Implementation of Perturb & Observe Based MPPT for Grid Connected Solar Photovoltaic System

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Abstract- The requirement of renewable energy has become a critical topic in modern days, due to increasing problem like global warming & other environmental issues. The generation of electricity from photovoltaic [PV] arrays has been increasingly considered as a prominent option to fossil fuels.. With greater research, alternative renewable sources like wind, water, geothermal &solar energy have become increasingly important for electric power generation. Although PV cells are not new, but their use is becoming more common, also practical, & useful for all the people worldwide. In this paper Solar PV cell system is modeled; and Perturb & observe based MPPT techniques are used, so as to keep the output of Solar PV system constant, so that energy can be harnessed for various application. The performance of proposed system is judged under varying solar insolation and with impacts of loads.

Keywords- Solar Photovoltaic, Maximum Power Point Tracker, Insolation, Irradiance, Perturb and Observation.

I. INTRODUCTION

The highly increased demand of energy whose cost is less and concern for environmental issues, which leads to various problems like health hazards, acid rains etc. has shown interest in utilization of renewable sources of energy like solar energy. The non- ending, freely available as well as abundantly presence of solar energy can be easily converted into electrical energy. A PV structure with various benefits such as cost of maintenance is less, no moving or rotating parts, and a pollution-free energy conversion process. However, the demerits found in the PV source about its ineffectiveness at nights or when isolation is low and also during partial shading condition.

The initial high capital cost is another hurdle at the time of installation, of PV systems. The above demerits are not withstanding. The emergence of PV systems is very popular alternatives to conventional energy, thanks to the advancement in technology and favorable government policies in several countries. The challenging condition in application of PV as shown by P-V non linear Current–voltage [I–V] characteristics. Furthermore since its characteristics totally depends on various changing weather condition because of which a change in Insolation, temperature and partial shading. As the above parameters vary continuously thus variation occurs faster, so the MPP does the same, maintaining power at its maximum value Including cost of installation is high in case of PV source and low value of energy conversion and thus the efficiency is also reduced, it is suitable to operate, the PV system at its MPP value so that highest power is achieved.

II. MAXIMUM POWER POINT TRACKER

Solar radiation when directly changed into electrical energy, obtained from cells of PV has a number of merits. A photo-voltaic [PV] module has non linear characteristics and its [P–V] quality study, makes clear that there is only one point, [P max] at which it delivers the maximum power. Depending on load variation, highest value of power is obtained and accordingly efficiency is optimized for transferring energy.

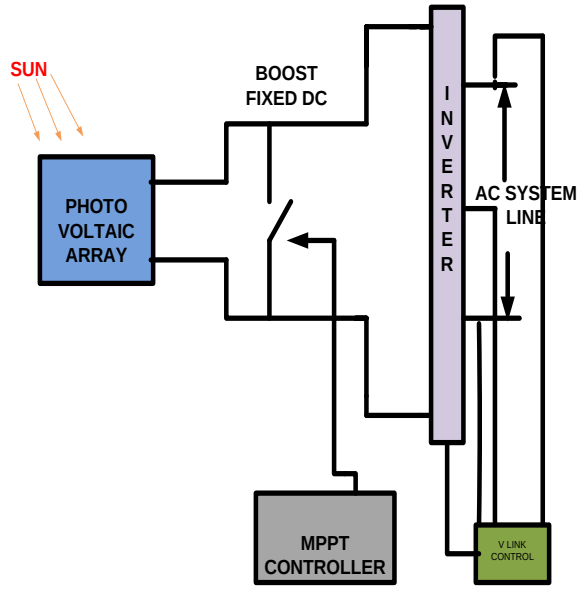

Fig 1: Maximum Power Point Tracker System

Tracking of highest power point [MPP] of a Solar PV array is usually an important for the PV system. There are various classic algorithms so that maximum power can be tracked they are constant voltage method, Hill climbing, Constant current ,Incremental conductance ,Perturb and observation etc specifically used is Inc and Perturb-and-observation [P&O] .The algorithms are dependent on technology, which regulates PV array's voltage by maintaining optimal set point. Various methods have been developed & implemented. The above methods varies in its complexity, the kind of sensors, its working speed, its cost, to the range at which it efficiently, implementation of

hardware, its popularity, and various other respect. Various other tracking schemes is brought. Among which the better option can be Perturb and observation [P&O] and Incremental conductance.

This paper Solar PV system is modeled; and Perturb & observe based MPPT techniques are used so as to output obtained from solar system remains constant, so that it can be harnessed for various application. The performance of proposed system is judged under varying solar insolation and with impacts of loads. This analysis is so designed so that MPPT can achieve an optimal algorithm. This analysis is so designed to find out the most suitable method for MPPT in order achieve an optimal algorithm.

A. Function of MPPT

The nature of MPPT is mostly influenced by three factors of environmental changes. The quality of each cells of solar are chiefly influenced by –a)Insolation b)Temperature c) Partial criteria of shading. Their impacts like that of an environmental affects various factor which are shown under.

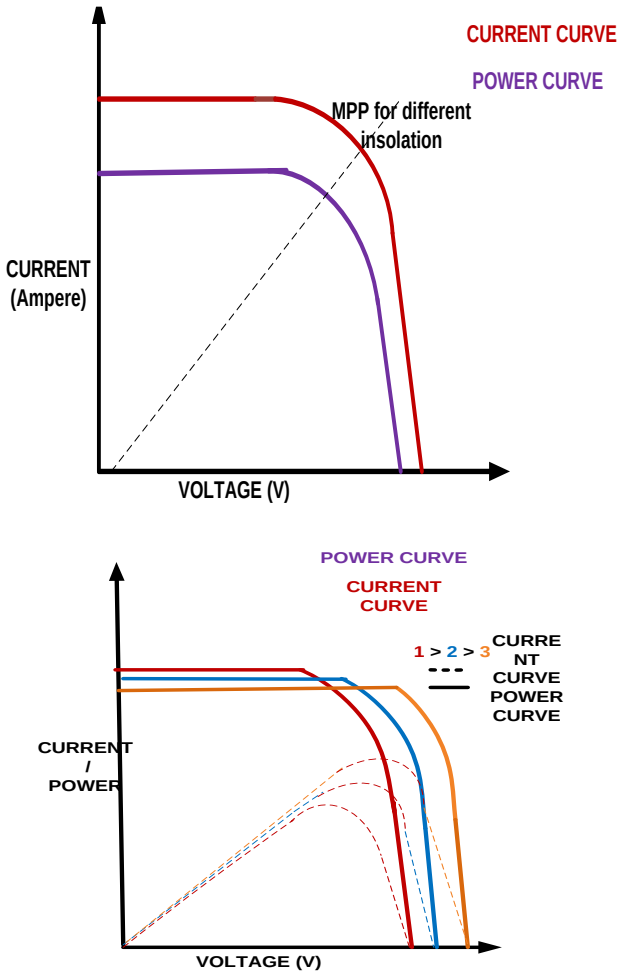

Fig 2: Solar I–V and P–V curve (a) with different temperature insolation and (b) MPP for different Insolation

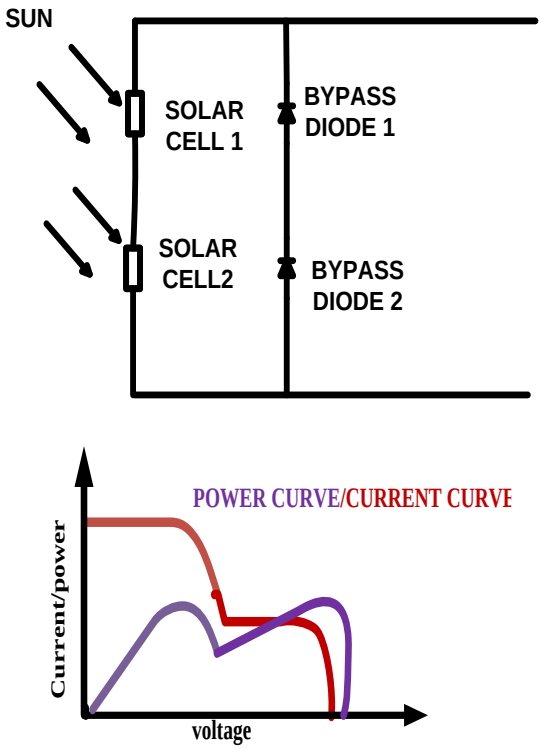

Fig 3. (a) Operation of solar P-V under partial shading (b) P–V graph under same partial shading criteria

From fig 3(a) : Connected solar cell with its terminal V: V1 andV2, overall power P and total V Thus it is seen that all these time variant and environmental dependent factors shows a major contribution in the adjustments of the operation point or highest or maximum power point tracker [MPP] throughout the whole day. Its behavior i.e. high power point tracker is there to make a shift in the continuously varying operating point [P max] here PV module delivers highest power. Photons energy is defined on the wavelength and the frequency; also calculate it from the Einstein's law, which is:

$E = h\upsilon$ (1)

E - energy of photon

H -Plank's constant = 6.626×10 – 34 Js

Y -Photon frequency

Photon frequency Released electrons obtained by such process of a photo electric effect is known as photo electron. The amount of energy required for the releasing the valence electron, from the atom on which photon are collided is known a work out Wi and it defines on the kind of material on which all such process of "photo electric effect", is being done. The process is as follow:

$hv = Wi + Ekin$ Where, (2)

hv - Photon energy

Wi, - work out

Ekin - kinetic energy of emitted

B. Characteristic of Photo-Voltaic Cell

The basic circuit diagram represents overall working of the MPPT method. It contains a current source which represents the photocurrent (I-ph) i.e. the current when solar radiation falls on the panel and current in diode,(I-d) which represents the saturation current in diode. It is that value of a current when solar radiation is absent on the solar panel. The load current value is kept at zero and output current flowing through the panel (I) and output voltage across the panel (Voc)is given as feedback signal to the MPPT.

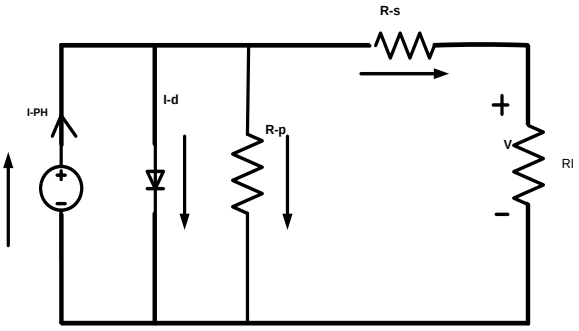

Fig 4 Equivalent circuit of photo voltage cell.

Applying Kirchhoff's law to the node where Iph, diode, RP and Rs meet, we get

$$I = I_{p⎚} - I_s\left(exp^{\frac{q(V+IRs)}{NKT}-1}\right) - (V + IR_s)/R_{sh} \quad \textbf{(3)}$$

$$I = n_p I_{ph} - n_p I_s\left(exp^{\frac{q(V+IRs)}{(NKT)n_s}-1}\right) \quad \textbf{(4)}$$

$$I_d = I_s\left(exp^{\frac{q(V+IRs)}{NKT}-1}\right) \quad \textbf{(5)}$$

Where RS = intrinsic sequence resistance, value is highly small, Rp = shunt/parallel resistance having high value, Iph = Isolation I, I = Cell I, Io = Reverse saturation I,V = Cell's voltage, Vt is the Thermal voltage [KT/q], K =Boltzmann constant, T = Temperature (Kelvin), q = electron charge.

C. Perturb & Observe [P&O] Algorithm

Solar cell power module changes continuously, in case of power increment, the perturbation will be continued in (same) as previous direction. The power will then at next step will decrease as soon as maximum power is attained, and after this perturbation will reverse. The algorithm starts oscillating around its highest point as soon as the steady value is reached. Size of perturbation is kept very small, thus power variation small. Even then this algorithm is important in mega service as it is simple. The algorithm can be understood from study of flow chart, which is shown below:

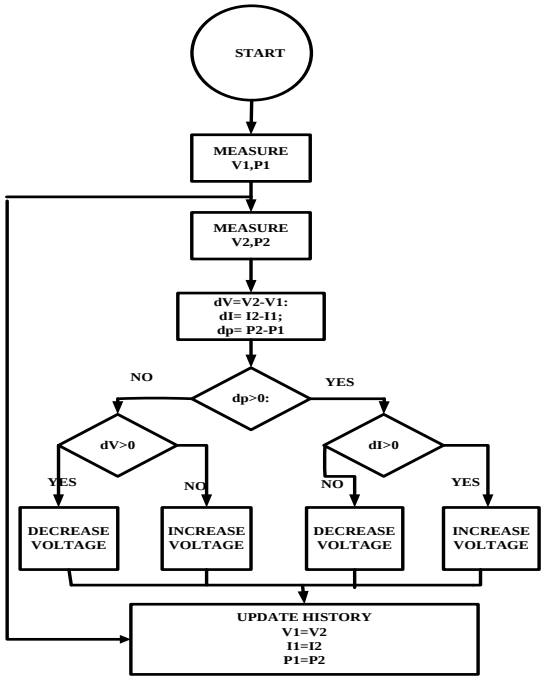

Fig 5 : Flow chart of Perturbation and observation

TABLE 1: FOR PERTURB & OBSERVATION METHOD

Sign of dv	Sign of dp	Direction of next step.
Positive	Positive	+C
Negative	Negative	+C
Negative	Positive	-C
Positive	Negative	-C

III. SIMULATIONS AND RESULTS

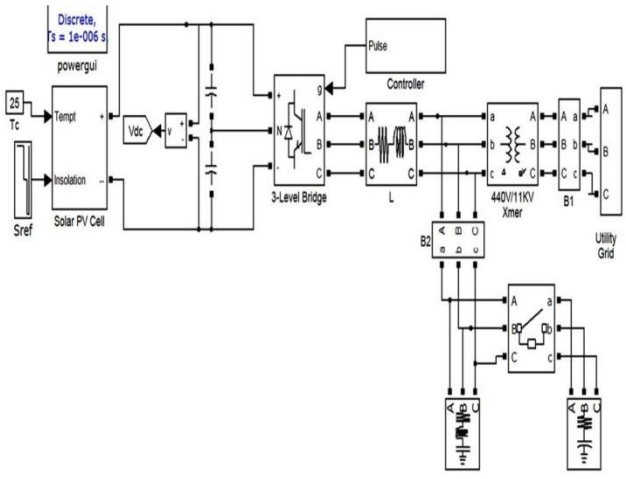

Fig 6: Simulink model of Grid connected Solar PV system

The PV array simulation model shown below in fig 1,Since the Irradiance effect is not constant all the time but do changes, therefore different Irradiance value is

taken at 1000 w/m2,800 w/m2,600 w/m2 and again at 1000 w/m2.and the temperature constant is 25.

The output obtained from Solar PV cell is fed into Inverter which then changes the Solar PV cell outut voltage into suitable AC voltage and frequency.A 33/11kv grid which is connected in parallel to the solar PV model, then 11kv voltage is stepped down to suitable voltage i.e 440 V .A load of 2kv connected intially and an additional load of 5kv is also connected by three phase circuit breaker.

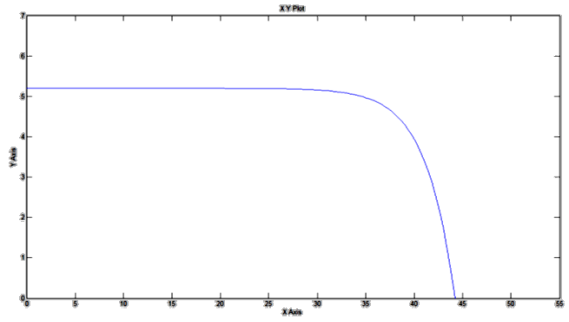

Fig:7 P-V curve

Above shown PV curve shows that, MPPT always tracks maximum current though the voltage varies.

The maximum voltage i.e VOC=44V. However the current is maintained at its maximum value i.e ISC =5.2A.

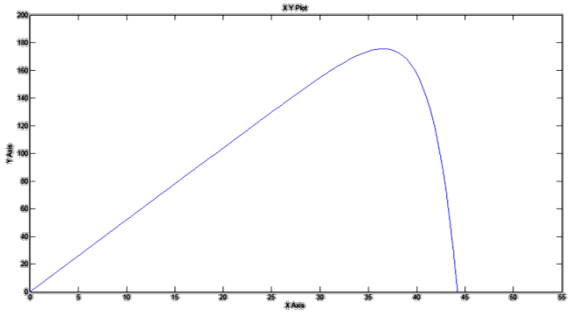

Fig 8: I-V curve

Above figures shows that MPPT maintains maximum Power i.e (short circuit current) ISC= 170A, and VOC=44V. and power obtained is 5.2 KW.

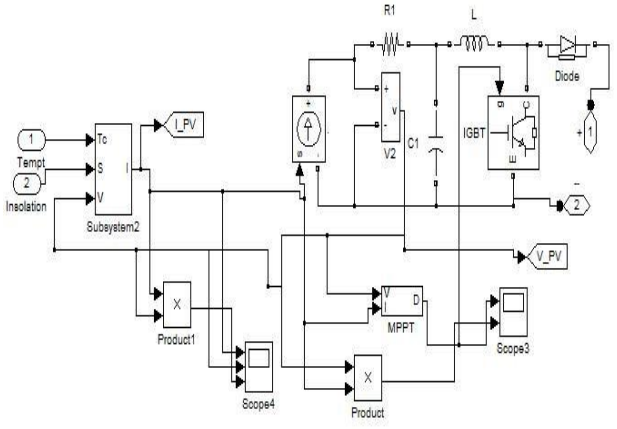

Fig 9: Simulink model for Solar PV cell

Simulation model for Solar PV cell shown in fig 2, An input with Irradinace 1000 w/m2,800 w/m2,600 w/m2 and again at 1000 w/m2.and the temperature constant is 25.

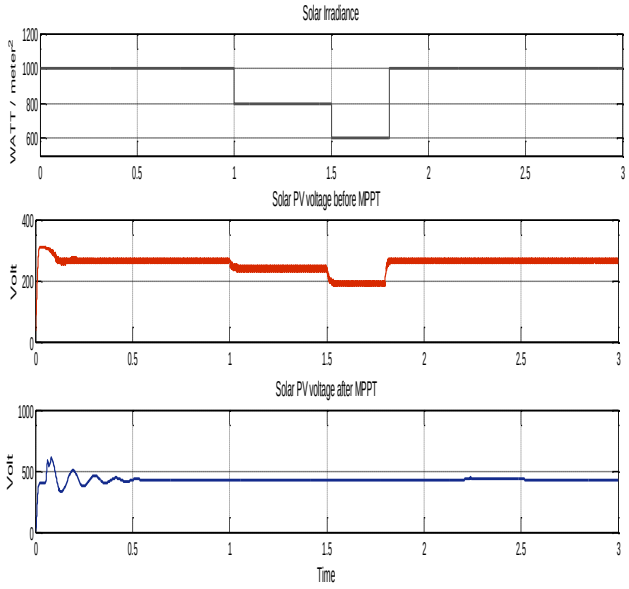

Fig:10 Effect of solar Irradinace on the PV cell voltage before and after MPPT

When Irradinace = 1000 w/m2,from 0 to1second PV voltage before MPPT is 40 V,and after MPPT it variates about550 V.As irradince drops to 800 w/m2, (t)=1 to 1.5sec. Voltage also goes down by 38 V and and after MPPT 600V.Further whenIrradince reduced to 600 w/m2 from t=1.5 to 1.8 sec,Voltage before MPPT goes more down to 22V.But clearly Voltage after MPPT is still 600V.And as Irradince increased to 1000 w/m2 from 1.8 to 3 sec,Voltage before MPPT is increased with it and becomes 40V again, but after MPPT it is still maintained to 600V.

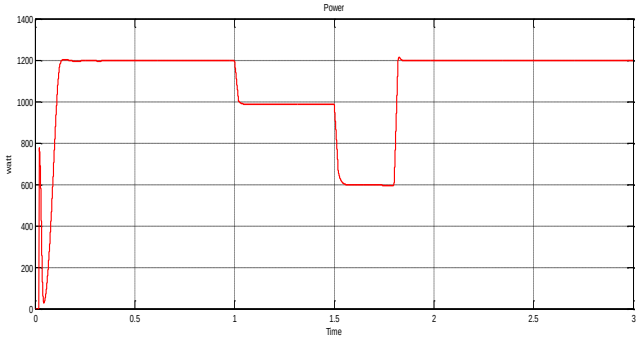

Fig 11: Power obtained from PV cell

Since Irradiance is 1000 watt/meter square, so the power 175 watt from 0 to 1second,as Irr value lowers at 800 watt/meter square, and so the power drops to 148watt, from 1 to 1.5 second, Similarly between 1.5 to 1.8 second power drops to75 watt, since irradiance goes down to 600 watt per meter square. Now again as Irr increases &

reaches 1000w/m^2 with time&so the power output also increases to 175 watt.

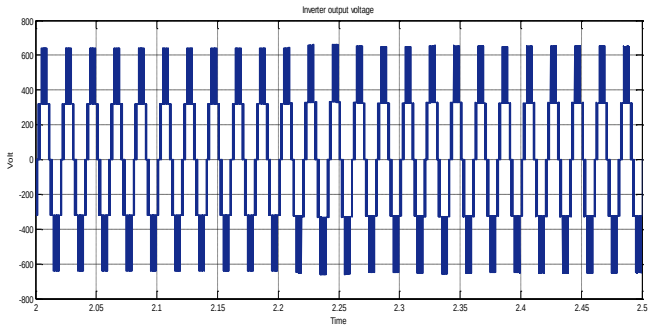

Fig12: Inverter Voltage

As shown in fig 8; Simulation model an Inverter is placed for changing the DC power obtained from Solar PV cell into AC suitable power required by the load. The results of simulation model for inverter output voltage is shown in Fig. 12.

IV. CONCLUSION

The perturb and observe based maximum power point algorithm is simulated under different loading condition with variation in solar radiations. When environmental conditions are constant or change slowly, the P&O based MPPT oscillates close to MPP accurately and give maximum output power in every condition.

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