iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 12 Issue: IV Month of publication: April 2024

DOI: https://doi.org/10.22214/ijraset.2024.61061

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 12 Issue IV Apr 2024- Available at www.ijraset.com

Solar Panel Cleaning System with Voltage Drop Detection

Dnyaneshwar G. Kanade[1], Tushar N. Bhandari[2], Atharva D. Awate[3], Amey R. Bhagwatkar[4], Sandesh S. Bellale[5]
Department of Multidisciplinary Engineering (DOME) Vishwakarma Institute of Technology, Pune, 411037, Maharashtra, India

Abstract: This research suggests a unique voltage drop sensor and LDR (light-dependent resistor) based solar panel dust removal detecting system. Whereas the voltage drop sensor gauges the voltage differential between the solar panel's input and output, the LDR sensor counts the amount of light reflected from the panel's surface. The system is able to precisely identify the existence of dust and assess its level of intensity by evaluating the aggregated data from these sensors. Afterwards, an automatic dust removal device, like a water spray system or robotic brush, can be started using this information. The suggested method improves the overall performance and lifespan of solar photovoltaic systems by providing an automated, economical, and efficient alternative for the removal of dust from solar panel.
Keywords: Automated dust removal system, dust detection, dust removal, LDR sensor, Precision dust detection, Solar panel, Voltage drop sensor.

I. INTRODUCTION

The solar panel cleaning mechanism is an innovative project that aims to improve the efficiency of solar panels by keeping them clean and free from dust and debris. The project uses an Arduino Uno microcontroller to monitor the voltage generated by the solar panels and the intensity of ambient light using an LDR sensor. If the voltage drops by 10%, the air blower is turned on with the help of a relay module to clean the solar panel. This system can work efficiently in gulf countries where water is not available in large scale and sanding causes huge power loss. The purpose of this research paper is to provide a detailed analysis of the solar panel cleaning mechanism, including the problem statement, methodology, experiments, and conclusion.

II. PROBLEM STATEMENT

Solar panels lose a considerable amount of their performance when dust and debris build up on their surface. The amount of dust that collects on the module's front surface reduces its ability to generate power by blocking solar radiation. After a month without cleaning the module, the power output drops by as much as 50%.Particularly in regions with limited water supply, cleaning solar panels is an expensive and time-consuming task. In order to avoid wasting time or energy, it is necessary to develop fresh and inventive cleaning techniques.

Despite variations in solar insolation levels across the globe, the effectiveness of solar photovoltaic systems is also influenced by a number of factors, including soiling, seasonal and weather patterns, ambient temperature and humidity, and the conversion efficiency of photovoltaic cell technology. [1]

The levelized cost of energy (LCoE) is known to change as a result of power plant performance and life expectancy being negatively impacted by soiling and rising PV cell temperatures. [1]

A method that targets panel color measuring, calibration, threshold selection, and calibration makes use of TCS3200 and Arduino Uno components. Several color sensors and heightened sensor sensitivity are among the improvements. Solar panel cleaning expenses are decreased and efficiency is increased with color sensing [2].

The soiling losses over time are estimated by the model using the following parameters: rain data, the tilt of the PV array (including tracking), ambient airborne particulate matter concentrations (PM 10 and PM 2.5), and PV array tracking information. The model employs established correlations in the literature between average airborne PM concentrations and dust accumulation, the removal of accumulated dust by rain, and the accumulated dust and transmission loss in order to estimate soiling losses in a time series. When compared to observed soiling data, the model's output that was generated using static settling velocities and recorded rain data matched the overall slopes, frequencies, and magnitudes of soiling losses. [5]

The voltage and current of photovoltaic systems are examined in relation to soiling-induced shadowing. There are two types of soiling that result in shade: soft shading from things like air pollution and hard shading from solids like collected dust that obstruct the sun.

When a PV module is subjected to harsh shadowing, its overall performance is determined by whether part of its cells are shaded or not. A few cleaning techniques are also provided in this study to stop dust from building up on solar array surfaces. [6]

III. METHODOLOGY

The methodology of the solar panel cleaning mechanism involves the use of an Arduino Uno microcontroller to monitor the voltage generated by the solar panels and the intensity of ambient light using an LDR sensor. If the voltage drops by 10%, the air blower is turned on with the help of a relay module to clean the solar panel. The system consists of an LDR sensor, a voltage sensor, a relay module, and an air blower. The LDR sensor detects the intensity of ambient light, while the voltage sensor measures the voltage generated by the solar panels. The relay module controls the air blower, which is used to clean the solar panel. The system uses an algorithm to analyse the data collected by the sensors and determine when to turn on the air blower.

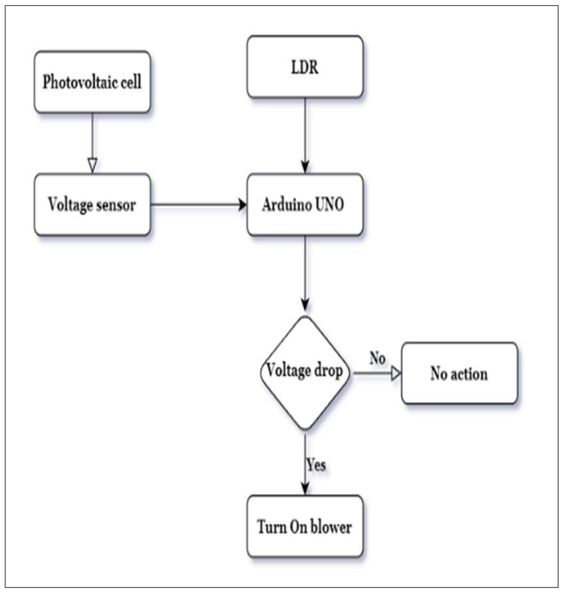


Figure 1: Flow of System

The first step in the methodology is to gather all the necessary components for the solar panel cleaning mechanism. This includes an Arduino Uno microcontroller, an LDR sensor, a voltage sensor, a relay module, and an air blower. The LDR sensor and voltage sensor are connected to the Arduino Uno microcontroller, which is programmed to analyse the data collected by the sensors. The next step is to calibrate the LDR sensor and voltage sensor to detect changes in ambient light and voltage. This involves adjusting the threshold values for the LDR sensor and the voltage sensor to ensure that the system can detect changes in ambient light and voltage accurately. Once the sensors are calibrated, the system is connected to a solar panel, and the air blower is tested to ensure that it is working correctly. The system is then tested under different lighting conditions to determine its effectiveness in cleaning solar panels. The data collected during the testing phase is analysed using statistical methods to determine the effectiveness of the solar panel cleaning mechanism.

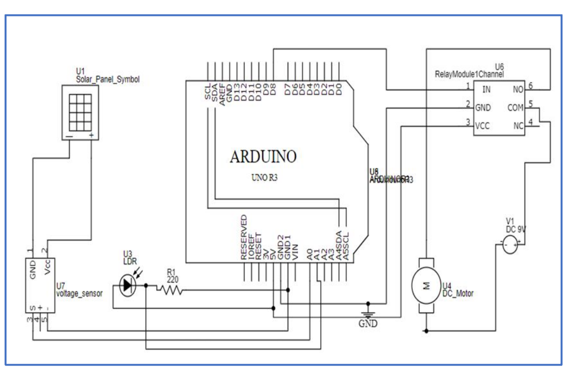


Figure 2 Circuit Diagram

The data is also used to optimize the algorithm used by the Arduino Uno microcontroller to ensure that the system can detect changes in ambient light and voltage accurately. The final step in the methodology is to evaluate the cost-effectiveness and energy efficiency of the solar panel cleaning mechanism. This involves comparing the cost of the system to the cost of traditional cleaning methods and determining the energy savings achieved by using the system. In conclusion, the methodology of the solar panel cleaning mechanism involves the use of an Arduino Uno microcontroller to monitor the voltage generated by the solar panels and the intensity of ambient light using an LDR sensor. The system uses an algorithm to analyse the data collected by the sensors and determine when to turn on the air blower. The system is tested under different lighting conditions to determine its effectiveness in cleaning solar panels, and the data collected is analysed to optimize the algorithm used by the Arduino Uno microcontroller. The cost-effectiveness and energy efficiency of the system are evaluated to determine its viability as a cleaning solution for solar panels.

IV. EXPERIMENTS

The solar panel cleaning mechanism was tested in a laboratory setting to determine its effectiveness in cleaning solar panels. The system was connected to a solar panel, and the LDR and voltage sensors were calibrated to detect changes in ambient light and voltage. The air blower was turned on when the voltage dropped by 10%, and the solar panel was cleaned. The system was tested under different lighting conditions to determine its effectiveness in cleaning solar panels.

V. RESULTS

The solar panel cleaning mechanism system produces economical and efficient outcomes. The device use voltage drops sensors and LDR technology to identify dust on solar panels and initiate an automated cleaning process. By precisely identifying the amount of dust present and evaluating its intensity, the device may then turn on an air blower to clean the solar panel. The approach is in line with prior study findings that emphasize the detrimental effects of dust collection on solar panels. With efficient dust removal, the suggested solution is a viable way to improve solar photovoltaic systems' lifespan and performance.

VI. FUTURE SCOPES

One key area for improvement is the adoption of a multi-panel cleaning mechanism using a moving blower. Implementing a moving system for the blower, whether through tracks, robotic arms, etc. would significantly enhance efficiency and cost-effectiveness by cleaning multiple panels sequentially. Such a mechanism could leverage self-positioning or obstacle detection technologies to navigate complex panel layouts with ease.

VII. CONCLUSION

The solar panel cleaning mechanism is an innovative project that aims to improve the efficiency of solar panels by keeping them clean and free from dust and debris. The system uses an Arduino Uno microcontroller to monitor the voltage generated by the solar panels and the intensity of ambient light using an LDR sensor. If the voltage drops by 10%, the air blower is turned on with the help of a relay module to clean the solar panel. The system can work efficiently in gulf countries where water is not available in large scale and sanding causes huge power loss. The system was tested in a laboratory setting and was found to be effective in cleaning solar panels. The solar panel cleaning mechanism is a cost-effective and energy-efficient solution to the problem of cleaning solar panel.

VIII. ACKNOWLEDGEMENT

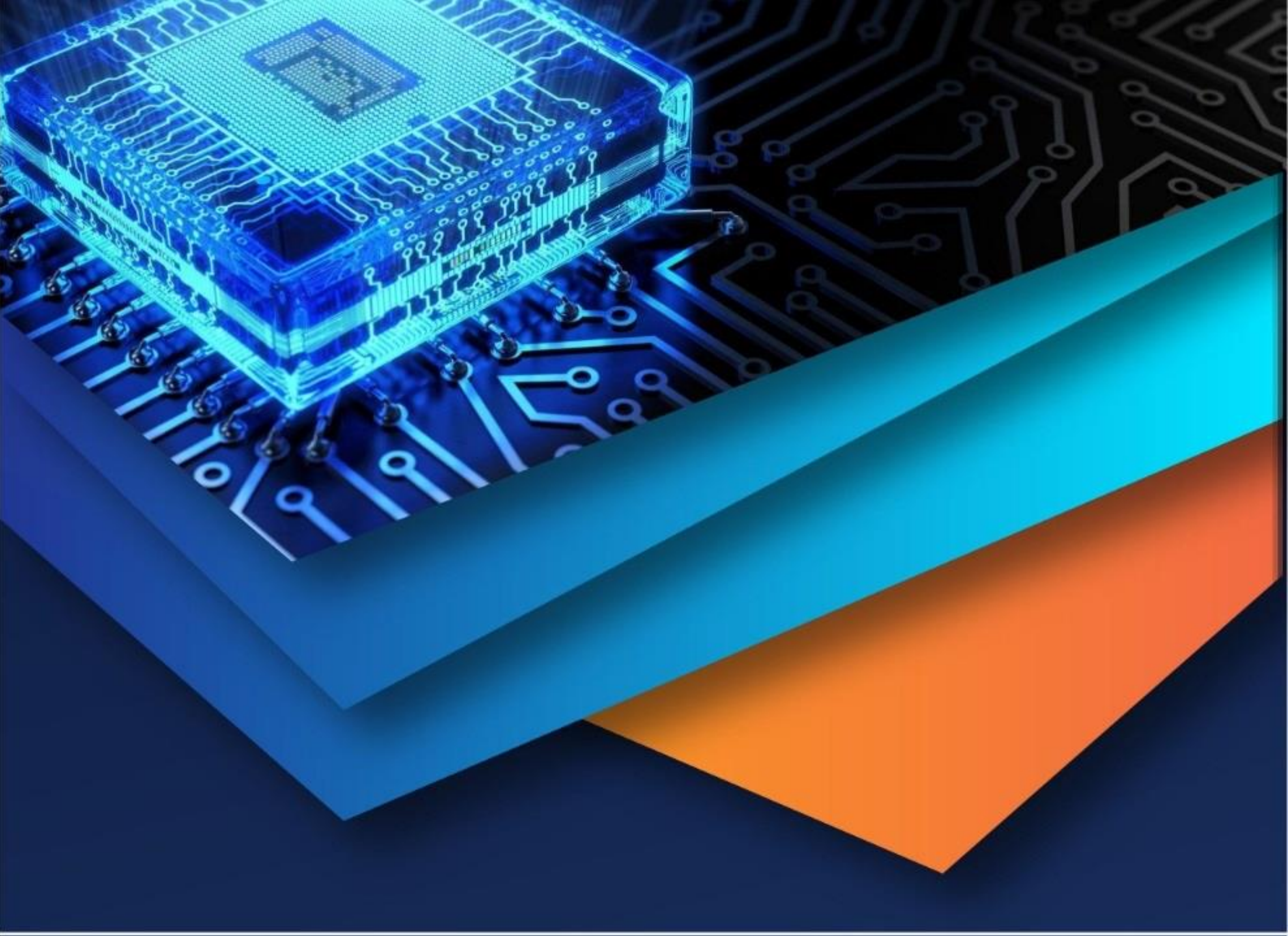
We extend our sincerest appreciation to our project guide, Prof. Dnyaneshwar G. Kanade, for their invaluable guidance and expertise throughout our project. Special thanks to our project coordinator, Shri. Ranjeet Singh Suryawanshi, for their organizational support. We also express gratitude to the Head of the Department, Shilpa Lambor Mam, for fostering an environment of academic excellence. Our heartfelt thanks to all faculty members and support staff for their contributions. This project's success is a result of your unwavering support and encouragement.

REFERENCES

[1] N. Khadka, A. Bista, B. Adhikari, A. Shrestha, D. Bista, and B. Adhikary, “Current practices of solar photovoltaic panel cleaning system and future prospects of machine learning implementation,” IEEE Access, vol. 8, pp. 135948–135962, Jan. 2020, doi: 10.1109/access.2020.3011553.

[2] B. O. Olorunfemi, N. Nwulu, and O. A. Ogbolumani, “Solar panel surface dirt detection and removal based on arduino color recognition,” MethodsX, vol. 10, p. 101967, Jan. 2023, doi: 10.1016/j.mex.2022.101967.

[3] "Effect of Depositions on PV Panel with proposal of a self-cleaning system," IEEE Conference Publication | IEEE Xplore, Nov. 26, 2021. https://ieeexplore.ieee.org/abstract/document/9708543
[4] "Self-cleaning solution for solar panels," SAIEE Journals & Magazine | IEEE Xplore, Jun. 01, 2023. https://ieeexplore.ieee.org/document/10071978
[5] M. Coello and L. Boyle, "Simple model for predicting time series soiling of photovoltaic panels," IEEE Journal of Photovoltaics, vol. 9, no. 5, pp. 1382–1387, Sep. 2019, doi: 10.1109/jphotov.2019.2919628.
[6] M. R. Maghami, H. Hizam, C. Gomes, M. A. M. Radzi, M. I. Rezadad, and S. Hajighorbani, "Power loss due to soiling on solar panel: A review," Renewable & Sustainable Energy Reviews, vol. 59, pp. 1307–1316, Jun. 2016, doi: 10.1016/j.rser.2016.01.044.



10.22214/IJRASET

INDEX COPERNICUS
45.98

IMPACT FACTOR:
7.129

TOGETHER WE REACH THE GOAL
IMPACT FACTOR:
7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY