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Maximum Power Extraction in Household Solar PV System using Image Processing

J. Abinaya Renuga[1], K. Anandh Jothi[2], K.R.Suha[3], Dr. D. Prince Winston[4], B. Praveen Kumar[5]

[1, 2,3,4,5] *Department of Electrical and Electronics, Kamaraj College of Engineering and Technology, India*

Corresponding author's Email: anandhjothikalidass@gmail.com

***Abstract*-Fossil fuels are depleting day by day and hence renewable sources became the need of hour. Among all the renewable sources, solar energy seems to be a promising and inexhaustible source of energy. Also, photovoltaic conversion devices play a major role in industrialized countries. Certain unfavourable conditions affect the entire output power of a solar panel. The unfavourable conditions which are temporary may occur due to the effect of shading, dust accumulation, rain drops, cracks etc. These temporary faults affect the panel power to a great extent and hence panel needs continuous monitoring to extract the maximum power. This paper proposes a method for continuous monitoring of partial shading levels using normal camera. The images captured are processed in MATLAB and the values of mean are calculated. A database is created with these values and a threshold value is fixed. If the calculated mean is less than the set value then the classifier identifies it as fault and sends its signal to the ARDUINO which takes decision to operate the switching circuit to extract maximum power. This switching circuit quickly reconfigures the array to enhance the power.**

Keywords-Digital Images, ARDUINO, Shading, Fault Classification, Array Reconfiguration

I. INTRODUCTION

Renewable sources are the one which is inexhaustible. Solar energy is one of the renewable energy sources. It is clean and green. Solar energy is the light and heat from the sun that is harnessed using photovoltaic (PV) cells. The PV cells convert the sun's radiation directly into electricity. The earth receives about 174,000 terawatts of solar radiation. From the survey it is found that the amount of radiation trapped by the PV cell is reduced due to surface faults such as shading, cracks, dust accumulation, antioxidants etc. This paper proposes a method to identify the shading levels and provides a switching circuit to track maximum power in rooftop PV systems. This is done at low cost by replacing thermal camera with normal camera.

II. PROJECTED SCHEME

A. Description of Block Diagram:

The PV cells are arranged in the order 2x4 as shown in fig. 1.

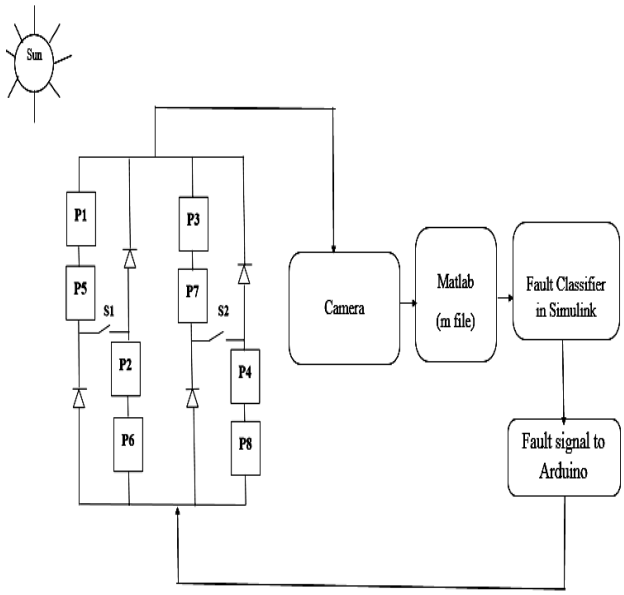

Fig.1. Block Diagram

Two switches are used to arrange panels in series parallel combinations. A 20 MP camera is used to capture the image of PV cells to identify the shading levels. The image is processed and mean is calculated.

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B. Generation Of Fault:

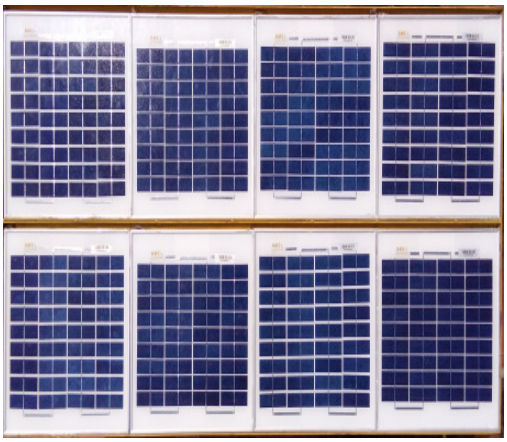

Fig.2. Healthy Panel

When the panel is healthy, rated output power is extracted. But, when shading occurs the power output is reduced.

Shading is nothing but when an object is exposed to light a shadow of the object is created. When this shadow falls on the panel it reduces the intensity of light falling on the panel. Hence, the power generated by the panel is reduced and so the entire output is reduced to a great extent.

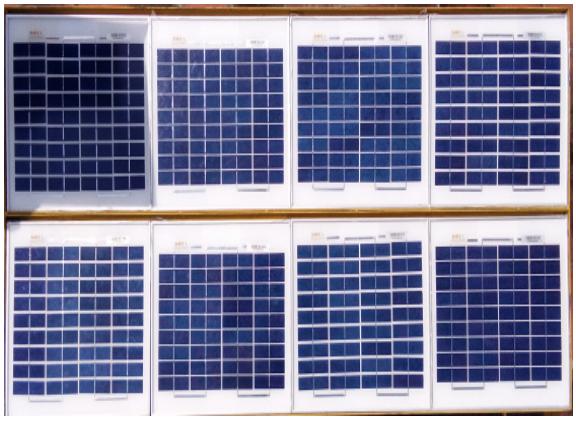

Fig.3. Shaded Panel

Shading is nothing but when an object is exposed to light a shadow of the object is created. When this shadow falls on the panel it reduces the intensity of light falling on the panel. Hence, the power generated by the panel is reduced and so the entire output is reduced to a great extent.

C. Switching Circuit:

This paper puts forward a model to reconfigure the panels. It consists of two switches. These switches are normally closed and the panels are connected in series as shown in fig. 4.

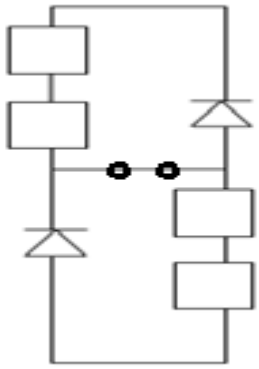

Fig.4. Panel Connection when switch is normally closed

Under normal condition the panels provide rated power output. But, if shading occurs then the power output is reduced since the panels are connected in series. So, when the switch is opened then the panels will be reconfigured by changing series connection to parallel connection thereby extracting maximum power.

III. Experimental Setup

The experimental setup of the proposed model is as shown in fig. 5 below.

Fig.5. Experimental Setup

IV. Results and Outcomes

Fig. 6 depicts voltage vs. power when the switch is closed.

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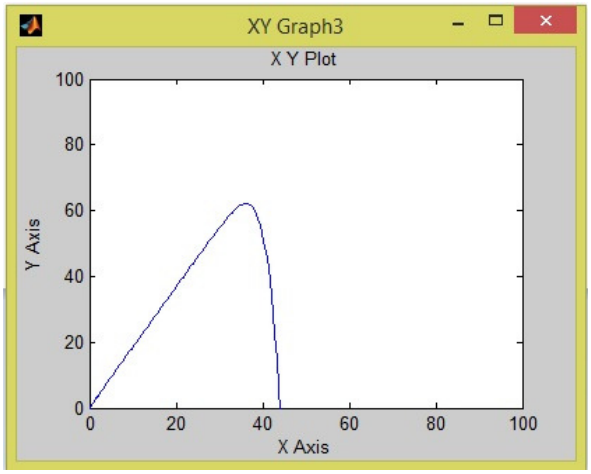

Fig. 6. Voltage vs. Power

Fig. 7. depicts voltage vs. power when the panels are reconfigured.

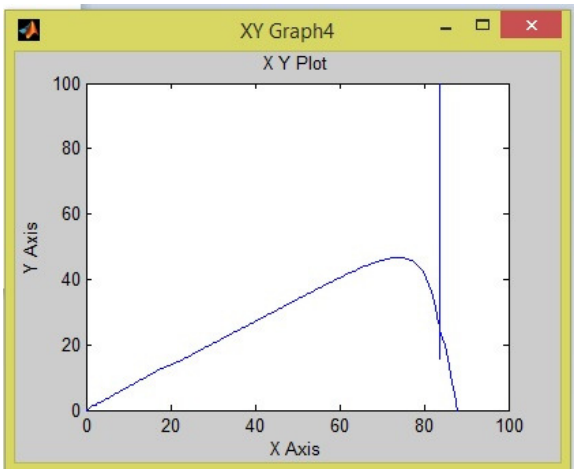

Fig. 7. Voltage vs. Power

TABLE I. COMPARISON OF POWERS WHEN THE SWITCH IS IN 0 AND 1 STATE

IRRADIATION LEVELS	POWER (W)	
	0 STATE	1 STATE
Rated	80	80
When a panel is fully shaded	60	40
When a panel is partially shaded	70	50

It is inferred from the table that under normal operating conditions the panel provides rated output. But, when one panel is fully or partially shaded the power output is reduced. When switching circuit is used the circuit reconfigures the panel quickly in series parallel combinations and extracts the maximum power thereby it enhances the power under shading.

V. CONCLUSION

It is inferred that when the panels are reconfigured under shading the maximum power is extracted. This model can also be used to identify crack and dust accumulation. This method produces increased power output. It is economically cheap. Shading levels are located exactly with the help of normal camera. When compared with existing models which detects only faults, this method locates different types of faults and also provides alternate path by changing the series connection to parallel thereby extracting the maximum power.

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