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Hardware Implementation of Incremental Conductance Based Solar MPPT System

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Abstract: **A simulation & hardware implementation of solar MPPT system with direct control method by using incremental conductance is presented in this paper. The whole system consists of converter design & hardware implementation. The maximum efficiency is obtained with the help of incremental conductance based algorithm solar MPPT system. Results obtain by hardware gives the precise control under rapidly varying atmospheric condition. After implementing the system the efficiency will be 49.35%.**

Index Term: - Photovoltaic (PV) system, maximum power point tracking (MPPT), incremental conductance (IncCond).

I. INTRODUCTION

In day today life electricity is the most essential need of human being .All the domains need the electricity for their operation. Solar is converted in to the electrical energy to reduce the fossil fuel consumption in the system. Considering the efficiency & cost of the solar system, it is very rarely used in the system. To increase the use of solar energy in the system Maximum power point techniques are used, which improves the cell efficiency.

In all renewable energy sources, solar power systems has more demand because they provide good opportunity to generate electricity where greenhouse emissions are reduced [1]. Now a day's it is very challenging for engineers and scientists to generate energy from efficient, clean and environmentally friendly sources. [2]. The Output power of photovoltaic (PV) array gets reduced due to changes in isolation on panels because of fast climatic changes such as cloudy weather and increase, in ambient temperature. In other way, each PV cell produces energy referring to its operational and environmental conditions [3].

It is also satisfying to lose dependence on conventional electricity obtained by burning natural gas and coal. Solar energy is the excellent solution for energy crises if see towards its aspects. Many factors such as temperature, spectral characteristics of sunlight, dirt, shadow, and isolation affect the efficiency of solar cells.

Looking towards the poor efficiency of PV systems, some methods are proposed, among which a new concept is called "Maximum power point tracking" (MPPT). All MPPT Methods follow the same goal which is maximizing the PV array output power by tracking the maximum power on every operating condition.

II. LITERATURE SURVEY

Different types of logic or control circuit are used in maximum power point tracker to search for this point & to obtain maximum power from cell by using converter circuit. There are various types of MPPT techniques are available to track the maximum power which are described below in detail.

A. MPPT METHODS

Various types of algorithms are available to track MPPs. The algorithms which are based on voltage & current feedback are simple, and perturbation and observation or the incremental conductances are complicated. perturbation and observation or the incremental conductance method has various features which vary in sensor requirement, complexity, range of operation, speed of convergence, cost, popularity, ability to detect multiple local maxima, and their applications [4]– [6].

Looking curiously towards MPPT methods, hill climbing and P&O [7]–[8] are most commonly used methods due to their easy implementation & simplicity. The P&O method [10] is perturbation in the operating voltage of the PV array as well as Hill climbing [9] is perturbation in the duty ratio of the power converter. The array terminal voltage with the actual MPP voltage cannot be compare in the P&O algorithm, therefore the array terminal voltage perturbation gives result as change in power only, which is not accurate due to steady-state oscillations & reduces energy .Reducing the step size of the perturbation, oscillation can be minimized, but the speed of tracking MPPs get slow down due smaller perturbation size. Under rapidly changing atmospheric conditions these methods fails to operate properly which the main disadvantage of it [11] On the contrary, some MPPTs are more accurate, rapid,

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more effective, which need specific design & familiarity with special subjects such as fuzzy logic [12] or neural network [13] methods. Fuzzy logic controllers of MPPT have good performance than the P&O control method & under rapidly varying atmospheric conditions [4]; however that its effectiveness is highly dependent on the technical knowledge of the engineer in computing the error and coming up with the rule-based table which is the main disadvantage of this method. It is mainly depend on the arrangement of the designer which requires skill & experience. The neural network method comes with its dependence on the characteristics of the PV array which are change with time, referring that the neural network has to be trained periodically to assure accurate MPPs.

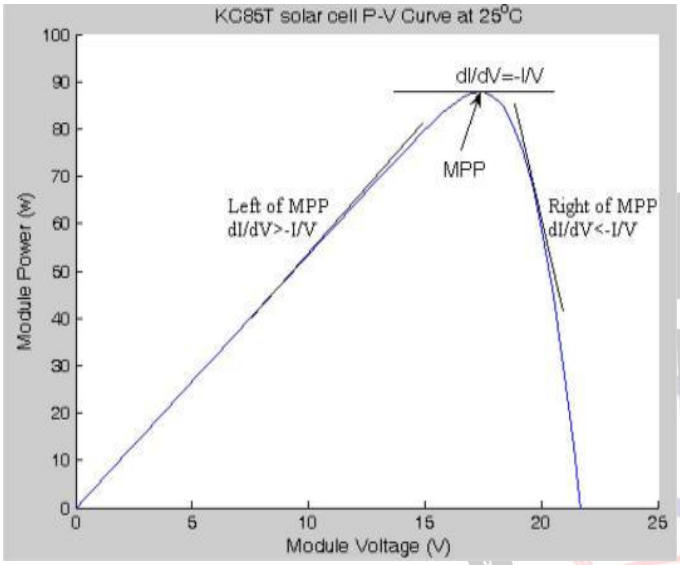

Figure 1: - Basic idea of the IncCond method on a P–V curve of a solar module.

The IncCond method is the one which overcome the all above drawbacks. According to the MPP voltage the array terminal voltage is always adjusted in this method. It is based on the instantaneous and incremental conductance of the PV module.

Figure 1 shows that at the MPP, slope of the PV array power curve is zero, increasing on the left of the MPP and decreasing on the right-hand side of the MPP. The basic equations of this method are as follows [16]:

$$\frac{dI1}{dV1} = -\frac{I1}{V1} \quad \text{AT MPP} \quad (1)$$

$$\frac{dI1}{dV1} > -\frac{I1}{V1} \quad \text{Left of MPP} \quad (2)$$

$$\frac{dI1}{dV1} < -\frac{I1}{V1} \quad \text{Right of MPP} \quad (3)$$

Where, V_1 and I_1 are the PV array output voltage and current, respectively. The right-hand side shows the Instantaneous conductance of the PV module, and the left-hand side of the equations shows the IncCond. From (2)–(3), it is obvious that the solar array will operate at the MPP when the ratio of change in the output conductance is equal to the negative output conductance. The MPPT will track the maximum power of the PV module by comparing the conductance at each sampling time. The method can be proving its accuracy i.e.it can track the accurate MPPs independent of the PV array characteristics. Roman et al. [14] specify it as the perfect MPPT method, where it has made a overall distinguish between P&O and the IncCond method with cuk converter and shows that the efficiency of experimental results is up to 96%. In, efficiency was observed to be as much as 98%, but in practice we are not getting that much efficiency due to noise problem of components.

Table 1: Characteristics of Different MPPT Technique

MPPT Technique	Speed	complexity	Reliability	Implementation
Fractional Isc	Medium	Medium	Low	Digital/Analog
Fractional voc	Medium	Low	Low	Digital/Analog
IncCond	Varies	Medium	Medium	Digital
P&O Method	Varies	Low	Medium	Digital/Analog
Fuzzy logic	Fast	High	Medium	Digital
Neural Network	Fast	High	Medium	Digital

B. DIRECT CONTROL METHOD

To control the MPPT, conventional MPPT systems have two independent control loops. The first control loop contains the MPPT algorithm, and the second one is usually a proportional integral controller. The IncCond method uses instantaneous and IncCond to generate an error signal, at the MPP which is zero, however at most of operating points it is not zero [4]. Due to the nonlinearity nature of PV and unpredictable environmental conditions and hence, PI controllers do not generally work well which is the main control problem of the MPPT system of standalone. In proposed system incremental conductance is used to improve the efficiency. Micro controller is used for controlling & monitoring of the system.

III.HARDWARE DESIGN IMPLEMENTATION & RESULTS

An incremental conductance algorithm with proper converter selection & component of system by designing MPPT system is shown in below figure

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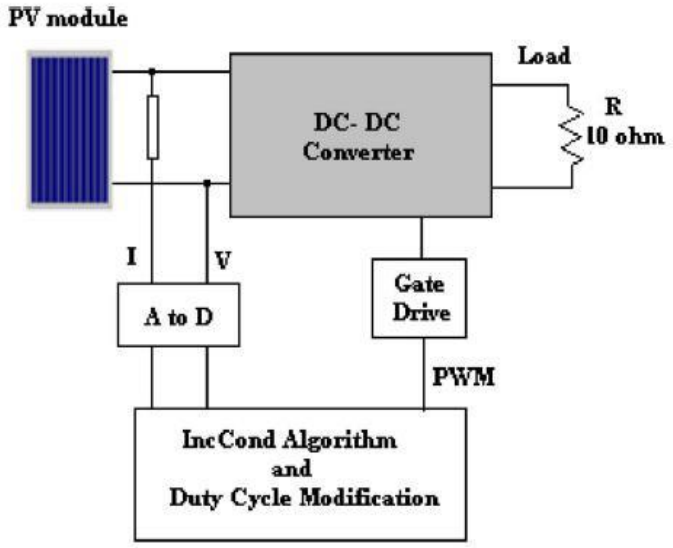

Fig. 2. Direct control method used in the MPPT

To attain high output power, solar modules are usually connected together. Generally solar modules are arranged in two different type's series and parallel. The arrangement of connection based on the implication where more voltage & current is necessary. Series connection of solar cell is required to obtain high output voltage as well as in parallel to gain high output current. Generally solar cells in module are connected in series to get more voltage [2].

Solar based MPPT system with direct control incremental conductance algorithm is as shown in below figure 3.

Fig.3: Design implementation of direct control method used in the MPPT.

Table .2: Observation with and without MPPT with respect to time

Time	Without MPPT			With MPPT		
	Voltage(V)	Current(mA)	Power(W)	Voltage(V)	Current(mA)	Power(W)
12.00PM	5	400	2.0	10	389	3.89
12.30PM	5.2	461	2.4	11	400	4.4
1.00PM	5.8	422.41	2.45	11	415	4.56
1.30PM	6	435.00	2.61	11	420	4.62
2.00PM	6.1	439.34	2.68	11	430	4.73
2.30PM	5.5	400	2.2	10	398	3.98
3.00PM	3.6	394.44	1.42	9	370	3.33
3.30PM	3.3	339.39	1.12	8	320	2.56
4.00PM	3.0	326.66	0.98	8	309	2.47
4.30PM	2.7	314.81	0.85	8	300	2.4
	Total Power		18.71	Total Power		36.94

$$\text{Efficiency} = \frac{\text{Total Power (with MPPT)} - \text{Total Power (without MPPT)}}{\text{Total power (with MPPT)}} * 100$$

$$= \frac{(36.94 - 18.71)}{36.94} * 100$$

$$= 49.35\%$$

From above table 2, If we calculate efficiency then percentage efficiency is 49.35% by considering total power without MPPT & total power with MPPT. An implementing incremental conductance algorithm with cuk converter, we can obtain maximum efficiency as shown in above calculation. In below table the average reading of 10 to 15 days are compare to find the maximum efficiency .The reading of voltages & currents can be taken without MPPT & with MPPT.

IV. CONCLUSION

Large arrays composed of several panels may be modeled in the same manner like photovoltaic cell, provided that the equivalent parameters (short-circuit current, open-circuit voltage) are properly inserted in the modeling process. As a result, the equivalent parameters (resistances, currents, etc) of the association are obtained. Generally experimental data are available only for commercial low-power modules and this is the reason why this proposed work has chosen to deal with small arrays.

The proposed system was then constructed and simulated, and the performance of the recommended control concept was proven. From the obtained results during the simulations, it was confirmed that, with a proper converter and algorithm, the

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implementation of MPPT became simple also it's become possible to obtained acceptable efficiency level of the PV modules .In proposed system employment of fixed-step-size IncCond MPPT with direct control method was done. The MPPT system with a Cuk converter using direct control method.0.2s is the required sampling time to compete the steady-state position for the designed Cuk converter. The step size of duty cycle is chosen to be 0.2, so the converter can smoothly track the MPP.

This resultant system is capable of tracking the maximum power, which improves the efficiency & reduces the cost of the system. 49.35% efficiency is obtained from the above system.

REFERENCES

[1] R.-J. Wai, W.-H. Wang and C.-Y. Lin, ―High-performance stand-alone Photovoltaic generation system,‖ *IEEE Trans. Ind. Electron., vol. 55, no. 1, pp. 240–250, Jan. 2008.*

[2] N. Mutoh and T. Inoue, ―A control method to charge series-connected ultra electric double-layer capacitors suitable for photovoltaic generation systems combining MPPT control method,‖ *IEEE Trans. Ind. Electron., vol. 54, no. 1, pp. 374–383, Feb. 2007.*

[3] F. Liu, S. Duan, F. Liu, B. Liu, and Y. Kang, ―A variable step size INC MPPT method for PV systems,‖ *IEEE Trans. Ind. Electron., vol. 55, no. 7, pp. 2622–2628, Jul. 2008.*

[4] T. Esram and P. L. Chapman, ―Comparison of photovoltaic array maximum power point tracking techniques,‖ *IEEE Trans. Energy Convers., vol. 22, no. 2, pp. 439–449, Jun. 2007.*

[5] V. Salas, E. Olias, A. Barrado, and A. Lazaro, ―Review of the maximum power point tracking algorithms for stand-alone photovoltaic systems,‖ *Sol. Energy Mater. Sol. Cells, vol. 90, no. 11, pp. 1555–1578, Jul. 2006.*

[6] G. Petrone, G. Spagnuolo, R. Teodorescu, M. Veerachary, and M. Vitelli, Reliability issues in photovoltaic power processing systems, *IEEE Trans. Ind. Electron, vol. 55, no. 7, pp. 2569–2580, Jul. 2008.*

[7] N. Femia, D. Granozio, G. Petrone, G. Spagnuolo, andM. Vitelli, Predictive & adaptive MPPT perturb and observe method,‖ *IEEE Trans. Aerosp.Electron. Syst., vol. 43, no. 3, pp. 934–950, Jul. 2007.*

[8] E. Koutroulis, K. Kalaitzakis, and N. C. Voulgaris, Development of a Microcontroller-based, photovoltaic maximum power point tracking control System,‖ *IEEE Trans. Power Electron, vol. 16, no. 1, pp. 46–54, Jan. 2001.*

[9] N. Femia, G. Petrone, G. Spagnuolo, andM. Vitelli, Optimization of perturb and observe maximum power point tracking method,‖ *IEEE Trans. Power Electron, vol. 20, no. 4, pp. 963–973, Jul. 2005*

[10] A. Pandey, N. Dasgupta, and A. K. Mukerjee, Design issues in implementing MPPT for improved tracking and dynamic performance,‖*in Proc. 32nd IECON, Nov. 2006, pp. 4387–4391.*

[11] K. H. Hussein, I. Muta, T. Hoshino, and M. Osakada, Maximum photovoltaic power tracking: An algorithm for rapidly changing atmospheric conditions,‖ *Proc. Inst. Elect. Eng.—Gener, Transmits. Distrib., vol. 142, no. 1, pp. 59–64, Jan. 1995.*

[12] T.-F.Wu, C.-H. Chang and Y.-H. Chen, A fuzzy-logic-controlled singlestage converter for PV-powered lighting system applications, *IEEE Trans. Ind. Electron., vol. 47, no. 2, pp. 287–296, Apr. 2000.*

[13] M. Veerachary, T. Senjyu, and K. Uezato, Neural-network-based maximum-power-point tracking of coupled-inductor interleaved-boostconverter-supplied PV system using fuzzy controller,‖ *IEEE Trans. Ind.Electron., vol. 50, no. 4, pp. 749–758, Aug. 2003.*

[14] E. Roman, R. Alonso, P. Ibanez, S. Elorduizapatarietxe, and D. Goitia, ―Intelligent PV module for grid-connected PV systems,‖ *IEEE Trans. Ind Electron., vol. 53, no. 4, pp. 1066–1073, Jun. 2006.*

[15]Azadeh Safari and Saad Mekhilef, Member, IEEE ," Simulation and Hardware Implementation of Incremental Conductance MPPT With Direct Control Method Using Cuk Converter *IEEE Trans. Ind. Electron., vol. 58, no. 4, april 2011.*

[16] D. Sera, T. Kerekes, R. Teodorescu, and F. Blaabjerg, Improved MPPT Algorithms for Rapidly Changing Environmental Conditions. *Aalborg, Denmark: Aalborg Univ. /Inst. Energy Technol., 2006*

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