Modeling of Single Phase Grid Connected Solar PV System with P & O MPPT Technique

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Abstract

This paper deals with P & O method in which the MPPT algorithm is based on the calculation of the PV output power and the power change by sampling both the PV current and voltage. In this thesis an improved P&O MPPT algorithm for PV module is proposed. Since the solar PV panel have a non-linear voltage-current relationship, which greatly affected by sun irradiation and temperature, hence, it is necessary to identify an effective method in extracting maximum amount of power from PV cell/modules over the past decade, there were many types of algorithm have been published. Firstly the photovoltaic system is designed by using perturb and observe method. Then we check the performance of solar PV cell under difference irradiance levels. This technique has drawback that it cannot perform under sudden change in irradiance, temperature etc. So the modified Perturb and Observe (P&O) or more commonly known as variable step size P&O method was introduced and implemented throughout the project to overcome the common drawbacks of conventional P&O method. The operation of the entire solar MPPT system was observed through MATLAB/Simulink simulation.

Keywords: *MPPT, Solar PV, Grid*

I. INTRODUCTION

Renewable energy resources exist over wide geographical areas, in contrast to other energy sources, which are necessary to increase the power demand and reduce the environmental problems in the world. Rapid deployment of renewable energy and energy efficiency is resulting in significant energy security, climate change mitigation, and economic benefits. In international public opinion surveys there is strong support for promoting renewable sources such as solar power. Among through various renewable energy sources, photovoltaic arrays are used in numerous applications such as water pumping, charging the batteries, grid connected PV module system etc.

Tracking the maximum power point (MPP) of a PV panel is an essential point of a PV system. It is decisive to operate the PV systems close to the MPP to improve its efficiency. Therefore, to optimize the energy withdrawn from the PV panel, we plan to insert a DC/DC converter controlled by an embedded system. This converter is implemented between the PV panel and the load. The embedded system is composed of two parts, the software, and the hardware. In this paper, we focus on the embedded software in which we implement a Maximum power point tracking (MPPT) algorithm.

For several years, research has been focusing on various MPPT control algorithms to draw the maximum power from the photovoltaic panel. Among these algorithms, there is perturb and observe (P&O) method with fixed and variable step size. This method, also known as the "hill climbing method", it presents oscillation around the MPP. Therefore a modified P&O algorithm is designed to minimize the oscillation in the output power.

II. SYSTEM MODELING

A. Solar Panel Modeling

A photovoltaic cell is a fundamental component in a photovoltaic panel. Since the net output voltage of a cell is very low, they are connected in parallel or in series or both ways, to meet practical demands. In order to mathematically model the PV cell, we derive the fundamental equation from the equivalent circuit of the solar cell shown in Fig. 1.

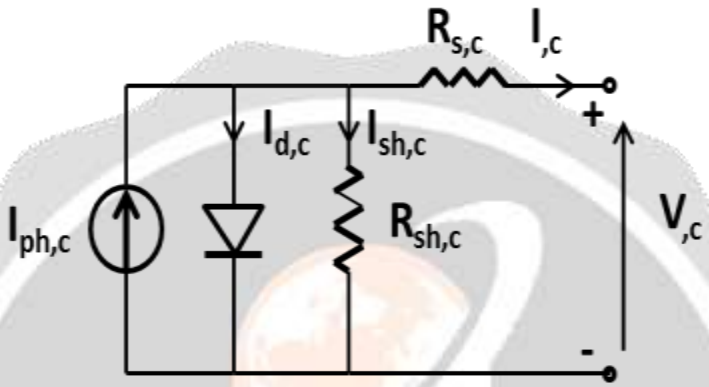

Fig.1 Solar Cell Model

The current generated by the cell can be given as

$$I(V, Ip, T) = I_{ph} - Is(e^{\frac{qV}{kT}} - 1) \quad (1)$$

$$Is = qA\left(\frac{D_n n_{p0}}{L_n} + \frac{D_p p_{n0}}{L_p}\right) \quad (2)$$

In this equation, Iph is the photocurrent

saturation current of the diode, V,c is the voltage across the cell, q is the electron charge, a is the ideality factor of the diode, K is the Boltzmann's constant, T is the junction temperature, and Rs,c and Rsh,c are the series and shunt resistors of the cell, respectively.

Using the equation of 1 and 2 modeling of the solar panel is done using MATLAB shown below in Fig.2.

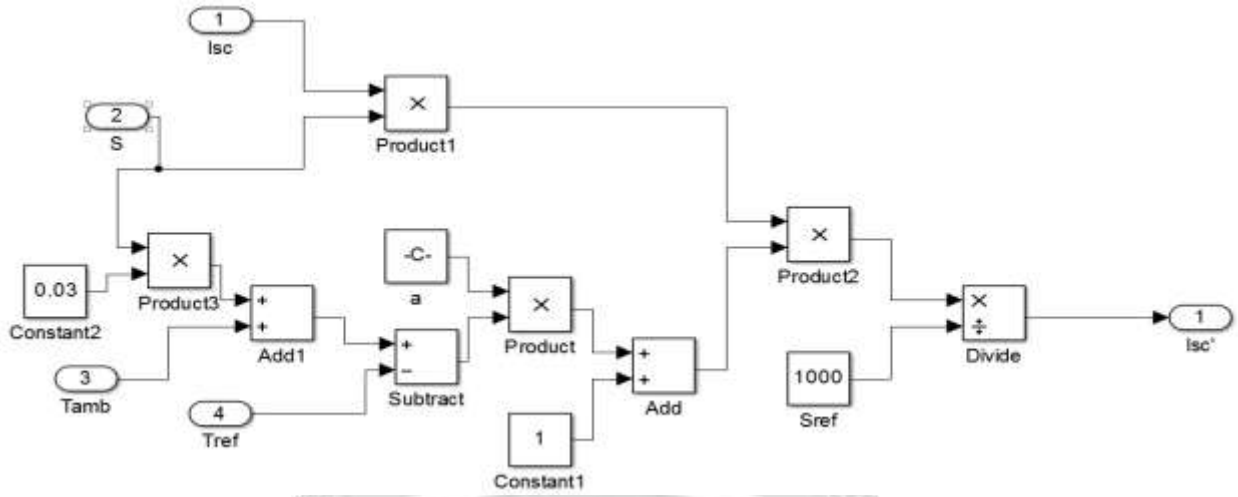

Fig.2 Solar Model in MATLAB

B. DC-DC Converter Modeling

The DC/DC (Fig.3) converter should always operate in the maximum power point tracking to maximize the PV array efficiency and consequently increase the efficiency of the global system. A buck-boost converter (Fig. 3) is a DC-to-DC power converter with an output voltage either greater or smaller than its input voltage. The output voltage is controlled by controlling the switch-duty cycle. The term d is the duty ratio and defined as the ratio of the on time of the switch to the total switching period.

So, when the switch is turned-on, the input voltage source supplies current to the inductor and the capacitor supplies current to the resistor (output load). While when the switch Opened, the inductor supplies current to the load via the diode.

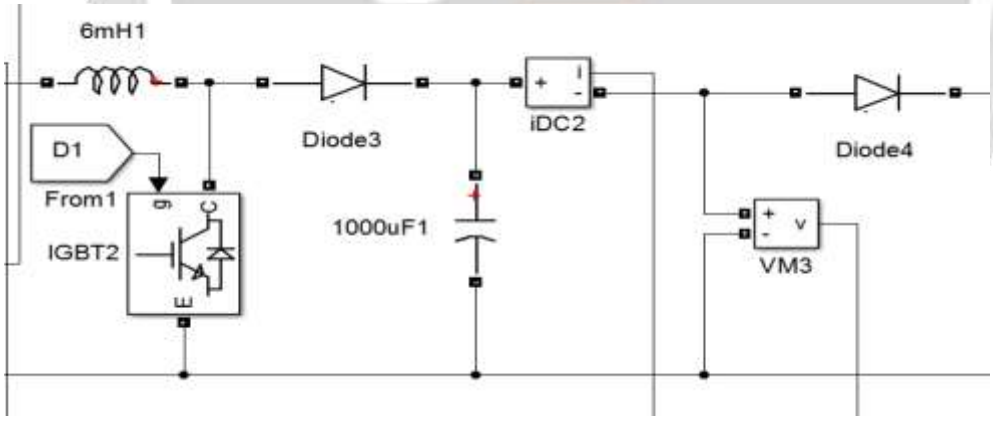

Fig.3 DC-DC converter Model in mATLAB

C. P&O MPPT

Perturb and Observe is the most regularly utilized MPPT strategy because of its simplicity of execution. The working voltage is expanded the length of (dP)/dV is sure, i.e. the voltage is expanded the length of we get more power. On the off chance that (dP)/dV is detected negative, the working voltage is diminished. The voltage is kept put if (dP)/dV is close to zero inside of a preset band. The time multifaceted nature of this calculation is less however on coming to near to the MPP it doesn't stop at the MPP and continues annoying. This calculation is not suitable when the variety in the sun oriented illumination is high. The voltage never really achieves a careful esteem yet annoys around the most extreme force point (MPP). Flow chart is shown in Fig.4.

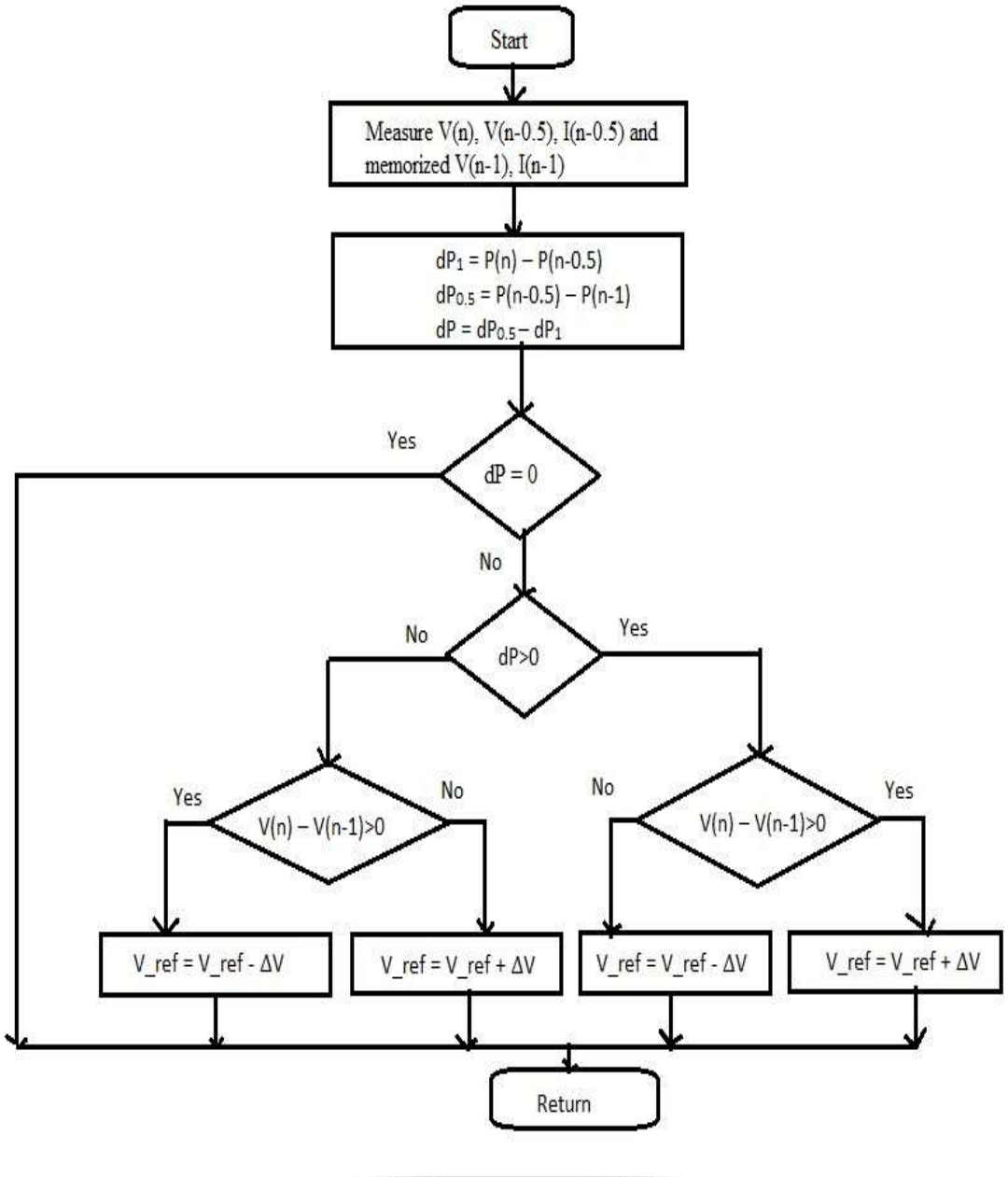

Fig.4 P&O MPPT Flow Chart

D. Proposed System Model

Complete modeling of the system is shown below. It consists of Solar PV Panel, DC-DC converter, Inverter after which it is connected to Grid is shown in Fig.5. Table 1 shows the Different parameter used for modeling.

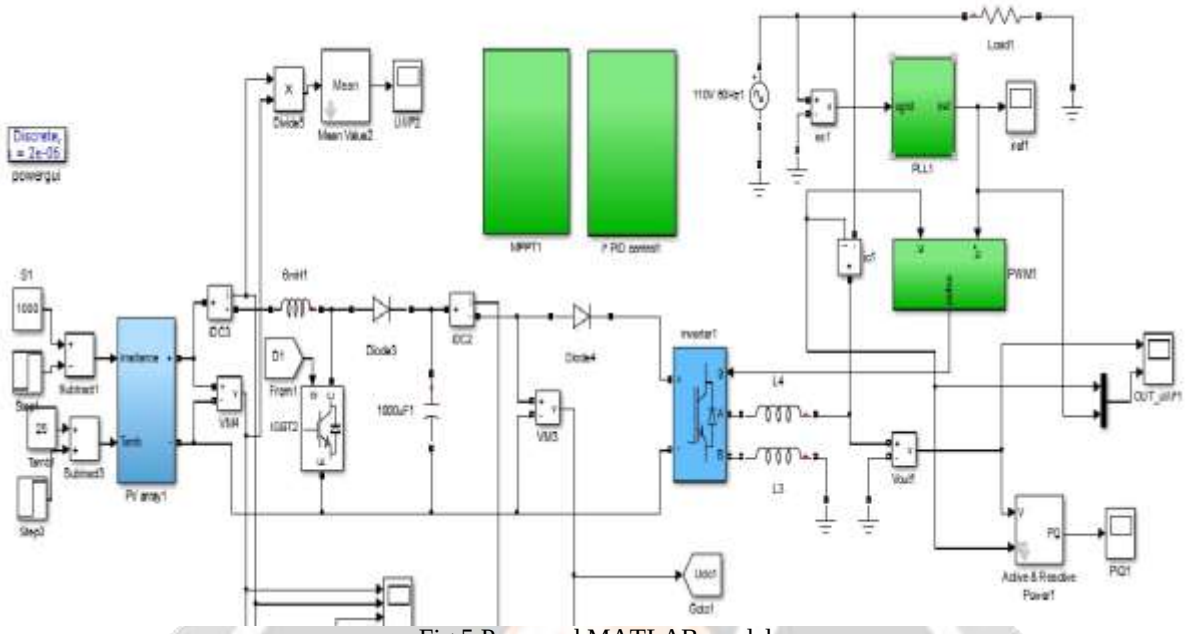

Fig.5 Proposed MATLAB model

Table.1 Simulation Parameters

Sr. No	Parameters	Value
1	Standard Solar Radiation	1000W/m2
2	Standard Temperature	25 Deg C
3	Open Ckt Voltage	86.8 V
4	Short Ckt Current	2.02 A
5	Maximum Voltage	70.4
6	Reference Temperature	55 Deg C
7	DC-DC Converter L	6Mh
8	DC-DC Converter C	1000uF
9	Inverter Snubber Resistance	250 ohm

III. SIMULATION RESULTS

Fig.6 shows the Current waveform for Grid Side connection of PV system.

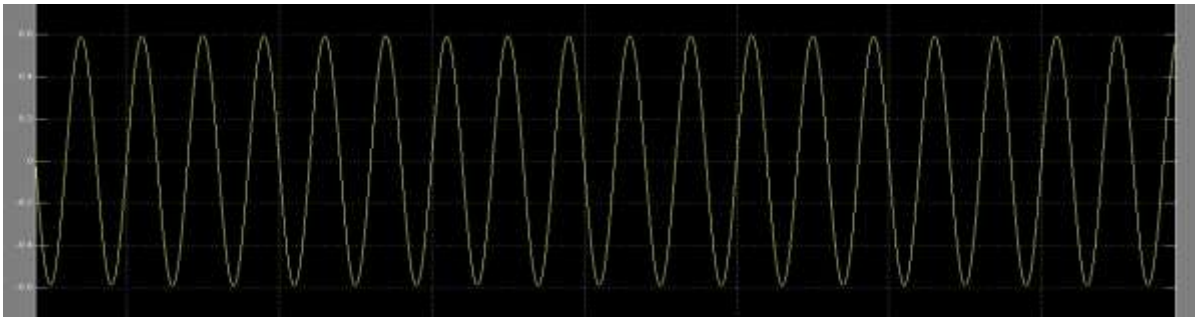

Fig.6 Grid Side Current Waveform

Fig.7 show the Active and reactive power produce by PV system. As Solar PV system deals with only Active power and the output have zero reactive power.

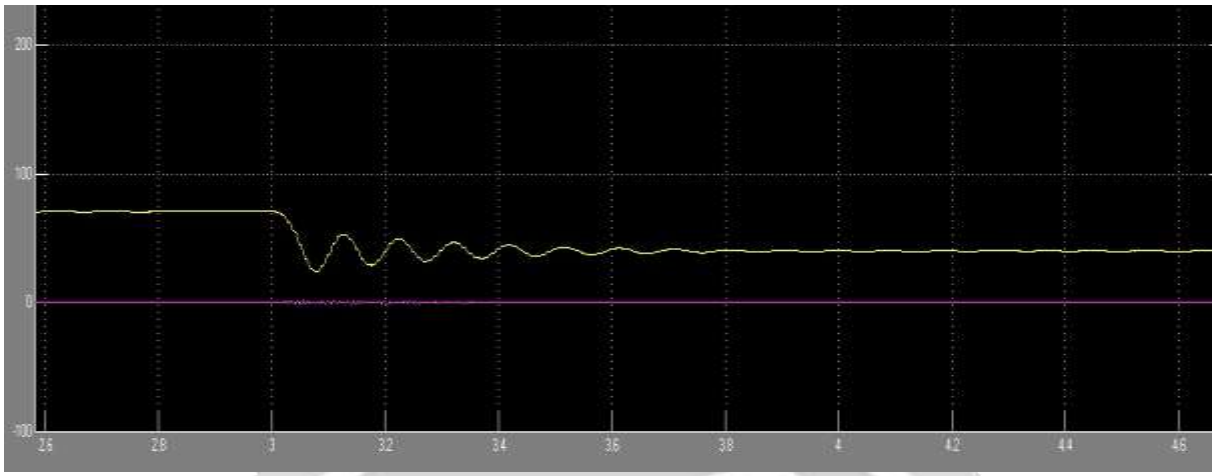

Fig.8 Active and Reactive Power

Fig.9 show the Solar panel DC power output. Due to irradiation change in starting the value fluctuate but aftwer getting constant insolation from the sun the output become constant.

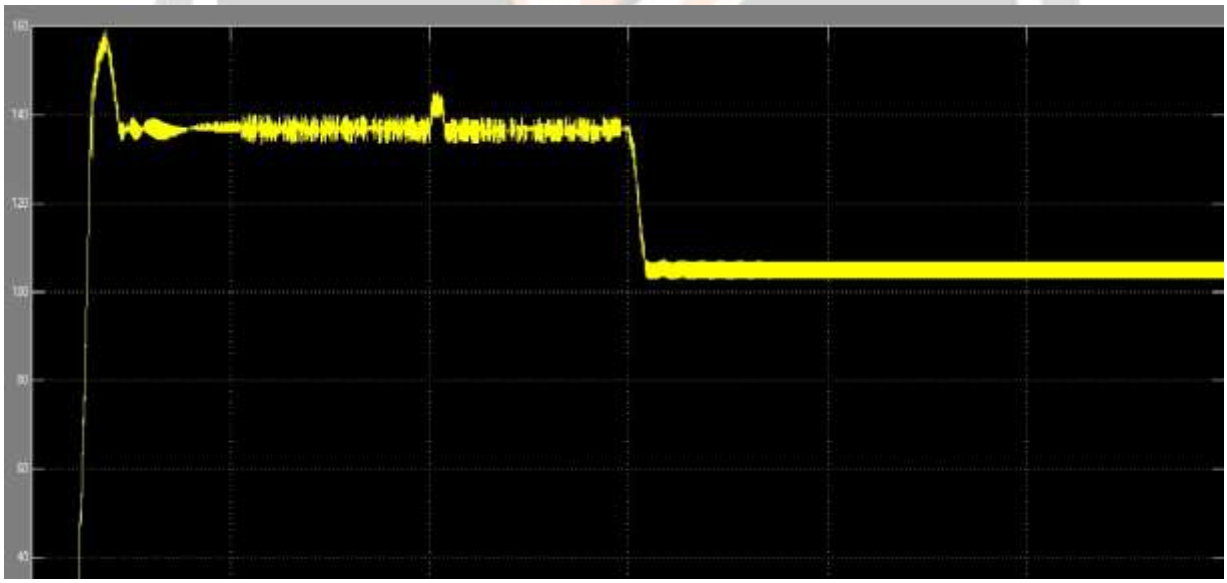

Fig.9 Solar DC Output

Fig. 10 shows Voltage, current and power waveform of solar pv system.

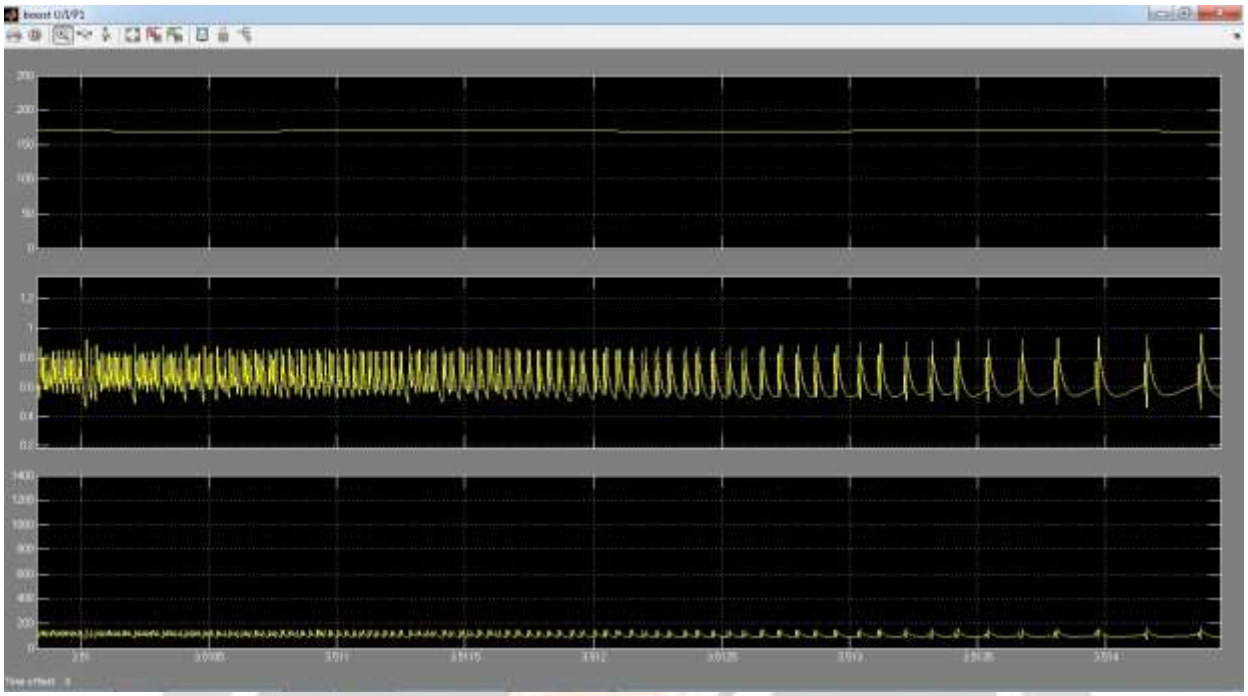

Fig.10 Voltage, Current and Power waveform of DC Solar panel

IV. CONCLUSION

In this work, we presented a modeling and simulation of a PV system. One-diode model for simulation of PV module was selected; Buck-Boost converter is studied and applied to test the system efficiency. Two Maximum Power Point Tracking techniques, P&O and IC, are presented and analyzed. The proposed system was simulated using the mathematical equations of each component in Matlab/Simulink. The simulation analysis shows that P&O method is simple, but has considerable power loss because PV module can only run in oscillation way around the maximum power point. In practice, in order to achieve maximum efficiency of photovoltaic power generation, a reasonable and economical control method should be chosen.

The following of this work is based on optimizing the performance of PV modules and stand-alone systems using more efficient algorithms to minimize the influence of the meteorological parameters on the PV energy production.

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