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A photovoltaic solar system with multiple tasks

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Abstract: Solar panels require full bright sunlight in order to produce optimal power. Shadow as well as prolonged cloudy weather can affect the panel's performance. When there is a lack of a bright sunlight, the rate of voltage output is reduced. So, to make sure that the panels are producing energy optimally, you must install them on mounts that are angled towards the sun. You should install solar tracking systems so solar panels can change their position towards the sun. Fortunately, rainfall does help when it comes to washing off dust, leaves, pollen, and any other lost debris collected on the panels during the rainy season. However, when these environmental elements are accumulated during dry season, you will need to clean the panels. Accumulated dirt can prevent enough sunlight from reaching the panels, hence causing reduced power output. To prevent this, you will need to perform regular inspections to see if the panel cleaning is required. Offers should contact a firm, professional solar panel cleaning company for the best results. You should insert a solar cleaning system by using a new technology. The performance of a photovoltaic solar panel can be determined by measuring the relationship between the panel's voltage current. The amount of solar radiation on the earth's surface can be instrumentally measured, and precise measurements are important for providing background solar data for solar energy conversion applications. These all things are to be included in the single system, so that the solar system will work effectively and give the high efficiency, due to this production of electrical energy will increases and demand of electrical power will be fulfilled.

Keywords: Solar, Multitasking, Arduino and Energy.

I. INTRODUCTION

Introduction Population growth is increasing day by day. Electricity is also required for this purpose. But the demand for electricity in India is increased. India stands a 4th place in producing electricity and stands a 3rd place in consuming electricity. Electricity consumed only by a person in India for one year is 248 MW. In order to maximize the amount of radiation collected by a solar collector, the tracker must follow the sun through the day. But if the environmental conditions in which the solar PV modules are installed like tropical climate around the equator, significant amount of dust gets deposited on PV modules. The regular cleaning of PV modules is required in tropical climate which adds to the cost of operational and maintenance of the PV system. The settled dust, if not cleaned, affects the performance of the solar PV modules by shading the front surface. It has been observed that the reduction in energy output from a PV panel with dust could be as much as 50%. When the module is not cleared for 30 days, the performance of the modules lowers in the case of dust accumulation, even so it is tracked [1-2].

The impacts of global warming are being felt across the globe. We have to reduce our dependence on fossil fuels and start using clean energy instead. Solar energy is an example of promising renewable sources that is presently being used in the world for meeting rising demands of electric power. This power is the conversion of sunlight into electricity, sunlight is collected either directly by using photovoltaics or indirectly using concentrations of solar energy. In this project a solar panel is used which keeps monitoring the parameters of the solar panel like the voltage, current and Maximum Power Point Tracking. Maximum Power Point Tracking, frequently referred to as MPPT, is an electronic system that operates the Photovoltaic (PV) modules in a manner that allows the modules to produce all the power they are capable of. MPPT is not a mechanical tracking system that “physically moves” the modules to make them point more directly at the sun. MPPT is a fully electronic system that varies the electrical operating point of the modules so that the modules are able to deliver maximum available power [12].

The main controlling device of the whole system is a Arduino microcontroller. Solar panel, voltage sensor, current sensor, ESP8266 Wi-Fi module are interfaced to Arduino. The microcontroller initially measures the voltage and current from solar panel and wind turbine without load connected. Also, the microcontroller measures the voltage and current from solar panel under load conditions. The Arduino microcontroller takes the decision of operating the load through PWM (Pulse Width Modulation) until the maximum voltage is obtained from solar panel without degrading the load performance. The values of voltage and current are to Thing speak through Wi-Fi module. To perform this intelligent task, Arduino microcontroller is loaded with an intelligent program written using embedded ‘C’. An embedded system is a combination of software and hardware to perform a dedicated task.

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Some of the main devices used in embedded products are Microprocessors and Microcontrollers. Microprocessors are commonly referred to as general purpose processors as they simply accept the inputs, process it and give the output. In contrast, a microcontroller not only accepts the data as inputs but also manipulates it, interfaces the data with various devices, controls the data and thus finally gives the result [1-13].

II. LITERATURE REVIEW

A. Building-integrated photovoltaics (BIPV)

These systems integrate solar panels into the architecture of buildings, replacing traditional building materials like roofs, windows, or facades while also generating electricity. BIPV represents a growing trend in sustainable building design, combining the benefits of renewable energy generation with the need for efficient building materials. This section of the literature review will explore the different aspects of BIPV, including its types, applications, advantages, challenges, and future directions.

B. Solar Thermal Systems

These systems not only generate electricity but also capture and use solar heat for space heating, water heating, or industrial applications. Examples include solar water heaters and hybrid solar systems. Solar thermal systems are technologies that use sunlight to generate heat rather than electricity, which can then be used for various applications, such as heating water, space heating, or even industrial processes. These systems harness the sun's energy to directly produce thermal energy, making them a highly efficient solution for reducing energy consumption in both residential and commercial settings. Unlike photovoltaic (PV) systems that convert solar energy into electricity, solar thermal systems rely on the collection and conversion of sunlight into heat using solar collectors. This heat can be stored or used immediately, offering a reliable and sustainable source of thermal energy.

C. Solar Storage Solutions

Hybrid solar systems that combine solar energy production with energy storage capabilities, enabling power generation even when sunlight is not available. Examples include solar battery systems, which improve grid stability and resilience. Solar Storage Solutions refer to the integration of solar energy systems with energy storage technologies, such as batteries, to enhance the flexibility, reliability, and efficiency of solar power generation. By combining solar energy with storage, these systems enable the capture and storage of excess solar energy during the day for use at night or during periods of low sunlight. This combination helps overcome one of the primary limitations of solar energy its intermittent nature while maximizing the overall value and utility of renewable energy.

In this section of the literature review, we will explore the different types of solar storage solutions, their applications, benefits, challenges, and the future of integrated solar and storage technologies.

D. Solar-Powered Desalination Systems

Solar energy can be used for water desalination, serving both energy generation and water purification purposes. Solar powered desalination systems use solar energy to drive the process of converting seawater or brackish water into freshwater. Desalination is a critical technology in areas suffering from freshwater scarcity, especially in coastal or arid regions where solar energy is abundant. Solar desalination is seen as an environmentally sustainable solution to address the growing demand for freshwater without relying on fossil fuels or conventional energy sources, which are typically used in traditional desalination plants. This section of the literature review explores the types of solar desalination systems, their applications, benefits, challenges, and future developments in the field.

E. Agrivoltaics

The dual use of land for both solar energy production and agricultural activities, enhancing land-use efficiency while providing power and food simultaneously. Agrivoltaics (also known as Agrophotovoltaics) is the simultaneous use of land for both solar power generation and agriculture. This innovative approach integrates photovoltaic (PV) panels with agricultural production, creating a system where crops and solar panels coexist on the same land. Agrivoltaics aims to optimize land use, increase agricultural productivity, and contribute to renewable energy generation, providing an effective solution to the dual challenges of food security and climate change.

III. METHEDOLOGY

In this proposed system, LDRs are working as light detectors in Fig.1. The two LDRs are placed at the two sides of the solar panel, and the servo motor is used to rotate the solar panel. The servo will move the solar panel towards the LDR whose resistance will be low, means towards the LDR on which light is falling, that way it will keep following the light, and if there is some amount of light falling on both the LDRs, then the servo will not rotate.

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The servo will try to move the solar panel in the position where both LDRs will have the same resistance, means where the same amount of light will fall on both the resistors, and if the resistance of one of the LDR will change then it rotates towards lower resistance LDR. In the automatic cleaning system, when the dust accumulates on the solar panel, Arduino sends a signal to actuate the system. Servo motor is used to move the brush in forward and reverse direction.

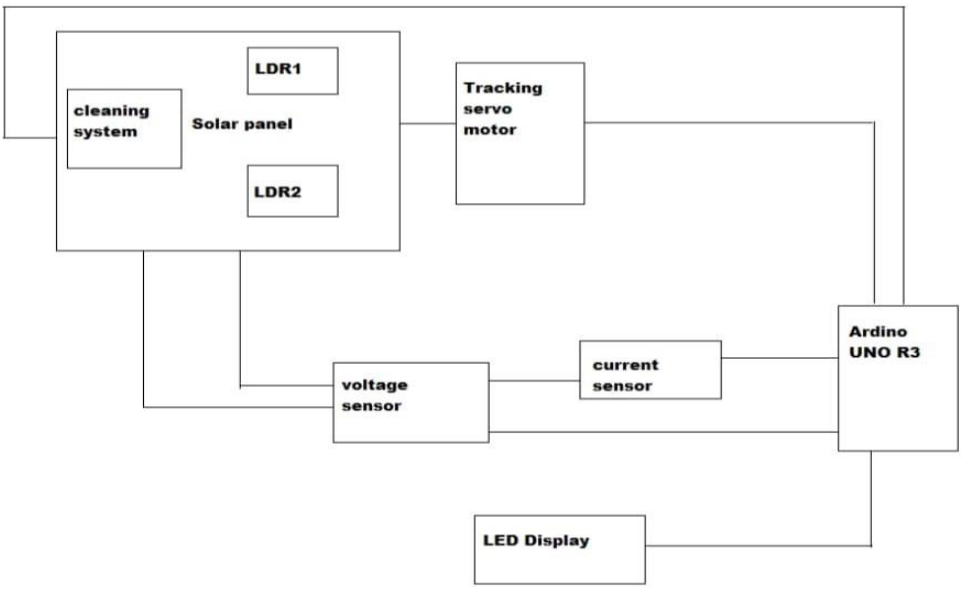

Fig. 1 Block diagram of proposed system

This horizontal movement of a brush will clean the panel. Two sensors are being used, the LDR and voltage sensors. If intensity of sunlight falling on solar panel is high and voltage is low, then it will trigger the cleaning system to clean the panel. The performance of a photovoltaic cell solar panels can be determined by measuring the relationship between the panel's voltage and current. The amount of solar radiation on the earth surface can be instrumentally measured and precise measurements are important for providing background solar data for solar energy conversion applications.

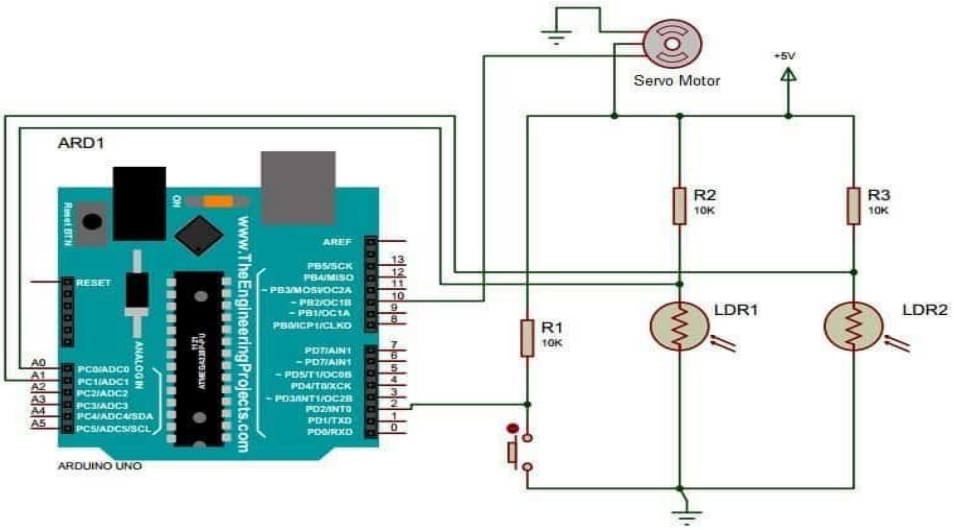

Fig. 2 Circuit diagram

As the fig. 2 shows the circuit diagram of multitasking solar system in proposed system controller is used. Circuit diagram consisting of following section

- Power generation unit
- Tracking unit
- Cleaning unit

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- Display unit

In tracking system LDR's are working as light detectors. The two LDR's are placed at the two sides of the solar panel and the Servo Motor is used to rotate the solar panel. In the automatic cleaning system, when the dust accumulates on the solar panel, Arduino sends a signal to actuate the system. Servo motor is used to move the brush in forward and reverse direction This horizontal movement of brush will clean the panel. Display unit is used for displaying the longitude and latitude position of that area. 16X2 display is used.

A circuit diagram also known as an electrical diagram, elementary diagram, or electronic schematic is a simplified conventional graphical representation of an electrical circuit. A pictorial circuit diagram uses simple images of components, while a schematic diagram shows the components of the circuit as simplified standard symbols; both types show the connections between the devices, including power and signal connections. Arrangement of the components interconnections on the diagram does not correspond to their physical locations in the finished device Circuit diagrams are used for the design. construction, and maintenance.

Once the schematic has been made, it is converted into a layout that can be fabricated onto a printed circuit board PCB. The layout is usually started by the process of schematic capture. These wires are routed either manually or by the use of electronic design automation (EDA) tools. The EDA tools arrange and rearrange the placement of components and find paths for tracks to connect various nodes This results in the final layout artwork for the integrated circuit or printed circuit board.

F. PV Cell

Solar panel is a device that converts sunlight into electricity by using photovoltaic PV cells. PV cells are made of materials that generate electrons when exposed to light. The electrons flow through a circuit and produce direct current electricity, which can be used to power various devices or stored in batteries. Solar panels are also known as solar cell panels, solar electric panels, or PV modules. 5V 1W solar panel is used. A solar cell, also known as a photovoltaic cell (PV cell), is an electronic device that converts the energy of light directly into electricity by means of the photovoltaic effect. It is a type of photoelectric cell, a device whose electrical characteristics (such as current, voltage, or resistance) vary when it is exposed to light. Individual solar cell devices are often the electrical building blocks of photovoltaic modules, known colloquially as "solar panels". Several of these solar cells are required to construct a solar panel and many panels make up a photovoltaic array. There are three types of PV cell technologies that dominate the world market: monocrystalline silicon, polycrystalline silicon, and thin film. You're likely most familiar with PV, which is utilized in solar panels. When the sun shines onto a solar panel, energy from the sunlight is absorbed by the PV cells in the panel. This energy creates electrical charges that move in response to an internal electrical field in the cell, causing electricity to flow.

G. Microcontroller (Arduino UNO R3 (original))

Arduino UNO is a microcontroller board based on the ATmega328P. It has 14 digital input-output pins, a bracket of which 6 can be used as PWM outputs, 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller. Simply connect it to a computer with a USB cable or power it with an AC to DC adapter or battery to get started. You can tinker without worrying too much about doing something wrong. In the worst-case scenario, you can replace the chip for a few dollars and start over again. Arduino Uno is a microcontroller board based on the ATmega328P (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator (CSTCE16M0V53-R0), a USB connection, a power jack, an ICSP header and a reset button. The Arduino Uno is a popular, open-source microcontroller board based on the ATmega328P, featuring 14 digital input/output pins, 6 analog inputs, a 16 MHz quartz crystal, USB connection, power jack, and an ICSP header for programming.

H. Servo motor (FUTABAS3003)

Servo motor combiner, excellent dynamics and torque accuracy, and future low torque ripple, minimal temperature rise, high power density, and high overload capacity. The careful selection of components, uncompressed quality, international certifications, and a wide range of power ratings assure that our servo motors are optimal for dynamic, reliable, and efficient automation. A servomotor is a closed-loop servomechanism that uses position feedback (either linear or rotational position) to control its motion and final position. The input to its control is a signal (either analog or digital) representing the desired position of the output shaft. This servo can rotate approximately 180 degrees (90 in each direction), but can be modified for full rotation, and comes with a range of horns and hardware to suit most applications! You can use any servo code, hardware or library to control these servos, so it’s great for beginners who want to make stuff move without building a motor controller with feedback & gear box, especially since it will fit in small places. They work great with 16 Channel Servo Driver, and other Raspberry Pi Motor Controllers.

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I. Voltage Sensors

Voltage sensors is a device that measures voltage. Voltage sensors can measure the voltage in various ways, from measuring high voltages to detecting low current levels. These devices are essentially for many applications, including industrial controls and power systems. A voltage sensor is a device that detects, measures, and monitors voltage levels (both AC and DC) within an electrical system, providing an output signal proportional to the measured voltage.Voltage sensors are crucial for monitoring and controlling electrical systems, ensuring they operate correctly and efficiently. This sensor is used to monitor, calculate and determine the voltage supply. This sensor can determine the AC or DC voltage level. The input of this sensor can be the voltage whereas the output is the switches, analog voltage signal, a current signal, an audible signal, etc. Some sensors provide sine waveforms or pulse waveforms like output & others can generate outputs like AM (Amplitude Modulation), PWM (Pulse Width Modulation) or FM (Frequency Modulation). The measurement of these sensors can depend on the voltage divider.

J. Current sensor

Current sensors are critical components in a wide range of electrical and electronic systems, ensuring that equipment and gadgets operate safely and efficiently. We will examine current sensors in this article, including their kinds, variables to consider when choosing a current sensor, performance comparison, and applications. It is used to monitor the current flowing through an electrical conductor. They generate the information needed for a status and metering application.A current sensor detects and measures the electric current passing through a conductor. It turns the current into a quantifiable output, such as a voltage, current, or digital signal, which may be utilised in a variety of applications for monitoring, control, or protection.

K. LCD Display

The LCD has a capacity of displaying 32 characters in two rows, and these characters can be integers, alphabets, or symbols. Similarly, the LCD can also display some user-made characters as well by turning some dots of the cell on and off. This technology uses liquid crystals, which are substances with properties of both liquids and solids, to create images on a screen. When an electric current is applied, the liquid crystals align to allow or block light, creating the images you see on the display. LCDs have a wide range of applications. They are commonly used in televisions, computer monitors, laptops, tablets, smartphones, digital cameras, portable gaming devices, and car displays. They are also found in industrial equipment, medical devices, and various consumer electronics.

III. RESULT AND DISCUSSION

The proposed systems as shown in Fig. 3 like solar-powered agricultural robots, can perform multiple tasks simultaneously, such as irrigation, pesticide spraying, and soil analysis, improving efficiency and reducing reliance on fossil fuels. Solar-Powered Agricultural Robots: These robots can perform various tasks like seed sowing, water spraying, pesticide spraying, and soil analysis. Irrigation Systems: Solar energy can power irrigation pumps, ensuring efficient water delivery to crops. Temperature Control in Greenhouses: Solar energy can power temperature control systems, allowing farmers to grow crops year-round. Drip Irrigation: Solar-powered drip irrigation systems can deliver precise amounts of water to crops, reducing water waste and increasing yields. Pest Control: Solar-powered drones or robots can be used for spraying pesticides and monitoring crops.

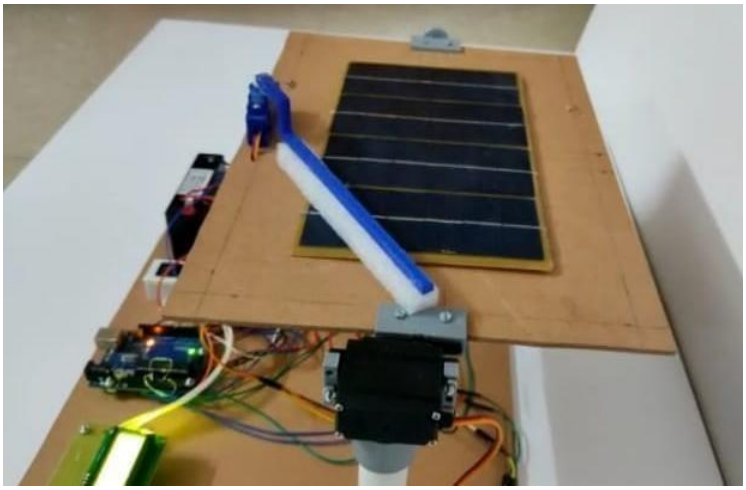

Fig. 3 Proposed System

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IV. CONCLUSION

The multitasking solar systems is highly promising, with advancements in efficiency, integration, and multifunctionality across various sectors. From energy generation and storage to smart cities, agriculture, and transportation, solar technology is evolving to meet diverse needs. Innovations like AI-driven energy management, agrivoltaics, building- integrated photovoltaics, and solar-powered EVs will make solar energy more sustainable and accessible. As research continues, these systems will play a crucial role in reducing carbon footprints, enhancing energy security, and promoting eco-friendly development worldwide.

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