Solar power remote controlled multi nozzle pesticide sprayer robot

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Abstract: Spraying of pesticides is an important task in agriculture for protecting the crops from insects. Farmers presently using hand operated or fuel operated knapsack sprayers for this task. This paper discussed about different types of solar sprayers developed by several researchers with an aim to reduce human drudgery while spraying in field and as part of pollution free and environment friendly green energy. Some advantages and drawbacks of solar sprayers have been identified, discussed and future need of research in line of development of green technologies have been presented in this paper. Comprehensive solution towards solving future energy needs of agriculture is attempted in this study. Spraying is not a continuous operation round the year. So, the same PV system available in solar sprayers can be utilized for energizing other farm operations such as pumping, farm lighting etc. One of the factors which affect the use of conventional electricity or fuel is increasing prices and its non-availability at peak time in rural area. The available solar sprayers used by the farmers are having low field coverage capacities, creating health hazards due to direct inhaling of spray drift and thus, polluting the environment with engine operated sprayers. Therefore, the emphasis should be given on design and developing independent renewable power source which can give uninterrupted energy and fulfill energy demand of remotely located farmers for operating various farm equipments.

Keywords: Solar Power, Agricultural, Sprayers.

I. Introduction

In agriculture, considerable amount of energy is used to perform different field activities e.g. plugging, irrigation, intercultural operations, spraying of agricultural chemicals, harvesting and post-harvest processing etc. Energy security of a country is very important and efforts are being made for utilization of renewable energy sources mainly solar energy, as the fossil fuel based energy is depleting at a very fast rate.

Spraying of pesticides is an important task in agriculture for protecting the crops from insects. Approximately, 18-25 % of the crop production is damaged if pest and diseases are not controlled at

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right time. Uniform spraying of liquid formulations throughout the crop field is very important for effective control of pest and diseases. Using sprayer, liquid pesticide formulations are generally broken down to minute droplets of effective size for uniform distribution over a large surface area. Dose of agricultural chemicals also plays a critical role since under dose may not give the desired coverage whereas overdose is expensive and may contaminate the food chain through residues. Farmers mainly use hand operated or fuel operated knapsack sprayers for this task. Sprayer is a machine to apply herbicides, fungicides, and insecticides in the form of droplets. Among the others lever operated knapsack sprayer, power sprayer and manually operated sprayers are commonly used by small to medium farmers. These conventional sprayer causes user fatigue due to excessive bulky and heavy construction. The traditional knapsack sprayer causes user tiredness due to continuous operation of lever and movement in the field with heavy load on its back.

The design of solar PV sprayer and developments in solar powered agricultural sprayers is discussed and reviewed in detail under this study.

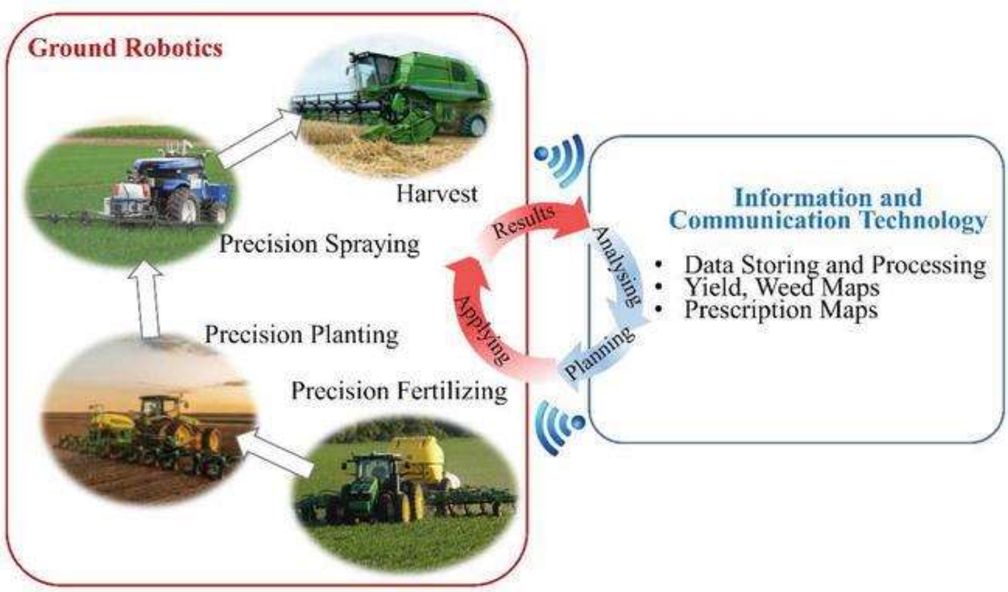

Figure 1 Automation in agriculture

This paper is structured as follows. Section 1 provides an introduction of Solar Power Remote Controller Pesticide Sprayer. Section 2 describes the Literature Survey. Section 3 and 4 briefly introduces power management scheme and article swarm optimization algorithm respectively. Design considerations of islanded HMGS explain in Section 5.Section 6 and 7 presents economic analysis and simulation results.

II. Literature Survey

2.2.1 First generation: First generation cells consist of large-area, high quality and single junction devices. First generation technologies involve high energy and labor inputs which prevent any

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significant progress in reducing production costs. Single junction silicon devices are approaching the theoretical limiting efficiency of 33% and achieve cost parity with fossil fuel energy generation after a payback period of 5-7 years.

2.2.2 Second generation: Second generation materials have been developed to address energy requirements and production costs of solar cells. Alternative manufacturing techniques such as vapor deposition and electroplating are advantageous as they reduce high temperature processing significantly. It is commonly accepted that as manufacturing techniques evolve production costs will be dominated by constituent material requirements, weather this be a silicon substrate, or glass cover. Such processes can bring costs down to a little under but because of the defects inherent in the lower quality processing methods, have much reduced efficiencies compared to First Generation. The most successful second generation materials have been cadmium telluride (CdTe), copper indium gallium solenoid, as glass or ceramics reducing material mass and therefore costs. These technologies do hold promise of higher conversion efficiencies, particularly CIGS-CIS, DSC and CdTe offers significantly cheaper production costs. In CdTe production represented 4.7% of total market share, thin-film silicon 5.2% and CIGS 0.5%.

2.2.3 Third generation: Third generation technologies aim to enhance poor electrical performance of second generation (thin-film technologies) while maintaining very low production costs. Current research is targeting conversion efficiencies of 30-60% while retaining low-cost materials and manufacturing techniques. They can exceed the theoretical solar conversion efficiency limit for a single energy threshold material; which was calculated in 1961 by Shockley and Queasier as 31% under 1 sun illumination and 40.8% under maximal concentration of sunlight.

III. Components

The solar powered agricultural sprayer has following components:

Tank

Solar power unit

i. Solar panel

ii. Charge controller

iii. Battery

DC motor/pump

Spraying unit

Spray boom

v. High pressure spray pipe

vi. Nozzles

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The selection of the components can be done as per requirement. Tank is used to store the pesticide/insecticide chemical solution. It supplies chemical solution to nozzles on boom through dc motor/pump and pressure pipe.

The solar power unit is energy conversion unit. Solar energy obtained from sun is converted into electrical energy using solar panel by photovoltaic effect. The output of the energy conversion is given to charge a deep cycle lead acid battery through a charge controller.

The charge controller limits the rate at which electric current is added to the battery. Thereby, preventing overcharging and protecting against over voltage. It employs the Pulse Width Modulation (PWM) technique which gradually stops charging the battery, when it exceeds a set high voltage level and gradually re-enables the charging, when the battery voltage drops back below the safe level.

The main advantage of PWM is that the power loss in the switching device is very low. The output from the charge controller is given to the battery by a three pin socket through an electrical network. This circuit is designed to control the RPM of the motor by controlling the amount of resistance between the motor and the battery while simultaneously providing a charging supply for the battery. DC motor/pump lifts the pesticide from tank and delivers to nozzles with desired high pressure. Energy is supplied to DC motor/pump by the solar power unit for its running/operation. Nozzles on the boom atomize the spray liquid into fine droplets and sprayed on the crop canopy. The droplet size and spray pattern depends on pressure and type of nozzle used as per requirement.

Actuator Type	**Advantages**	**Disadvantages**
Mechanical	Cheap, Repeatable, No power source required, Self-contained, Identical behaviour extending or retracting	Manual operation only. No operation
Electro-Mechanical	Cheap, Repeatable, Operation can be automated. Self-contained, Identical behaviour extending or retracting. DC or stepping motors. Position feedback possible.	Many moving parts prone to wear.

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Table 1: Comparison of electrical and mechanical actuators

IV. Conceptual design and proposed system

The design was carried out in Fusion 360 3D Modeling software. This software is chosen for this project because it has user friendly interface and it is easy to use.

S.no	Type of Material	Capacity
1	Solar Panel	12 V
2	Two Batteries	12V+12V=24V
3	Arduino	5V
4	Motor	12V
5	Current	3.0Amps

Table 2: Mechanical properties

Proposed system

This system is a robot designed for agricultural purpose.

This system is a robot designed for agricultural and sport fields maintenance purpose. Agro robot is developed with Arduino, L293D Motor control Shield, HC-05 Bluetooth Module, 4 Wheel drive with 4 DC Motors, Water pump, Nozzles, Mower setup, Battery and Solar Panel. This Agribot with Manual Sun Tracking Solar Panel performs a number of concurrent operations. Today, the man power to do the farming is major concern; this machine removes the hurdles of agriculture laborers. Their efficiency and operating speed greatly affect the productivity. The different electrical components are connected to the combination of Arduino board and Motor Shield.

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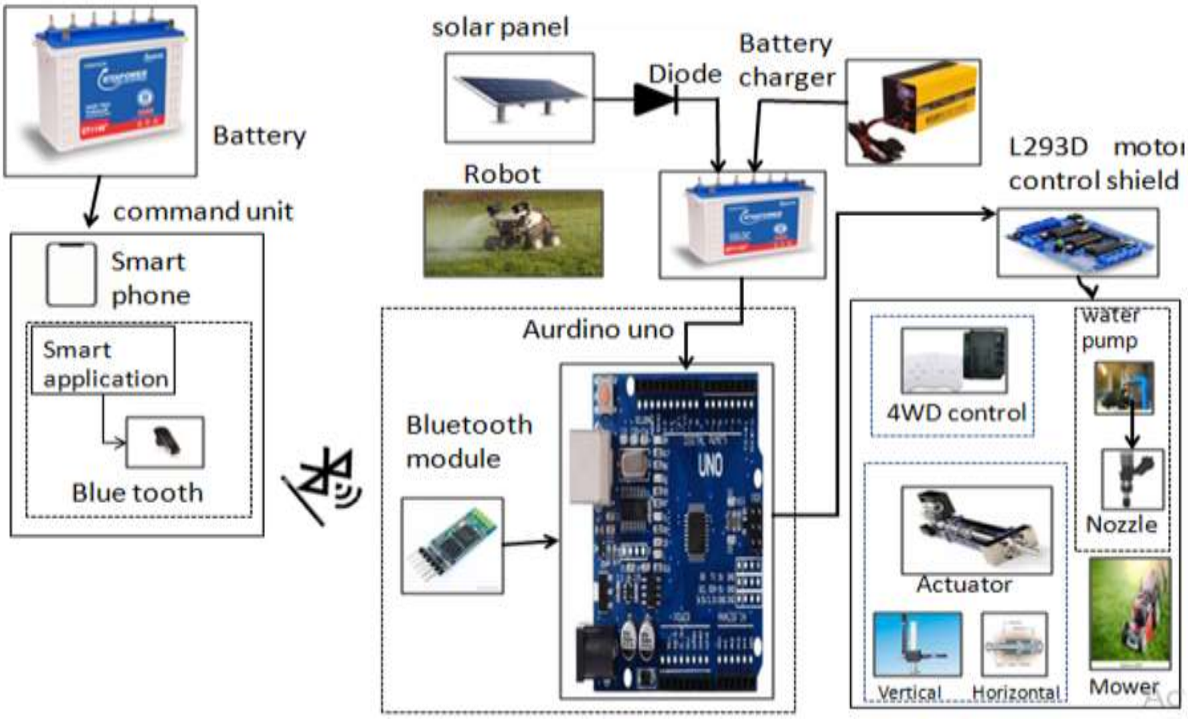

Figure 2: Block diagram of proposed system

Working

First make sure that the program for the robot is successfully uploaded into the Arduino board and we have two batteries where one battery is connected to the Arduino, the another one is connected to the pressurized motor. The system also consists a pesticide tank. For the Arduino board the voltage regulator and the relays are connected.

When we switch on the proposed system it gets turn on and the power supply flows from battery which will generate 12V, by using voltage regulator it regulates 12V to 5V, this voltage will be received by the Arduino and the Arduino gets operated, and it will control the proposed system. We have relays in our proposed system when the relay gets commanded through remote and it will rotate clockwise and anticlockwise direction which is responsible for the movement of our proposed system forward and backward direction respectively according to the rotation.

The pesticide tank will be filled with water/pesticide. The motor is connected to the sprayer tank through a pipe. Through this process, spraying will be done.

The battery is connected to the pressurized motor, this pressurized motor applies the pressure to the normal water and will sprinkle the pressurized water/pesticide, and this is all done when the command was given.

The operations performed by the remote will be received by the Arduino.

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BUTTONS	DIRECTIONS
1	LEFT
2	RIGHT
3	FORWARD
4	BACKWARD
5	SPRINKLER

Table 3: Remote mechanism   Fig 3: Remote

If there is no available of Renewable energy (Solar energy), at that time we can also charge the robot by using of external electrical energy (charger).

Fig 4: Charger

By using this charger we can charge up the two batteries. Which they can convert 230V of AC supply to 12V DC supply, and it is given to a pressurized DC motor.

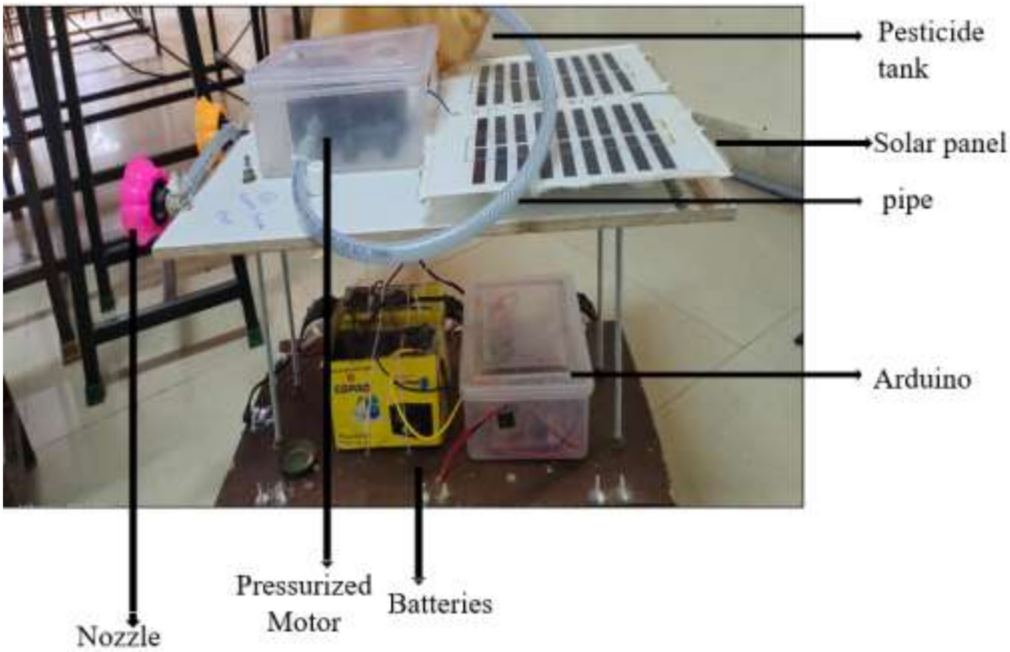

Fig 5: proposed proto type

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Fig 6: Front View

Fig 7: Top View

V. Experimental Analysis

In order to evaluate the performance of the system, several trials were performed on the robot. We have evaluated different functions that are to be performed by the robot. The functions are listed below.

1. Pesticide spraying
2. Robot's movement
3. Battery performance

Battery backup of Conceptual design:

The selection of battery is of paramount importance. The battery has to be selected in such a way that it has the capacity to power all the electronic components viz 4 Drive motors, 1 Mower motor, 2 Horizontal actuators, 1 Vertical Actuator, 1 Pump, and the Arduino – Motor Driver setup. And it has to be rechargeable for uninterrupted low maintenance usage. Considering the above parameters we have selected sealed Lead-Acid Battery of 12V and Maximum current discharge of 1.1 Amps.

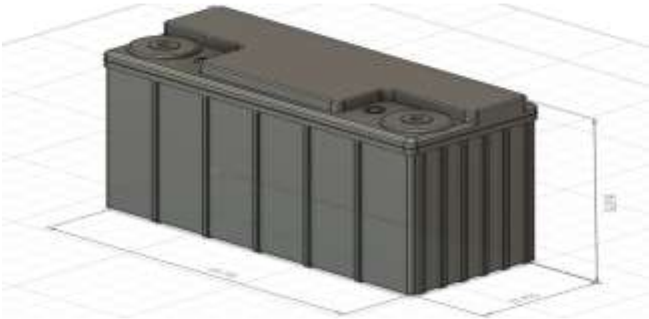

Fig 8: Battery

VI. FUTURE SCOPE

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Mechatronics is playing an enormous role in agricultural production and management. There is a desire for autonomous and timesaving technology in agriculture to possess efficient farm management. The researchers are now aiming towards different types of farming parameters to style autonomous multipurpose agricultural robots because traditional farm machineries and topological dependent. Till date the multipurpose agricultural robots have been researched and developed mainly for harvesting, fertilizer spraying, picking fruits, sowing, solar energy and monitoring of crops. Robots like these are brilliant replacements for manpower to a better extent as they deploy unmanned sensors and machinery systems. The agricultural benefits of development of these autonomous and intelligent robots are to improve repetitive precision, efficiency, reliability and minimization of soil compaction and chemical utilization. The robots have the potential of multitasking, sensory measures, idle operation as well working in odd operating conditions. The study on multipurpose agricultural robot system had been done using model structure design along with various precision farming machineries. With fully automated farms in the future, robots can perform all the tasks like ploughing, seed sowing, pesticides spraying, monitoring of pests and diseases, harvesting, etc. This allows the farmers to just supervise the robots without the need of manual operation. In the future robots may also run on PLC and SCADA with automatic systems. In this paper, overview of mechatronics approach of our multipurpose agriculture robot for precision Agriculture in India and worldwide development is reviewed.

VII. CONCLUSION

The prototype gave a fairly good rate of area coverage with a reasonably low operating cost. The system addresses the issue of dearth of agricultural labour and ensures safe agricultural practices by completely eliminating, handling of harmful chemicals, cutting crops and extensive labour by the farmer as it can be operated remotely. The proposed spraying & mower robot is suitable for small and medium scale farmers. Large scale production of the spraying unit will reduce the cost significantly giving partial thrust to Indian agriculture practices. The unit can be scaled up based on the requirement. The developed system can not only be used for spraying fertilizer, pesticides, fungicides, lawn watering and crop cutting, weeding and lawn mowing but also for maintenance of sports fields like cricket ground.

With the proposed design of the robot in this project, the abovementioned gaps can be eliminated completely. This project integrates two of the major activities in agriculture which are Pesticide spraying and Crop Cutting (or Weed Removal). Work load on the farmers is decreased and health problems also. Successful in constructing robot which can be travelled on rough, uneven surfaces

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also and weighing enough load of pump and other equipment. Successful in developing a robot whose construction is enough to withstand the challenges of the field.

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