Multipurpose Agricultural Robot - AGRIBOT

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Abstract – *Mechanization revolutionized Indian agriculture, replacing tedious manual work with efficient machines for plowing and harvesting. This boosts productivity, reduces labor costs, and saves time. From land preparation to crop processing, machines handle nearly every aspect of farming. This shift not only streamlines operations but also meets the demands of a growing population. The present work introduces a versatile agricultural robot using Arduino Uno for the seamless automation of key farming tasks. This multipurpose robot excels in plowing, seed sowing, water spraying, and pesticide application, enhancing agricultural efficiency and productivity. By integrating Arduino Uno, the robot achieves precise control and coordination in executing these operations, ensuring optimal resource utilization and minimizing manual intervention. With its ability to automate multiple tasks, this agricultural robot presents a sustainable solution for modern farming practices, promising increased yields and reduced labor costs.*

Keywords: *Agriculture, Arduino Uno, Crop, Farming, Labor Cost, Robot.*

1. INTRODUCTION

Farming is vital to India's economy, relying heavily on traditional methods like plowing and sowing. However, these methods often lead to productivity challenges and high labor costs. Mechanization offers a solution, bridging the gap between manual labor and modern technology. Agribusinesses increasingly turn to automation, focusing on automating key farming tasks like seeding, weeding, and spraying. Designing robots for these tasks requires consideration of both the agricultural environment and precision levels compared to conventional methods. Environmental factors such as bumpy terrain and varying soil moisture levels must be accounted for in sensor selection. Despite advancements, challenges like limited energy and water access persist, urging the need for technological advancement in farming [1]. Research is ongoing in areas like remote sensor usage for data collection to improve agricultural efficiency. However, full automation in farming remains elusive due to various obstacles, hindering widespread adoption by farmers. This paper proposes smart agriculture solutions using IoT technology to address these challenges and benefit farmers. The integration of IoT technology in agriculture facilitates automation, enabling real-time data collection on soil conditions and crop growth for informed decision-making. Solar-powered robots offer sustainability benefits by reducing reliance on fossil fuels and lowering carbon emissions. By optimizing crop yields and enabling remote monitoring, IoT-based robots have the potential to transform agriculture, making it more efficient, sustainable, and profitable. an agricultural robot (AG bot) provides an overview of its significance, functionality, and applications in modern farming practices. Agricultural robots, also known as robots or robots, are innovative machines designed to assist and automate various tasks in agriculture, ranging from planting and harvesting to irrigation and pest control.

2. LITERATURE SURVEY

Here are summaries of papers on multipurpose agricultural robots, including details of the year, authors, title, and a brief introduction to their work:

D A Mada In 2013, made a research paper and mentioned the importance of smart agricultural systems by giving examples [2]. 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 [3]. 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 [4] and colleagues developed a versatile agricultural robot system capable of performing multiple tasks in 2020. Their work focuses on the design and implementation of the robot's mechanical structure, control system, and task-specific modules. 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. The robot is designed to be affordable and adaptable to various farm sizes and crop types. Their research addresses the specific challenges faced by small-scale farmers, offering a practical solution to improve productivity and sustainability [5].

In 2021, Chen and co-authors explore the integration of IoT technology into a multipurpose agricultural robot. Their work focuses on enhancing the robot's capabilities through real-time data collection and analysis. By leveraging IoT, the robot can optimize resource usage, monitor crop health, and adapt to changing environmental conditions for improved agricultural performance [6].

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 [7].

Gupta and collaborators introduce a vision-based control system designed for a multipurpose agricultural robot in 2022 [8]. 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. [9] explore a swarm robotics approach for multipurpose agricultural tasks. Their research investigates the coordination and cooperation of multiple robotic agents to accomplish complex farming.

In 2023 Yang et al. propose an energy-efficient design for a solar-powered multipurpose agricultural robot. 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 [10].

The design of multipurpose agro equipment machines will help Indian farmers in the rural side and small farms It will reduce the cost of seed feeding, pesticide sprinkling, and crop cutting in the field and will help to increase the economic standard of an Indian farmer.

1. The main objective of this project is to design and fabricate multipurpose agriculture machines.

2. To minimize the cost so that it should be affordable for everyone.

3. To reduce Human efforts, all operations can be performed by a single person, thus it will reduce labor costs.

4. To reduce the amount of time for operation.

3. METHODOLOGY

The automated irrigation system controlled by the Agribot utilizes an ATmega2560 microcontroller programmed via the Arduino platform. Designed to move along the contour of a rectangular field, the robot's control unit is based on the ATMega2560 microcontroller using Arduino. The control unit regulates the irrigation system by toggling it on/off based on soil moisture levels and ambient temperature. Various hardware components are connected to the Agribot to facilitate its operation, including H bridges for driving the DC motor wheels and a screw rod mechanism for soil moisture sensing. Additionally, a relay manages the pump, while solar panels convert solar energy into usable electrical energy through a boost converter. Finally, an LM7805 IC regulator transforms a 12 V DC supply into a 5 V DC supply, which powers the relay. The servomotor in a robot regulates the precise dispensing of seeds. It controls the mechanism responsible for releasing seeds at specific intervals and quantities. By receiving instructions from the robot's control system, the servomotor ensures accuracy in seed distribution, minimizing wastage and promoting uniform planting. Its flexibility allows for adjustable dispensing rates, accommodating various crop types and planting needs. In summary, the servomotor plays a crucial role in optimizing seed placement and enhancing the efficiency of agricultural operations.

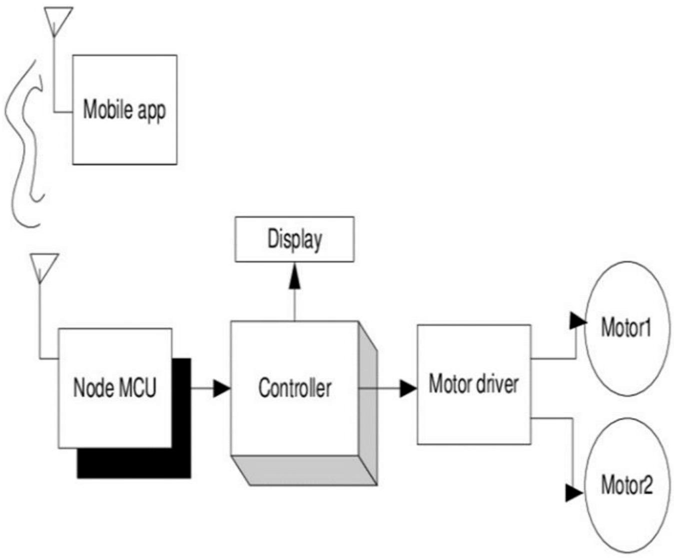

Fig -1: Mechanism of Proposed System

Node MCU plays a crucial role in agriculture robots by enabling wireless communication, sensor integration, control, data processing, and cloud connectivity. It facilitates remote monitoring, controls actuators, processes sensor data for real-time analysis, and integrates with cloud platforms, enhancing efficiency and productivity in farming practices.

Our robot can perform various operations like

3.1 Steering Operation

The robot is powered by two wiper motors, which are also responsible for turning. The motors are powered by a 12V battery. The power for the motor is regulated by the Relay switch. The direction of motor rotation can be controlled by a remote controller for steering the vehicle in either left or right-side direction.

3.2 Ploughing Operation

The actuator is designed using a 12V BLDC (200 RPM) motor attached with a 4" lead screw, for the plowing operation. The screw is further connected to a plougher (rake), which has 12 teeth (12" * 3"). The actuator is powered by the same 12V battery and is controlled by a 6-pin DPDT switch.

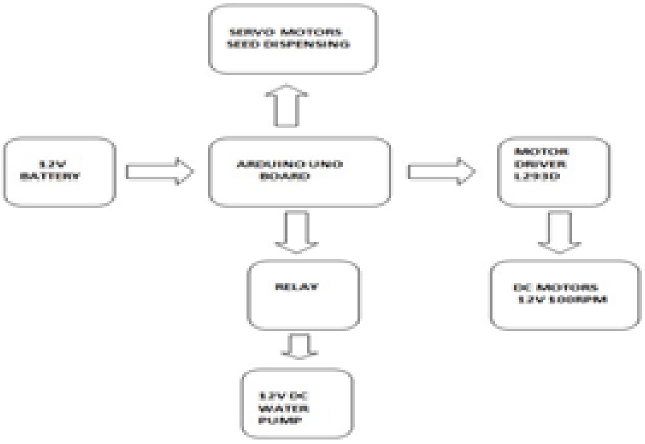

Fig -2: Multipurpose Agriculture System

3.3 Seed Sowing Operation

A wooden box (18*6.5*7) inch is used for seed storage as well as dispensing mechanism. Three holes of 1" diameter each are used which are further connected to valves for controlling the appropriate quantity of seeds dropping. A rotating shaft is passed through the box, which is powered by the rear wheels through a chain-sprocket mechanism. As the motor is switched on, the wheels tend to rotate, and the rotation of the shaft makes the seeds fall on the cultivated field. There is a time gap where seeds are alternately fed to the ploughed field

3.4 Water Spraying Operation

The front box houses the water tank as well as the battery components. A water pump is used for pumping water, which passes through a tube. The tube is attached in front of the box. The power for the pump is regulated by a toggle switch.

Arduino Uno: The Arduino Uno plays a pivotal role in the agricultural robot's functionality across various farming operations. Firstly, it manages the steering operation, ensuring the robot navigates the field accurately by processing sensor data and adjusting direction accordingly. Additionally, Arduino Uno oversees the plowing operation, controlling the depth and direction of the plow based on soil conditions to facilitate effective soil tillage. Furthermore, it regulates the seed-sowing process by coordinating the dispensing mechanism, ensuring precise seeding at optimal intervals as the robot traverses the field. Moreover, Arduino Uno orchestrates the water spraying operation, adjusting the spray pattern and intensity to optimize irrigation based on environmental factors such as soil moisture levels. In summary, Arduino Uno's control and coordination capabilities are integral to the seamless execution of steering, plowing, seed sowing, and water spraying operations in the agricultural robot, contributing to enhanced efficiency and productivity in farming practices.

Fig -3: Arduino Uno for Agriculture System

4. RESULTS AND DISCUSSIONS

The Agribot is purely non-convectional and reduces human effort. It saves time for farmers and water for irrigation. The result shows accuracy in seed sowing and watering the crop. The estimated time for basic activities is observed to be less than traditional farming. The prototype of the project is shown in Figures 4 and 5. The setup contains a seed drum for seeding, plowing rods for plowing the soil, and a tank to supply water to the field.

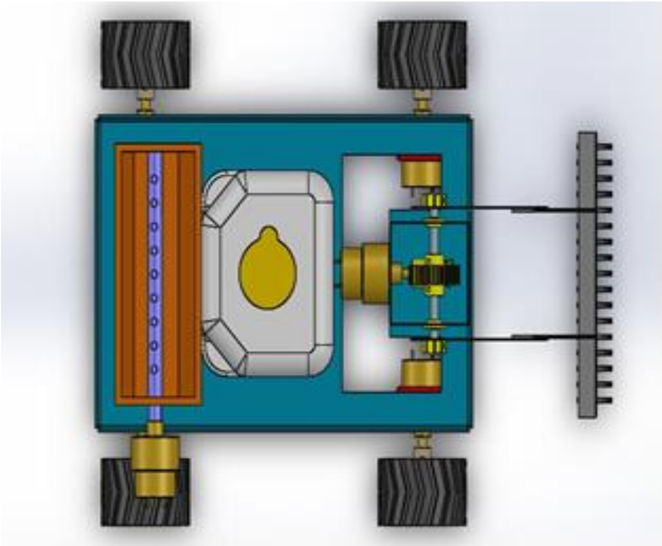

Fig -4: Design Model of Agriculture System

A prototype of a multipurpose agriculture robot has been implemented successfully which is capable of sowing seeds and watering crops accordingly. The greater part of this robot is that it is mostly self-governing so that farmers can spend more time on other agricultural activities.

Fig -5: Prototype of Agriculture System

In automated mode, it performs all functions automatically upon receiving power. This mode allows users to activate specific functions individually by pressing corresponding buttons. For instance, if plowing is required, only the plowing function is activated when its switch is turned on. Additionally, the robot can be controlled via mobile devices using a Bluetooth system, operating within a range of 10 meters. It also emits audible signals when the water tank is empty. Testing of the robot was conducted on small farmland, where it successfully performed tasks, such as plowing, seeding, and watering.

5. CONCLUSIONS

The project "Multipurpose Agricultural Robot" aims to conduct various farming tasks such as plowing, seeding, and sprinkling, thus eliminating the need for traditional energy sources like electricity. This makes the robot environmentally friendly and cost-efficient. The robot gathers and analyzes Steering Operations, Ploughing Operations, Seed Sowing Operations, and Water Spraying Operations using real-time data. This technology holds promise in addressing key challenges in agriculture, including labor shortages and sustainability concerns, while meeting the increasing demand for food production. Precision farming techniques, facilitated by sensors and data analytics, enable farmers to optimize crop production by adjusting irrigation, fertilization, and pest control strategies in real time. This technology aids farmers in the early detection of crop issues like pests and diseases, reducing water usage and fertilizer wastage for more sustainable farming practices. Overall, the robot has the potential to revolutionize agriculture by enhancing crop monitoring, reducing environmental impact, and improving overall efficiency and cost-effectiveness for farmers globally.

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