International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 09 Issue: 05 | May - 2025 SJIF Rating: 8.586 ISSN: 2582-3930

Design and Implementation of Smart Agriculture Robot powered by ESP32 and Blynk App

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Abstract- This project introduces an advanced agricultural automation system featuring a smart robot car powered by an ESP32 microcontroller and integrated with the Blynk app. Designed to optimize crop growth, the system uses precise sensors to monitor critical environmental parameters such as temperature, humidity, and soil moisture. Additionally, it includes automated tools like a weeder cutter for efficient grass management and a sprayer for targeted pesticide application. By utilizing the Blynk app, farmers can remotely access real-time data and control the robot, reducing manual labor while improving efficiency and crop yields. This innovative solution aims to enhance farm productivity and sustainability through the strategic use of technology and automation.

***Key Words*:** Automation, Robotics, ESP32, Sensors, Blynk app

1. INTRODUCTION

Farmers face numerous challenges in managing their land effectively, including labour intensive monitoring and inconsistent pest control methods. Traditional farming practices often rely on manual intervention, leading to inefficiencies and increased costs. Moreover, unpredictable environmental conditions can further impact crop yields and overall profitability. In response to these challenges,

We present an innovative solution: The Smart Agricultural Robot. This advanced system integrates IoT and Wireless Sensor Network technologies to monitor critical environmental parameters essential for optimal crop production. Equipped with sensors for soil moisture, temperature, humidity, and more, controlled by a powerful ESP32 microcontroller and the user-friendly Blynk App, our robot aims to revolutionize farming operations.

Key features include automated tools such as precise weed cutting and targeted pesticide spraying, all seamlessly integrated into a robust 6WD smart robot car platform. This integration not only enhances operational efficiency but also reduces dependency on manual labour, thereby improving crop yields and sustainability.

By providing farmers with real-time data insights and remote-control capabilities via the Blynk App, our solution empowers them to make informed decisions promptly. This approach not only optimizes resource management but also minimizes environmental impact by reducing chemical use and enhancing crop health. Join as we delve into the capabilities and transformative potential of our Smart Agricultural Robot, paving the way for sustainable and productive agriculture through technological innovation.

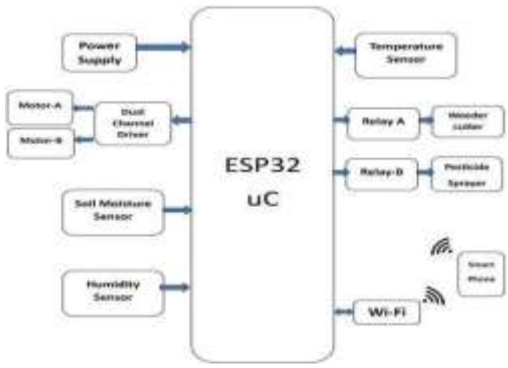

Fig.1. Block Diagram.

2. EXISTING SYSTEMS

The existing system in agriculture primarily involves traditional practices that demand significant manual effort and time. Farmers manually monitor environmental conditions such as temperature, humidity, and soil moisture, often using outdated or non-automated tools. This approach is labour-intensive and prone to inaccuracies, leading to suboptimal crop growth and inefficient resource utilization. Weed control and pesticide application are typically done manually or using basic machinery, which increases labour costs and environmental risks due to overuse or uneven application of chemicals.

Moreover, farmers lack real-time access to data, making it difficult to respond promptly to changes in environmental conditions. This often results in delayed actions, potentially harming crop health. Conventional methods do not support remote monitoring or automation, limiting farmers' ability to manage larger areas effectively.

Additionally, the absence of integrated systems means separate tools are needed for each task, increasing operational costs and complexity. The inefficiency of existing systems often leads to lower productivity and higher environmental impact, including water wastage and chemical runoff. These challenges highlight the need for innovative, automated solutions that reduce manual labour, enhance precision, and improve sustainability in modern agriculture.

3. PROPOSED SYSTEMS

The proposed system introduces a smart agricultural automation solution using a robotic car equipped with an ESP32 microcontroller and integrated with the Blynk app. This system automates the monitoring of critical environmental parameters such as temperature, humidity, and soil moisture using precise sensors, ensuring optimal crop conditions. It features a weeder cutter for automated grass management and a sprayer for targeted pesticide application, reducing manual labour.

Farmers can access real-time data and remotely control the robot via the Blynk app, enabling efficient resource management and timely responses to environmental changes. The system's automation enhances precision, minimizes chemical overuse, and reduces water wastage. By consolidating multiple farming tasks into a single robotic platform, it lowers operational costs and increases productivity.

This innovative solution promotes sustainable agriculture by improving resource efficiency, boosting crop yields, and reducing the environmental footprint. With its user-friendly design and advanced automation capabilities, the proposed system provides a modern, effective approach to overcoming the limitations of traditional farming methods.

4. HARDWARE REQUIREMENTS

The Design and Implementation of Smart Agriculture Robot powered by ESP32 and Blynk App are carried out using following hardware components:

1. **ESP32 Microcontroller:**
   The ESP32 is a powerful, low-cost microcontroller by Espressif Systems, featuring dual-core processors, Wi-Fi, and Bluetooth connectivity. It supports various I/O interfaces and is ideal for IoT, automation, and embedded systems. With low power consumption and extensive programmability, it's versatile for a range of smart applications.

2. **Citron maker driver:**
   The Citron Maker Driver is a compact and versatile motor driver designed for makers and robotics enthusiasts. It supports various motor types like DC motors, stepper motors, and servos, offering easy integration with microcontrollers like Arduino and ESP32. Known for its reliability and user-friendly design, it's ideal for DIY robotics and automation projects.

3. **Relay:**
   A relay is an electromechanical or solid-state switch used to control a high-power circuit with a low-power signal. It consists of an input coil and output contacts, enabling isolation between the controlling and controlled circuits. Relays are widely used in automation, home appliances, and industrial systems for switching operations.

4. **Soil Moisture Sensor:**
   A soil moisture sensor measures the water content in soil, helping to monitor and manage irrigation effectively. It typically uses probes to detect soil conductivity or capacitance, translating it into moisture levels. These sensors are widely used in agriculture, gardening, and smart irrigation systems to optimize water usage.

5. **DHT 11 Sensor:**
   The DHT11 is a low-cost digital sensor that measures temperature and humidity. It uses a capacitive humidity sensor and a thermistor to provide accurate readings with a simple digital output. Popular in IoT and environmental monitoring projects, it's easy to use with microcontrollers like Arduino and ESP32.

6. **Dosing Pump:**
   A dosing pump is a precision pump designed to deliver specific volumes of liquid at controlled rates. Commonly used in applications like water treatment, chemical dosing, and laboratory processes, it ensures accurate and consistent delivery. These pumps are often programmable and support integration with automated systems.

7. **DC Motor:**
   A DC motor is an electric motor that converts direct current (DC) electrical energy into mechanical energy through electromagnetic interactions. It is widely used in applications requiring variable speed and torque, such as robotics, fans, and conveyor systems. DC motors are simple, efficient, and come in brushed or brushless variants.

8. **6WD Robot:**

A 6WD robot is a six-wheeled robotic platform designed for enhanced stability, traction, and mobility, particularly on uneven terrain. It is commonly used in robotics projects and applications like exploration, surveillance, and transportation. Equipped with independent motorized wheels, it offers better maneuverability and load distribution compared to fewer-wheel designs.

5. IMPLEMENTATION:

The implementation process involves the following step:

1. **System Design:**
   The system uses an ESP32 microcontroller for processing and communication. It integrates environmental sensors like DHT11, soil moisture sensor, and control mechanisms for automated tools.

2. **Hardware Setup:**
   6WD robot platform is used for mobility. The Citron Maker Driver controls the motors for movement. The system also includes a dosing pump for precise pesticide application and a relay for controlling devices.

3. **Blynk App Integration:**
   The system communicates with the Blynk app for real-time data monitoring and remote control. Users can control robot movements, speed, and tools (like the sprayer and grass cutter) through the app.

4. **Sensor Data Monitoring:**
   The robot continuously collects data from sensors (temperature, humidity, soil moisture) and sends it to the Blynk app for remote monitoring.

5. **Automation Features:**
   Automated weeding and pesticide spraying based on sensor readings. The system performs tasks like soil moisture monitoring and adjusts irrigation or pesticide spraying accordingly.

6. **Remote Control:**
   Farmers can control robot movement and operations (forward, backward, left, right) remotely via the Blynk app.

6. EXPECTED OUTCOME

The Proposed Smart Agriculture Robot is expected to achieve the following outcome:

1. **Real-time Monitoring and Control:**
   The system provides farmers with real-time data on environmental parameters (temperature, humidity, soil moisture), which can be monitored remotely through the Blynk app. This allows for quick decision-making and immediate intervention when needed.

2. **Resource optimization:**
   The automated tools, such as the sprayer and weeder, help optimize the use of resources like water, pesticides, and labor, reducing waste and cost.

3. **Data Driven Farming:**
   The collection of valuable environmental and operational data enables farmers to analyze trends, improve farming practices, and make informed decisions, contributing to more sustainable and profitable agriculture.

4. **Scalability and Flexibility:**
   The system is adaptable to various farm sizes and types, and can be easily expanded or modified to include additional features like more sensors or automated tools.
   Improving the Blynk app interface to include more intuitive controls, real-time alerts, and customizable dashboards can enhance user experience. Providing educational resources and support through the app can help farmers maximize the benefits of the robot.

Fig.2. Data analysis result.

7. CONCLUSION

The Smart Agricultural Robot is a ground breaking advancement in modern farming, integrating the power of IoT, Wireless Sensor Networks, and the ESP32 microcontroller. This autonomous solution is designed to help farmers overcome significant challenges by automating key tasks and enhancing operational efficiency. By continuously monitoring crucial environmental factors like soil moisture, temperature, and humidity, the robot ensures optimal growing conditions and supports better crop yields. Additionally, it automates processes such as weed cutting and targeted pesticide spraying, reducing labour costs and promoting more sustainable farming practices. With real-time data insights and remote control capabilities via the Blynk App, farmers can easily monitor and manage their fields, making timely, informed decisions. This increased control not only boosts productivity but also minimizes chemical use, ultimately decreasing environmental impact. In essence, the Smart Agricultural Robot demonstrates how technology can revolutionize agriculture, providing farmers with the tools to meet the demands of tomorrow's farming while promoting sustainability and profitability. Through continued innovation, this solution will help shape a more efficient and resilient agricultural sector.

ACKNOWLEDEGEMENT

We would like to express our deepest gratitude to Mr. Pawan P, for their valuable guidance, continuous support, and expert insights throughtout this research on the design and implementation of a smart agriculture robot. This encouragement and technical advice were instrumental in helping us navigate challenges and improve the quality of our work. We are also thankful to the faculty members and staff of P.E.S. Institute of technology and Management for providing the resource, facilities, and a conductive environment that facilitated the progress of this project. The support received from our institution played a significant role in refining the methodologies and ensuring accurate implementation for project.

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