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Modeling and Analysis of Solar Photovoltaic System in Dynamic Atmospheric Condition

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Abstract

This paper presents simulation of solar Photovoltaic system (PV) with implementation of incremental conductance (INC) maximum power point tracking (MPPT) technique.INC method give the better results in dynamic atmospheric conditions. Most suited converter for implementation of this method is boost converter. This system has checked successfully through simulation results.

Key words- Maximum power point, Incremental conductance, Boost converter, PV system.

I. INTRODUCTION

The major concern now days has been put forth on the issue of global warming which is resultant of efficient gas emission and according to literature it is evident that there has been increase of 0.6°C/century in the global surface temperature [1].Very limited source of fossil fuel forces us to do concentrate in renewable energy resources and among them photovoltaic panels and wind generators are widely used. The solar photovoltaic (PV) power generation is based on the principle of photovoltaic effect. With the advent of silicon p-n junctions, the photoelectric current was able to produce power due to inherent voltage drop across the junction. However, such power generation is well-known for having nonlinear relationship between the current and voltage of the photovoltaic cell. It was then observed that, there is a unique point at which the photovoltaic cell produces maximum power [2], so-called Maximum Power Point (MPP).For most of the Maximum power point tracking (MPPT) techniques require dc/dc converter for load interface. This interface increases the system efficiency and also the cost [3].

Nonlinear characteristic posed by the panel and a unique operating point (MPP) is a major challenge in PV system, this challenge become more difficult because of the dependence of the power and voltage (P-V) curve in insulation and temperature. These parameters are continuously varying so the MPP also varying and for efficient tracking our purpose is to operate at MPP. Incremental conductance (INC) and perturb observer (PO) are two methods of MPPT which is widely using in the literature because of its easy implementation and efficient tracking but PO method is fail to track in atmospheric change conditions [4]. So in this report INC method is used as MPPT.

II. CLASSIFICATION OF SOLAR PV ARRAY SYSTEM

PV system classified by their function and configuration [5]as:
(a) Stand-alone PV array system
(b) Grid connected PV array system

Stand-alone PV systems are termed as autonomous or off-grid systems as they are not connected to the utility grid [6]. They require battery in order to have power management.

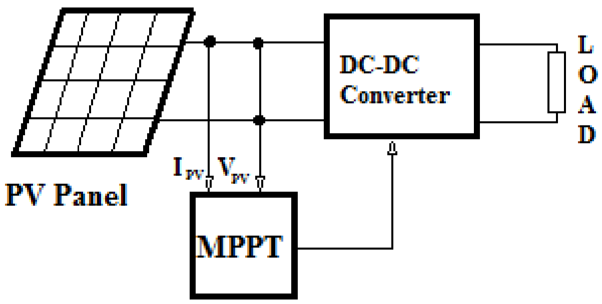


Fig.1.Stand-alone PV system

III. MAXIMUM POWER POINT TRACKING TECHNIQUES

In literature, different types of MPPT controllers have been proposed and each of them is having its own merits and demerits. Different MPPTs [11] which are used more often are given below:
(a) Hill climbing/ P&O method
(b) Incremental conductance method (INC)
(c)Ripple correlation control (RCC)
(d) State-based MPPT
(e)Fuzzy logic control
(f) Neural network
(g)DC-link capacitor droop control
(h) dP/dV or dP/dI feedback control
(i)Fractional open-circuit voltage
(j) Fractional short-circuit current

Among all above mentioned MPPT techniques P&O and INC mostly used technique but according to [7] INC is the best method and accuracy of these method is proven in [8].

Incremental conductance method

Major problem with the PV system is to track maximum power in atmospheric change condition because of the nonlinear characteristic of P-V curve highly depends on the atmospheric changes.

INC is very effective in atmospheric changes (change in temperature and irradiance) it is able to detect local maxima [9].

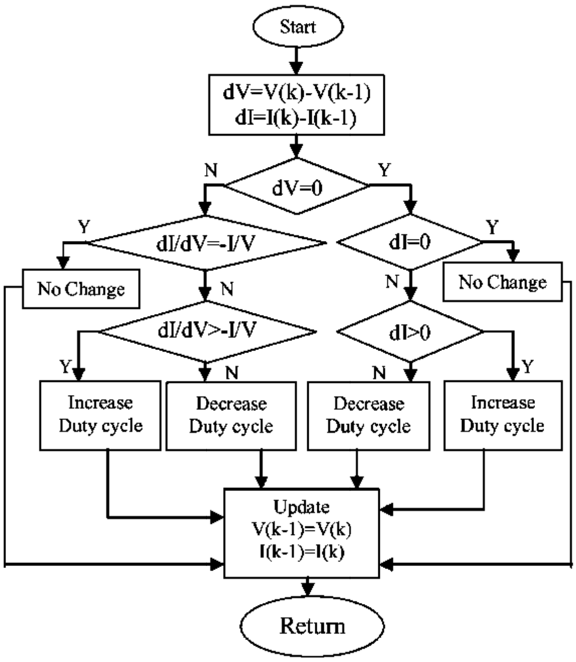


Fig. 2. Flow chart of Incremental conductance method

IV. IMPLEMENTATION OF INC WITH PV SYSTEM

1) PV model

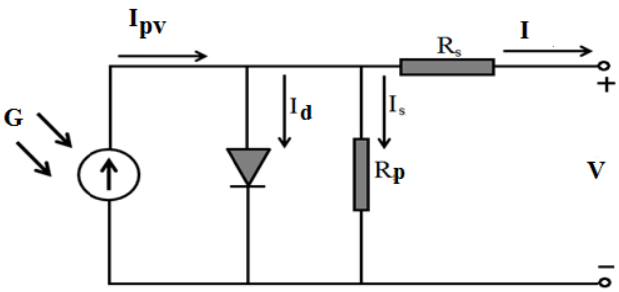


Fig. 3.Single-diode model of the theoretical PV cell

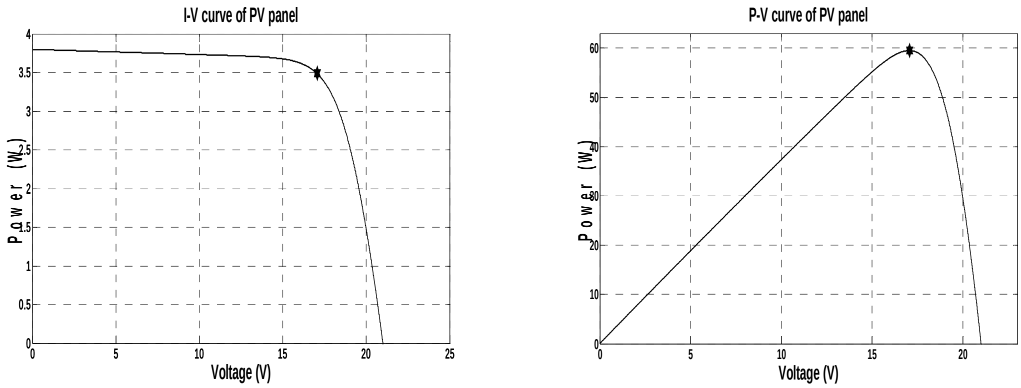
Mathematically describes the I-V characteristics of practical PV cell is [10]

$$I = I_{PV} - I_0 \left[\exp\left(\frac{V+IR_S}{aV_t}\right) - 1\right] - \frac{V+IR_S}{R_P} \ldots \quad \textbf{(1)}$$

Where I_{PV} andI_0 are the photovoltaic and saturation currents respectively, Rsis the equivalent series resistance and $R_P$is the equivalent parallel resistance, I andV are the output current and voltage respectively, a is diode constant, V_t is thermal voltage.

V SIMULATION RESULTS

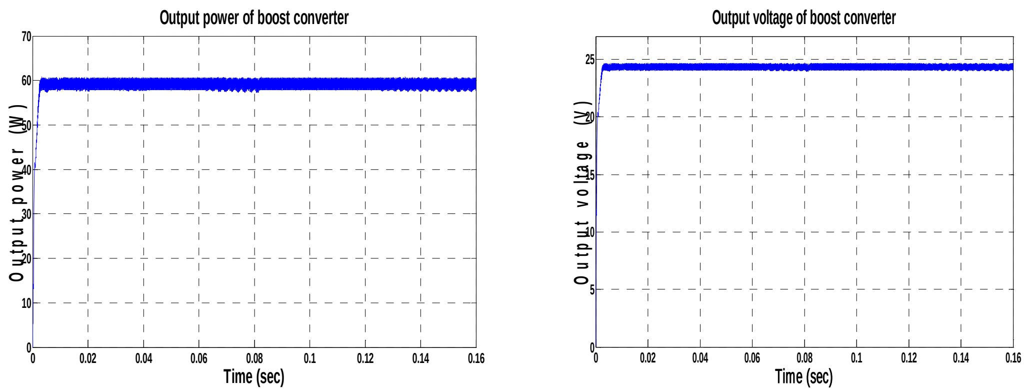
5.1 Simulation of pv model



(a) (b)

Fig. 4. (a) I-V plot (b) P-V plot of PV array

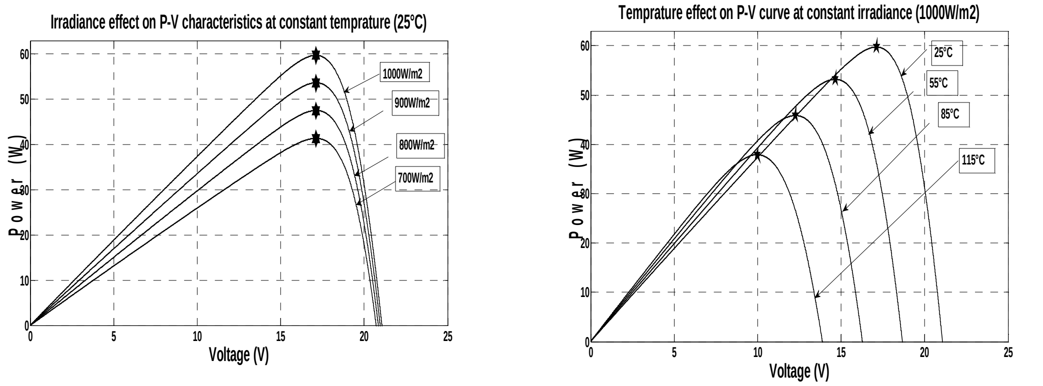
5.2) Simulation result of PV array with Boost converter:



(a) (b)

Fig. 5 (a) output power wave form (b) output voltage waveform

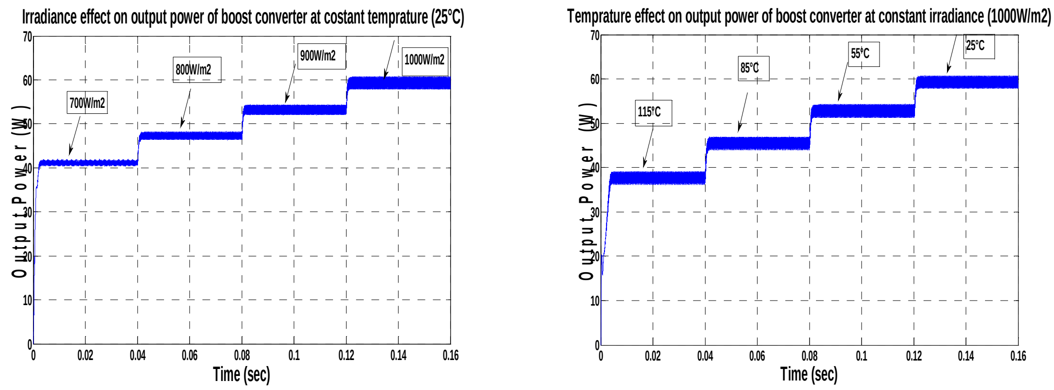
5.3. Simulation results of PV panel with different irradiance and temperature conditions



(a) (b)

Fig.6 (a)with different irradiance P-V curve (b)with different tempratureP-V curve

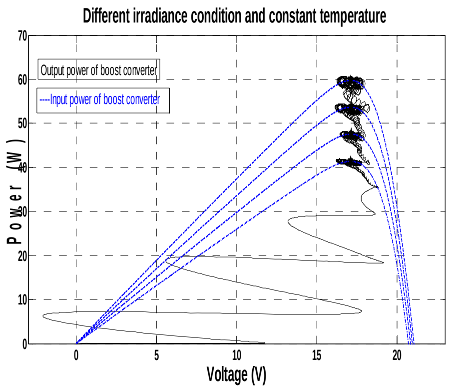
5.4. Simulation results of output power with different irradiance and temperature conditions:



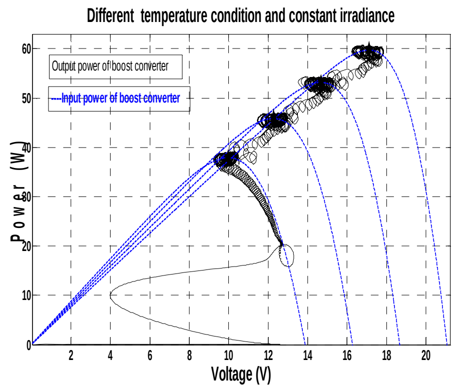
(a) (b)

Fig. 7 (a) with different irradiance output power (b)with different temprature output power

5.5. Simulation results of PV system with different irradiance and temperature conditions:



(a)



(b)

Fig. 8 (a) with different irradiance (b)with different temprature

VI. CONCLUSION

INC effectively tracks the power in various atmospheric conditions. It is a digital implementation of MPPT whose practical implementation is easy and efficient**.**

PV system is very growing technology and power eletronics is playing an important role to make this perfect.There are many methods for tracking maximum power but INC has some advantages over other methods.

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