© May 2025 | IJIRT | Volume 11 Issue 12 | ISSN: 2349-6002

Multi purpose agriculture robot using IOT

[1]Mr. M.V SUSHUMNA, [2] M. BHANU PRASAD, [3] M. SANTHOSH NAIK, [4] I. JYOTHIRMAI, [5] J. MADHAN SAI

[1]*Assistant Professor, Dept., of Electronics and Communication Engineering (ECE), Teegala Krishna Reddy Engineering College, Hyderabad, Telangana, India*

[2,3,4,5]*Students, Dept., of Electronics and Communication Engineering (ECE) , Teegala Krishna Reddy Engineering College , Hyderabad, Telangana, India.*

Abstract— ***The escalating demand for food production, coupled with increasing labor costs and the need for sustainable agricultural practices, necessitates the integration of advanced technologies in farming. This paper presents the development of a multi-purpose agriculture robot leveraging the Internet of Things (IoT) for enhanced efficiency and automation in various farming tasks. The core of the system revolves around the NodeMCU microcontroller, chosen for its Wi-Fi capabilities and ease of integration with IoT platforms. Powering the robot is a battery, ensuring autonomous operation in the field. Environmental monitoring is achieved through the DHT11 sensor, which provides real-time data on temperature and humidity, crucial parameters for optimal crop growth.***

The robot is equipped with a water pump and controlled by a relay, enabling automated irrigation based on the sensor data and predefined schedules managed through the Blynk IoT platform. A DC motor, driven by the L293D motor driver, facilitates the robot's movement across the field, allowing it to perform tasks such as monitoring and targeted actions. The inclusion of an ESP32 CAM module provides remote visual monitoring of the crops and the field, enabling farmers to assess plant health and identify potential issues from anywhere.

The Blynk IoT platform serves as the central interface for users to monitor sensor data, control the robot's movement, manage irrigation schedules, and receive real-time alerts. This user-friendly interface empowers farmers with remote access and control over their agricultural operations, leading to optimized resource utilization, reduced manual labor, and improved crop yields. The integration of these components into a cohesive robotic system demonstrates a cost-effective and scalable solution for precision agriculture, paving the way for smarter and more sustainable farming practices. This research highlights the potential of IoT-enabled robotics in transforming traditional agriculture into a more efficient and data-driven industry.

Index Terms – Node MCU, Battery, DHT 11 Sensor, Relay, Pump, DC motor, ESP32 cam

I. INTRODUCTION

Agriculture, the backbone of sustenance, faces escalating challenges in meeting the demands of a growing global population while optimizing resource utilization and minimizing environmental impact. Traditional farming practices often involve labor-intensive tasks, inefficient resource management, and delayed responses to dynamic environmental conditions. The advent of the Internet of Things (IoT) and robotics offers a transformative paradigm shift, enabling the development of intelligent and autonomous agricultural systems. This paper presents the design and implementation of a cost-effective and versatile multi-purpose agriculture robot leveraging IoT principles.

This project introduces an innovative robotic platform designed to automate crucial agricultural tasks, thereby enhancing efficiency, reducing labor costs, and promoting sustainable farming practices. The core of the system revolves around the NodeMCU microcontroller, chosen for its integrated Wi-Fi capabilities, enabling seamless connectivity to the Blynk IoT platform. This cloud-based platform provides a user-friendly interface for remote monitoring and control of the robot's functionalities.

The robot is equipped with a suite of sensors and actuators to perform a range of agricultural operations. A DHT11 sensor monitors crucial environmental parameters such as temperature and humidity, providing real-time data for informed decision-making. A relay module controls a water pump, enabling automated irrigation based on soil moisture levels or pre-programmed schedules. DC motors, driven by an L293D motor driver, provide the necessary locomotion for navigating the agricultural field. Furthermore, an ESP32-CAM module integrates visual monitoring capabilities, allowing for remote surveillance of crop health and field conditions.

The integration of Blynk IoT facilitates remote access and control of the robot's functions through a smartphone application. Farmers can monitor environmental conditions, initiate irrigation, and even observe their fields remotely, leading to more timely interventions and optimized resource allocation. This multi-faceted approach, combining autonomous operation with remote monitoring and control, presents a significant step towards smart agriculture. This paper details the hardware and software architecture of the robot, the integration of various components, and the potential applications of this system in modern agricultural practices. The results of preliminary testing and future scope for expansion are also discussed.

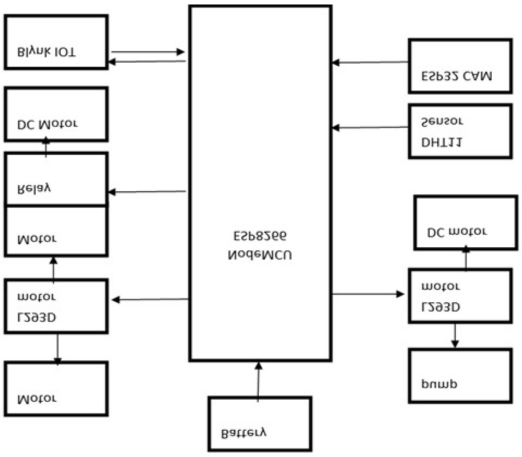


Figure 1: Block Diagram

II. LITERATURE SURVEY

The escalating demand for efficient and sustainable agricultural practices has spurred significant research into the integration of robotics and the Internet of Things (IoT). This literature survey examines the current landscape of multi-purpose agricultural robots utilizing IoT, specifically focusing on the integration of NodeMCU, battery power, DHT11 sensors, relays, pumps, DC motors, ESP32 CAM, Blynk IoT platform, and L293D motor drivers. Existing research highlights the potential of such robots to automate crucial farming tasks, including soil monitoring, irrigation, pest control, and environmental data collection, thereby reducing human intervention and optimizing resource utilization.

Several studies have explored the application of IoT in agriculture for tasks like automated irrigation systems based on soil moisture and weather data (Dasgupta & Daruka, 2023). Furthermore, the development of multi-functional agricultural robots capable of performing tasks like plowing, seeding, and harvesting has been investigated (TIJER, 2025). These robots often incorporate various sensors for real-time data acquisition and utilize microcontrollers like Arduino or Raspberry Pi for control (IJRPR, 2025). The integration of cameras and image processing techniques enables tasks such as weed detection and plant health monitoring (Singh et al., 2022).

The proposed project leverages the NodeMCU for its integrated Wi-Fi capabilities, facilitating seamless IoT connectivity with platforms like Blynk for remote monitoring and control. The DHT11 sensor enables the robot to gather crucial environmental data such as temperature and humidity, while relays and pumps facilitate automated irrigation. DC motors, driven by L293D motor drivers, provide the necessary mobility and control for various agricultural tasks. The inclusion of the ESP32 CAM introduces the capability for visual monitoring and data acquisition, potentially enabling tasks like crop health assessment and automated anomaly detection.

This literature review reveals a strong foundation for the development of multi-purpose agricultural robots using IoT technologies. However, further research is warranted in optimizing the integration of specific components like the ESP32 CAM for advanced agricultural applications and enhancing the robustness and efficiency of these systems for real-world deployment in diverse farming environments. The proposed project aims to contribute to this body of knowledge by developing and evaluating a cost-effective and versatile agricultural robot utilizing the specified components for enhanced farm management.

Node MCU:

The NodeMCU is a low-cost, open-source development board that has gained immense popularity in the world of IoT (Internet of Things) and embedded systems. Built around the ESP8266 Wi-Fi System-on-a-Chip (SoC) from Espressif Systems, it integrates a microcontroller with Wi-Fi capabilities, making it incredibly convenient for connecting projects to the internet. The name "NodeMCU" typically refers to both the firmware that runs on the ESP8266 and the hardware development board itself.

What makes the NodeMCU so appealing is its ease of use and versatility. It can be programmed using the Lua scripting language, which is known for its simplicity and lightweight nature. Furthermore, it boasts compatibility with the Arduino IDE, allowing a vast community of developers to leverage their existing knowledge and libraries. The board features multiple GPIO (General Purpose Input/Output) pins, analog inputs, and serial communication interfaces like UART, SPI, and I2C, enabling connection with a wide array of sensors, actuators, and peripherals. Its onboard USB interface simplifies programming and power supply, making it an ideal platform for rapid prototyping and DIY projects. The NodeMCU's affordability and rich feature set have made it a go-to choice for hobbyists, makers, and professionals alike, facilitating the creation of countless innovative IoT applications, from smart home devices to environmental monitoring systems.

Figure 2: Node MCU

DHT 11 Sensor:

The DHT11 sensor is a low-cost digital temperature and humidity sensor that is widely used in various applications. It measures the relative humidity and temperature of the surrounding air and outputs a digital signal. The sensor consists of a capacitive humidity sensing element and a thermistor for temperature measurement. It has a measurement range of 20-90% for humidity with an accuracy of ±5% and a temperature range of 0-50°C with an accuracy of ±2°C.

The DHT11 communicates with microcontrollers using a single-wire serial protocol, making it easy to interface with systems like Arduino and Raspberry Pi. It's a popular choice for hobbyists and professionals alike due to its simplicity, low power consumption, and affordability. However, it has a relatively slow sampling rate and lower accuracy compared to more advanced sensors like the DHT22. Despite these limitations, the DHT11 remains a reliable and cost-effective solution for many basic temperature and humidity monitoring needs in home automation, environmental monitoring, and educational projects.

Figure 3: DHT – 11 Sensor

Relay:

A relay is essentially an electrically operated switch, acting as a crucial intermediary that allows a low-power circuit to control a separate high-power circuit. Think of it as a messenger or a gatekeeper in an electrical system. It comprises a set of input terminals for control signals and a set of output terminals with contacts that can either make (close) or break (open) an electrical circuit. This switching action is typically achieved through an electromagnetic mechanism. When a small current flows through the relay's coil, it generates a magnetic field. This magnetic field then attracts a movable armature, which in turn operates the contacts, either connecting or disconnecting the high-power circuit. When the control current is removed, a spring mechanism returns the armature to its original position, and the contacts revert to their default state (either normally open or normally closed).

Relays serve several vital functions in electrical and electronic systems. Firstly, they provide electrical isolation between the control circuit and the circuit being controlled, safeguarding sensitive low-power components from high voltages or currents. Secondly, they enable a single low-power signal to control multiple circuits simultaneously or to switch a high current load using a small current. This "amplifying" effect makes them indispensable in numerous applications. Relays are found in a vast array of devices and systems, from household appliances and automobiles to industrial machinery and telecommunications equipment. They are used for motor control, lighting circuits, safety interlocks, and numerous other control and automation functions, highlighting their versatility and importance in modern electrical engineering.

Figure 4: Relay

Figure 5: Pump

Pump:
A DC water pump is a device that utilizes direct current (DC) electricity to move water from one location to another. Unlike AC pumps that rely on alternating current, DC pumps are powered by sources like batteries, solar panels, or rectified AC power. This makes them particularly useful in off-grid applications, portable systems, and those powered by renewable energy.

The fundamental working principle involves a DC motor that drives an impeller or diaphragm. When electricity flows through the motor, it creates a rotational force, which in turn causes the impeller to spin or the diaphragm to oscillate. This mechanical action generates pressure, forcing water to be drawn into the pump's inlet and expelled through the outlet.

DC water pumps come in various types, each suited for specific applications. Submersible pumps are designed to be immersed in the water source, pushing water upwards. Surface pumps sit outside the water and use suction to draw water in. Diaphragm pumps utilize a flexible membrane to displace water and are often self-priming.

Advantages of DC water pumps include their compatibility with battery and solar power, making them ideal for remote locations and energy-efficient systems. They often offer variable speed control and can be more compact and lighter than their AC counterparts. However, they may have limitations in terms of power and head compared to larger AC pumps.

ESP32 cam:
The ESP32-CAM is a compact and versatile development board that integrates a powerful ESP32-S chip with an OV2640 camera module. This combination enables a wide array of Internet of Things (IoT) applications, particularly those involving image capture and processing. Its small size, typically around 40mm x 27mm, makes it ideal for embedded projects where space is a constraint. The ESP32-S module at its core features a low-power 32-bit dual-core processor with integrated Wi-Fi and Bluetooth connectivity, providing a robust platform for wireless communication and control.

The onboard OV2640 camera is capable of capturing images up to 2 megapixels, suitable for tasks like image recognition, surveillance, and streaming video. Many projects utilize the ESP32-CAM to create low-cost IP cameras, accessible over a local network or the internet. Furthermore, the board often includes a microSD card slot, allowing for local storage of captured images or video footage, enhancing its автономность for remote applications.

Programming the ESP32-CAM is commonly done through the Arduino IDE, leveraging the esp32-camera library, which simplifies tasks like initializing the camera, capturing images, and streaming video. The board exposes several GPIO pins, enabling connection to other peripherals like sensors, LEDs, and actuators, expanding its capabilities beyond just image processing. Its low power consumption also makes it suitable for battery-powered applications, although careful power management is necessary for extended operation. The ESP32-CAM's affordability and feature-rich design have made it a popular choice for hobbyists, makers, and developers exploring vision-based IoT projects.

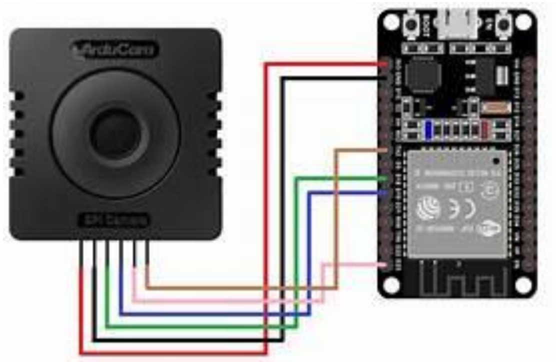
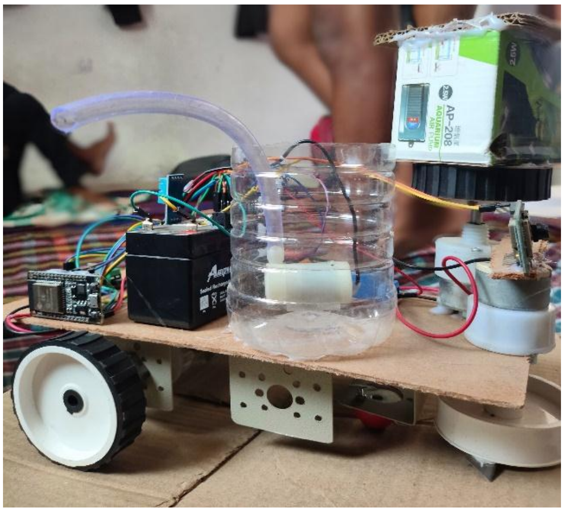
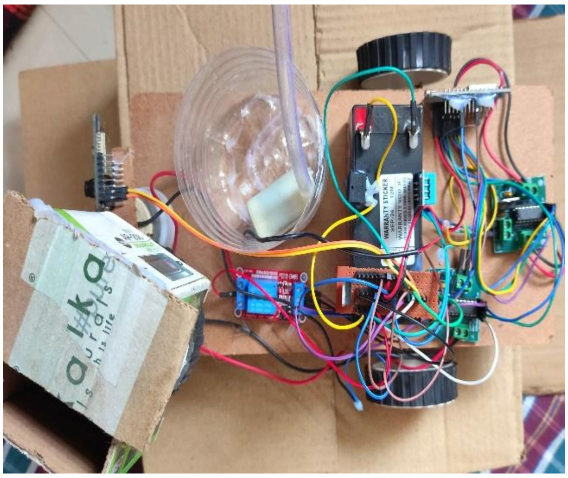


Figure 6: ESP 32 Camera

III. RESULT





IV. CONCLUSION

In conclusion, the development of an IoT-based multi-purpose agriculture robot using NodeMCU, ESP32 CAM, and other components presents a promising solution to address various challenges in modern agriculture. The integration of sensors like the DHT11, along with components like DC motors, relays, and pumps, enables the robot to perform essential tasks such as environmental monitoring, irrigation, and potentially other agricultural operations. By incorporating the ESP32 CAM, real-time visual data can be captured, adding another layer of information for analysis and decision-making.

Furthermore, the use of Blynk IoT facilitates remote monitoring and control, allowing farmers to manage their fields from anywhere with an internet connection. This capability is particularly valuable for optimizing resource usage, reducing manual labor, and improving overall efficiency. The L293D motor driver ensures precise control of the robot's movements, enabling it to navigate the terrain effectively. This project demonstrates the potential of IoT and robotics to revolutionize agricultural practices, leading to increased productivity, reduced costs, and more sustainable farming methods. Further research and development in this area could explore more advanced sensors, improved automation, and integration with other smart farming technologies.

REFRENCES

[1] Ray, P. P., Hossain, M. A., & Kumar, D. (2017). Internet of Things (IoT) for smart agriculture: Challenges and opportunities. *IEEE Access*, *5*, 20605-20628.

[2] Islam, N., Rashid, M. M., Wahid, K. A., & Gupta, K. D. (2020). Development of a low-cost smart irrigation system using IoT and open-source platform. *Computers and Electronics in Agriculture*, *170*, 105299.

[3] Blynyk, D., & Peleshko, D. (2016). Blynk as a visual programming tool for IoT rapid prototyping. In *2016 IEEE First Ukraine Conference on Electrical and Computer Engineering (UKRCON)* (pp. 630-633). IEEE.

[4] Martins, D., Gonçalves, J., Cruz, L., & Lamas, D. (2020). Low-cost remote monitoring system for agriculture using ESP32-CAM and IoT platform. *Information Processing in Agriculture*, *7*(4), 538-547.

[5] Mazumder, S. R., & Dey, K. C. (2018). Performance analysis of L293D motor driver IC for robotic applications. In *2018 International Conference on Computer, Communication, Chemical, Material and Metallurgical Engineering (IC4ME2)* (pp. 1-4). IEEE.