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DESIGN OF MPPT BASED SOLAR CELL WITH VARIABLE IRRIADIATION

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ABSTRACT:. This light usually comes from sun. Animal get their food from plants or by eating other animals that feed on plants. Plants and animals also need some heat to stay alive. Thus plants are store houses of solar energy. The solar energy that falls on India in one minute is enough to supply the energy needs of our country for one day. Man has made very little use of this enormous amount of solar energy that reaches the earth. Energy from the sun is called solar energy. The Sun's energy comes from nuclear fusion reaction that takes place deep in the sun. Hydrogen nucleus fuses into helium nucleus. The energy from these reactions flow out from the sun and escape into space. Solar energy is sometimes called radiant energy. These are different kinds of radiant energy emitted by sun. The most important are light infrared rays. Ultra violet rays, and X- Rays. This paper proposes an advanced algorithm for tracking the maximum power point of a solar PV panel. Solar PV cells have a non-linear V-I characteristic with a distinct MPP which depends on environmental factors such as temperature and irradiation. Since the power output varies, based on the irradiation and cell temperature, appropriate algorithms must be utilized to track the (MPP) and maintain the operation of the system in it. Matlab/Simulink is used to establish a model of photovoltaic system with (MPPT) function.

KEYWORDS: Solar cell, PV System, MPPT, P&O.

I.INTRODUCTION

. There have been advances in renewable energy resources that extract power from various natural sources like the Sun, Wind, Ocean and many more. Sun is a readily available source of energy and the scope of solar power generation is very huge.It has been forecasted that by 2050, global solar energy production could supply 7000 TWh of energy. Thus, it is necessary to constantly devise new methods that can increase the power output of the solar energy harvester. The simplest way to do so is to use mechanical tracking such that the incident light offers maximum solar energy to the apparatus. Mechanical tracking has been discussed in the literature and has been proven to be a better method than fixed systems. However, the operating voltage has to also be tracked so that maximum electrical power can be obtained from a solar panel. The point at which maximum power is obtained is called Maximum Power Point (MPP).

There are various means to make the solar panels operate at the MPP. The help of power electronic converters have been considered to adjust the operating voltage as they are easy to control and an interface is anyway required to connect the solar panels to the grid. The most commonly used method is the Perturb and Observe (P&O) algorithm which constantly compares the current operating point with the previous operating point and then decides whether to increase or decrease the operating voltage. This comparison is carried out until MPP is reached. However, this method tends to oscillate about the MPP which results in the loss of energy that could have been otherwise generated. The paper proposes an algorithm that eliminate problem of oscillation about the MPP.

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It's certainly clear that fossil fuels are mangling the climate and that the status quo is unsustainable. There is now a broad scientific consensus that the world needs to reduce greenhouse gas emissions more than 25 percent by 2020 -- and more than 80 percent by 2050. The idea of harnessing the sun's power has been around for ages. The basic process is simple. Solar collectors concentrate the sunlight that falls on them and convert it to energy. Solar power is a feasible way to supplement power in cities. In rural areas, where the cost of running power lines increases. Solar power, a clean renewable resource with zero emission, has got tremendous potential of energy which can be harnessed using a variety of devices. With recent developments, solar energy systems are easily available for industrial and domestic use with the added advantage of minimum maintenance. Solar energy could be made financially viable with government tax incentives and rebates. An exclusive solar generation system of capacity 250KWh per month would cost around Rs. 20 lakhs, with present pricing and taxes (2013). Most of the developed countries are switching over to solar energy as one of the prime renewable energy source.

II. MODELLING OF PV PANEL

Typically, a solar cell can be modeled by a current source and an inverted diodeconnectedinparalleltoit.Ithasitsownseriesandparallelresistance.Seriesresistance is due to hindrance in the path of flow of electrons from n top junction and parallel resistance is due to the leakage current.

When irradiance hits the surface of solar PV cell, an electrical field is generated inside the cell. As seen in Fig.3 this process separates positive and negative charge carriers in an absorbing material (joining p-type and n-type). In the presence of an electric field, these charges can produce a current that can be used in an external circuit. This generated current depends on the intensity of the incident radiation. The higher the level of light intensity, the more electrons can be unleashed from the surface, the more current is generated.

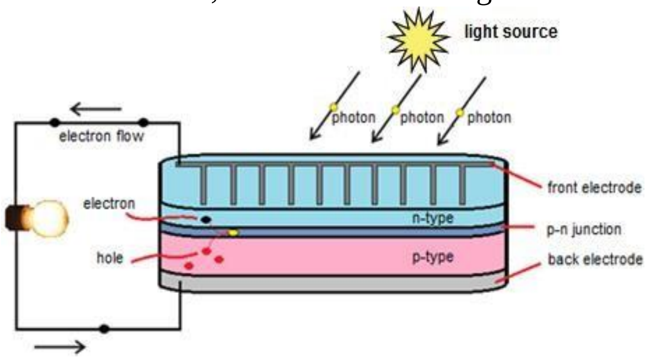

Figure 1.Schematic Cross-Section of a Typical Solar Cell

The most important component that affects the accuracy of the simulation is the PVcellmodel.ModellingofPVcellinvolvestheestimationoftheI-VandP-Vcharacteristics curves to emulate the real cell under various environmental conditions. An ideal solar cell is modeled by a current source in parallel with a diode. However no solar cell is ideal and thereby shunt and series resistances are added to the model as shown in theFig.2

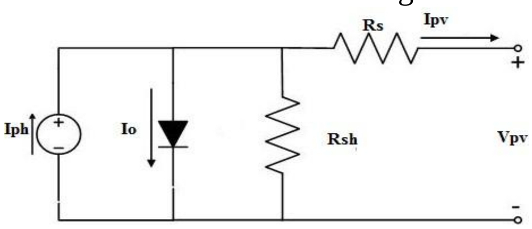

Figure 2. Equivalent Circuit of PV Cell

The current source Ipv represents the cell photo current, Rsh and Rs are used to represent the intrinsic series and shunt resistance of the cell respectively. Usually the value of Rsh is very large and that of Rs is very small, hence they may be neglected to simplify the analysis.

The resultant ideal voltage-current characteristic of a photovoltaic cell is given by the relation below and illustrated by the figure above.

$$I=I_{ph}-I_D$$

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$$I = I_{ph} - I_0\left[\exp\left(\frac{q(V+R_S I)}{Ak_B T}\right) - 1\right] - \frac{V+R_S I}{R_{sh}}$$

Where,

Iph = photocurrent,
ID = diode current,
I0 = saturation current,
A = ideality factor,
q = electronic charge 1.6x10-9,
kB = Boltzmann's gas constant (1.38x10-23),
T = cell temperature,
Rs = series resistance,
Rsh = shunt resistance,
I = cell current,
V = cell voltage

The power output of a solar cell is given by

PPV = VPV * IPV

Where,

IPV = Output current of solar cell (A).
VPV = Solar cell operating voltage (V).
PPV =Output power of solar cell (W).

The power-voltage (P-V) characteristic of a photovoltaic module operating at a standard irradiance of 1000 W/m2 and temperature of 25oC is shown below.

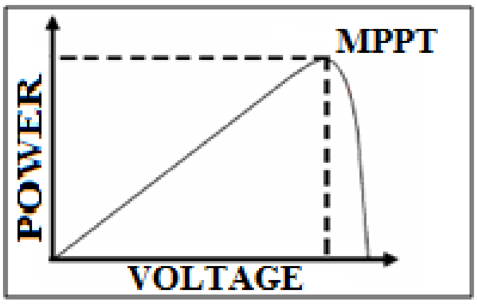

Figure 3. Power-Voltage (PV) Characteristic of a Photovoltaic Module.

III. MAXIMUM POWER POINT TRACKING ALGORITHM

Atypicalsolarpanelconvertsonly30to40percent oftheincidentsolarirradiationinto electrical energy. Maximum power point tracking technique is used to improve the efficiency of the solar panel.

According to Maximum Power Transfer theorem, the power output of a circuit is maximum when the The veninimpedance of the circuit (source impedance) matches with the load impedance. Hence our problem of tracking the maximum power point reduces to an impedance matching problem.

In the source side we are using a boost convertor connected to a solar panel in order to enhance the output voltage so that it can be used for different applications like motor load. By changing the duty cycle of the boost converter appropriately we can match the source impedance with that of the load impedance.

1) Perturb & Observe

Perturb & Observe (P&O) is the simplest method. In this we use only one sensor, that the voltage sensor, to sense the PV array voltage and so the cost of implementationislessandhenceeasytoimplement.Thetimecomplexityofthisalgorithmisveryless but on reaching very close to the MPP it doesn't stop at the MPP and keeps on perturbing on both the directions. When this happens the algorithm has reached very close to the MPP and we can set an appropriate error limit or can use a wait function which ends up increasing the time complexity of the algorithm. However the method does not take account of the rapid change of irradiation level (due to which

MPPT changes) and considers it as a change in MPP due to perturbation and ends upcalculatingthewrongMPP.Toavoidthisproblemwecanuseincrementalconductancemethod.

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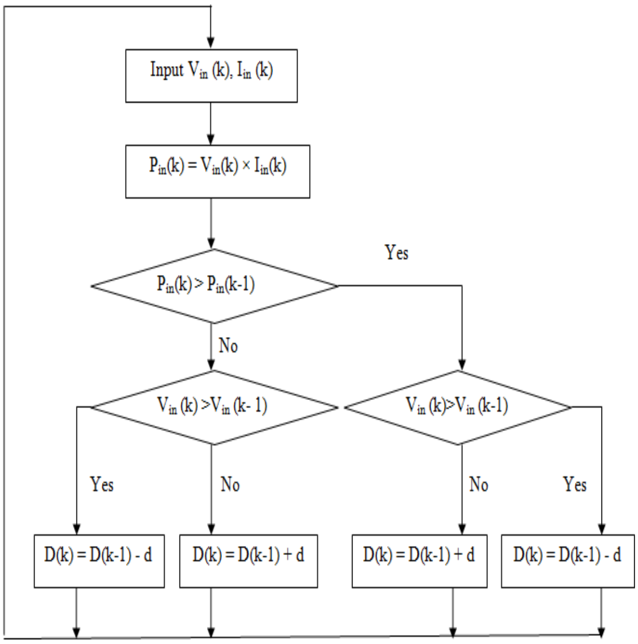


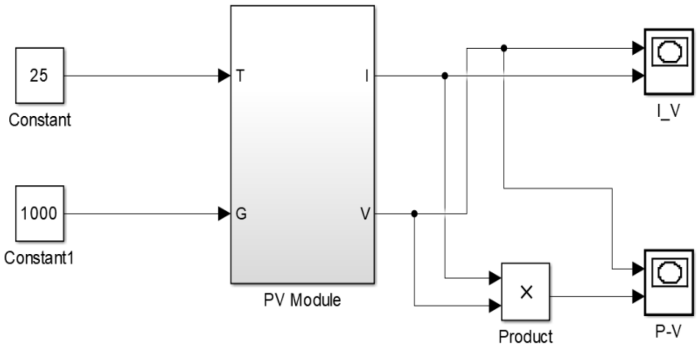
Figure 4.Flowchart of Perturb &Observe Algorithm

IV. SIMULATION RESULTS

Construction of PV Module Using MATLAB

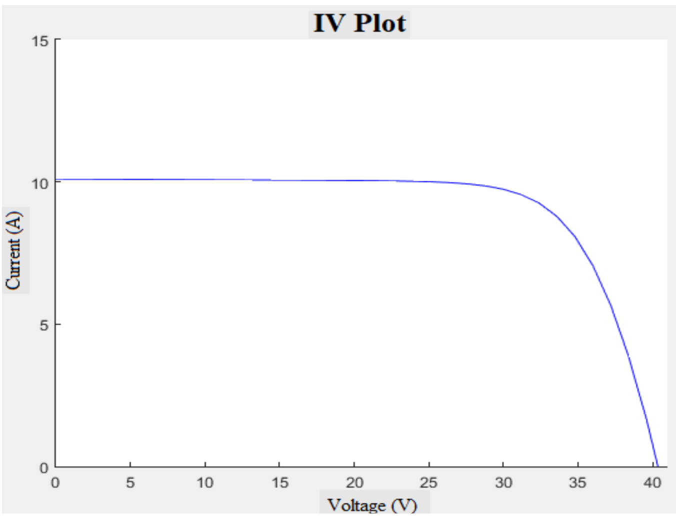
TABLE 1. Solar Cell Parameters [13]

Parameter	Variable	Specifications
Open Circuit Voltage	VOC	40.4Volts
Short Circuit Current	ISC	10.11Amps
VoltageatMPP(Calculated)	V_M	34.0013Volts
CurrentatMPP(Calculated)	I_M	9.4614Amps
PoweratMPP(Calculated)	P_M	321Watts
Diode Saturation Current	I_d	300nano-Amp
Diode Ideality Factor	n	1.5
Number of solar PV cells in a panel	N	60
Thermal Voltage	V_t	0.0259Volts

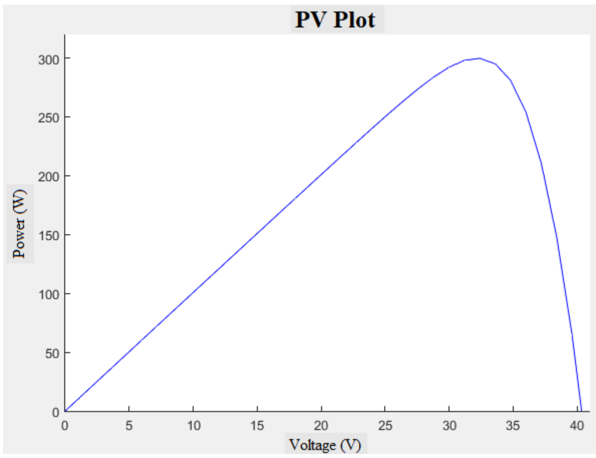


Figuer-5: Construction of PV Module (Main Block) Using MATLAB

Output at 1000W/m^2 Irradiance



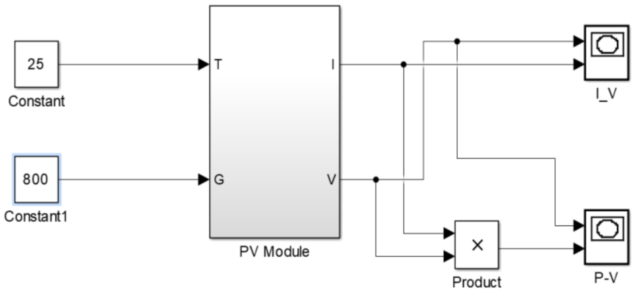
Figuer-6:IVcharacteristics



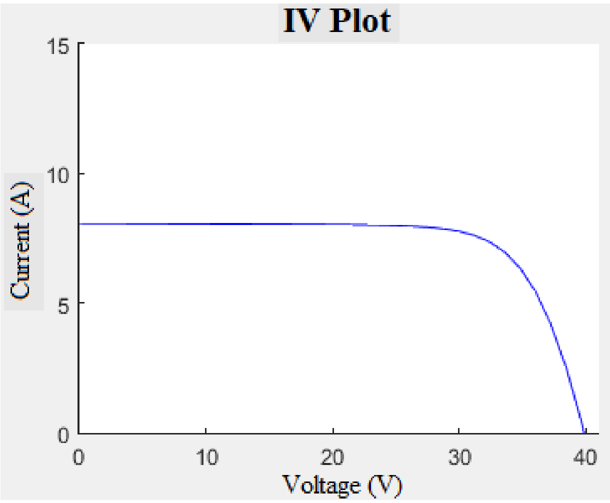
Figuer-7: PV characteristics

From the above figure maximum power is 300 W which is obtained at 33V and the current is 9.09A

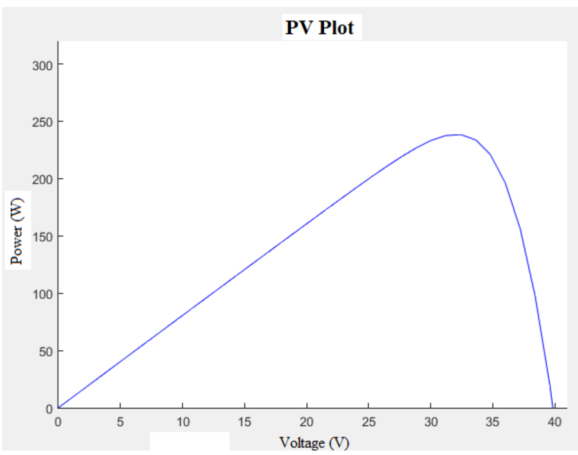
Output at 800W/m^2 Irradiance



Figuer-8: Construction of PV Module for 800W/m^2 Irradiance



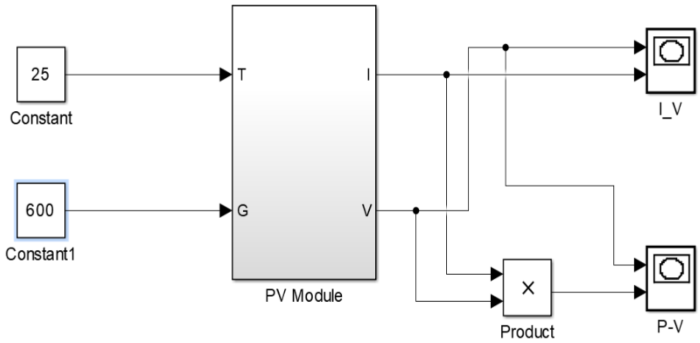
Figuer-9:IVcharacteristics



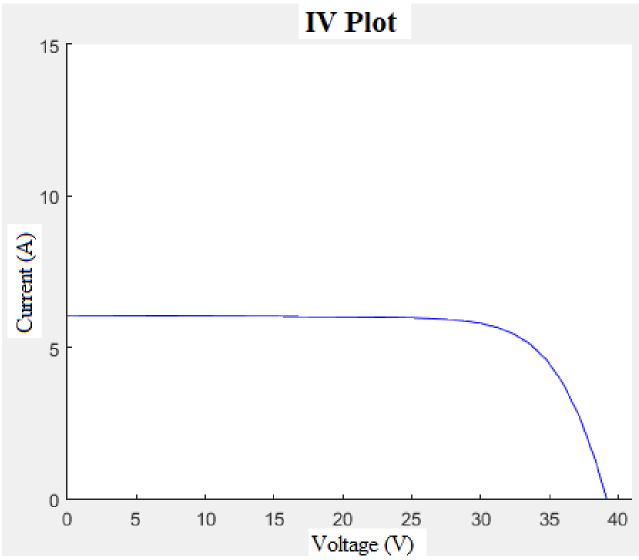
Figuer-10: PV characteristics

From the above figure maximum power is 250 W which is obtained at 32V. The current is 7.8A

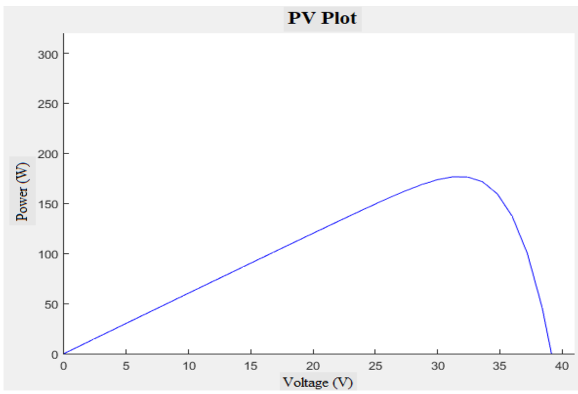
Output at 600W/m^2 Irradiance



Figuer-11: Construction of PV Module for 600W/m^2 Irradiance



Figuer-12:IVcharacteristics



Figuer-13: PV characteristics

From the above figure maximum power is 200 W which is obtained at 31V. The current is 6.4A

V. CONCLUSION

In summary, this study presents a general purposes PV simulation module and its application examples in Mat lab/Simulink simulation environment. This PV model is easy to configure for a desired PV response characteristics and it directly connects to Sim Power Systems electrical circuit for transient response analyses. The PV module has two main parts: A behavioral model of PV cells and a power–limited electrical driver for circuit connection. The behavioral model estimates voltage and current potential of PV panel for a given solar radiation (G) and module temperature (Tc) conditions.Thepower–limitedelectricaldriverimplementsarelevantelectricalresponse on the load. The proposed PV module can be employed in transient analysis of power system supplied with PV panels. It is also useful for testing MPP tracking methods. Nowadays, solar energy integration in micro grids is becoming primary concern of power system industry. Modeling renewable energy sources for a large-scale power system integration simulation is more important today, because thesesimulationtoolswillbeapartofoptimaldesignandintelligentmanagementprocess.

And thus conclusion is drawn

[1] In this project 60 cells are used in series which are connected to constant irradiance. It gives the maximum output up to 300watt.

[2] Maximum output is generated by the photo voltaic array when irradiance is 1000W/m^2.

Future Scope

This photovoltaic based system project demonstration to utilize solar power for does desire work. With increase demand of energy, energy shortage is big problem this can be minimizing by increased usage of non conventional energy sources. In most parts of India, clear sunny weather is experienced 250 to 300 a year. India is having 5 trillionkWh/year theoretical potential. Most of the country receives more than 4 kWh/m2/day and photovoltaic array is best way to generate electricity from solar. So by maximize usage of photovoltaic array India can satisfy it power demand. Due to this future scope of photovoltaic based system is very bright in India but this project can be most suitable and would be use below to application in future.

- After increase size of photovoltaic array and photovoltaic output power this project would be use in farm or well to drawn pump. To use this project in thisapplicationisrequirearrangementwhichpreventconnectionofmotortophotovoltaicarraywhenirradianceisbelowonelevel.
- This project may more efficient if it integrated with wind mill so solar-wind integrated system found which is more efficient.

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