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A Review on IoT Based Solar Power Automatic Multi-Tasking Agriculture Robot

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Abstract: *Basically, the agricultural sector provides the strongest support to the Indian economy and about 70% of the population depends on it for a living. Traditional agricultural practices are labor-intensive, time-consuming, and costly due to the expensive machinery involved in seed sowing, spraying water with pesticides, etc. This project addresses these issues with the solar-powered automated multitasking agricultural robot that will propel efficiency and reduce human effort in farming operations. The proposed system integrates all work into an affordable and user-friendly robotic platform. The salient features include a dual spray system for pesticides using a single heavy-duty DC pump, a fertilizer hopper for periodical dispensing, and with four 4-inch wheels with free shafting to allow smooth movement. A button-enabled electronic control unit operates the machine either manually or automatically through a servo tester. The solar panel is of 12W in size, sustaining energy to charge a 12V, 1AH battery, thus enabling uninterrupted operational capability even in remote agricultural fields.*
A NodeMCU microcontroller is also included in the system for stronger automation and remote monitoring. The system features the integration of a soil moisture sensor that monitors soil conditions to determine whether the soil is dry or wet, Soil parameters are shown on the blynk app. This feature ensures optimal water usage by automating irrigation processes, thereby reducing water wastage and increasing crop yield. This system aims to improve agricultural productivity, reduce labor costs and endorse sustainable agricultural practices by integrating automation, renewable energy, and precision agriculture techniques. Such an innovative approach not only improves efficiency but ensures the accessibility of precision farming to small and medium-scale farmers for their long-term benefit in the agricultural sector.

Keywords: Robotics for multitasking, DC Pump, solar power system, agriculture robot

I. INTRODUCTION

Agriculture is the backbone of every growing country, including India. However, agricultural development has witnessed a gradual downturn due to a variety of reasons. To throw light on this aspect, it becomes imperative to enhance farming efficiency and productivity. This PAPER proposes an automated system to carry out various tasks in agriculture, thus alleviating manual labor and enhancing productivity. Agriculture has taken a turn in certain areas of mechanization, but in India, most of the farming work is done with traditional implements such as wooden plows and sickles. Particularly, small and marginal farmers still depend entirely on human labor for plowing, sowing, irrigation, and weeding, resulting in excessive labor use and low productivity. While the limited use of modern machines increases the burden of fieldwork on farmers, it also drastically reduces production.

The mechanization of agricultural practices will help solve some of these issues. This paper proposes a mechanized farming solution that would mitigate wastage of labor power and improve efficiency and ease of agricultural operations. The introduction of a solar- powered automated agricultural system will thereby enhance productivity and support sustainable agriculture. India's techniques of agriculture today are economically unfeasible and unsustainable service systems, with poor yields from many crops. Such innovative solutions provided by agricultural robots can help in equipping this sector to fill this gap and convert traditional agriculture into an efficient, modern, and productive industry.

II. PROBLEMS STATEMENT

Agriculture is still the primary occupation for a large section of the Indian population. Traditional farming methods applied in India are labor-intensive, inefficient, and costly in comparison to modern agricultural practices. Small and marginal farmers, in particular, depend anachronistically even for simple jobs like seed sowing, pesticide application, or fertilizer application. Thus, needless labor input contributes to low productivity. In addition, labor shortages, increased operational costs, and limited access to mechanization are also offsetting agricultural productivity. The proposed solution would thus be fully automated, cost-efficient, and environmentally friendly in order to streamline farming operations, cut down on manual labor, and increase efficiency. This Paper proposes a solar- powered automated multitasking agriculture robot as a solution to the existing problems facing Indian agriculture by providing the technological interface for modern farming practices.

The objective is to design and ultimately construct an integrated solar-powered agricultural robot that performs diverse agricultural tasks with minimum human intervention.

- To monitor soil conditions through the Blynk app.
- To apply a dual pesticide spraying system using a single heavy-duty DC pump for more efficient and uniform spraying.
- To effectuate intermittent dispensing of fertilizers using a hopper system for maximum optimization of crop performance.
- To control using manual and automatic modes through a button-based electronic control unit and a servo tester for dynamic functionality.
- The renewable energy sources are hence in use: there is a 12W solar panel and a 12V, 1AH battery for eco-friendly and economical operations.
- Movement and adaptability would be enhanced via a four-wheel (4-inch wheels with free shafting) mechanism allowing the robot to move smoothly on different terrains.
- To assist in reducing manual labor, increasing efficiency, and mechanizing farming for small and marginal farmers.

III. LITERATURE REVIEW

Shamshiri et al. [1] state the advances and challenges in agricultural robotics. The thrust areas include weed control, field scouting, and harvesting. Also, swarm robotics and simpler manipulators for optimization are described. Again, digital farming technologies have been emphasized.

Kushwaha, Sahoo, et. al. [2] classified the agricultural robotic systems and throw light on the major technologies that ultimately highlight the global market which paper was heading to hit $10 billion by 2023. Discuss the emergence of agricultural robotics driven by the emergence of demand requirement in terms of goods against limitations in resources and labor.

Cheng, C. et al. [3] examined the increasing importance of agricultural robots. This paper shows strong academic interest and technology advancement in this field. Categorization of agricultural robots with consideration of

Tang Q, et. al. [4], present the idea of agricultural robotics in combination with IoT and smart agriculture. A method of evaluation has been proposed in this paper, which integrates the classification of user requirements and ranking of solutions for increasing practicality in design.

Khadatkar, et. al., [5] enumerate how robotics and the next revolution in AI will be the answer to labor shortages and high productivity for agricultural concerns. Precision operation in the fields can be achieved using IoT and machine learning where drones help with crop management. Future focus should focus on advanced robots for labor-intensive operations.

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Prakash S, et. al., [6] has detailed the design and development of an autonomous agricultural robot using battery, solar energy, and relay switch control with the use of IR sensors to dig the soil, plant seeds, level the land, and spray water. Important features include plowing and automated

Namburi Nireekshana, et. al., [7] discuss India's case, an agricultural giant with all costs, labor-shortages, water- lack, and crop-monitoring issues. Due to small landholdings, it is a hindrance to moving toward automation to reduce all these barriers. The proposed robot will plough, sow, cut grass, spray pesticides, and identify leaf diseases at the same time enhancing efficiency and safety. Development will require coordination between electrical and agricultural experts.

P. K. Paul, et. al., [8] were of the opinion that robotics powered by AI automates tasks in different sectors, right from production to consumption. In agriculture, robotics automates several tasks like weed control, planting, and monitoring. The integration of technology such as cloud computing and big data into agriculture has led to the rapid growth of the market in robotics. The paper is all about basics of robotics and talks mainly on its application in agriculture, challenges, and issues.

IV. METHODOLOGY

This system is designed for solar-powered automated multitasking agriculture robots that assist with farming efficiency with minimal human intervention. It has dual spray operations for pesticide spraying, powered by a heavy-duty DC pump for uniform spraying. The four 4-inch wheels have a free shafting system enabling smooth movement of the robot over different terrains. The simple operation of the device is enabled by a button-based electronic control system, while a servo tester allows for the adaptability of the robot to either manual or automatic control as needed for various agricultural operations. A solar panel of capacity 12W is used to charge the 12V, 1AH battery, thus providing the robot with nonstop working capability.

A NodeMCU microcontroller was also incorporated into the system to make automation and remote monitoring more effective. The soil moisture sensor integrated into the main system can detect the condition of soil, whether dry or wet. With this, irrigation could be automated, thus promoting water conservation and enhancement of crop yields. It also aids in fertilizing the crops by allowing the hopper to distribute fertilizers at regular intervals.

By automating pesticide spraying, fertilizer mixing, and detection of moisture, farming costs are lowered, and agricultural productivity is overall raised.

V. BLOCK DIAGRAM

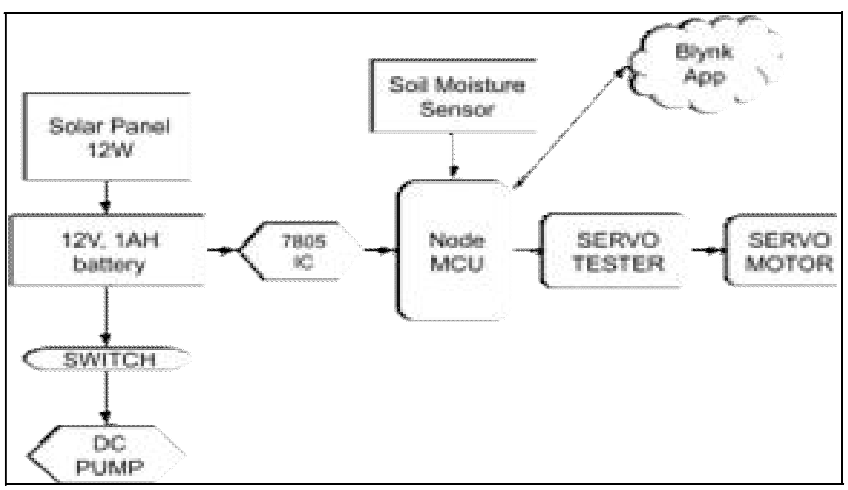

Fig (1) shows the block diagram of the project

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DESCRIPTION

The block diagram of an Automated Solar-Powered Multitasking Agriculture Robot consists of many main components that bring closer an automation of agricultural activities such as pesticide spraying and fertilizer dispensing.

1. Solar Panel (12W)-Collects solar energy and converts it into electrical power for powering the system.
2. 12V, 1AH Battery-Stores energy generated from the solar panel and supplies it to different components.
3. Voltage Regulator (7805 IC)-Regulates voltage in the system for safe and stable power distribution.
4. NodeMCU-The main controller of the system controlling automation and remote access to the system.
5. Blynk App-Offers a very friendly interface for remote operation and real-time monitoring of the systems.
6. Soil Moisture Sensor-Detects soil conditions to determine whether the soil is dry or wet for a process of automating irrigation.
7. Servo Tester-Control the operations of the servo motor in both a manual or automated manner.
8. Servo Motor-Controls mechanical movement, such as that of a fertilizer hopper and spraying mechanism.
9. DC Pump-This is part of a dual line for spraying pesticide.
10. Switch-It refers to manual access to the operating system.
11. This is the ultimate step in automation for agricultural operations which will reduce labor dependency and improve greatly productivity with IoT-based monitoring and control.

FLOW CHART

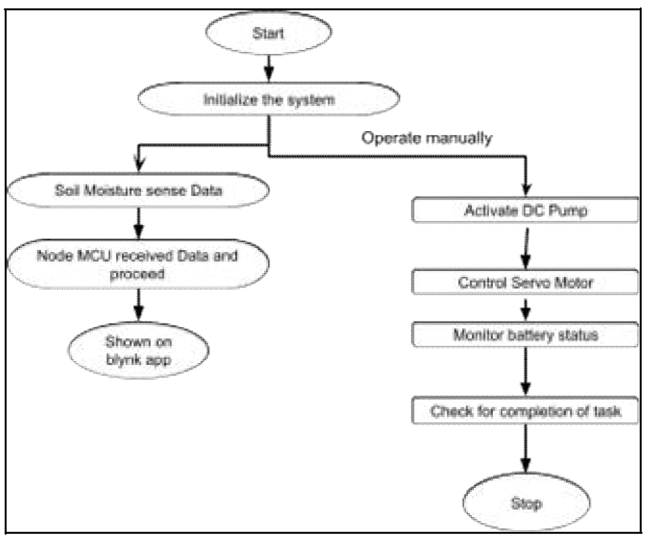

Fig (2) shows the Flowchart of the project

WORKING

The functioning of the Solar-Powered Automated Multitasking Agriculture Robot involves gathering solar energy through a50-watt solar panel that charges a 12V, 1AH battery to enable smooth functioning of the system. The button-residing electric control unit allows the user to choose manual or automatic mode of operation. In the manual mode, every action of the robot can be controlled by the farmer using a solder tester, while in the automated mode, the system executes the pre-programmed tasks. The control of the whole system lies with the NodeMCU microcontroller that enables automation and remote monitoring through the Blynk application. The DC pump runs a dual pesticide spray system to ensure proper and uniform spraying in the field. Simultaneously, a control servo motor-operated hopper system deposits fertilizer at intervals, thus ensuring crop improvement with less human interference.

A soil moisture sensor continuously monitors the soil condition, determining whether it is dry or wet. Based on these sensor readings, irrigation processes can be automated for the efficient management of water. With four 4-inch wheels with free shafting, the robot is capable of smooth movement over different terrains. The voltage regulator ensures that

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7805 IC supplies stable voltage to all components without damaging the circuitry. The system monitors its battery level while giving an alert to the user on low battery conditions. It stops once all of its assigned tasks of pesticide spraying, fertilizer dispensing, and soil moisture detection are completed. This project provides lower dependence on labor, higher efficiency, and sustainable farming by integrating solar power, IoT-based monitoring, and modern agricultural technology.

VI. HARDWARE REQUIREMENT

- Service Tester
- Servo Motor
- 12 V Solar Panel
- 12 V, 1 AH Battery
- L298 IC
- DC 12 V Water Pump
- Switch
- Node MCU
- Soil Moisture Sensor

SOFTWARE REQUIREMENTS

- Arduino IDE
- Proteus

VII. EXPERIMENTAL SETUP & RESULT

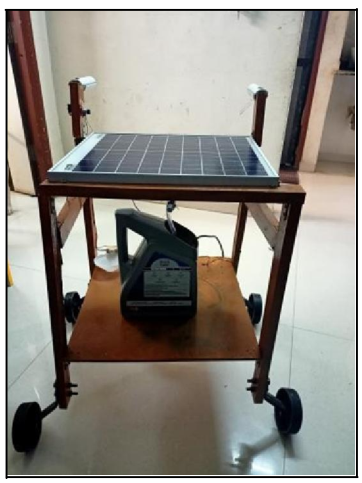

Fig (4)shows the Top View of Project

VIII. RESULTS

The Solar-Powered Automated Multitasking Agriculture Robot is a prime innovation in smart farming realizing important agro tasks such as spraying pesticides and distributing fertilizers. This system aids in the reduction of labor dependence, maximization of resource-consumption, and ensures continuous and uniform application of agrochemicals while giving farmers a safe distance from the dangerous substances. The solar power behind the robot makes it a cheap and environmentally friendly alternative to traditional machines meant especially for small and marginal farmers, who should receive accessible and effective technologies. The robot increases operational flexibility thanks to the combination of manual and automatic modes of control. The transformative aspect of this smart doing companion lies in its enhanced mobility, better control, sssand optimized power consumption compared to traditional agricultural robots. Finally, the unique addition of being enhanced with the Blynk app—enabling real-time monitoring of soil moisture levels and indicating soil wetness or dryness—sets this invention apart. Farmers can keep tabs on field status from anywhere; irrigation scheduling can thus be made smarter and more data-driven, all with a few taps on their smartphones. Results from the fields show the genuine harvest: renewable-energy-based mechanization is aiding in agricultural productivity but is also setting high standards for sustainable farming. This is not just a robot; it is truly a revolution in motion.

IX. CONCLUSION

The Solar-Powered Automated Multitasking Agriculture Robot has been designed as an affordable, energy-conserving, and simple technology to boost agricultural productivity by less dependence on labor. Solar energy, automation, and multiple functions are synergistically brought together to perform, among other things, spraying pesticides and subsidizing fertilizers used in farms. The manual and automatic modes are flexible to make sure the farmers find it easier to operate, making it better and easier for modern technology in agriculture. The project illustrates that mechanization through renewable energy can add much value to agriculture by improved efficiencies of cost and operation and sustainability, and at the very least, can take technology advancement to rural farming communities.

X. FUTURE SCOPE

There are further extensions of this project aimed at increasing automation using AI and IoT for real-time monitoring and control through smartphone applications. Integration of GPS and computer vision makes precision farming possible, whereby the robot may navigate and detect health status of a crop without human intervention. Further addition of soil moisture sensing, weed detection, and automated ploughing may drastically cut down human intervention and make agriculture more effective. Upgradation of battery capacity and hybridizing with other energy sources, such as wind energy or kinetic energy harvesting, may also make the robot more sustainable and dependable for long-term use. With continuance of technology improvements, this system will prove to be a major influence in modernizing agriculture and a great contribution to global food security.

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