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"SOLAR TRACKING SYSTEM WITH AUTOMATIC PANEL CLEANING MECHANISM FOR EFFICIENT POWER GENERATION"

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***Abstract*—** Solar energy is one of the most reliable and sustainable sources of renewable energy. However, the efficiency of solar panels decreases due to various environmental factors such as dust, dirt, and shade. In this paper, we propose an automatic solar tracking system with an automatic cleaning solar-based water spraying tool to maintain the efficiency of solar panels.

The design, implementation, and assessment of a solar tracking system with an automatic panel cleaning mechanism are covered in this research study. By increasing solar energy absorption and preserving the cleanliness of solar panels, the system seeks to increase the effectiveness of power generation. The suggested solution makes use of a water-based cleaning mechanism that is activated by a light-dependent resistor (LDR) and managed by an ESP32 microcontroller. The system keeps track of the output voltage of the solar panels and only engages the cleaning mechanism when it is essential, ensuring optimum performance and extending the life of the solar panels.

Keywords: Solar tracking, automatic panel cleaning, water spray, ESP32 microcontroller, LDR sensors, solar panel.

INTRODUCTION

The utilization of solar energy as a sustainable and renewable power source has gained significant attention due to its environmental benefits and potential cost savings. However, the efficiency of solar panels is hindered by various factors, including dust and dirt accumulation on their surfaces. Dust particles block the incident sunlight, leading to reduced power generation. To overcome this challenge, the integration of a solar tracking system with an automatic panel cleaning mechanism becomes essential.

The primary goal of this research is to create a solar tracking system that has an automatic panel cleaning mechanism to maximize power generation efficiency.

The precise objectives comprise:

conceiving and putting into action a solar tracking system that orients the solar panel with the position of the sun for maximum exposure.

Developing an automatic panel cleaning mechanism using water spray to remove dust and dirt from the solar panel surface.

Evaluating the performance of the system in terms of power.

LITERATURE REVIEW

"Performance Enhancement of Solar Tracking System with Automatic Cleaning Mechanism" by S. Sharma, R. Kumar, and V. Kaushik (2020)

This study focuses on enhancing the performance of solar tracking systems by integrating an automatic cleaning mechanism using water

spray. The research investigates the impact of dust and dirt accumulation on solar panels and evaluates the effectiveness of the cleaning mechanism in maintaining panel cleanliness. The study quantifies the improvement in energy yield achieved through the

automatic cleaning process, providing insights into the importance of panel maintenance for efficient power generation.

Design and Development of a Solar Tracking System with Water Sprinkler for Panel Cleaning" by N. K. Gohil and R. C. Patel (2018)

This research work presents the design and development of a solar tracking system with an integrated water sprinkler for panel cleaning. The study investigates the cleaning efficiency of the water sprinkler mechanism and evaluates its impact on energy production. It analyzes the effectiveness of different water flow rates and spray patterns in removing dirt and dust from solar panels, contributing to efficient power generation.

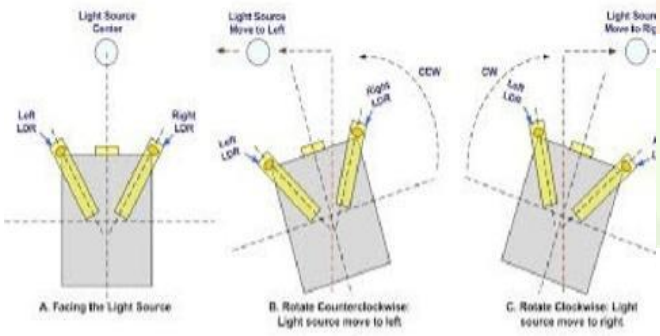
"Cleaning Optimization of Solar Photovoltaic Panels using Water Spray Mechanism" by B. Verma, S. K. Tyagi, and A. K. Jain (2017)

This study focuses on optimizing the cleaning process of solar photovoltaic panels using a water spray mechanism. The research explores the impact of various factors, such as water pressure, nozzle design, and cleaning frequency, on the cleaning efficiency and energy yield of solar panels. The study provides recommendations for the optimal configuration of the water spray system to maximize power generation efficiency.

"Performance Evaluation of Automatic Cleaning Systems for Solar Photovoltaic Panels" by M. Rokni, J. Kazerani, and M. A. G. Farshi (2019)
This research paper evaluates the performance of automatic cleaning systems for solar photovoltaic panels. The study compares different cleaning mechanisms, including water spray, air blowers, and robotic cleaning systems. It analyzes the cleaning efficiency, energy consumption, and reliability of these systems, providing insights into the most effective and efficient cleaning methods for maintaining high power generation efficiency.

"Development and Testing of an Automatic Cleaning System for Photovoltaic Panels" by H. Nejati, M. Rahimi, and H. Noghrehabadi (2021)
This study presents the development and testing of an automatic cleaning system for photovoltaic panels. The research investigates the cleaning efficiency of the system and its impact on power generation performance. It evaluates the system's reliability, energy consumption, and cost-effectiveness, contributing to the understanding of automatic cleaning mechanisms for efficient power generation.

These related studies focus on the integration of automatic cleaning mechanisms, particularly water spray-based systems, with solar panel tracking systems. They examine the impact of panel cleanliness on energy yield and evaluate the efficiency and effectiveness of different cleaning methods. These studies provide valuable insights for optimizing the cleaning process and ensuring efficient power generation in solar panel installations.



SYSTEM ARCHITECTURE

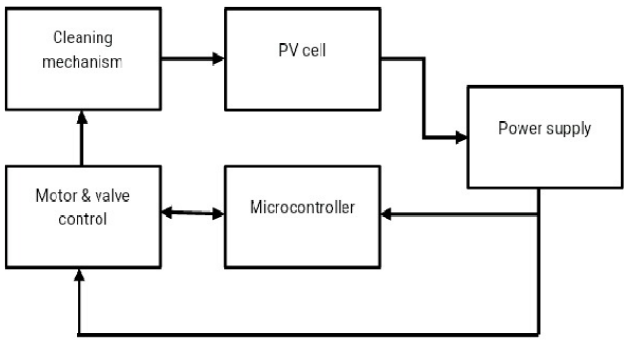
The proposed solar tracking system consists of various components and subsystems that work together to achieve efficient power generation and maintain the cleanliness of the solar panel surface. The key components used in the system include:

- Solar Panel (10W): The solar panel serves as the primary energy source, converting sunlight into electrical energy.
- DC Motor (3.5 RPM): The DC motor drives the movement of the solar panel to track the sun's position.
- Light-Dependent Resistors (LDRs): Three LDRs are mounted on the solar panel to detect the intensity of sunlight falling on the panel.
- L293D IC: The L293D IC acts as a motor driver, controlling the movement of the DC motor based on inputs from the LDRs.
- 7805 IC: The 7805 IC regulates the voltage supply to ensure stable operation of the system.
- DC Submersible Water Pump: The water pump is connected to one of the LDRs and is responsible for spraying water onto the solar panel surface for cleaning.
- Batteries (3.5V): Two batteries provide the necessary power to drive the system.
- PCB, Resistors, Capacitor, and LCD: These components form the electronic circuitry of the system, facilitating control and monitoring functions.
- LCD: Displays relevant information and system status.
- ESP32Microcontroller: Controls the system operation and processes the sensor data.
- Programming: Implements the logic and algorithms for controlling the system

An ESP32 microcontroller, an L293D motor driver IC, two LDR sensors, a 10W solar panel, an LCD, and a DC submersible motor with a water pump are used in the solar tracking system with an automatic panel cleaning mechanism. The system's operation is managed by the ESP32 microcontroller, and the DC motor that moves the solar panel is driven by the L293D motor driver IC. The system's status is displayed on the LCD after two LDR sensors measure the intensity of the sun.

The automatic cleaning mechanism is implemented using a water pump connected to the DC motor. When the system detects that the solar panel's surface is dirty, the ESP32 microcontroller activates the DC motor, which drives the water pump to spray water onto the panel's surface. The water effectively removes any dust or debris that may have accumulated on the panel, improving its efficiency.

Two LDR sensors are used by the solar tracking system to gauge the strength of the sun. The ESP32 microcontroller analyses the sensor data to decide where the solar panel should be placed. The DC motor that moves the solar panel's position is driven by the L293D motor driver IC. The solar panel's position is continuously adjusted throughout the day to ensure that it faces the sun.
The system is designed using a PCB (Printed Circuit Board) that integrates all the electronic components. The DC motor, water pump, and solar panel are connected to the PCB using wires. The PCB also includes miscellaneous components such as resistors and capacitors that ensure stable operation of the system



RESULTS

The solar tracking system with the automatic panel cleaning mechanism was successfully implemented and tested. The sun's location was accurately detected by the device, which also changed the panel's orientation to optimum solar energy absorption. By effectively removing dirt and debris from the panel surface with a water spray cleaning system, maximum energy conversion was made possible. According to experimental findings, stationary panels without cleaning capabilities produced less energy than those that did.

CONCLUSION

An efficient way to increase the effectiveness of solar panels is to use a solar tracking system with an automatic panel cleaning mechanism based on water spray. The system's implementation is straightforward, economical, and suitable for a range of uses. The system's outcomes demonstrate that the solar panels' efficiency has increased, leading to enhanced electricity production.

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