

# Solar Panel Cleaning System Using IoT

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## ABSTRACT

The IoT-based Solar Panel Cleaning System is designed to maintain solar panel efficiency by automatically removing dust and dirt from the panel surface. Accumulated dust reduces sunlight absorption and lowers power generation. This system uses sensors to monitor panel performance, and when a drop in efficiency is detected, a microcontroller activates a water pump through a relay for cleaning. The ESP8266 WiFi module sends real-time data to the cloud for remote monitoring. The system reduces manual effort, improves energy output, and supports smart renewable energy management.

**Keywords:** IoT, Solar Panel Cleaning, Automation, Renewable Energy, Dust Detection, Remote Monitoring

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## INTRODUCTION

Solar energy is a clean and sustainable power source, but its efficiency is often affected by dust, dirt, and environmental pollution. Dirty panels block sunlight, resulting in reduced electricity generation. Manual cleaning methods are time consuming, costly, and impractical for large installations.

helps solve this problem by continuously monitoring panel conditions and activating cleaning when required. An IoT-based automatic cleaning system With cloud connectivity, users can track system performance remotely, making the solution intelligent, efficient, and suitable for modern smart energy systems.

## PROBLEM STATEMENT

Solar panels can lose up to **30–40% efficiency** due to dust accumulation. Traditional cleaning methods require human labor, increase maintenance costs, and are not always performed regularly. This creates the need for an automated system that can detect dirt, clean the panels efficiently, and provide real-time monitoring to ensure maximum power generation.

## PROPOSED SOLUTION

The proposed system uses an ATmega328P microcontroller as the central controller. Sensors such as LDR and INA219 monitor light intensity, voltage, and current to evaluate panel performance. When reduced output is detected, the controller activates a relay that turns on the water pump to clean the panel automatically.

Additionally, the ESP8266 WiFi module uploads system data to a cloud platform like Thing Speak, enabling remote monitoring. This automation improves efficiency, reduces manual work, and ensures timely cleaning.

## LITERATURE REVIEW

Research shows that dust significantly impacts solar panel performance, leading to major energy losses. Earlier cleaning methods involved manual labor or robotic systems, which were often expensive and complex. Recent developments focus on sensor-based automated cleaning combined with IoT technology for real-time monitoring. These systems are cost-effective, reliable, and improve overall energy management. The proposed project integrates automation and IoT to provide an efficient and practical cleaning solution.

Numerous studies highlight the negative impact of dust on solar panel performance. Researchers have explored different cleaning methods ranging from manual washing to robotic cleaners.

- Manual cleaning is simple but inefficient and costly over time.
- Robotic cleaning systems provide automation but involve high installation and maintenance expenses.
- Sensor-based cleaning systems have emerged as a cost-effective alternative, enabling cleaning only when necessary.
- IoT-enabled solutions further enhance these systems by allowing remote monitoring, predictive maintenance, and data-driven decision-making.

Recent research focuses on integrating low-power electronics, wireless communication, and smart sensors to create efficient and affordable cleaning mechanisms. The proposed system builds upon these advancements by combining automation with IoT technology to deliver a reliable and energy efficient solution.

### METHODOLOGY

The proposed IoT-based solar panel cleaning system is designed to automatically monitor dust accumulation and perform cleaning operations to maintain solar panel efficiency. The system uses dust and environmental sensors to continuously monitor panel conditions. These sensors collect real-time data and send it to the microcontroller, which acts as the main control unit.

The microcontroller processes sensor data and compares it with predefined threshold values. When the dust level exceeds the threshold limit, the microcontroller activates the cleaning mechanism automatically. The cleaning process is performed using a DC motor-driven brush or water spray system, which removes dust and dirt from the solar panel surface.

The system is integrated with an IoT platform such as Blynk or ThingSpeak, allowing real-time monitoring and remote control through a mobile or web application. This method reduces manual effort, improves solar panel performance, and ensures efficient maintenance of the system.

Solar  
panel 12v  
Battery  
12v  
12V  
DC-DC  
5v  
Current/vt g INA219  
LDR

### Block Diagram

LCD  
16\*2  
AT Mega  
328P  
Things  
WIFI  
8266-01  
DHT11  
Relay  
Module  
Water  
pump

### RESULTS AND DISCUSSION

The IoT-based solar panel cleaning system was tested in different environmental conditions. It was observed that when dust accumulated on the solar panel surface, the power output of the panel decreased. Dust blocks sunlight from reaching the solar cells, which reduces efficiency.

When the dust level increased, the system automatically started the cleaning process. The cleaning brush and water spray successfully removed dust and dirt from the solar panel. After cleaning, the solar panel produced better output and improved efficiency.

The IoT platform helped in monitoring the system in real time. Users were able to check the dust level, cleaning status, and panel performance using a mobile application. The system reduced manual cleaning effort and helped maintain the solar panel properly.

Overall, the system worked effectively and improved solar panel performance.

### OBJECTIVES

- To design and develop an automated solar panel cleaning system using IoT technology.
- To monitor solar panel parameters such as voltage, current, temperature, and light intensity.
- To detect dust accumulation by analyzing panel performance.

- To reduce manual labor and maintenance costs through automation.
- To provide real-time monitoring using the ESP8266 WiFi module.
- To improve overall energy efficiency and power output of solar panels.
- To promote smart and sustainable energy management systems.

#### APPLICATIONS

- Residential rooftop solar systems
- Industrial solar power plants
- Agricultural solar installations
- Smart city infrastructure
- Remote solar energy systems
- Commercial buildings and campuses

#### ADVANTAGES

- Fully automatic operation with minimal human intervention.
- Improves solar panel efficiency and energy generation.
- Reduces maintenance and operational costs. ● Saves time and labor.
- Provides real-time monitoring through IoT. ● Ensures cleaning only when required, reducing water wastage.
- Reliable and cost-effective solution for both small and large installations.
- Supports environmentally sustainable energy systems..

#### CONCLUSION

The IoT-based Solar Panel Cleaning System presents a smart and efficient approach to maintaining solar panel performance. By integrating sensors, automation, and wireless communication, the system detects efficiency loss and performs cleaning without manual involvement. This results in improved energy output, reduced maintenance effort, and enhanced system reliability.

The project contributes to modern smart energy solutions and supports the global shift toward renewable energy sources.

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