

Evaluating the Impact of Solar-powered Robots on Agricultural Practices

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Abstract

Agriculture is the principal occupation of more than 40% of the global population. The primary goal of this study is to create an agricultural multifunctional vehicle that might operate automatically. It is intended to reduce the load of work for farmers which speeds up and improves the quality of the work. The use of automated multitasking solar-powered agriculture robots is a novel way to increase agricultural productivity while reducing the demand for human labour. In India, agriculture provides a living for around 70% of the population. These days, applying pesticides, water, and seeds are challenging tasks. To prevent pest and weed attacks in the field, the robot sprays pesticides, and weedicides. The solar panel that is mounted above the car can also be used to recharge the battery. The equipment required for the operations is pricy and cumbersome to operate. Therefore, by creating a system that will require less manpower and time, the agricultural system in India should be developed. This system guarantees the use of environmentally acceptable energy sources and reduces the need for frequent vehicle charging. In this study, solar-powered automated multitasking agriculture robots provide farmers with a practical and sustainable option to increase output and lessen their environmental impact.

Keywords: Agriculture, robot, automation, solar panel, microcontrollers, seed sowing, water sprinkling, pesticide spraying

INTRODUCTION

In a developing nation like India, agriculture is the main industry. In rural India, agriculture is the main industry. A lack of timely access to an effective labour force is one of the issues farmers face due to regular migration of labour in search of work. However, for a variety of reasons, fewer individuals

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are working in the agricultural sector these days. So, increasing agriculture's productivity and efficiency is crucial. Therefore, automation in the farming sector is required to lessen the workload for farmers. We can carry out several agricultural tasks with this project. Precision farming, which treats each crop separately, increases yield productivity by reducing the time and energy needed for repeated farming chores. This is the primary driver behind the automation of farming procedures. Despite extensive mechanisation in some regions of the nation, most agricultural operations are still performed by hand in many other regions using tools like sickles and wooden ploughs. For the purposes of ploughing, seeding, irrigating, and weeding the crops, very little or no machinery is

used. This is particularly true for marginal and small-scale farmers. It leads to a significant loss of manpower and poorer labour force productivity per capita. Solar-powered Agriculture Robot extracts electrical energy stored in the batteries to run its mechanical, electrical, and electronic devices to perform the several tasks for industrial as well as commercial work. Robots can operate in a hazardous environment for long duration of time without human assistance with high accuracy. A robot used for agriculture is referred to as an agricultural robot. Nowadays, the harvesting stage of agriculture is when robots are mostly used.

Agribot or agbot are other names for agricultural robots. This robot is helpful in farming and is autonomous. It increases crop productivity for the farmer and lessens the amount of manual labour he or she must perform. The capacitor banks serving as a battery system alternative are charged using the solar cell output. The robot mimics the stations in a production environment as it moves from one station to another. A voltage sensor is included in the solar-powered robot to ensure quick charging. The heavy lifting, positioning, and installation of solar modules requires a lot of energy, but this robot can also offer cutting-edge functions like automated cleaning. The solar sector can benefit from this technology by having faster project timeframes, less energy expenses, and a safer working environment. Solar-powered robots are promoted as an alternative to human-operated machines for a variety of reasons. By using solar energy, a renewable energy source, this robot contributes to the mitigation of climate change and the reduction of greenhouse gas emissions, both of which are critical for the protection of humans, animals, and ecosystems. Modern farmers spend a lot of money on labour-saving gear that boosts agricultural yield, but the efficiency and profit margins are rather low. Therefore, automation is the best way to overcome all the drawbacks by building machines that execute a single task and automating it to boost output significantly. The capacitor banks serving as a battery system alternative are charged using the solar cell output. In a production setting, the robot moves from one station to another. A voltage sensor is included in the solar-powered robot to ensure quick charging. Robotics and AL are examples of contemporary technology that help to advance digital health and vastly enhance medical care.

LITERATURE SURVEY

The developed robotics approaches are effective for completing duties like autonomous cultivating, seed provision, water sprinkling, insecticide spraying, and grassland wounding using solar energy.

To increase crop growth, farming can be done utilising innovative technologies, according to Abdullah *et al.* Their study assessed conditions such as temperature, light, humidity, and soil moisture [1]. This essay focuses on automatic control features with cutting-edge electrical hardware that uses a microcontroller and a GSM phone line. The project requires less manpower because it is mechanised.

The study by Gorjian *et al.* suggests that high starting costs for PV modules and battery storage units, as well as limitations in electricity storage technology, are two important obstacles to the broad adoption of current solar-powered electric farm gear [2]. Given that they operate outside, PV modules connected with agricultural machinery should consider how environmental factors such as air humidity, dust collection, surface temperature, and shadowing affect their efficiency. The practical application of these sustainable devices can be facilitated by further technological advancements, cost reductions, and the establishment of government incentives.

The goal of the study of Amrita *et al.* was to create a robot that can automatically plough, distribute seeds, collect fruit, and spray pesticides [3]. Additionally, it offered manual control as necessary and uses humidity sensors to monitor the humidity. The AVR At mega microcontroller controls everything which is the key element. The robot begins by tilling the entire field before beginning to plough and concurrently distributing seeds side by side. The robot only used human operation outside of the field; it ran in automated mode inside. A Bluetooth connecting app may be used to manually operate the robot; this software also helps the robot navigate outside of the field. Humidity sensors installed around the field regularly check the atmosphere for humidity levels. It warned the farmer after comparing these

levels to the humidity set point. The farmer was notified of the set point breach through text message by the GSM module, which serves as the alerting mechanism. The farmer then replies through SMS, choosing whether to activate the sprinklers or disregard the alert. If the water sprinklers are running, they reduce the humidity, which creates the perfect climate for crops to flourish. The process domain includes descriptions of the concepts of fruit picking and pesticide application.

The design, growth and development, and manufacturing of a robot that can dig, plant seeds, level the ground to remove dirt, and spray water were the main topics of the paper by Nithin and Shivaprakash [4]. The robot is powered entirely by solar and battery energy. More than 40% of the world's population selects agriculture as their major profession, and in recent years, interest in the development of autonomous cars in agriculture has surged. The vehicle is controlled by a relay switch that receives information from an infrared sensor. The language input enables a user to communicate with the robot, which is well-known to most people. The advantage of immediate and hands-free data entry is provided by these robots. The autonomous robot presented by Usha *et al.* used a microcontroller to prefer developing systems like ploughing the land, sowing the seed, water the plant, spray the fertiliser, and navigate the motion of a vehicle [5]. The ultrasonic sensor aids in obstacle recognition based on how this robot moves across the ground, and as a result, turns the robot's location either left, right, or forward. With the aid of proteus, the navigational component was simulated. At once, seeds are dispersed in four rackets. At first, the robot excavates the entire field while also dispensing seeds side by side, completing the necessary tasks in a robotic mode with embedded programmes [6].

ACTIVITIES PERFORMED BY AGRIBOTS

Sowing

Sowing is the process of putting seeds in the soil. This process involves digging a mini hole and putting the seed there. The robot completes the initial phase of determining the soil's moisture content after choosing the seeding process on the application developed by Shinde *et al.* Subsequently, the controller examines the ultrasonic sensor's output to identify any obstructions in the path. The following step is to dig holes, and if the soil's moisture content is suitable for the crop that was chosen, seeds are deposited into the holes at the same time as the robot advances. The process of spreading seeds is finished then the farm will be undisturbed for a few days [7].

Fertilizer Spraying

The Android application in the system of Shinde *et al.* is set up so that the farmer can determine when it is necessary for him to apply fertiliser. The farmer can also choose to spray fertilisers by choosing the application's fertiliser spraying option when he receives the leftover material, or even without it. After then, a sprinkler will assist the controller in carrying out the action [7].

Weeding

An important part of the agriculture industry is weed control. The crucial issue of weed management has a substantial impact on agricultural productivity. Chemical and mechanical methods can be used to control weeds. Farmers employ sickle and hoe tools in the mechanical procedure to get rid of weeds. Furthermore, farmers use weedicides by chemical processes. Flame weeders, which eliminate weed by applying fire to the plant, are increasingly popular these days. The purpose of the agricultural weeding robot is to remove weeds from cotton fields over nearly the whole growing and harvesting cycle in a sizable region [8].

Ploughing

A tool used in the agriculture industry to turn or loosen the soil and cultivate it in preparation for seeding is the plough. Typically, a plough is made of cast iron, steel, or wood and has a stick or blade attached that is used to puncture the ground. It is one of the most significant developments in the world of agriculture and has been a fundamental piece of machinery for most of human history that has been documented. The main purpose of ploughing is to bury weeds and the remnants of previous crops so

they can decompose while turning over the top layer of soil and bringing new nutrients to the surface. Furrows are created as the plough is driven into the soil, creating fertile soil trenches. A ploughed field is usually harrowed before being ploughed again in modern times. People initially drove ploughs, but after animals like bulls were used, the procedure became incredibly effective. Although other animals have also been employed, oxen were the first animals to power ploughs. Later, horses and mules were employed in some regions. Tractors driven by internal combustion engines (IC engines) have supplanted steam engines, which were the original means of towing a plough in industrialised nations. The creation of a solar-powered ploughing robot prototype is covered in the study by Salunkhe *et al.* The gadget is a solar-powered mobile robot that operates on its own [9].

EXISTING METHOD

A growing tendency in agriculture is to rely less on fossil fuels because of their limited supply and associated environmental consequences. In this regard, using infrastructures updated with alternative energy sources would be crucial. Solar energy has the best compatibility with agricultural activities out of all renewable energy sources. The development of photovoltaic (PV) solar energy conversion technology reduces the demand for oil-based fuels in this industry, provides a more cost-effective and environmentally friendly method of generating power, and results in a notable decrease in greenhouse gas (GHG) emissions. The necessity for electrification in modern farm activities has increased, creating a significant opportunity for the use of PV technology in this industry. Robots for sowing seeds are not available in the current system. To plant seeds, one must manually till the ground. It takes a great deal of effort and time. We then moved to suggest this system.

Limitations

- It is not exact.
- It can lose connection under certain circumstances.
- There is no seeding done with this method.

PROPOSED METHOD

We suggest using “an agri-bot” to get around every flaw in the current setup. It lessens the workload for farmers, as farming requires automation. By automating farming activities, farmers may boost produce productivity and save time and energy by performing repetitive chores with greater efficiency. All the components used for system framework are presented in Figure 1.

1. *Arduino*: The Arduino Uno, which has an Atmega328 microcontroller, 14 digital I/O pins, 6 analogue pins, and a USB interface, is a very useful addition to the world of electronics. Using the Tx and Rx pins, serial communication is also supported. Several Arduino board iterations, such as the Arduino Uno, have been released onto the market, Arduino Due, Arduino Leonardo, Arduino Mega, however, most common versions are Arduino Uno and Arduino Mega. An ultrasonic sensor that transmits data to the microcontroller continually is the navigational device.

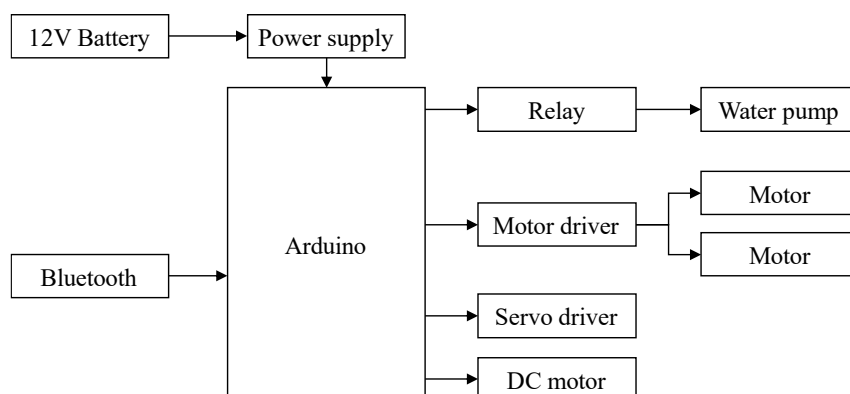


Figure 1. Block diagram of solar-powered agriculture robot.

2. *Battery*: The battery is charged using the charge it receives from the solar panel. The battery transfers power to the structure.
3. *Servo drive*: A controller can be utilised to rotate a servo motor at any angle. In this structure, the servo motor is employed for seeding purposes beneath the hopper. It may serve as a shut-off valve.
4. *Solar panel (power supply)*: A solar panel is a collection of photovoltaic cells installed in a building for use as electricity. It generates DC by utilising solar light. A solar panel is a collection of solar modules, and an array is a configuration of panels. Different photovoltaic framework configurations elegantly direct solar electricity to electrical gear.
5. *Water pump DC*: Direct current from a battery is used by DC water pumps to transfer fluid in an alternative manner.
6. *Motor driver*: With just a few control lines needed for each engine, this engine driver board is ideal for mechanical applications and may be connected to a microcontroller. It can also be interfaced with relays, TTL logic gates, simple manual switches, and so forth. This double bidirectional engine driver depends on the extremely used Motor Driver Integrated Circuit i.e., L293D.

METHODOLOGY

A camera or several cameras are often used in machine or computer vision, providing the robot with data that enables it to detect and access the nearby crops. Robots are now capable of plucking weeds, monitoring plant growth, harvesting, sorting, and packing thanks to machine vision [10–12]. Designing robots' Faster integration in a wider variety of applications that are future-proof is made possible by built-in collaborative force/torque sensors, safety features, and greater precision. Collaborative robots are defined by four key characteristics: quick setup, simple programming, flexible deployment, and safe operation. Most farming tasks are automated by solar-powered agriculture robots, which also save farmers' money by decreasing or doing away with manual labour. Productivity rises and operational costs are reduced. It effectively utilises necessary resources like water, chemicals, fertilisers, etc. [13]. The developed robot is powered by a solar panel and controlled by a Wi-Fi or Android app, which transmits signals to the robot to activate any necessary mechanisms and move the robot. This lessens the issue with hand planting and improves the effectiveness of seed sowing, spraying, ploughing, and grass cutting. Figure 2 shows a solar-powered agricultural robot.

The methods above explain the algorithm of an autonomous robot that uses a Bluetooth/android app to sow seeds, mow grass, and spray pesticides. The robot's algorithm is as follows:

- Step 1*: Start the motor or process.
- Step 2*: The robot is turned on in step two.
- Step 3*: Linking the Bluetooth gadget and cell phone together.
- Step 4*: The robot needs to wait till it gets a signal from the application.
- Step 5*: If the robot receives a signal, it responds appropriately.
- Step 6*: If the signal is not received, go back to step 4.
- Step 7*: Employ the global OFF signal to deactivate.



Figure 2. Solar-powered agricultural robot.

This study uses Android platform to considerably assist farmers and provide a configurable user interface so they may properly operate the machine. It lessens the need for manual labour, which is good for farmers because it can be tough to find workers these days. In contrast to people, the Agribot can work continuously and in every type of weather. In comparison to performing the same tasks manually, the time needed to complete the five capabilities is significantly reduced. The entire cost of farming is greatly reduced by this one-time expenditure. The automated smart farming system is accessed by this Agribot.

CONCLUSION

The primary motivation behind creating this method is to modernise agriculture. It is designed to carry out numerous duties, just as its name suggests. The system carries out four distinct tasks, including cutting grass with a blade, spraying crops with fertiliser and pesticides using a compressor cum motor, and analysing soil using temperature and moisture to determine the right amount of nutrients to be applied using various fertilisers. The main feature of our project, which sets it apart from all other agricultural robots on the market, is that all these actions are controlled through Bluetooth or remote.

Future Scope

The framework can also be modified to estimate numerous ranching parameters, such as yield development, weed occurrence, kind, and so forth. Through the GSM framework, one or more frameworks can be observed. GPS attached flying little robot including a camera for live streaming.

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