International Research Journal on Advanced Engineering and Management
https://goldncloudpublications.com
https://doi.org/10.47392/IRJAEM.2025.0160

e ISSN: 2584-2854
Volume: 03
Issue:03 March 2025
Page No: 980 - 986

Creation of Multifunctional Agricultural Robot with Remote Control

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Abstract
The creation of a multifunctional agricultural robot with a remote control that automates and optimizes a range of farming operations. By combining several tasks, including seeding, spraying pesticides, harvesting fruit, and cutting grass, the robot saves time and effort compared to conventional farming methods. Even in challenging terrain, the remotely operated technology provides flexibility and accuracy in agricultural operations. By lowering resource waste, improving accuracy, and limiting human interaction, this innovation supports sustainable agriculture. Labor is one of the issues facing agriculture. The necessity for sustainable techniques, the growing demand for food production, and a lack of manpower are some of the issues facing agriculture. These problems are resolved by the creation of a Multipurpose Agribot, which offers a self-sufficient, effective, and adaptable farming solution.

Keywords: *ESP 32 Module; DC Gear Motor; Servo Motor; Motor Driver; Sustainable Agriculture.*

1. Introduction
Farming has long been one of the oldest and most crucial economic activities in our nation. Over the years, different farming practices have evolved in various regions, shaped by local environmental conditions, cultural traditions, and available resources. However, these agricultural practices have been significantly influenced by various factors such as climate change, advancements in technology, and sociocultural shifts. One of the most important developments in agriculture, particularly in developed countries, is the automation of farming processes. The decline in the agricultural labor force has been a primary driver of the development of agricultural automation technologies. Additionally, the increasing demand for better food quality and the need for higher productivity and efficiency in farming practices have spurred the growth of technologies such as robotics and artificial intelligence (AI).[2][9]

1.1 The Role of Technology in Modern Agriculture
Technological advancements, particularly in robotics and AI, have provided solutions for precision agriculture. These innovations enable more efficient farming operations, such as chemical applications, grove supervision, weed control, sowing, and harvesting. The demand for these technologies is largely driven by the desire to improve the quality of food, while also ensuring higher crop yields and reducing the reliance on manual labor. As a result, the use of agricultural robots is expanding rapidly, addressing tasks that were once manual and labor-intensive. Robotics, in particular, has the potential to replace human operators in various agricultural tasks, especially those involving heavy machinery or hazardous chemicals, such as spreading fertilizer or pesticides.[4]

1.2 Autonomous Robotics in Indian Farming
In India, where traditional farming practices still dominate, there is a growing interest in the potential applications of autonomous robots. These robots are designed to perform key agricultural tasks, such as irrigation, soil preparation, planting, and plowing. The proposed system aims to automate these tasks by digging the soil according to moisture content, plowing seeds with a specialized structure, and

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providing irrigation using an automated pump. Such technologies could revolutionize farming in regions where subsistence farming is common and where small land plots are worked with basic tools like digging sticks, hoes, and daos. The introduction of robotic systems could enhance productivity and reduce the labor-intensive nature of Indian agriculture, offering practical solutions to meet the demands of modern farming.[1]

2. Literature Survey

Agri-Bot: IoT Based Unmanned Smart Vehicle for Multiple Agriculture Operations. In 2021 International Conference on Simulation, Automation & Smart Manufacturing. Farming practices in India have evolved over the years, adapting to changes in weather, climate conditions, technological advancements, and socio-cultural practices. D A Mada In 2013, made a research paper and mentioned the importance of smart agricultural systems by giving examples. The conclusion from the paper was the need for a multipurpose machine that will be used before harvesting the crops. We considered this for our research and further production of our multipurpose agricultural machine. Jin et al., present the design and experimental results of a multipurpose agricultural robot in 2021. The robot is equipped with various modules for tasks such as plowing, seeding, spraying, and harvesting. It utilizes advanced control algorithms and sensor systems to navigate and perform tasks autonomously in different agricultural environments. Wang and colleagues developed a versatile agricultural robot system capable of performing multiple tasks in 2020. The robot system aims to improve efficiency and reduce labor costs in agricultural operations. Liu et al. present the development of a multipurpose agricultural robot tailored for small-scale farms in 2021. Their research addresses the specific challenges faced by small-scale farmers, offering a practical solution to improve productivity and sustainability. In 2021, Chen and co-authors explore the integration of IoT technology into a multipurpose agricultural robot. By leveraging IoT, robots can optimize resource usage, monitor crop health, and adapt to changing environmental conditions for improved agricultural performance. Department of Electrical Engineering, GCOERC, Guru Gobind Singh Foundation, Nashik 15 Kim et al. propose an autonomous navigation system tailored for a multipurpose agricultural robot in 2022. Their research emphasizes the development of robust localization and mapping algorithms to enable accurate and efficient navigation in complex farm environments. The system aims to enhance the robot's autonomy and reliability during task execution. Gupta and collaborators introduce a vision-based control system designed for a multipurpose agricultural robot in 2022. Their work focuses on integrating computer vision techniques to enable object detection, localization, and manipulation tasks. By harnessing visual information, the robot can perform precise and adaptive actions, enhancing its effectiveness in various agricultural tasks. In 2022 Patel et al. explore a swarm robotics approach for multipurpose agricultural tasks. Their work focuses on optimizing the robot's power management system to maximize energy harvesting and utilization. By harnessing solar energy, the robot can operate autonomously for extended periods, reducing reliance on conventional power sources and minimizing environmental impact. A Comprehensive Review of Parameters Optimization and Applications. Communications on Applied Nonlinear Analysis Applications and Challenges of Machine Learning Techniques for Smart Manufacturing in Industry 4.0. In 2023 7th International Conference on Computing, Communication, Control and Automation Design and Analysis of Automatic Tripod Style Horizontal Multi Bobbin Wire Winder. Recognition and localization methods for vision- based fruit picking robots. Development status and trend of agricultural robot technology. A robot-based intelligent management design for agricultural cyber-physical systems.[3]

3. Multifunctional Agricultural Robot Using Remote

Multifunctional agriculture robots employ various methodologies to optimize their functionality and efficiency in performing multiple agricultural tasks. The best methodologies integrate advanced technologies and innovative approaches to ensure precision, adaptability, and sustainability. Figure 1

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shows Block Diagram of Remote Control Based Multipurpose Robot.[10]

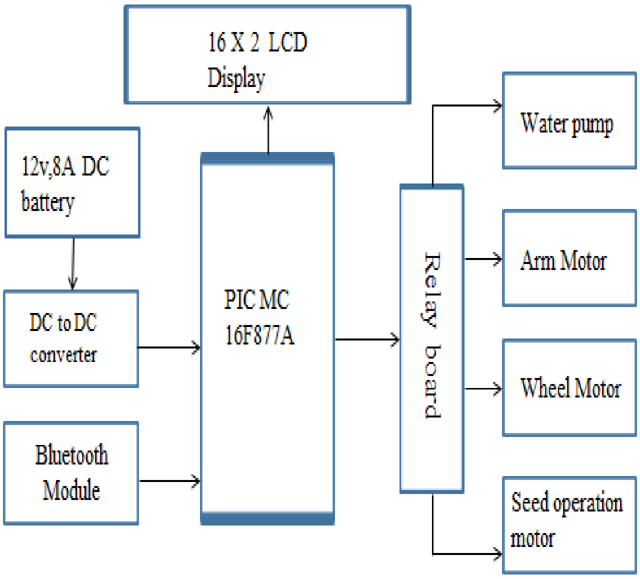

Figure 1 Block Diagram of Remote Control Based Multipurpose Robot

3.1 Hardware Model

Agribot is a robot designed for agricultural purposes. It is designed to minimize the labor of farmers in addition to increasing the speed and accuracy of the work. It performs the elementary functions involved in farming i.e. ploughing the field, sowing seeds and covering the seeds with soil. Multifunctional agricultural robots can perform a variety of tasks, including plowing, seeding, watering, and weed removal. These robots can be powered by solar panels and can be controlled using a smartphone. How they work Navigation: The robot uses image processing to navigate and identify crop diseases. Communication: The robot can be controlled using a smartphone via Bluetooth. Power: The robot can be powered by solar panels or a rechargeable battery. Sensors: The robot uses sensors to detect soil moisture, temperature, and humidity. Control: The robot is controlled by a microcontroller that controls the DC motors that move the wheels. This driver required 12V DC supply, when supply provided then drivers help to control dc motor as forward and reverse application. ENA, IN1, IN2, IN3, IN4,ENB this 6 pins are connected to 9,8,7,5,4,3 digital pins of the Arduino. 4 dc motor connected parallel to each other and (+ve) & (-ve) connected to the OUTPUT 1,2,3,4, pins of the drivers. Bluetooth Module is used for remote control application for the remote-control application create the program and dumped to the Arduino program file and compile it. 12V DC pump will help to spray the water during the running condition. Pumps will help to pumped the water with the help of sprinkler it will spray surrounding the plants. For the grass cutting application we have used a separate DC motor connection by another motor driver. When program will dump into the Arduino then servo as well as DC motor runs simultaneously and by the remote control it will operate as per controlling command. Figure 2 shows Simulation Diagram.

Figure 2 Simulation Diagram

3.2 Software

- **MPLAB Software:** A free, integrated toolset from Microchip for developing applications for PIC microcontrollers. Includes a graphical user interface, compilers, and debugging tools. Runs on Microsoft Windows. Includes starter kits with hardware and software to get started developing applications. Figure 3 shows MPLAB Software.
- **PIC Simulator IDE:** A graphical development environment for Windows that includes a simulator, compiler, assembler, disassembler, and debugged. Supports many Microchip 8-bit PIC microcontrollers. Includes a simulation interface, editors for program memory, data memory, and

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hardware stack, and more. Figure 4 shows PIC Simulator IDE. [6]

Figure 3 **MPLAB Software**

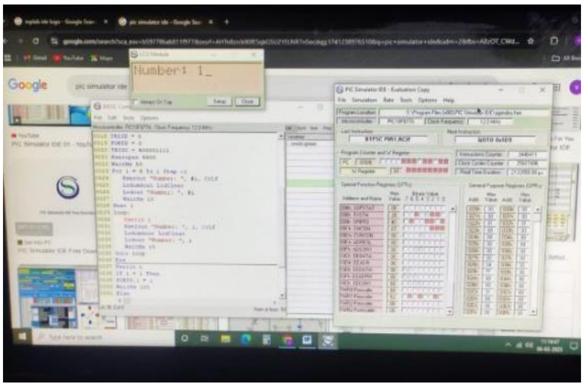

Figure 4 **PIC Simulator IDE**

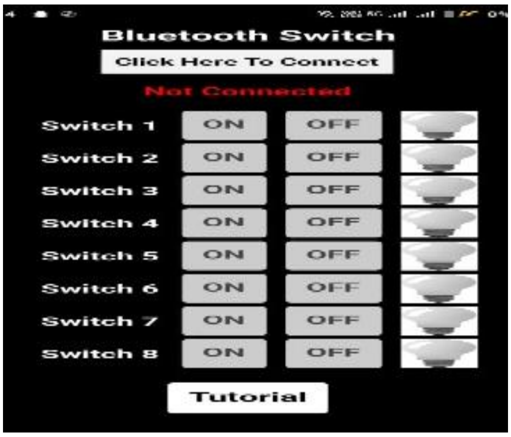

Figure 5 **Blink Android App**

Arduino ATmega328p microcontroller, which is the brain of the system, is programmed to manage. A 12V DC battery controlled by a buck converter powers the robot, guaranteeing dependable operation of every part. Wireless is made possible via the ESP32 module

Table 1 **Switch and Robot Operation**

Switch no	Switch operation
Switch 1	Robot Arm in upward direction
Switch 2	Robot Arm in Downward direction
Switch 3	Seed Motor Operation
Switch 4	Water Pump Operation
Switch 5	Grass Cutting Operation
Switch 6	Robot Wheel Forward Operation
Switch 7	Robot Wheel Reverse Operation
Switch 8	Fruit Cutting Operation

4. Methodology

In order to produce a flexible, effective, and user-friendly system for agricultural applications, the "Remote Control Multifunctional Agricultural Robot" development technique combines a thorough fusion of hardware design, software development, and rigorous testing. Finding the essential agricultural tasks—such as planting, ploughing, watering, pruning, and lifting—that serve as the basis for the robot's design is the first step in the process. A robotic arm kit for job execution, DC gear motors for mobility, servo motors for accurate operations, and L298n motor drivers are just a few of the components that the Arduino ATmega328p microcontroller, which is the brain of the system, is programmed to manage. A 12V DC battery controlled by a buck converter powers the robot, guaranteeing dependable operation of every part. Wireless is made possible via the ESP32 module. connectivity, making it possible to control it remotely using the Blynk Android app. For longevity and functionality, additional parts such as wheels, blades, and jumper wires are meticulously included. The Arduino IDE is used in the software development process to code the microcontroller that controls wireless connection, sensor inputs, and motor control. Circuit simulation using Proteus Design Suite 8.13 verifies the electrical design before to assembly, lowering the possibility of mistakes during hardware integration. The Blynk app interface is tailored to offer user-friendly remote control, enabling users to effortlessly complete activities and monitor real-time data. Following the integration of hardware and software, each component is checked

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to guarantee correct operation, and then the entire system is tested in controlled settings to confirm that all modules are working together. After that, the robot

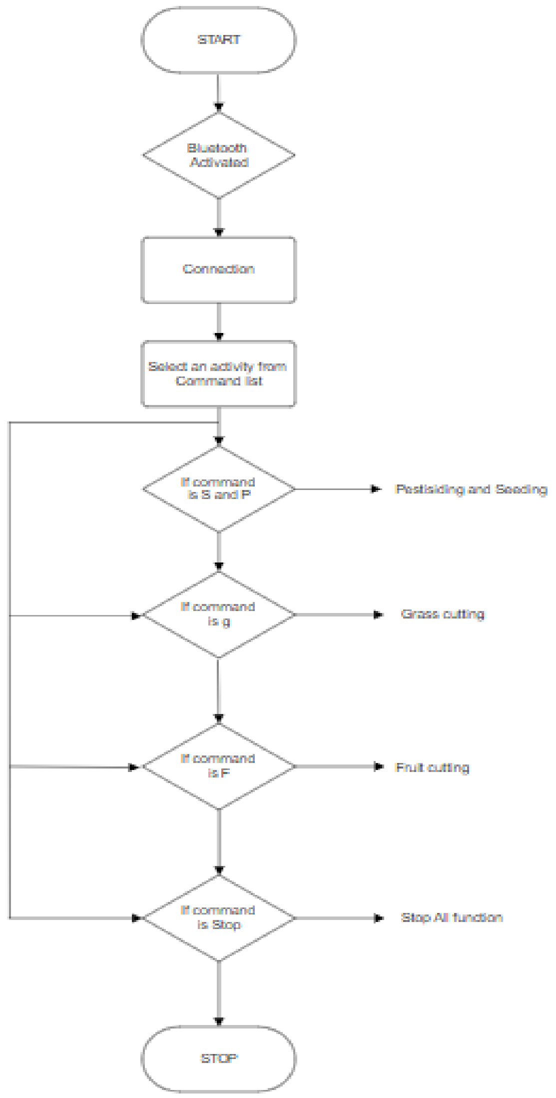

Figure 6 **Flow Chart of Remote-Control Multifunctional Robot**

proceeds through field tests, in which its effectiveness is assessed for operations like crop cutting, seeding, and soil tilling under actual conditions. To assist end users with setup, operation, and maintenance, thorough documentation is produced, including user manuals and training guides. Lastly, the robot is used as a multipurpose, scalable solution for contemporary agricultural demands, providing automation and remote control to boost output and decrease manual labor. Table 1 shows Switch and Robot Operation. [5]

4.1 Flow Chart

Circuit for managing DC motors with an Arduino UNO microcontroller and a L298N Motor Driver module is depicted in the simulated diagram. The L298N receives digital signals from the Arduino, which acts as the central control unit, to regulate the motors' speed and direction. Table 2 shows Table 2 Grass Cutting Function. Two DC motors attached to the L298N's output terminals can be independently controlled by this dual H-bridge motor driver. Table 4 shows Fruit Cutting Function. Depending on the logic levels of these inputs, the motor driver's input pins (IN1`, `IN2` for Motor 1 and `IN3`, {IN4` for Motor 2) receive the control signals from the Arduino, allowing for both forward and backward rotation. An external voltage source that is attached to the L298N's `VS` terminal provides power to the motors. the common ground needed for the system to function properly. Pulse Width Modulation (PWM) signals sent to the motor driver's enable pins (ENA` and `ENB`) can also be used to adjust the motors' speed. Table 3 shows Seed Sowing Function. The circuit's four DC motors are probably employed for mechanical operations like lifting or cutting, or for robotic applications like wheel driving. The Arduino, motor driver, and motors are all connected correctly thanks to jumper wires. As a validation stage, the simulation tests the circuit's operation prior to physical implementation, which makes it appropriate for applications like automated vehicles or remotely controlled robots. Figure 6 shows Flow Chart of Remote-Control Multifunctional Robot. The conclusion from the paper was the need for a multipurpose machine that will be used before harvesting the crops. We considered this for our research and further production of our multipurpose agricultural machine. Jin et al., present the design and experimental results of a multipurpose agricultural robot in 2021. The robot is equipped with various modules for tasks such as plowing, seeding, spraying, and harvesting. It utilizes advanced control algorithms and sensor systems to navigate and perform tasks autonomously in different agricultural environments. [8]

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Table 2 Grass Cutting Function

S.NO	Parameter	Values obtained by proposed model
1	Torque of the motor	5 kg-cm
2	Speed of the motor	10 RPM
3	Distance covered by the model	11m
4	Time taken by the proposed model	1 min

Table 3 Seed Sowing Function

S.NO	Parameter	Values obtained by proposed model
1	Torque of the motor	5 kg-cm
2	Speed of the motor	10 RPM
3	Distance covered by the model	11m
4	Time taken by the proposed model	1 min
5	Number of seeds sowed for minute	20

Table 4 Fruit Cutting Function

S.NO	Parameter	Values obtained by proposed model
1	Torque of the motor	5 kg-cm
2	Speed of the motor	10 RPM
3	Distance covered by the model	11m
4	Time taken by the proposed model	1 min

Table 5 Irrigation Function

S.NO	Parameter	Values obtained by proposed model
1	Torque of the motor	5 kg-cm
2	Speed of the motor	10 RPM
3	Distance covered by the model	11m
4	Time taken by the proposed model	1 min

Conclusion

Multipurpose agricultural robots can be operated remotely and carry out a range of tasks, including watering, cutting grass, planting seeds, and cutting fruit. Servo motor, ESP32 module, and Arduino UNO microcontroller are used. This robot has three axes of motion and can move like a little fruit. Harvesting. It is controllable from a distance. Robots can help agriculture by lowering labour costs and increasing productivity, efficiency, and product quality. There are countless prospects for robot-enhanced productivity in agriculture, and more and more robots are showing up on farms in a variety of forms. Technology is likely to be able to solve the other issues related to autonomous farm equipment. Although this technology might be used in the future, there are compelling arguments that it might not simply replace human drivers with A computer. The non-farm community may find the smaller machines more acceptable, which is one of their benefits. Because agricultural activities are labour-intensive, hazardous, and need rapid thinking and a lot of repetition, robots can be a suitable replacement for human operators. Machines can precisely detect the higher-quality products based on their A computer. It can entail reconsidering the methods used in crop production. A multitude of little machines may be more efficient and cost- effective than a limited number of large ones in the production of crops. The non-farm community may find the smaller machines more acceptable, which is one of their benefits. Because agricultural activities are labor-intensive, hazardous, and need rapid thinking and a lot of repetition, robots can be a suitable replacement for human operators. Machines can precisely detect the higher-quality products based on their color, firmness, weight, density, ripeness, size, and shape. Although they can make our lives better, robots have drawbacks. Currently, every agricultural machine in our nation operates manually; otherwise, it runs on a petrol engine. Table 5 shows Irrigation Function.[7]

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