Automatic Cleaning of Solar Panel and Online Monitoring the Efficiency using IoT

Rajesh Gawai[1], Raghav Baheti[2], Apar Shambharkar[3], Devesh Patil[4]

[1-4]Dept. of Electrical Engineering, PVG's College of Engineering and Technology, Maharashtra, India

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Abstract –*Energy is one of the major issues that the world is facing in India; the supply of energy has been one of the major problems for both urban and rural households. About 60% to 70% of the energy demand of the country is met by fuel, wood and agriculture residues. Solar energy is a renewable source of energy, which has a great potential and it is radiated by the sun. Renewable energy is important to replace the use of electric energy generated by petroleum. Solar power has become a source of renewable energy and solar energy application should be enhanced. The solar PV modules are generally employed in dusty environments which are the case in tropical countries like India. The dust gets accumulated on the front surface of the module and blocks the incident light from the sun. It reduces the power generation capacity of the module. The power output reduces as much as by 50% if the module is not cleaned for a month. The cleaning system has been designed to clean the module by controlling the Arduino programming to remove the dust in the PV modules to improve the power efficiency.*

Keywords: power efficiency; cleaning system; solar power; Renewable energy;

1. INTRODUCTION

The sun emits energy at an extremely large rate hence there is abundant availability of solar energy in nature. If all solar energy could be converted into usable forms, it would be more enough to supply the world's energy demand. However, this is not possible because of conditions in the atmosphere such as the effect of clouds, dust and temperature. Solar energy can be converted to more usable energy forms through solar panels. There is unprecedented interest in renewable energy, particularly solar energy, which provides electricity without giving rise to any carbon dioxide emission. Of the many alternatives, photovoltaic methods of extracting power from solar energy have been considered promising toward meeting the continuously increasing demand for energy. The efficiency of solar panels is limited due to natural conditions, so it is very much essential to take care of parameters like dust, humidity, and temperature. In this regard the work has been taken up to study the efficiency of solar panels with and without dust collected on it. The developed project includes design and to implementation of microcontroller-based dust cleaning system. The main aim of the project is to provide automatic dust cleaning mechanisms for solar panels.

1.1 Problem Faced in Solar Generation

Solar energy is a sustainable energy source. It is renewable as well. It has many applications like solar water heater, solar air heaters and electricity generation. It has its advantages as well as disadvantages. Some of the disadvantages are

Low efficiency of solar power conversion.

Initial cost incurred in purchasing solar panels and their installation its fairly high enough to think about it twice.

Obviously, the plant won't be in working condition during night period. The weather is also a big factor in reducing the efficiency of solar system used.

2. PROBLEM STATEMENT

1) The main problem is to get sustainable power production from solar plant.

2) To decrease the maintenance cost.

2.1 Dust accumulation

The main factors of dust accumulation which directly affect the performance of solar plant has been categorized into 3 groups.

1. Environmental Factor
2. Type of particulate matter
3. Location and Technical factors

All these factors are responsible for dust accumulation on the solar surface array.

1. Environmental Factor
    i. Wind Flow
    ii. Wind direction
    iii. Temperature of solar cell
    iv. Solar Insolation
    v. Air pollution
    vi. Air pressure
    vii. Dust and storm
    viii. Volcanoes
    ix. Snow and Smog
    x. Humidity
2. Type of particulate matter

The particulate matter which mainly effects with maximum reduction of power output is grain dust (5-1000 micron), combustion of vehicles, wood burning (up to 2.5 micron), coal ash (1-100 micron), fly ash (1-1000 micron), atmospheric dust (0.001-40 microns), sugars (0.0008-0.005 microns).

3. Location and Technical Factors

(i) Latitude and Longitude for maximum power extraction

(ii) Selection of site related to pollution

(iii) Tilt Angle

(iv) Orientation of panel

(v) Distance related to solar radiation

Figure.1 Dust laden PV panel

2.2 Methods of improving efficiency

1. Proper Installation of Solar Panel (adjusting tilt angle).

2. Prevent an increase in Temperature.
3. Solar panel should be clean.
4. Using cooling system (water and air).

2.3 Solution Strategy

1. Adjusting tilt angle in such a way that will generate more output power and improve the efficiency of solar panel.
2. Cleaning of solar panel by different cleaning agents like water, alcohol, detergents, Sulphur etc. to get efficient output power from panel.

3. METHODOLOGY

A commercial polycrystalline solar panel is of 65×60 cm^2. The load is connected to panel. The reading of voltage and current are taken with the help of Thing speak software every 15 min starting from 10 am to 3 pm (peak time of solar radiation) for 5 days and average is taken. The temperature of the panel is measured using thermocouple (K-type) at four different places and average is taken. From the observation it is seen that there is constant drop in voltage with increase in temperature which results in drop in power generated.

For this reason, we built a Arduino based cleaning and cooling system when panel temperature reaches at 45˚C on that time automatically cooling and cleaning mechanism starts, and help to improve the efficiency and life of panel.

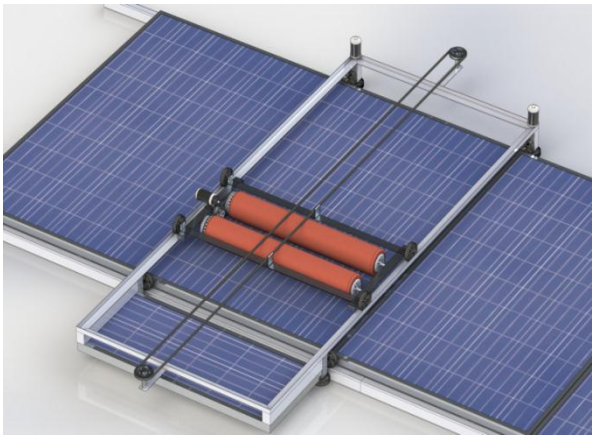

Figure. 2- 3-D Picture of Solar Panel Cleaner

3.1 Data Acquisition Model

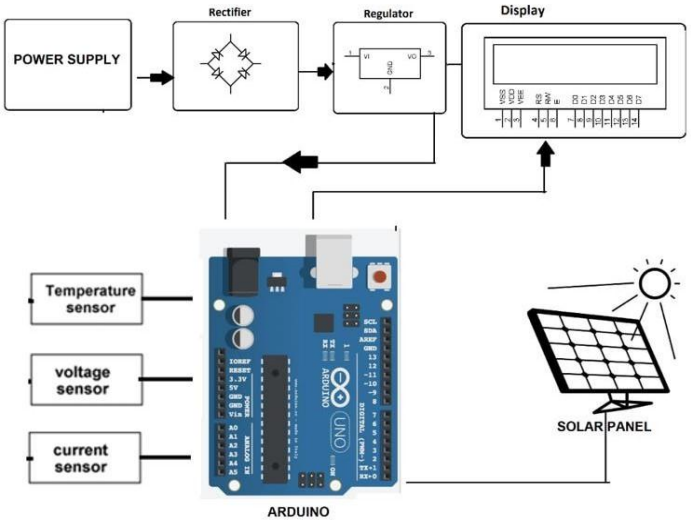

Figure.3- Data acquisition model

3.2 Algorithm

1) Initialize LCD display 16x2.
2) Initialize Wi-Fi module ESP8266.
3) Check for WiFi connections.
4) Display " Automatic Solar Panel Cleaning "
5) Define input and output pins.
6) Sense analog input and output A0, A1, A2, A3, A4 and voltage, temperature, current, etc.
7) Upload Data to Thingspeak.com.
8) Define Forward Switch, Reverse Switch, Upper limit switch, Lower limit switch.
9) Press forward push button and check If Upper limit switch is high, if it is high then motor brush assembly moves downward. When it reaches at lower limit. Motor brush assembly stops and runs upward again. When it reaches Upper limit. Upper limit sensor gets sensed. And stops the motor.
10) This process repeats again.

3.3 Flowchart

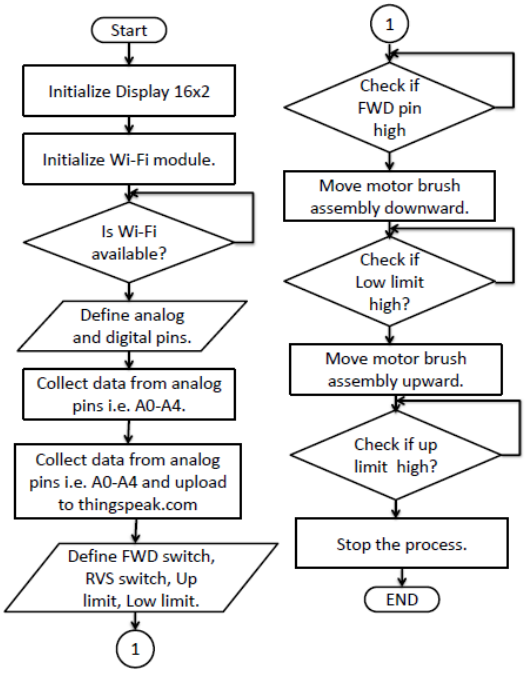

Figure. 4- 3Flowchart of Solar Panel Cleaner

3.4 Advantages

1) Cost of production is low.
2) No need to purchase heavy machinery.
3) Reduces threat to human life.
4) Manual assistance is not required
5) Working principle is quiet easy.
6) Portable.

7) Autonomous self-cleaning mechanism that can be attached to solar panels and operated without human operation.

8) It is easy to construct, low cost and low maintenance.

3.5 Disadvantages

1) Ineffective for sticky dust and cannot clean the dust at the corners.

2) The sticky dust need to be removes using hard brush or through mopping action.

3.6 Observations

Experimental values of solar panel without cleaning and cooling

Time	Voltage (V)	Current (A)	Power (W)
10:00 AM	18.17	1.89	34.341
10:30	19.1	1.92	36.672
11:00 AM	19.13	1.91	36.538
11:30	17.97	2.29	41.136
12:00 PM	16.18	2.98	48.216
12:30	16.2	2.81	45.522
1:00 PM	16.29	2.39	38.933
13:30	16.5	2.23	36.791
2:00 PM	16.9	2.02	34.138
14:30	17.1	1.97	33.68
3:00 PM	17.22	1.94	33.407

Table 1. Experimental values of solar panel without cleaning and cooling

Experimental values of solar panel with cooling and cleaning

Time	Voltage (V)	Current (A)	Power (W)
10:00 AM	19.1	1.92	36.672
10:30	19.6	1.94	38.024
11:00 AM	19.98	1.99	39.76
11:30	20.4	2.24	45.696
12:00 PM	20.9	2.77	57.893
12:30	20.3	2.69	54.6
1:00 PM	19.8	2.3	45.54
13:30	19.5	1.99	38.805
2:00 PM	19.2	1.93	37.056
14:30	19.04	1.9	36.176
3:00 PM	18.9	1.87	35.343

Table 2. Experimental values of solar panel with cleaning and cooling

RESULT

The considered PV panel is installed at the terrace of Mechanical building in our case study. We have taken measurement of, I_{sc} and Pout at different weather condition with respect to time. In rainy season the panel is naturally cleaned and we observed it is effect on performance characteristics. Naturally cleaned module is not giving maximum efficiency.

PV panel is more polluted in winter and autumn season the produced current and voltage that results in power is highly reduced and there is more accumulation of dust with naturally cleaned phenomenon. The Power is obtained by multiplication for measured value of current (I) and voltage (V).

CONCLUSIONS

A non-pressurized cooling system has been develop based on spraying the PV panel by water once in a while. In this project solar radiation data of one region has been analyzed.

The analysis has been done using Thing Speak software. The case study shows that the particulate matter tremendously affects the performance of PV panel studied under different conditions. PV module cleaning method reveals most effective way to overcome these problems. Natural cleaning process such as water droplets from rain is not as effective to enhance performance of PV panel. We concluded that alcohol and sodium surfactants agents preserve the performance of PV panel with higher rates.

In this experiment we analysis when panel temperature is increase comparatively efficiency of panel decreases but when start the cooling and cleaning mechanism on hot PV panel after few second increase output power. The experimental result can say that a way to improve the performance of PV module by cooling of the solar module by using back water thereby improving the efficiency by 3-4%.

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BIOGRAPHIES

Rajesh Gavai
Dept. of Electrical Engineering,
PVG's College of Engineering and
Technology, Maharashtra

Raghav Baheti
Dept. of Electrical Engineering,
PVG's College of Engineering and
Technology, Maharashtra

Apar Shambharkar
Dept. of Electrical Engineering,
PVG's College of Engineering and
Technology, Maharashtra

Devesh Patil
Dept. of Electrical Engineering,
PVG's College of Engineering and
Technology, Maharashtra