fw1,HIGH);
    digitalWrite(fw2,HIGH);
    digitalWrite(bw1,LOW);
  digitalWrite(bw2,LOW);
  }
  else
 {
    digitalWrite(fw1,LOW);
    digitalWrite(fw2,LOW);
    digitalWrite(bw1,LOW);
  digitalWrite(bw2,LOW);
  }
}
 BLYNK_WRITE(V1)
{
```

```
  int pinstate2=param.asInt();
  if(pinstate2==1)
  {
    digitalWrite(fw1,LOW);
    digitalWrite(fw2,LOW);
    digitalWrite(bw1,HIGH);
  digitalWrite(bw2,HIGH);
  }
  else
  {
    digitalWrite(fw1,LOW);
    digitalWrite(fw2,LOW);
    digitalWrite(bw1,LOW);
    digitalWrite(bw2,LOW);
  }
}
 BLYNK_WRITE(V2)
{
  int pinstate3=param.asInt();
  if(pinstate3==1)
  {
    digitalWrite(fw1,HIGH);
    digitalWrite(fw2,LOW);
    digitalWrite(bw1,LOW);
  digitalWrite(bw2,HIGH);
  }
  else
  {
    digitalWrite(fw1,LOW);
    digitalWrite(fw2,LOW);
    digitalWrite(bw1,LOW);
    digitalWrite(bw2,LOW);
  }
}
BLYNK_WRITE(V3)
{
  int pinstate9=param.asInt();
  if(pinstate9==1)
  {
    digitalWrite(fw1,LOW);
    digitalWrite(fw2,HIGH);
    digitalWrite(bw1,HIGH);
  digitalWrite(bw2,LOW);
  }
  else
 {
    digitalWrite(fw1,LOW);
    digitalWrite(fw2,LOW);
    digitalWrite(bw1,LOW);
  digitalWrite(bw2,LOW);
  }
}
BLYNK_WRITE(V4)
{
  int pinstate6=param.asInt();
```

```
  if(pinstate6==1)
  {
    digitalWrite(cut,HIGH);
  }
  else
 {
    digitalWrite(cut,LOW);
  }
}
```

CHAPTER 4
Mechanism

4.1. Sprayer

A **water sprayer** is a device designed to disperse water in the form of a fine mist or spray, commonly used for watering plants, cooling, cleaning, or as a part of automated irrigation systems. Water sprayers come in various forms, from simple hand-held sprayers to larger, automated systems that can be integrated into smart gardens or agriculture projects. Hand-held sprayers typically feature a trigger or pump mechanism that forces water through a nozzle, creating a controlled spray pattern. Larger sprayers may use pumps and pressure systems to deliver water more efficiently over a larger area.

In agriculture and gardening, water sprayers are especially useful for evenly distributing water to plants, ensuring consistent moisture levels without over-saturating the soil. In industrial or cleaning applications, sprayers are used to clean surfaces or apply water-based chemicals. Automated water sprayer systems can be programmed to activate at specific times, reducing water waste and ensuring that plants receive the optimal amount of water. These systems are often paired with moisture sensors and controllers to further enhance efficiency and sustainability in irrigation practices.

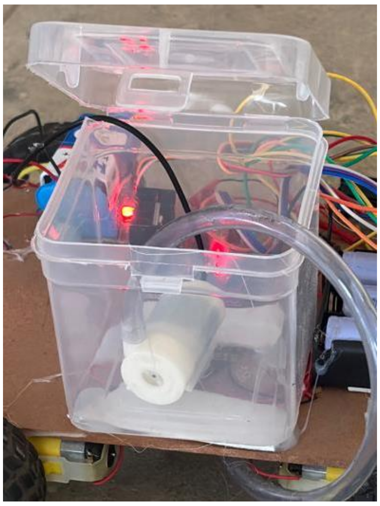

Fig. 4.1 Sprayer

4.2. Weed Remover

A **weed remover** is a tool or device designed to eliminate unwanted weeds from gardens, lawns, and agricultural fields. It can come in various forms, from manual hand tools like weed pullers and hoes to more advanced, motorized equipment such as electric or gas-powered weeders. The primary goal of a weed remover is to uproot or destroy weeds without damaging the surrounding plants or soil. Manual weed removers often feature long handles for ease of use, with forked or serrated blades that can be inserted into the ground to grip the weed and pull it out by the roots, preventing regrowth.

Motorized weed removers, on the other hand, typically use rotating blades or brushes to cut or burn weeds, often with adjustable settings to target specific weed types or areas. These machines can be more efficient for larger areas but may require careful handling to avoid damaging desired plants or crops. Some advanced weed removal systems incorporate techniques like steaming or using environmentally-friendly chemicals to suppress weed growth. Overall, a weed remover helps maintain garden aesthetics, improve crop yield in agriculture, and reduce the labor intensity involved in garden maintenance.

Fig.4.2 Weed Remover

4.3. Monitoring

a. Soil Moisture:

Soil moisture monitoring refers to the process of measuring and tracking the water content in soil, which is crucial for maintaining healthy plants and efficient agricultural practices. Monitoring soil moisture helps ensure that plants receive the right amount of water, preventing both overwatering and underwatering. This is especially important in farming, gardening, and landscaping, as it allows for more precise irrigation control, ultimately saving water and improving plant health.

b.Temperature:

Temperature monitoring involves measuring and tracking temperature levels in an environment, system, or device to ensure optimal conditions for various applications. It is a critical aspect of climate control, industrial processes, healthcare, and agricultural systems. In agriculture, for instance, monitoring temperature is essential for maintaining the health of plants and animals, while in industrial settings, it helps ensure machinery operates within safe limits.

Temperature monitoring is often performed using sensors like thermistors, thermocouples, or digital temperature sensors such as the DHT11, DHT22, or DS18B20. These sensors can measure ambient or surface temperatures and provide real-time data to a microcontroller or monitoring system. This data can be logged, analyzed, or used to trigger automated responses, such as turning on cooling systems, heaters, or alarms if temperatures exceed preset thresholds.

c.Humidity:

Humidity monitoring involves measuring and tracking the amount of water vapor in the air, which is essential for maintaining comfort, health, and efficiency in various environments. Humidity levels significantly impact plant growth, industrial processes, and indoor air quality. Monitoring humidity helps ensure optimal conditions, whether it's preventing mold in homes, protecting sensitive equipment in industrial settings, or maintaining ideal conditions in greenhouses and agricultural fields.

Humidity is typically measured using sensors such as capacitive, resistive, or digital sensors like the DHT11 or DHT22. These sensors provide real-time data on relative humidity, often integrated with microcontrollers or monitoring systems for analysis. The data can be used to automate climate control systems, triggering dehumidifiers, humidifiers, or ventilation when humidity levels exceed or fall below desired thresholds.

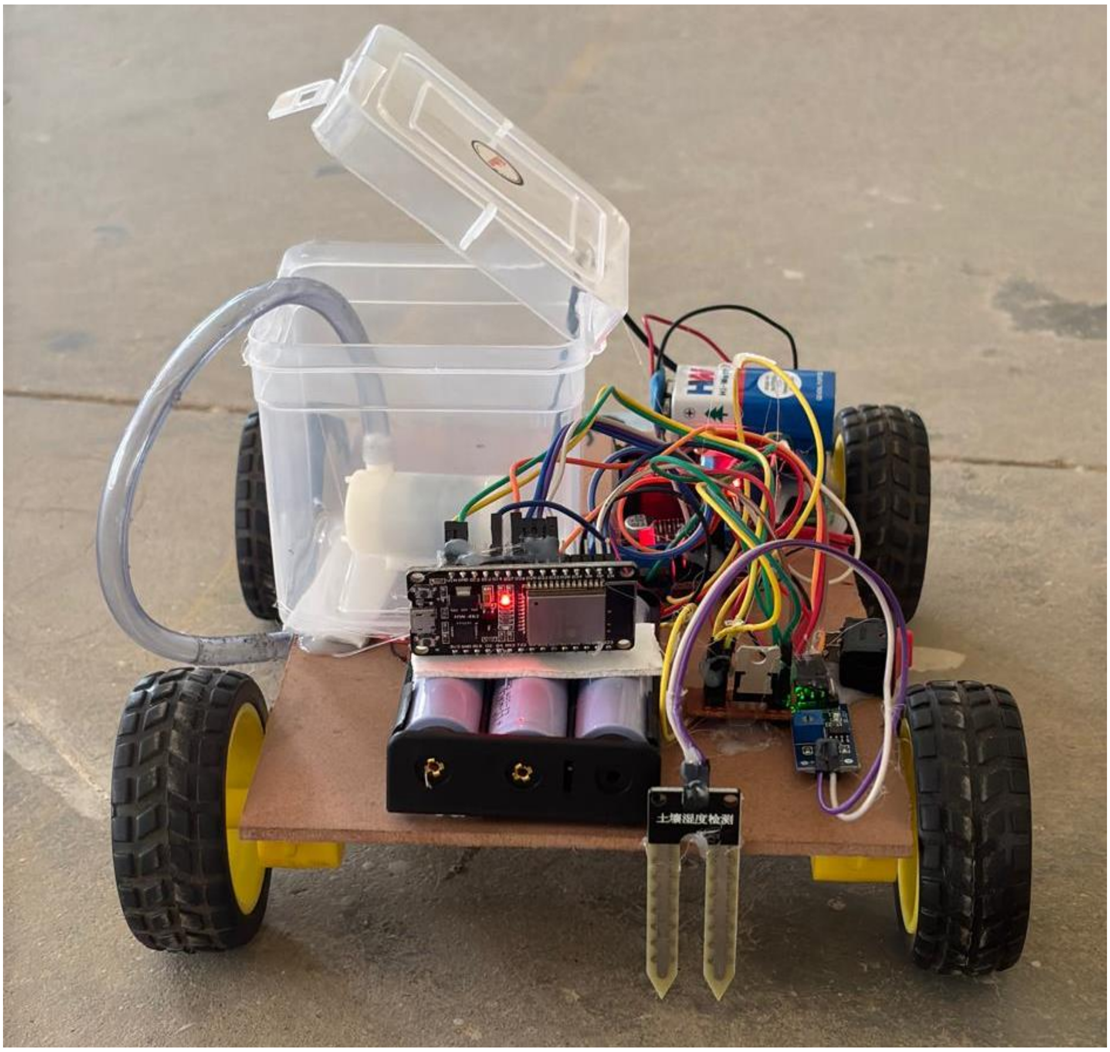

Fig 4.3 Complete Working Model of Agricultural Utility Vehicle with Field Monitoring

CHAPTER 5
CONCLUSION AND RESULT

5.1 CONCLUSION

Automatic irrigation systems offer a sustainable and efficient solution for watering your plants. By harnessing the sun's power, these systems reduce dependence on fossil fuels and minimize environmental impact. Equipped with smart sensors, they monitor factors like soil moisture and temperature, delivering the precise amount of water needed by your plants. This not only conserves water but also promotes healthier plant growth. Automating the irrigation process saves time and labor costs, allowing you to focus on other aspects of your garden or farm. With scalability for various applications, these systems can be adapted to small home gardens or vast agricultural fields. Advanced features like integration with weather data and smartphone apps enable further optimization and automation. While the initial investment might be higher, the long-term benefits and minimal maintenance requirements make automatic irrigation systems a compelling choice for a smarter and greener approach to watering your plants.

RESULT

Automatic irrigation systems are revolutionizing how we water our plants. By harnessing the sun’s power, these systems are environmentally friendly, reducing reliance on fossil fuels. Smart sensors ensure plants receive the exact amount of water needed, preventing waste and promoting healthier growth. Automation frees up time and labor costs, while scalability allows the system to fit small gardens or vast fields. Advanced features like smartphone apps and weather integration offer further optimization. While the initial investment might be higher and sunlight availability is a factor, the long-term benefits and minimal maintenance make solar-powered automatic irrigation systems a sustainable and efficient choice for a thriving, green landscape

5.2 Future Scope of Work

Real-Time Monitoring: IoT sensors can collect real-time data on soil moisture, temperature, humidity, crop health, and pest activity, allowing AUVs to make informed decisions.

Variable Rate Application: The vehicles can apply fertilizers, pesticides, and water selectively based on sensor data, reducing waste and environmental impact.

Self-Driving AUVs: IoT-enabled vehicles combined with AI can autonomously navigate fields, perform tasks like plowing, planting, or harvesting, and avoid obstacles.

Fleet Coordination: Multiple AUVs can work collaboratively using IoT, optimizing operations across large farms.

Water Conservation: Precise irrigation reduces water usage, an essential feature in water-scarce regions.

Energy Efficiency: IoT-based monitoring ensures vehicles operate only when necessary, reducing fuel and energy consumption.

Targeted Treatment: Accurate application of nutrients and pesticides ensures healthier crops and higher yields.

Continuous Feedback: Real-time monitoring allows adjustments during the growing season to optimize crop health.

Global Expansion: Increased interest in smart farming will drive adoption worldwide, especially in regions focusing on high-tech agricultural innovations.

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