HARDWARE IMPLEMENTATION OF MAXIMUM POWER POINT TRACKING SYSTEM USING INCREMENTAL CONDUCTANCE ALGORITHM

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Abstract:

Maximum power point tracking systems system are designed to extract the maximum possible power from the PV module using sun tracking and maximum power point tracking (MPPT) algorithms. In sun tracking technique PV panel is oriented according to sun within a day to generation of maximum power from a PV panel. MPPT algorithms are utilized to exploit the efficiency of solar generators and shrink the photovoltaic array cost by decreasing the number of photovoltaic panels essential to attain the chosen solar output power. To maximize the increase in the production of electricity the hardware implementation using photovoltaic (PV) systems, implementation of maximum power point tracking control of PV system using an incremental conductance algorithm, sun tracking technique and monitoring software for monitoring the performance of Photovoltaic system is presented in this work.

Keywords: Maximum power point tracking (MPPT), Perturbation and observation (P & O), and Incremental conductance (InC).

I. INTRODUCTION:

The solar photovoltaic (PV) generation symbolize at present one of the most hopeful sources of renewable energy. It offers lots of advantages such as the energy produced is not polluting, necessitate little maintenance, and most promising, clean and inexhaustible energy [1] [2]. Therefore, photo-voltaic (PV) systems have fascinated more attention. The aim of the PV systems is maximizing the effectiveness of power conversion and dropping the cost. Indeed, the solar output peak power provided by the photovoltaic module depend on the irradiation, temperature, and electrical loads and it has a maximum (MPP) at a definite effective point [3]. At the MPP (Maximum Power Point), the PV functions at its peak efficiency.

Therefore, to extort the peak power under the different environment stated earlier, a maximum peak power point tracking (MPPT) method is used to control the varying operating output power point of the photo-voltaic array through a DC-DC converter. The MPPT controller can be realizing based on different methods and algorithms. The most popular methods are known as Perturb and Observe (P&O) and Incremental Conductance (INC) [4]. This paper represents a hardware implementation of INC MPP algorithms used to control DC-DC boost converter so as to generate the MPP for 50 Watts PV array. This work is planned as follows: the experimental setup of the 50 Watts PV module specified in section 2. In section 3, the INC algorithm is discussed. Of course, the experiment results of photovoltaic system is presented and specified in section 4. Eventually, conclusion is presented in section 5.

II. EXPERIMENTAL SETUP:

Experimental setup includes 50 watts solar panels, MPPT unit and sun tracking unit.

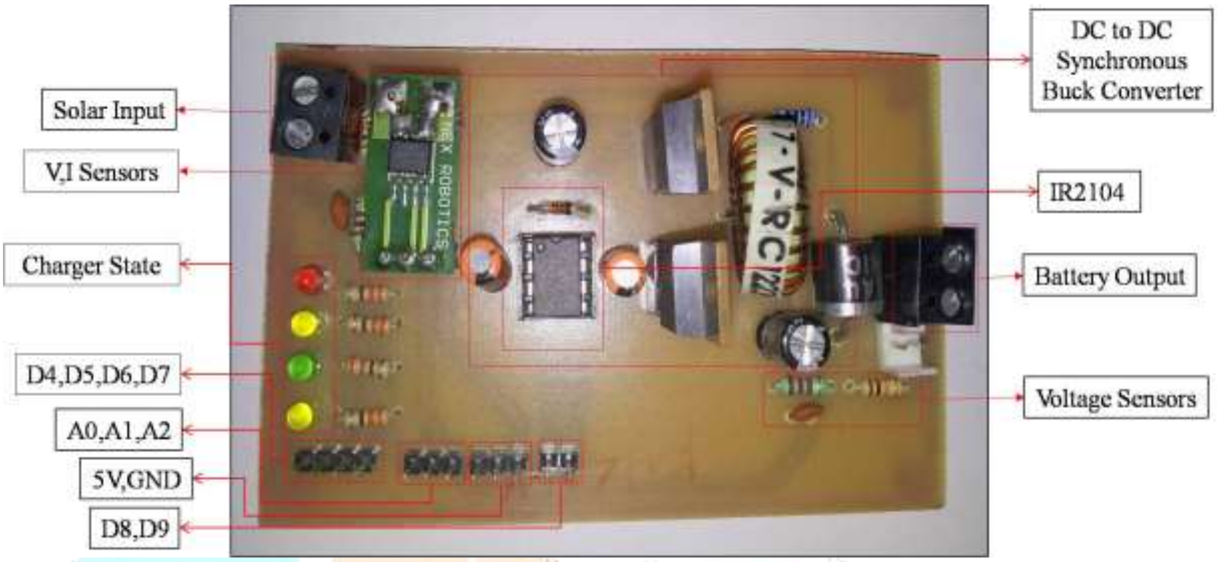

Figure 1: MPPT unit

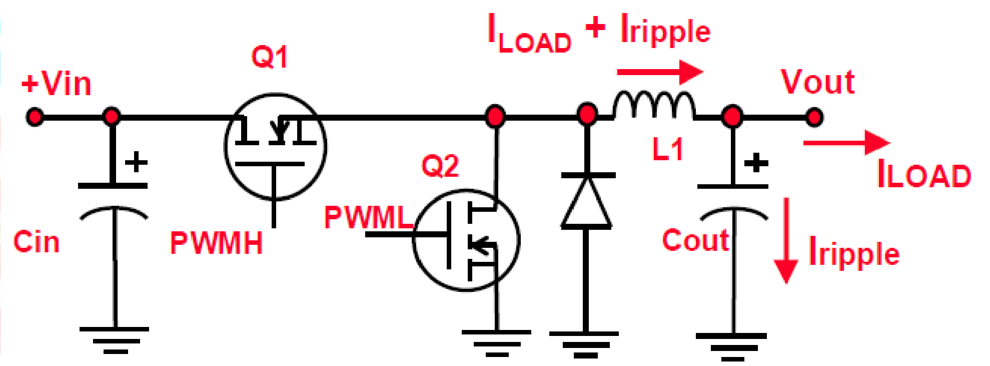

Figure 2: DC to Dc convertor

I have utilized 12V 50W monocrystalline solar panel. As shown in figure 1 the MPPT unit consists of charge controller which is implanted with MPPT algorithm to increase the quantity of current entering into the battery from Photovoltaic module. As shown in figure 2 MPPT is chopper circuit (DC to DC converter) that works by receiving DC input from solar PV module, changing it to alternating quantity and translate it again to a specified direct voltage and direct current to equivalent the solar photovoltaic module to the battery.

Figure 3: sun tracking unit

Figure 3 Shows assembly diagram of the sun tracking unit. It consists of servo motor, LDR sensors, battery for supply, power supply unit. The LDR sensors senses light intensity which is then used to move a servo and rotating panel for tracking the strongest light level. Output of these sensors are interfaced to A/D channel of Arduino board on the voltage input using which PWM signal is generated. Arduino is used to operate the servo motor. MPP unit will energize the battery as described previously. Power supply circuit is designed to provide voltage of 7 V for servo motor and 9V for Arduino. Servo motor is connected to solar photovoltaic panel by hardware assembly.

III. INCREMENTAL ALGORITHM:

Incremental Conductance (IC) method overcome the limitation of perturbation and observes method in tracking the output power under rapid changing atmospheric condition. It is probable to show that, at the MPP dI/dV=-i/v. This process can find whether the MPP has searched the MPP and then stops finding the operating point. If this situation is not achieved, the direction in which the MPPT operating point must be perturbed can be calculated using the condition between dl/dV and –I/V. This correlation is obtained from the sense that change in power with respect to voltage is negative and if the MPPT is on the right side of the MPP and positive if it is on the left side of the MPP [5] [6]. The INC can trace the rapidly varying irradiation conditions with greater correctness than P&O [8]. The limitation of this algorithm is the design complexity when related to perturb and observe indirectly extending calculation time [7]. The algorithm can be studied by the following operational flow-chart diagram which is shown in figure 4.

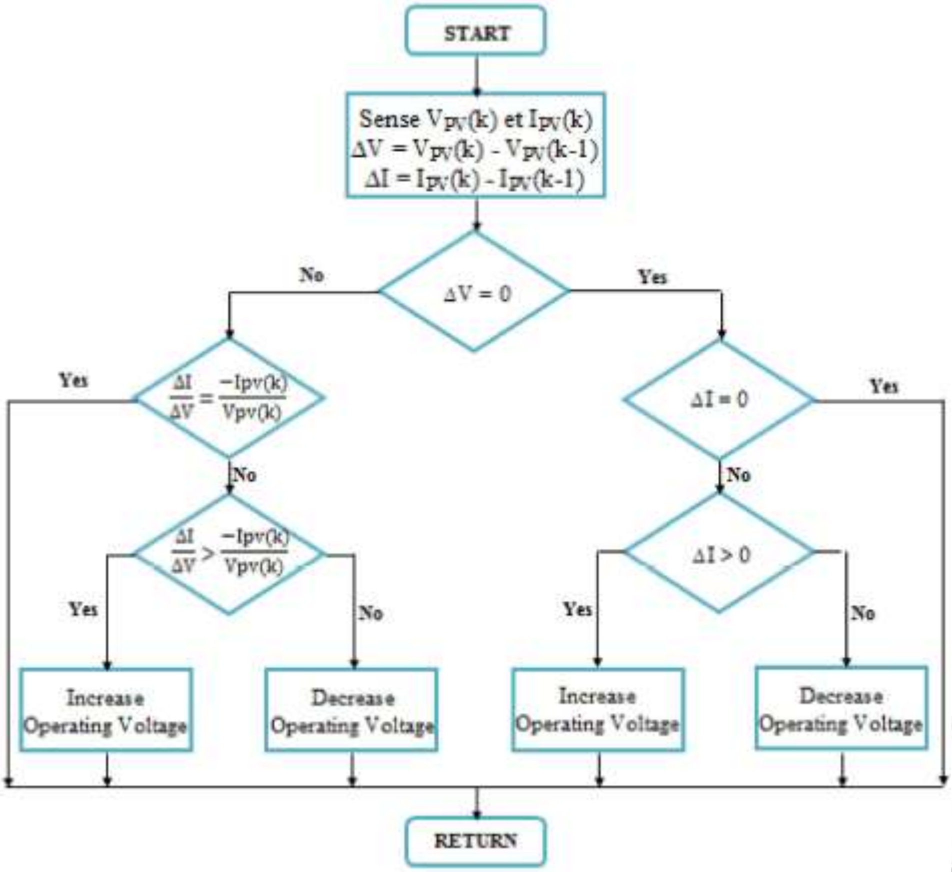

Figure 4: InC algorithm

IV. RESULTS:

The hardware setup is implemented with the 50 Watt solar PV panel and its results are also being verified. In the solar tracking strategies, a servo motor is used as the source to rotate the solar photovoltaic panel. This motor is run with the output signals which are received from the LDRs. The screen shot of experimental results of obtained maximum output power using InC algorithm under the stable solar irradiation is shown in figure 5 and is examined by measuring the voltage and current for the same load and calculating the total power. The output power with respect to angle of solar panel is also listed in the table 1 shown below. These results show that the output power always tracks the MPPs.

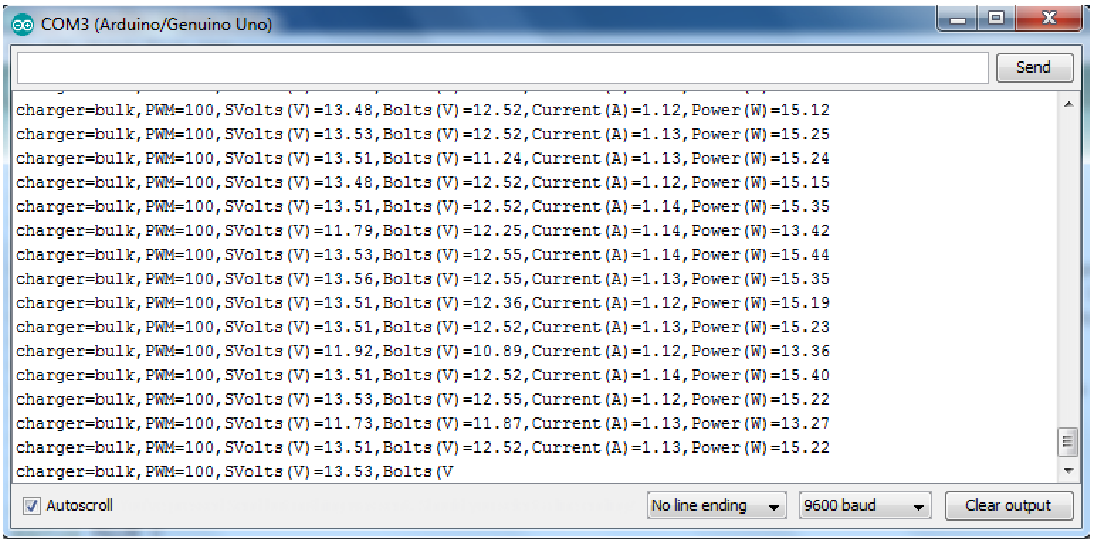

Figure 5: results of InC

Angle	Voltage (Volts)	Current (Ampere)	Power (Watts)
30°	14.90	0.57	8.50
40°	14.90	0.60	8.97
50°	14.92	0.61	9.03
60°	14.98	0.62	9.27
70°	14.98	0.62	9.27
80°	14.98	0.63	9.46
90°	15.01	0.64	9.64
100°	15.01	0.62	9.37
110°	15.01	0.61	9.37
120°	14.98	0.58	8.63
130°	14.90	0.54	8.01
140°	14.92	0.51	7.57
150°	14.84	0.48	7.15

Table 1: output power with respect to angle

V. Conclusion:

From the above observations, the incremental conductance (InC) algorithm is suitable as it is able of reducing the ripple about the maximum operating power point and has advantages of exact perturbing and tracking direction and steady maximum operating voltage. It is also observed that the MPPT system produce maximum output power when the PV modules are perpendicular to solar irradiations, such as in above table it produces maximum power at an angle of 90°.

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