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Remote Control Based Multipurpose AgroRobot

S. M. Akolkar[1], Darshan Jejurkar[2], Pratiksha Ahire[3], Kanchan Jore[4], Prathamesh Gawale[5]

[1]Assistant Professor, Dept of EE, LoGMIEER-Nashik
[2,3,4,5]UG Student, Dept of EE, LoGMIEER-Nashik

Abstract:
To automate and optimize a variety of agricultural chores, a multipurpose agricultural robot with remote control capabilities is being developed. Compared to conventional agricultural methods, this robot's ability to combine several tasks—such as seeding, pesticide spraying, fruit harvesting, and grass cutting—improves efficiency and saves time and labour. Precision and adaptability in agricultural processes are ensured by the robot's capacity to function well in a variety of difficult terrains, made possible via remote operation. This innovation encourages sustainable farming practices by eliminating human involvement, improving operational accuracy, and minimizing resource waste. Critical issues facing the agriculture industry include a lack of workers, rising needs for food supply, and the need for sustainable farming practices. The creation of the Multipurpose Agribot, an independent, incredibly effective, and adaptable device, addresses these issues.

Keywords : Agrobot, Fruit Cutting , Crop Cutting , Proteus Software , ARDUINO.

INTRODUCTION

In many countries, including ours, farming has long been a fundamental economic activity. Several factors, including changes in the climate, technological breakthroughs, and shifting sociocultural dynamics, have had a substantial impact on the evolution of farming techniques across time. These elements have caused agricultural practices to change; while they differ from one area to another, they have all been modernized in response to more general global tendencies.

The growing automation of agriculture is a significant trend in modern agriculture, largely due to the reduction in agricultural labour, particularly in wealthy nations. The adoption of technological solutions has also risen due to the desire for more productive and higher-quality food. Precision farming—which includes more precise chemical treatments, enhanced grove supervision, better weed control, and optimized sowing and harvesting techniques—has been made possible by robotics and artificial intelligence (AI), which has completely changed agricultural methods. These technologies have shown a significant return on investment as they have developed, which has further encouraged their broad use.

Agricultural robot applications have grown quickly, especially in fields where automation can take the place of human labour in monotonous or dangerous jobs. Drones and autonomous vehicles, for instance, are being utilized more and more for jobs like watering crops, monitoring soil conditions, and applying pesticides or fertilizers. These technologies' accuracy guarantees that resources are used more effectively, minimizing waste and lessening the negative effects of farming operations on the environment.

Recent developments in autonomous agricultural robotics have produced devices that can carry out a variety of challenging activities, such as soil irrigation, ploughing, and sowing. For example, one such system is made to level the ground, plough the seeds with an integrated structure that guarantees adequate seed burial, dig the soil based on its moisture content, and cover the seeds with dirt. Additionally, pumps that precisely regulate the amount of water applied to the field can be used to automate irrigation.

Nonetheless, traditional farming practices are still used in many parts of India. This frequently entails subsistence farming on tiny plots, with farmers using simple implements like hoes, digging sticks, and daos (traditional agricultural tools). Despite being less effective, these methods are still essential to the local community, underscoring the sharp difference between contemporary and conventional farming methods.

In conclusion, the continued evolution of agriculture, propelled by automation, robots, and AI, offers both opportunities and challenges. While large-scale automation has the potential to improve efficiency, precision, and sustainability, traditional farming practices continue to be an important component of the agricultural landscape in many countries, particularly those with limited access to new technology. The balance of these technologies is likely to influence the future of global agriculture.

LITERATURE SURVEY

The Agrobot's autonomous functionality and advanced decision-making algorithms optimize crop productivity and minimize the need for human labor in agricultural operations. The vision system of the mobile robot, employed for path localization, utilizes color detection algorithms and contour recognition techniques, representing an advanced application of image processing technology. The developed Agrobot minimizes human labor and oversight, which were critical in traditional farming practices, thereby addressing challenges associated with labor shortages and high labor costs.

The robot facilitates the concept of automated agriculture, reducing manual labor while offering a more efficient and expedited farming process. The proposed solution represents a small-scale initiative aimed at alleviating the extensive workload of farmers in large-scale operations. The robot facilitates the concept of automated agriculture, reducing manual labor while offering a more efficient and expedited farming process. The proposed solution represents a small-scale initiative aimed at alleviating the extensive workload of farmers in large-scale operations.

METHODOLOGY

To provide a flexible, efficient, and user-friendly system for agricultural applications, the "Remote Control Multifunctional Agricultural Robot" employs a complete strategy that includes hardware design, software development, and intensive testing. The development process begins with determining the basic agricultural tasks—such as planting, plowing, watering, pruning, and lifting— that determine the robot's functional requirements.

The Blynk app interface is designed primarily to create a user-friendly control environment, allowing operators to effortlessly communicate with the robot. The app has simple controls for task selection (for example, plowing or watering), real- time data monitoring (such as battery status and task progress), and operational changes. The seamless integration of these hardware and software components results in a versatile robotic system that is sturdy, reliable, and efficient, making it appropriate for a wide range of agricultural applications.

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The Arduino ATmega328p microcontroller powers the robot and serves as the central processing unit (CPU) for system functions. The microprocessor is in charge of operating a variety of components, including a robotic arm kit for task completion, DC gear motors for mobility, and servo motors for precise activities like seed planting or trimming.

L298N motor drivers assist motor control by regulating the power given to the motors, resulting in smooth and accurate movements.

The robot is powered by a 12V DC battery, which is optimized with a buck converter to ensure consistent voltage management for the system components. This configuration ensures stable performance even under variable load situations.

The ESP32 module facilitates wireless connectivity, allowing the robot to be controlled and monitored remotely. This allows users to control the system in real time using the Blynk Android app, which provides a unified interface for task management.

For software development, the Arduino Integrated Development Environment (IDE) is used to program the microcontroller. The code manages a variety of functions, including as wireless connectivity, sensor inputs (for sensing soil moisture or impediments), and motor control. This program ensures that the robot can accomplish its tasks autonomously or with a remote control, depending on human input from the app.

Prior to hardware assembly, the electrical design is thoroughly validated with Proteus Design Suite 8.13, a robust circuit Proteus simulation tool. This simulation step is critical for identifying and mitigating potential issues in the electrical system, such as circuit faults or compatibility concerns, therefore minimizing the likelihood of errors during the physical integration of components.

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The servo motor receives a control signal, typically a Pulse Width Modulation (PWM) signal. The width of the pulse determines the desired angle of rotation.

Inside the servo, there is a position sensor (usually a potentiometer) that continuously monitors the current position of the motor.

The control circuit compares the desired position (based on the input signal) with the current position (from the feedback sensor).

If there is a discrepancy (error) between the desired and actual position, the control circuit adjusts the power to the motor. If the current position is less than the desired position: The motor rotates in the forward direction. If the current position is greater than the desired position: The motor rotates in the reverse direction.

The DC motor converts electrical energy into mechanical energy through the interaction of Remote Control Based Multipurpose Agribot magnetic fields. When voltage is applied, the rotor spins due to electromagnetic forces.

The gear system reduces the motor's speed while increasing its torque. This is crucial for applications requiring significant force to move or lift loads, such as in planting or tilling. The speed and direction of a DC gear motor can be controlled using PWM (Pulse Width Modulation) or H-bridge circuits, allowing for precise movement in the robot.
Upon powering up, the ESP32 starts executing code from a predefined location. The initial setup includes configuring GPIO pins, initializing Wi-Fi and Bluetooth, and preparing peripherals. The dual- core architecture allows running multiple tasks simultaneously using FreeRTOS, enabling efficient multitasking and real-time processing. The ESP32 can read inputs from sensors and control outputs such as LEDs, motors, and relays. It supports digital reads/writes and analog reads. The module can connect to Wi-Fi networks, enabling data transmission to and from the internet. It can also create a Wi-Fi hotspot or connect to other devices via Bluetooth. The microcontroller processes data from sensors or user inputs, executing programmed logic to make decisions and control connected devices. External interrupts can be configured to respond immediately to events (e.g., button presses), allowing for real-time responsiveness.

PROTEUS SOFTEARE

Proteus Professional is a comprehensive electronic design software.
Labcenter Electronics developed Proteus Professional, a powerful software suite for electronics engineers, enthusiasts, and students. Its purpose is to make it easier to design, simulate, test, and troubleshoot complex electrical and electronic circuits. The software includes a sophisticated collection of tools that allow users to model and analyze circuits in schematic and simulation modes.
Key features include an easy-to-use graphical user interface (GUI), comprehensive component libraries, and support for microcontroller programming and simulation. The software's advanced simulation engine enables users to see real-time behavior of analog, digital, and mixed- signal circuits. Furthermore, Proteus Professional includes advanced debugging features, making it an indispensable tool for efficient circuit design and analysis.

ARDUINO IDE SOFTWARE:

The Arduino Integrated Development Environment (IDE) is a software application that facilitates the development, compilation, and deployment of code to an Arduino micro-controller. It provides an interface for writing, editing, and uploading code, referred to as "sketches," in the .into file format.
Core Features:

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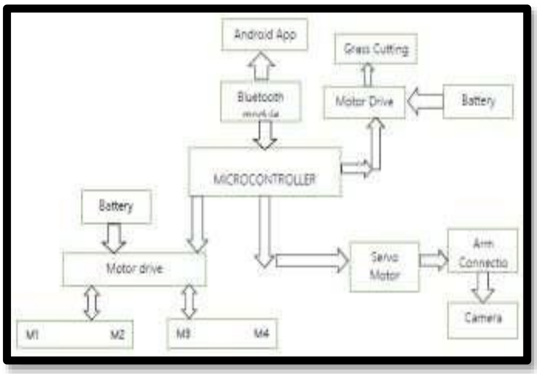
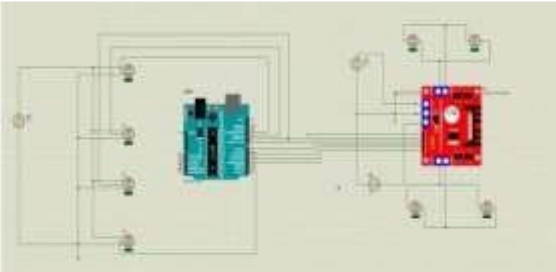
1. Code Development: The IDE provides a text editor for writing sketches, as well as built-in tools like syntax highlighting, auto-completion, and error detection to help you program in the Arduino language.
2. Code Uploading: The IDE allows you to compile your sketch and then upload it to an Arduino board via serial communication, ensuring that executable code is transferred to the microcontroller.
3. Board Communication: The IDE uses serial communication protocols to interface with the Arduino board, allowing for real-time data transfer, debugging, and interaction between software and hardware.
4. Library Management: The IDE features a library manager that gives access to pre-existing libraries, allowing for the incorporation of specialized functions and hardware support in drawings to improve system capabilities.
5. Board and Library Configuration: Within the IDE, users may configure and select certain rduino boards, as well as manage associated libraries, to ensure compatibility and optimal performance across multiple hardware platforms.
6. Data Visualization: The IDE offers functionality for real-time data monitoring and visualization, aiding in debugging and analysis by displaying output values, sensor data, and system diagnostics

FLOW CHART:



We have used Arduino uno r3 which is have ATmega328p microcontroller in this Arduino there are 14 digital input output pins and 6 analog input output pins.
Total four servo motors are used for arm connection in which 3 pins configuration are used including 1st for source, 2nd for control and 3rd for ground connection. Control pins of four servo motors are connected to the PWM signal pins of the Arduino namely pins with no. 11,10,9,6.
For the DC motor control application, we have selected the L298n motor driver which helps to control the DC motor which is used for wheels of the DC motor driver. This driver required 12V DC supply, when provided helps to control dc motor in forward and reverse direction. ENA, IN1,IN2,IN3,IN4,ENB this 6 pins are connected to 9,8,7,5,4,3 digital pins of the Arduino. fours DC motor are connected parallel to each other with (+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. Pump 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 dumped into the arduino then servo as well as DC motor runs simultaneously and by the remote control it will operate as per controlling command

SIMULATION DIAGRAM:



The system requires a 12V DC power supply to function. When electricity is supplied, the motor driver controls a DC motor, allowing for forward and backward motion. The motor driver pins (ENA, IN1, IN2, IN3, IN4, and ENB) are connected to the Arduino's digital pins 9, 8, 7, 5, 4, and 3, respectively. Two DC motors are interconnected in parallel, with positive (+) and negative (-) terminals attached to driver output pins 1, 2, 3, and 4.

A Bluetooth module is included for remote control purposes. The relevant remote-control application is developed, compiled, and uploaded to Arduino memory. The device also has a 12V DC pump that is activated to spray water when it is operating. The pump, in conjunction with a sprinkler system, distributes water over the plants.

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This type of agriculture robot can only perform small height crops cutting activity, grass cutting, spraying activity. High force, high speed response is not achievable because of small scale prototype but if in future if large scale equipment is designed, then agriculture robot can replace with conventional technique. This type of agriculture robot can work up to 10 m distance with remote control. Simultaneously it can perform three task successfully.

RESULT TABLE & DISCUSSION

Sr No	Parameters	Calculated Value
1	Torque of the servo motor	0.15696 N-m
2	Angular speed	19.12 r/s
3	Speed of servo motor	187.35 RPM
4	Radius of the wheel	23 cm
5	Arc length	0.7068 m
6	Speed of DC gear motor	100RPM

CONCLUSION

Multi-functional agricultural robots are designed for remote operation and can perform a diverse set of tasks, such as irrigation, grass cutting, seed planting, and fruit harvesting. These robots incorporate key components, including servo motors, the ESP32 module, and the Arduino UNO microcontroller. They are equipped with three degrees of freedom in motion, allowing them to maneuver in a manner akin to small fruit- harvesting machines. The system is controllable via remote communication interfaces.

The introduction of such robotic systems into agriculture provides the farmer potential for significant reductions in labor costs while simultaneously improving overall productivity, operational efficiency, and product quality. The versatility of robots in agricultural processes is becoming increasingly evident, with various robotic solutions being deployed on farms in multiple forms.

Furthermore, technological advancements may offer solutions to additional challenges associated with autonomous farming machinery.

While the use of robots in agriculture is expected to expand, it is not merely a matter of replacing human labor with automated systems. It may necessitate a reevaluation of traditional crop production methodologies. Smaller, distributed robotic units could offer greater efficiency and

cost-effectiveness compared to a limited fleet of large-scale machines, especially in crop production. Additionally, smaller robots may be more socially acceptable to the non-farming community, thus broadening their potential for adoption.

Robots are particularly well-suited for agricultural applications due to the labor-intensive, hazardous nature of many tasks, which require rapid decision- making and repetitive actions. By utilizing advanced sensors and machine learning algorithms, agricultural robots can precisely evaluate product quality, assessing factors such as color, firmness, weight, density, ripeness, size, and shape.

Despite their advantages, the widespread employment of robots in agriculture presents challenges. Currently, most of the agricultural machinery operates either manually or relies on traditional internal combustion engines. This limits the potential for full automation in the sector.

However, as robotic technologies evolve, they are expected to address these limitations and further optimize agricultural processes quality, assessing factors such as color, firmness, weight, density, ripeness, size, and shape.

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