ISSN : 2347 - 8446 (Online)
ISSN : 2347 - 9817 (Print)

Analysis of Enivronmental Parameters Influencing Solar Cell Power Generation

[I]Asha Teja Bhattarusetty, [II]Niladri Shekar Dey, [III]K. Dasaradha Ramaiah
[I]Student of M.Tech, Specialization - Software Engineering,
Padmasri Dr.B.V.Raju Institute of Technology, Hyderabad, India
[II]Asst. Professor, Dept of IT, Padmasri Dr.B.V.Raju Institute of Technology
Hyderabad, India
[III]Professor, Dept of IT, Padmasri Dr.B.V.Raju Institute of Technology
Hyderabad, India

Abstract
Solar Energy is one of the alternative resource that can generate electricity using solar panels which converts the sun's energy to electricity. The performance of panels is to be tested before they are launched. Replacing a panel to test involves a lot of money and time. This project helps the user to predict the efficiency of the Solar panel and choose a best efficient panel to their climatic conditions. Here we consider three conditions Temperature, Irradiance and Wind Speed.

Keywords
Solar Panel, Temperature, Irradiance, Artificial Neural Network (ANN), Flume

I. Introduction

Solar cells produce energy which varies with the intensity of sunlight using a phenomenon known as photovoltaics. This is also known as photovoltaic effect. According to this phenomenon, the sunlight will be converted to electricity. A photovoltaic system includes solar panel that consists of photovoltaic modules which are an assembly of solar cells.
Solar cell efficiency depends on some factors like:

- Irradiance (Intensity of light)
- Temperature
- Wind speed
- Wind Direction
- Visibility

II. Why Cloud?

Cloud computing refers to the sharing of services in terms of software, sharing of infrastructure in terms of hardware resources and sharing of platform in terms of operating system environments so that the collective effort can make any customer application enabled for high availability, high performance, high mobility and less costly anywhere anytime.
We use cloud because of its centralized infrastructure, to increase dynamicity of our resources, to increase big load capacity, to increase efficiency in application and maintenance and also to increase consistency.
The concept of cloud computing has been considered for the project mainly because of two reasons:

A. Big Data Problem

Nowadays, the world generates one petabyte of data every 11 seconds and the generated data from multiple sources give rise to „big data". Big data analysis is a process of analyzing three characteristics of data namely volume, variety and velocity.
The big data issue related to the project is:
The input, output parameters and past results must be stored, manipulated for analysis purpose. Trapping data from real time solar cell systems will be "big" enough to handle by normal relational data base systems.
To overcome the issue we need to use technical skills that will discover, process and analyze the massive data and also need to have the knowledge of big data architectures.

1. Apache Hadoop Using Flume

Flume allows:

- Stream data from multiple sources into Hadoop for analysis
- Collect high-volume Web logs in real time
- Insulate themselves from transient spikes when the rate of incoming data exceeds the rate at which data can be written to the destination
- Guarantee data delivery
- Scale horizontally to handle additional data volume

So in our project we aslo need this kind of features so flume using hadoop will be more reliable and his will overcome the big data issue.

B. Scaling

The use of an SQL-based database with strict consistency requirements in each of these applications both limits their ability to scale. To overcome this limitation use of NO-SQL technologies is beneficial.

III. Implementation

The logic is as follows:
The Solar cell system input parameters that is taken into consideration are Irradiance (I), Temperature (T), Wind Speed (WS), Wind Direction (WD) and the output parameters are Voltage (V), Current (C), Watt (W).
The system is implemented as follows:

A. Finding Past Results

The past data has to be collected in order to estimate the future results. An equation must be formulated so that it will take the input parameters and will determine the output parameters. The input parameters must be compared in the database, if there is a match then it will output the values of the output parameters. If not match then there is a need to do calculation with the formulation.
New output=old input+input+Θ (desired-output)*input
Where Θ is the learning rate parameter. The new output is stored in the database for future references.

B. Prediction on Future Data

The difference that is obtained while calculating the results is considered. Then for the given input parameters in the future date we need to calculate the output parameters and in addition to it the difference will be added in order to get the approximate result.
The predicted outputs for the future data will be calculated using the following formulations:-
1. Calculation of standard current using the formula:
voc_comp = (voc -(voc*c*(b-25)))
2. Voltage calculation of the open circuit
isc_comp = (isc* a/1000)*(isc* a/1000)*d*(b-25)
3. Current calculation for each solar module
imp_comp = (imp+(imp*isc*(b-25)))
4. Calculation of maximum power generation
pmax_comp = pmax-(pmax*e*(b-25))
5. Calculation of voltage at each solar module
vmp_comp = pmax_comp/imax_comp

C. Training

Artificial Intelligence

Artificial Intelligence is phenomenon that deals with finding of solutions for complex problems and it requires intelligence which will be gained through a most efficient process known as learning. The process of learning is an efficient approach to predict the results and moreover saves time and energy of research work. So there is need for training of data and here is a method for training outputs from solar cell power generation systems. The above formulas for prediction can be summarized as:
For prediction the formulation is:

$$a_i = \sum_{i=0}^{n} u_i w_i \pm \theta$$

where,
"θ" represents threshold in artificial neuron
"w_i" represents weights.
"u_i" represents input values.
For weight modification the formulation is:

$$\theta(t+1) = \theta(t) \pm \frac{\Delta\theta}{\Delta t}$$

where,
"θ (t+1)" represents the next threshold in an artificial neuron
"θ (t)" represents the present threshold in an artificial neuron

IV. Results

For finding out the results the formulations mentioned in this paper are applied on a test-bed solar panel. The actual readings (inputs / outputs) were taken into the database for a period of 1 year which is the initial data table. This data was used to create a real-time predictive model that resides on the cloud. The logic is to calculate predictive output values using artificial inputs. The test output thus obtained was compared with actual outputs to validate the model. An accuracy of above 98% was obtained using this predictive model.

Table 1: Input Parameters

Input Parameters		
temperature	irradiance	Wind speed
27.333	864.174	2.678
27.552	786.549	1.879
27.833	1153.793	4.276
27.58	1118.05	5.874
27.625	1166.908	1.879

Output Parameters							
Actual Values				Predicted Values			
dcamps(act)	dcvolts(act)	watts(act)	energy(act)	dc amps	dc volts	watts	energy
7.08	187.754	1329.762	22.1627	6.356	192.8	1225.926	20.4321
5.05	197.235	995.999	16.5999833	4.435	207.324	919.48194	15.324699
9.334	181.494	1694.475	28.24125	8.935	198.554	1774.08	29.568
8.982	180.077	1616.627	26.9437833	7.996	191.234	1529.1071	25.485118
7.459	203.574	1518.514	25.3085667	7.123	210.78	1501.3859	25.023099

Table2: Output Parameters

V. Conclusion

In this paper, we present a predictive model to test the efficiency of the Solar panel. This system not only predicts data, but also provides functions for further information by data mining and friendly user interface display. The performance of Solar panel is analyzed on a recorded dataset, which is large in volume and the learning of ANN is well studied. and a comparison of the actual value to the predicted values are shown above. With this the panel may be tested before it is launched.

VI. Future Work

In this paper, we have demonstrated predictions using Artificial neural networks..the data can be further analyzed to predict the temperature for mere future i.e.,, future weather prediction.

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