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Improving the Efficiency of Solar Photovoltaic Power System

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Abstract—*Photo-Voltaic system is a technology that converts the energy from sunlight into electrical energy. Photo-Voltaic system becomes an important renewable energy source due to its pollution-free and inexhaustible nature. However output power of PV system is still low, hence continuous hard work are taken to develop the techniques for maximum extracting power and reduced cost factor. Maximum power point tracking (MPPT) is a technique that grid connected inverters, solar battery chargers and similar devices use to get the maximum possible power from one or more photovoltaic modules. A number of algorithms have been proposed to find the maximum power point tracking (MPPT) for photovoltaic system. This paper is simulation studies of maximum power point tracking (MPPT) for photovoltaic system using incremental conductance algorithm. And it can be experimentally proved by modeling the PV system by MPPT algorithm in MATLAB/SIMULIMK software.*

1. INTRODUCTION

Photovoltaic (PV) is a method of converting solar energy into direct current electricity using semiconducting materials that reveal the photo-voltaic effect. A photovoltaic system makes use of solar panels collected of a number of solar cells to supply usable power. Energy from PV modules offers numerous advantages, such as, necessity of little maintenance and no environmental pollution. Recently, PV arrays are used in numerous applications, such as, battery chargers, solar powered water pumping systems, solar hybrid vehicles, grid connected PV systems and satellite power systems.

The energy obtained from PV system largely depends on solar radiation, temperature and the voltage produced in the photovoltaic module. PV systems have two main disadvantages: the conversion efficiency of electric power generation is very low (9-17%), particularly under low irradiation conditions and the amount of electric power generated by solar changes continuously with varying weather conditions. Different methods were proposed to minimize the problem of poor efficiency of photovoltaic system, among which a concept is called “Maximum power point tracking” (MPPT) is implored.

Maximum Power Point Tracking is an algorithm that incorporated in charge controllers used for extract maximum available power from PV module under certain conditions. The voltage at which PV module can produce maximum power is called ‘maximum power point’. Maximum power varies with solar radiation, ambient temperature and solar cell temperature. Thus maximum power point tracking (MPPT) techniques are looked-for to maintain the PV array’s operating point at its MPP. Many MPPT algorithms have been proposed to track the maximum operating point. In this paper incremental conductance algorithm is used for this purpose.

2. MAXIMUM POWER POINT TRACKING

Maximum Power Point Tracking (MPPT) is an electronic system that operates the Photovoltaic (PV) modules, by varying the electrical operating point, to generate the maximum power. MPPT is not an automatic tracking system that “physically moves” the modules to capture the sunlight more directly. However MPPT can be used in conjunction with a mechanical tracking system, but the two systems are completely different. A Typical PV module produces power with maximum power voltage of around 17V when measured at a cell temperature of 25^0C; it can drop around 15V on a very hot day and it can also rise to 18V on a very cold day. Fig. 1. Shows a typical block diagram of a PV module with MPPT.

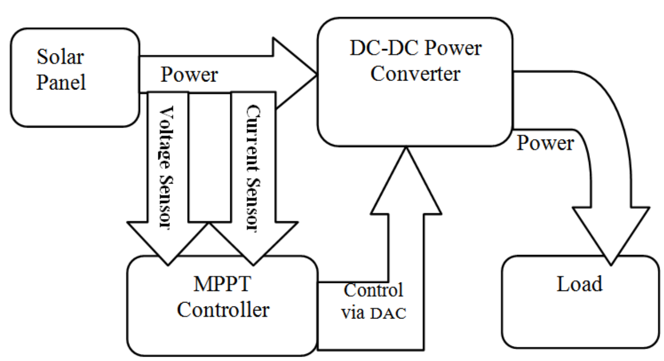

Fig. 1: Block diagram of PV module with MPPT

MPPT’s are most effective in winter, and/or cloudy or hazy days- when the extra power is needed the most.

3. INCREMENTAL CONDUCTANCE MPPT ALGORITHM

For the MPPT control strategy different algorithms are used. Incremental conductance algorithm is one of them which are commonly used due to its ease of implementation. Its working principle is that the array terminal voltage is always attuned according to the MPP voltage it is based on the incremental and instantaneous conductance of the PV module. Fig. 2. Shows the flow chart of incremental and conductance algorithm.

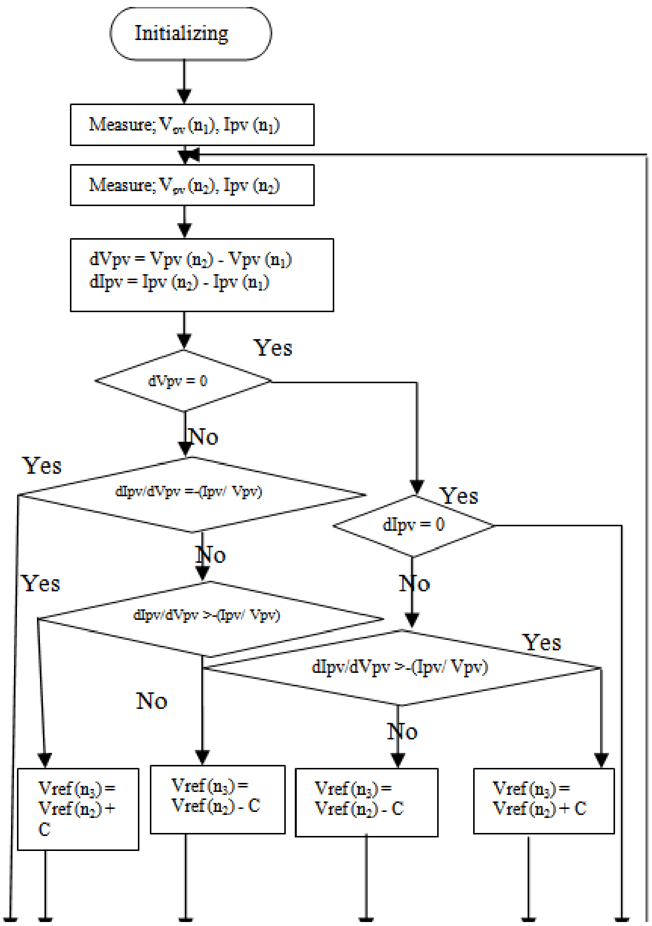

Fig. 2 Flow chart of incremental and conductance algorithm of MPPT control strategy

This algorithm is based on equation (1) & (2)

$$dP/dV = dVI/dV = I + VdI/dV = 0 \tag{1}$$

$$- (I/V) = dI/dV \tag{2}$$

The left hand side of equation (2) represents the opposite of the instantaneous conductance, G = I/V, whereas the right hand side of the equation (2) represents its incremental conductance. By analyzing the derivative it is clear that whether the PV generator is working at its MPP or distant from it according to equations (3), (4) & (5).

$$dP/dV > 0 \text{ for } V < V_{mp} \tag{3}$$

$$dP/dV = 0 \text{ for } V = V_{mp} \tag{4}$$

$$dP/dV < 0 \text{ for } V > V_{mp} \tag{5}$$

Main advantage of this algorithm is that it offers a good yield method under speedily changing environmental conditions. It also achieves lower oscillations around MPP. Main drawback of this method is that it requires a complex control circuitry which makes it more costly. However at present there are many ways to use this method in a cheaper way.

4. SIMULATION AND RESULT

Based on Incremental Conductance MPPT algorithm a model is developed in Matlab/Simulink.

The Fig. 3 shows the modeling diagram for the incremental conductance MPPT algorithm.

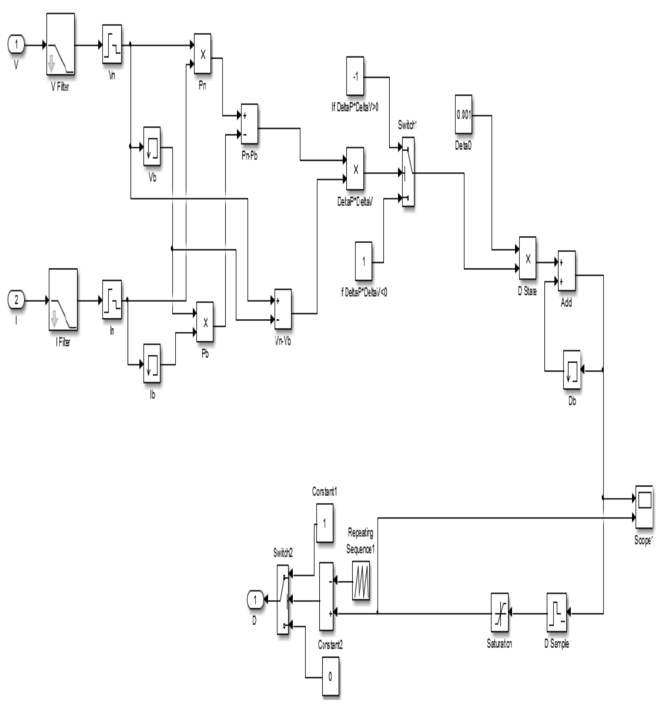

Fig. 3: Model of Incremental conductance MPPT algorithm

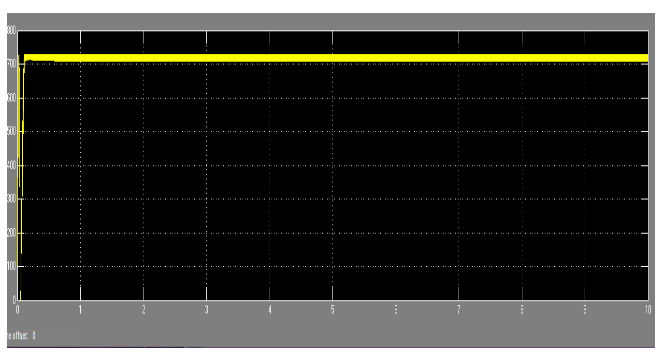

Fig. 4: PV output with MPPT

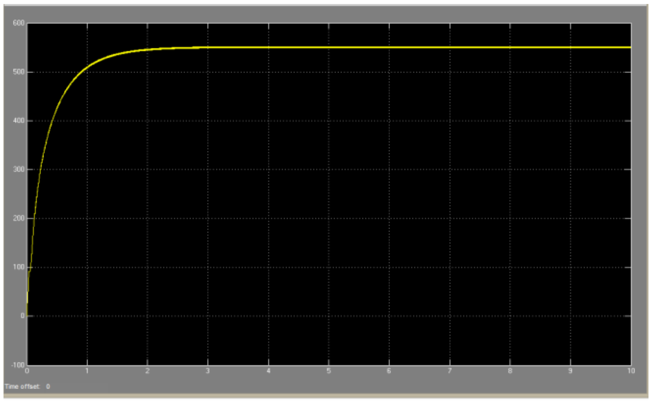

Fig. 5: PV system output without MPPT output

5. COMPLETE SYSTEM SIMULATION

The Complete system simulation is shown in Fig. 5. It includes the PV module, the converter, MPP tracker using incremental conductance algorithm and the resistive load.

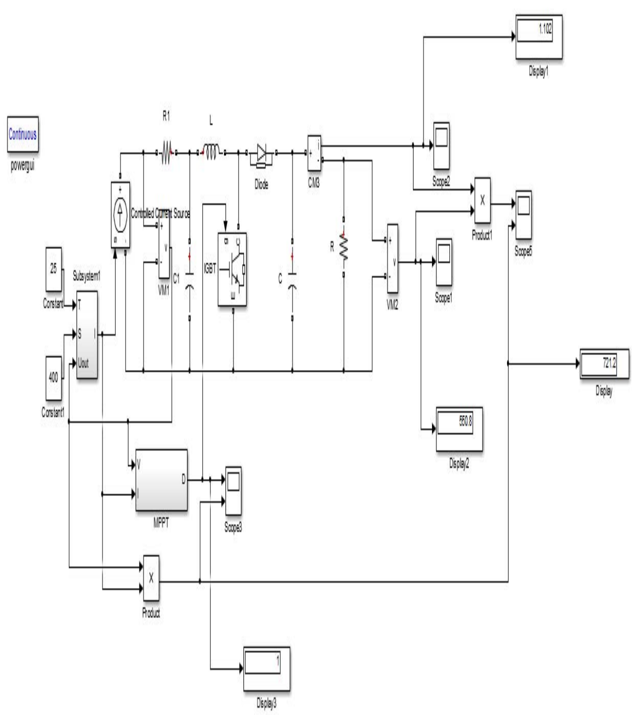

Fig. 6: Complete system simulink model

6. CONCLUSION

In this paper based on the experimental work, a stand-alone PV model is simulated and studied in Matlab/simulink. For maximum power point tracking (MPPT) incremental conductance method is simulated in Matlab/simulink. From the simulation result we conclude that the system extract maximum possible power.

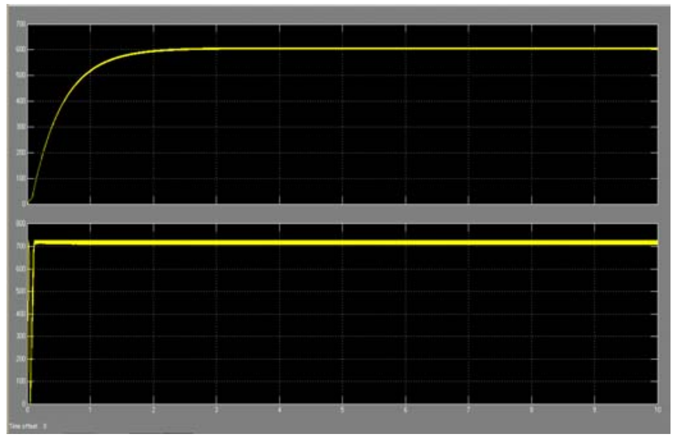

Fig. 7: Complete system output

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