Perturb and Observe Method MATLAB Simulink and Design of PV System Using Buck Boost Converter

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Abstract— **This paper is a simulation study of maximum power point tracking (MPPT) for photovoltaic systems using perturb and observe algorithm. Maximum power point tracking (MPPT) is used in photovoltaic (PV) systems to maximize the photovoltaic array output power, irrespective of the temperature and radiation conditions and of the load electrical characteristics the PV array output power is used to directly control the dc/dc converter, thus reducing the complexity of the system.**

Index Terms—**MPPT(maximum power point tracking), Perturb and Observe method ,Photovoltaic system ,Simulation**

I. INTRODUCTION

The rapid increase in the demand for electricity and the recent change in the environmental conditions such as global warming led to a need for a new source of energy that is cheaper and sustainable with less carbon emissions. Solar energy has offered promising results in the quest of finding the solution to the problem. The harnessing of solar energy using PV modules comes with its own problems that arise from the change in insulation conditions. These changes in insulation conditions severely affect the efficiency and output power of the PV modules. A photovoltaic (PV) system directly converts sunlight into electricity. The obtained energy depends on solar radiation, temperature and the voltage produced in the photovoltaic module. The voltage and current available at the terminals of a PV device may directly feed small loads.

II. PV ARRAY

A solar panel cell basically is a p-n semiconductor junction. When exposed to the light, a DC current is generated. The generated current varies linearly with the solar irradiance [1]. The equivalent electrical circuit of an ideal solar cell can be treated as a current source parallel with a diode shown in figure 1.
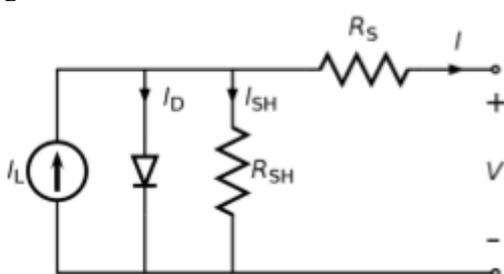

Fig 1:- Equivalent Model Of PV cell

The I-V characteristics of the equivalent solar cell circuit can be determined by following equations [1]. The current through diode is given by:

$$ID = I \; [\; \exp (q(V + I\,RS)/KT) – 1] \qquad (1)$$

While, the solar cell output current:

$$I = IL – ID – ISH \qquad (2)$$

$$I = IL – I \; [\; \exp (q(V + I\,RS)/KT)) – 1] – (V + IRS)/ RSH \qquad (3)$$

Where:

I : Solar cell current (A)

I: Light generated current (A) [Short circuit value assuming no series/ shunt resistance]

ID: Diode saturation current (A)

q : Electron charge (1.6×10-19 C)

K :Boltzman constant (1.38×10-23 J/K)

T : Cell temperature in Kelvin (K)

V : solar cell output voltage (V)

RS: Solar cell series resistance (Ω)

RSH: Solar cell shunt resistance (Ω)

III. DC-DC CONVERTER

A. Buck Converter

The buck converter can be found in the literature as the step down converter [2]. This gives a hint of its typical application of converting its input voltage into a lower output voltage, where the conversion ratio M = Vo/Vi varies with the duty ratio D of the switch [2, 3].

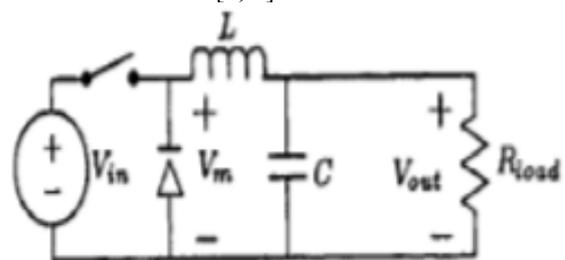Fig. 2: Ideal buck converter circuit

B. Boost Converter

The boost converter is also known as the step-up converter. The name implies its typically application of converting a low input-voltage to a high out-put voltage, essentially functioning like a reversed buck converter [2, 3].
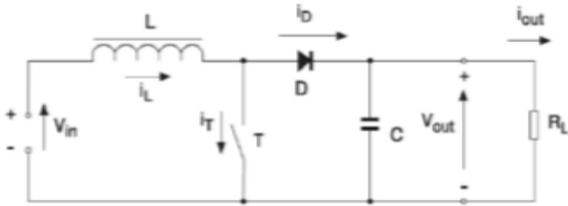

Fig. 3: Equivalent Circuit of a Boost Converter

IV.   PERTURB AND OBSERVE (P&O)

In this algorithm a slight perturbation is introduce system [4]. This perturbation causes the power of the solar module changes. If the power increases due to the perturbation then the perturbation is continued in that direction [4]. After the peak power is reached the power at the next instant decreases and hence after that the perturbation reverses. When the steady state is reached the algorithm oscillates around the peak point. In order to keep the power variation small the perturbation size is kept very small. A PI controller then acts moving the operating point of the module to that particular voltage level. It is observed that there some power loss due to this perturbation also the fails to track the power under fast varying atmospheric conditions. But still this algorithm is very popular and simple[4].
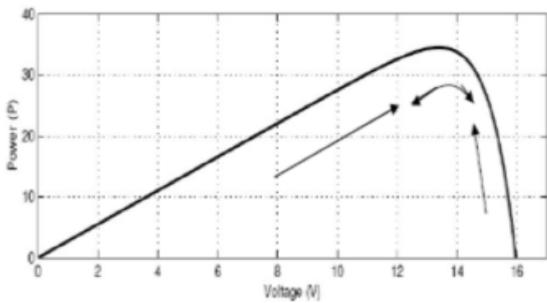

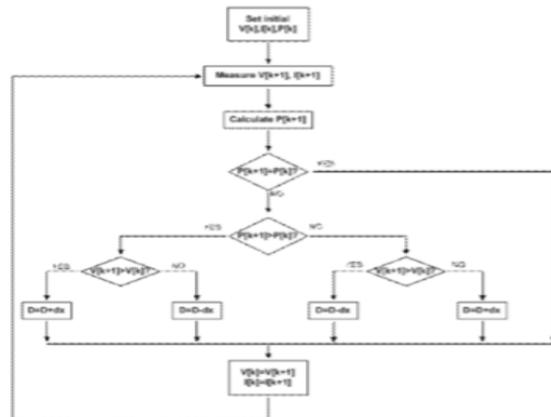Fig. 5: Graph Power versus Voltage for Perturb and Observe Algorithm [4]

Fig. 4 :-Flow diagram of P&O MPPT method
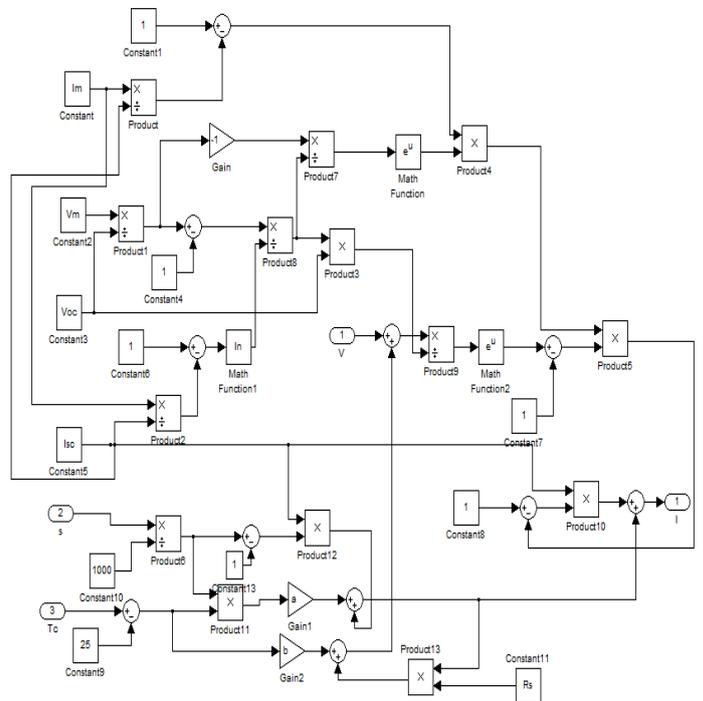
V.   SIMULATION DIAGRAM OF PV ARRAY

Fig. 6.Simulation model of photovoltaic array

The solar cell was modeled in the single diode format. This consists of a 0.1 ohm series resistance and an 8 ohm parallel resistance. This was modeled using the Sim Power System blocks in the MATLAB library. The Simulink model is as shown. A controlled current source is utilized to drive the solar cell. The control signal is provided by the buck boost converter unit. The buck boost converter takes into account the number of series connected, number of parallel connected solar cells and the temperature to determine the input signal from the solar cell .

SIMULATION DIAGRAM OF BUCK BOOST CONVERTER

It provides an output voltage that may be less than or greater than the input voltage –hence the name "buck-boost" ; the output voltage polarity is opposite to that of the input voltage.

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This regulator is also known as an inverting regulator During Mode 1, IGBT is turn on and diode D is reversed biased. The input current , which rises ,flows through inductor L and IGBT .During mode 2 , IGBT is switch off and the current ,which was flowing through inductor L, would flow through L,C , diode and the load .The energy stored in inductor L would be transferred to the load and the inductor current would fall until IGBT is switched on again in the next cycle.
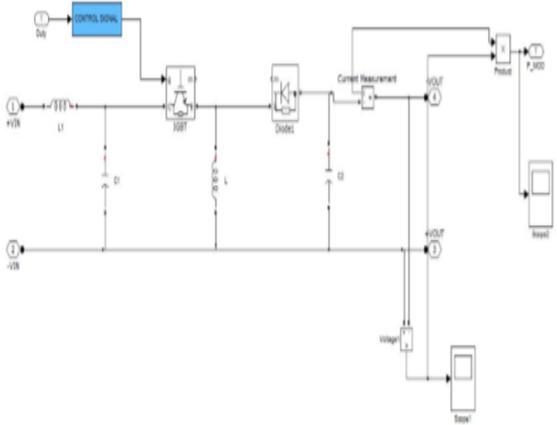

Fig.8 Matlab Model Of Buck Boost Converter.

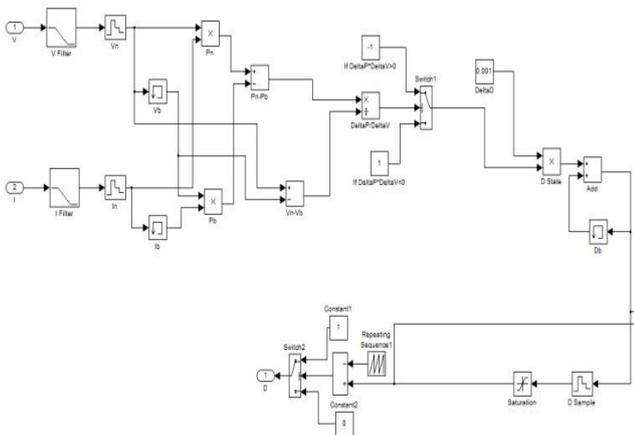### VI. SIMULATION CIRCUIT OF INCREMENTAL CONDUCTANCE METHOD

Fig 7:- Simulink Model For MPPT by Incremental Conductance Method
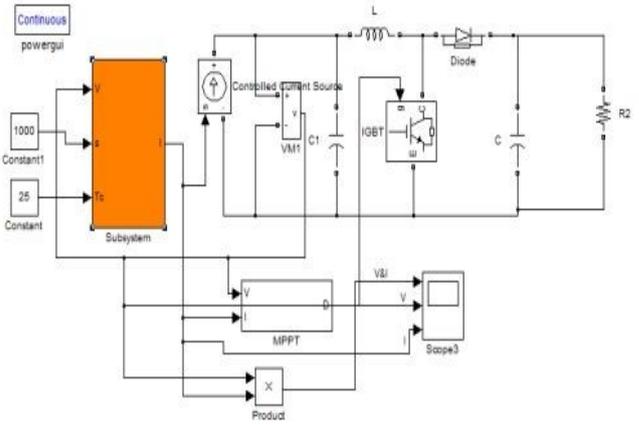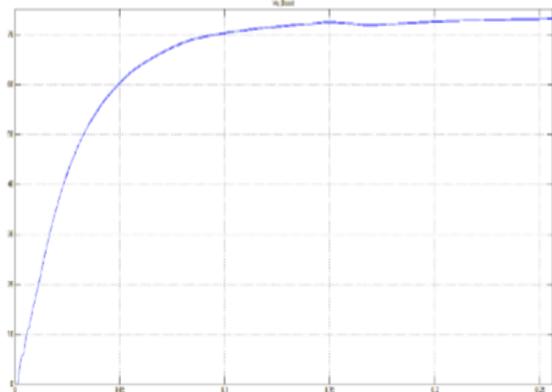
SIMULATION OF PROPOSED METHOD

Fig. 9 simulation circuit of proposed method

SIMULATION RESULT OF BUCK BOOST CONVERTER

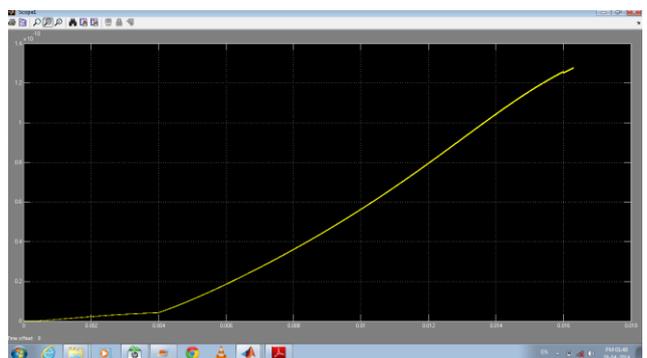SIMULATION RESULT OF MPPT AND BUCK BOOST CONVERTER

Figure 31 Power Output Of MPPT And Buck Boost Converter
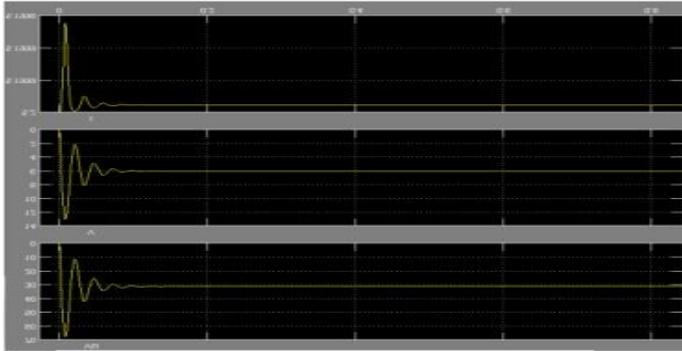
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SIMULATION RESULT OF PROPOSED METHOD

Figure 32 Power Output Of incremental conductance method

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CONCLUSION

The open loop maximum power point tracking technique aimed at solving the problems present in two of the most common techniques used for that   purpose: the perturb and observe (P&O)and incremental conductance algorithms. The main drawbacks of the P&O technique are its poor dynamic response and swinging around the maximum power point during steady state operation. During fast changes in atmospheric conditions, the P&O technique may erroneously move in the Wrong direction on the PV power curve if each perturbation caused power to increase. The other issue is the steady state swing it has when it reaches the maximum power point as it perturbs the duty cycle of a DC converter to check for power variations. The incremental conductance technique suffers also from a relatively slow dynamic response time. In each control step it is required to carry some computations to calculate the instantaneous and incremental conductance and then compare them to each other. Although it has an improved response time than the P&O technique, it is difficult to implement that technique in grid connected systems in its basic form. The open loop MPPT technique employed in this thesis aims at providing an improved dynamic response time as compared to the previously mentioned techniques. It does not suffer from high implementation complexity as well. The PV array maximum power point was approximated using test PV cells that kept track of the current weather conditions. The various waveforms were obtained by using the plot mechanism in MATLAB. There is a small loss of power from the solar panel side to the boost converter output side. This can attributed to the switching losses and the losses in the inductor and capacitor of the boost converter. This can be seen from the plots of the respective power curves.

VIII.   REFRENCES

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