International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 09 Issue: 06 | June - 2025 SJIF Rating: 8.586 ISSN: 2582-3930

Design of Automatic Solar Panel Cleaning System using IOT

Prof. Sagar Mali, Miss. Vaishnavi Kumbhar, Mr. Prathmesh Shirke, Mr. Karan Sutar Mr. Avinash Patil, Mr. Sai Awale

Asst. Prof. ,Student
Department of Electrical Engineering

1.Abstract –

Energy is still one of the most critical issues facing the world today. In India, energy access continues to be a critical issue for both urban and rural households. Approximately 60% to 70% of the country's energy needs are still fulfilled using fuelwood and agricultural waste. Among renewable sources, solar energy stands out for its abundance and sustainability, making it a key solution for reducing reliance on petroleum-based electricity. However, in tropical regions like India, solar photovoltaic (PV) modules are frequently exposed to dusty environments. Accumulated dust on PV surfaces blocks sunlight and can reduce power output by up to 50% if not cleaned regularly. To combat this issue and enhance efficiency, an Arduino-based automated cleaning system has been developed to remove dust from PV modules effectively.

Key Words: Solar Panel, Dust, Efficiency, Cleaning.

2.INTRODUCTION

Energy continues to be one of the most significant challenges faced globally. In India, ensuring consistent energy access remains a persistent concern for both urban and rural communities. A large portion—about 60% to 70%—of the nation's energy demand is still met through traditional sources such as fuelwood and agricultural residues. Solar energy, being abundant and renewable, offers a promising alternative to decrease dependency on fossil fuels like petroleum. Nevertheless, in tropical climates such as India's, solar photovoltaic (PV) modules are commonly installed in environments prone to dust accumulation. This layer of dust can obstruct sunlight, leading to a substantial drop in energy output—up to 50% if left uncleaned for a month. To address this challenge and boost system efficiency, an automated dust removal solution powered by Arduino programming has been introduced to maintain the cleanliness of PV modules.

Dust and dirt are major factors that significantly reduce the efficiency of photovoltaic (PV) panels—by as much as 50%. The most effective solution to this problem is regular cleaning of the panels. Traditionally, this has been done manually, but manual cleaning poses several challenges, including the risk of worker injury, potential damage to the panels, difficulty in accessing certain locations, and inconsistent maintenance. To resolve these issues, a fully automatic system for dust removal has been created. An automated dust-cleaning system has been introduced to address these challenges.

The primary objective of this project is to implement an automated mechanism for cleaning solar panels, ensuring improved performance and reliability.

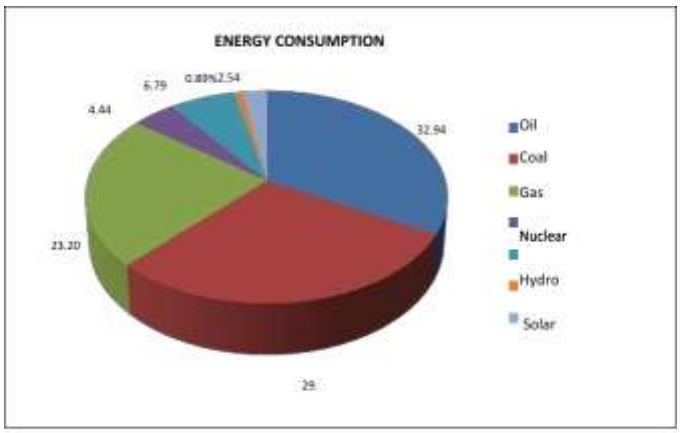

Figure 1. Pie Chart of Energy Consumption

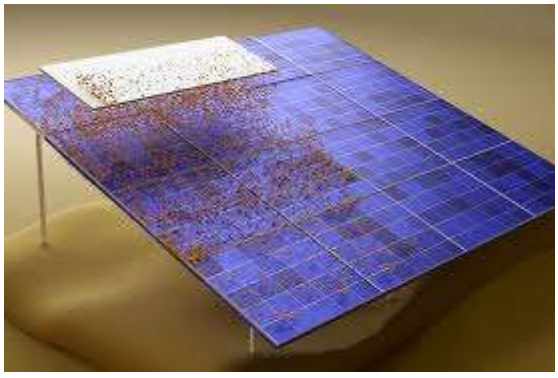

Fig.2. Dust containment panels

3. CLEANING METHODS FOR SOLAR PANEL'S –

2.1 Natural removal of dust –

Natural forces such as wind, gravity, and rainwater help to some extent in removing dust from solar panels, but their effectiveness is limited. It has been observed that tilting the solar panel array to a vertical or inclined position during early morning, late evening, nighttime, or rainy days can aid in dust removal more effectively.

2.1 Mechanical removal of dust-

Mechanical methods such as brushing, blowing, tilting and ultrasonic vibration are commonly used to remove dust from solar panels. Brushing systems, often designed like windshield wipers, clean the panel surface using machine-driven brushes or broom, however, these methods face limitation: the fine and adhesive nature of dust reduce. Cleaning efficiency is often reduced by harsh environmental conditions, which also make maintenance challenging, while the expansive surface area of solar arrays requires high powered cleaning systems.

2.2 Electrostatic removal of dust-

If there is a high potential on the surface of the solar panels, the charged and uncharged dust will be attracted to the panels because of the electrostatic forces. As a result, dust particles become electrically charged by solar panels, acquiring the same polarity. This causes electrostatic repulsion between the particles, eventually causing them to be repelled and floating away from the panel surface. However, this strategy cannot be used in PV system, because of the effect of the rain on earth.

4.OBJECTIVE

- To enhance panel performance through effective cleaning.
- To make the system automated using IOT.
- To avoid the manual work.
- They avoid dust associated problems on solar panels.

5. COMPONENTS USED-

1. Servo Moto
2. ESP 32
3. Water Pump
4. Relay
5. Wiper
6. Battery
7. Battery holder
8. Water pump
9. Solar Panel

6. OBJECTIVE

- Literature Survey.
- Design of model
- Material selection
- Fabrication.
  - i. The first frame is fixed.
  - ii. The second frame is a movable aluminum structure designed to move horizontally.
  - iii. The third frame consists of brush mechanism that moves vertically.
  - iv. The above frames are controlled by ESP 32.

7. WORKING PRINCIPLE-

Fig.3.Automatic Solar panel cleaning system using IOT Model

The cleaning and cooling system is developed using a prototyping research method, which includes stages such as data collection, hardware design, software development, and system simulation testing to evaluate its performance.

The ESP32 is Wi-Fi enabled, allowing real-time data to be sent to a cloud platform or a mobile app. Users can monitor system performance, cleaning status, and sensor data remotely. In some systems, users can also manually trigger cleaning through the IoT interface.

The system can be set to operate on a schedule or work entirely autonomously based on real-time data, ensuring regular maintenance without human intervention.

8. CONCLUSIONS

Test results of the IoT-based automatic solar panel cleaning and cooling system indicate that it can function autonomously under specified conditions.
The condition of the solar panel can be monitored from anywhere the user is located through the application of IoT technology, where the monitoring process is related to the solar panel's condition, whether it is currently undergoing the solar panel cooling process or the solar panel surface cleaning process. Through the application of IOT technology, users can also control the electrical devices connected to the solar power system.

Most automated cleaning solutions are tailored for large-scale installation and do not effectively accommodate smaller systems like those found on residential rooftops. For users with limited space, this often restricts them to smaller arrays. Our proposed solution offers a significant advantage for these smaller- scale applications.

The system is designed for seamless integration with rooftop solar panel installations. The linear actuator system worked very nicely and was able to achieve the required design parameters.

9. ACKNOWLEDGEMENT

Many thanks to the organizers of the International Scientific Journal of Engineering and Management (ISJEM) who have given the author the opportunity to publish this paper. As well as to the Shri. Sant Krupa College of Engineering, Ghogaon for facilitating the research paper.

10. REFERENCES

1. [1] Agus Eko Setyono , Berkah Fajar Tamtomo Kiono, 2021, Dari Energi Fosil Menuju Energi Terbarukan: Potret Kondisi Minyak dan Gas Bumi Indonesia Tahun 2020 – 2050, Jurnal Energi Baru dan Terbarukan, Vol. 2, No. 3, pp 154 – 162, doi: 10.14710/jebt.2021.11157
2. M. Syaiful Alim, Suyono Thamrin, Rudy Laksmono W, 2023, Pemanfaatan Pembangkit Listrik Tenaga Surya sebagai Alternatif Ketahanan Energi Nasional Masa Depan, Jurnal Pengabdian kepada Masyarakat Nusantara, Vol. 4 No.3, doi.org/10.55338/jpkmn.v4i2.148