iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 3 **Issue:** V **Month of publication:** May 2015

DOI:

www.ijraset.com Volume 3 Issue V, May 2015
IC Value: 13.98 ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

Implementation of Fuzzy Logic Based On Photovoltaic Maximum Power Point Tracking For PMDC Motor

M.Ramakrishnan [1], R.Gandhi [2]
[1]M.E- Power Electronics and Drives, Assistent Professor, [2]Department of EEE
Gnanamani College of Engineering, Namakkal, Tamil Nadu, India

Abstract---This paper presents implementation of maximum power point tracking (MPPT) method employed in photovoltaic system to extract maximum solar energy and utilise it for driving pmdc motor. In this we use fuzzy logic technique to control the speed of pmdc motor. There are various techniques in MPPT, among which incremental resistance technique is employed here. With this technique variable step-size for pwm pulses can be obtained.
Index Terms—Incremental resistance (INR), maximum power point (MPP) tracking (MPPT), Incremental conductance (INC).

I. INTRODUCTION

Maximum power point (MPP) of photovoltaic (PV) generation systems is technique by which peak power can be tracked. In recent years, a large number of peak-power tracking methods have been proposed and implemented. Two widely used algorithm for control structures of PV systems are "Hill-Climbing and Perturb & Observation (P&O). Hill climbing involves a perturbation in the duty ratio of the power converter, and P&O is a perturbation in the operating voltage of the PV array. For these two methods, a tradeoff must be made in choosing the increment value by which the controlled parameter, such as duty cycle or reference voltage, is adjusted; large values increase the losses in steady state due to large perturbations around the MPP, while small values reduce the dynamic behavior in situations involving quickly changing irradiation conditions or load.
Fuzzy and neural-network methods are well adopted for handling nonlinearity. Since most PV arrays do not have the same characteristics, neural-network strategies have to be specifically trained for each PV array. The characteristics of a PV array also change with time so that the neural network has to be trained to assure accurate MPPT periodically.
For this reason we go for fuzzy logic. Incremental Conductance and Incremental Resistance are two techniques available in fuzzy logic control. Incremental-conductance (INC) methods are based on the fact that the slope of the PV array power curve versus voltage is zero at the MPP. The INC MPPT algorithm usually has a fixed iteration step size determined by the requirements of the accuracy at steady state and the response speed of the MPPT. In Incremental – conductance method, the step size is automatically adjusted according to the derivative of power to voltage (*dP/dV)* of a PV array. The step size will become tiny as *dP/dV* becomes very small around the MPP. Thus, the variable step-size INC MPPT has a very good accuracy at steady state. To acquire a fast response speed, a modified variable step-size incremental-resistance (INR) MPPT based on the current-mode control is proposed in this paper. If the operating point is far from MPP, it keeps the maximum step-size which enables a fast tracking ability. If the operating point is close to the MPP, the step size becomes so small that the steady-state oscillation is well reduced.

II. PROPOSED MPPT ALGORITHM

A general PV panel comprises a number of PV cells connected in either series or parallel and the *P–V* characteristic of the solar panels is modeled by the following.

$$V_{PV}=N\lambda \ln\left(\frac{Isc-Ipv+MIo}{MIo}\right)-\frac{N}{M}R_S I_{PV} \quad (1)$$

Where I_{pv} is the PV output current, V_{pv} is the PV output voltage, λ denotes the material coefficient of the PV cell, I_{sc} is the short-circuit current, *Io* is the PV saturation current, *Rs* is the series resistance of the PV cell, and *N* and *M* are the numbers of series strings and parallel strings in the PV panel, respectively. The output power of the solar cell is calculated as

$$P = V_{PV} * I_{PV} \qquad (2)$$

III. VARIABLE STEP-SIZE INR MPPT ALGORITHM

The step size for the INC MPPT determines how fast the MPP is tracked. Fast tracking can be achieved with bigger increments, but the system might not run exactly at the MPP but instead oscillate around it; thus, there is a comparatively low efficiency. The variable step-size iteration can solve the tough design problem. The derivative of power to voltage (*dP/dV)* of a PV array was introduced as a suitable parameter for regulating the variable increment for the INC MPPT algorithm.

In this paper, the derivative of power to current (*dP/dI*), as shown in Fig.1, is employed to determine the variable increment for the proposed INR MPPT algorithm which has a duality relation with the INC MPPT. The variable step-size method introduced to solve the problem discussed earlier is given as follows

$$D(k) = D(k-1) \pm N * \left|\frac{dP}{dV}\right|$$

$$D(k) = D(k-1) \pm N * \left|\frac{P(k)-P(k-1)}{V(k)-V(k-1)}\right| \qquad (3)$$

Where $D(k)$ is the duty cycle and coefficient N is the scaling factor adjusted at the sampling period to regulate the step size. In addition, the step size is the change of duty cycle. In the variable step-size algorithm can also be implemented according to the slope of the P–D curve for P&Q MPPT as

$$D(k) = D(k-1) \pm N * \left|\frac{\Delta P}{\Delta D}\right| \qquad (4)$$

Where ΔD is the step variety of the duty cycle in the former sampling period. The performance of the MPPT system is essentially decided by the scaling factor N for the variable step-size MPPT algorithm. Manual adjusting of this parameter is slow and tedious, and the acquired optimal values may be just suitable for a given system and certain operating conditions. To guarantee the convergence of the MPPT update rule, the variable step rule must meet the following inequality:

$$N * \left|\frac{dP}{dV}\right| < \Delta D_{max} \qquad (5)$$

Where ΔDmax is the largest step size for fixed step-size MPPT operation and is chosen as the upper limit for the variable step size INC MPPT method. Therefore, the scaling factor can be obtained as

$$N << \Delta D_{max} / \left|\frac{dP}{dV}\right| \qquad (6)$$

Equation (6) provides a simple guidance to determine the scaling factor N of the variable step-size INCMPPT algorithm. If (6) cannot be satisfied, the variable step-size INC MPPT will be working with a fixed step size ΔDmax. In this paper, an improved variable step-size algorithm is proposed for the INR MPPT method and is devoted to obtain a simple and effective way to ameliorate both tracking dynamics and tracking accuracy. The primary difference between this algorithm and the others is that the step-size modes of the INR MPPT can be switched by extreme values/points of a threshold function which is the product (C) of the exponential of the PV array output power (Pn) and the absolute value of the PV array power derivative ($|dP/dI|$) as

$$C = P^n * \left|\frac{dP}{dI}\right| \qquad (7)$$

Where n is an index. As shown in Fig. 1, the product of the first degree exponential ($n = 1$) of the PV array power (P) and its derivative ($|dP/dI|$) is applied to control the step size for the INR MPPT. The product curve has two extreme values/points ($M1$ and $M2$) corresponding to two current values ($I1$ and $I2$) at the two sides of MPP. The INR MPPT is in the variable step-size mode when the PV array output current is between $I1$ and $I2$.

IV. SIMULATION AND EXPERIMENTAL ANALYSIS

A stand-alone MPPT PV system shown in Fig. 1 is applied to test the feasibility of the proposed method. A boost converter is used as the power electronics interface between the PV array and the load to obtain the peak power.

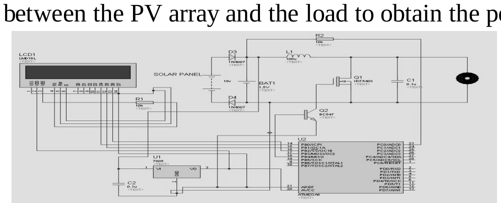


Fig. 1 Proposed MPPT System

Volume 3 Issue V, May 2015
ISSN: 2321-9653

International Journal for Research in Applied Science & Engineering Technology (IJRASET)

V. SIMULATION RESULT &ANALYSIS

In order to verify the feasibility and the performance of the proposed improved variable step-size INR MPPT algorithm, a simulation model of the PV system shown in Fig. 2 is developed in MATLAB-SIMULINK. An SX-110 crystalline silicon PV module is adopted as the PV array model in simulation and experiment. To compare the performance of the proposed method with the fixed step-size INR MPPT method, the simulation configurations are under exactly the same conditions. The figure 2 shows the simulation circuit of proposed system and the corresponding waveform is shown in figure 3.

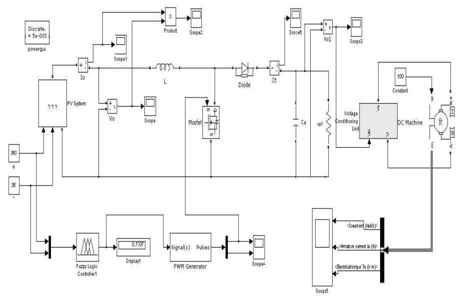


Fig. 2 Simulation Circuit of Proposed System

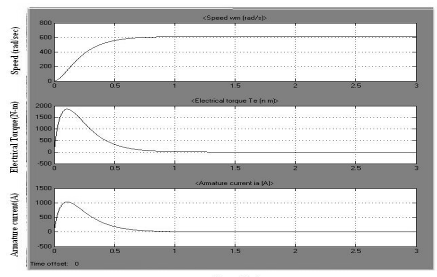


Fig. 3 Waveform of Simulation Circuit of Proposed system

In figure 4 the hardware circuit of proposed system is shown. In this system we are using ATMega8 microcontroller. The purpose of using this controller is due to its various features compared PIC or Atmel microcontroller.

VI. FEATURES OF ATMEGEA8 MICROCONTROLLER

In-built ADC converter
In-built Oscillator
In-built EMI

VII. EXPERIMENT RESULTS

The proposed variable step-size INR MPPT method has also been verified by experiment results. A laboratory prototype of the MPPT system in Fig. 4 is developed, and the dc-boost system specifications are given as follows:
Input capacitance: 330 μF;
Boost inductance: 325 μH;
Output capacitance: 100 μF;
Switching frequency: 50 kHz.

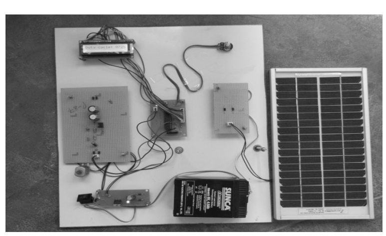


Fig. 4 Hardware of proposed system

Volume 3 Issue V, May 2015
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

Experiments were conducted by varying duty cycle of boost converter. Waveforms of various stages were illustrated in figure as below.

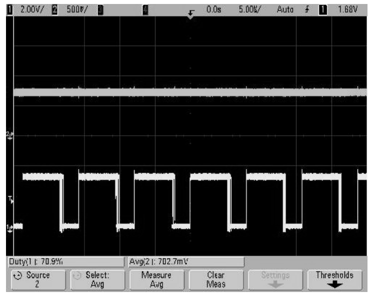


Fig. 5 Input voltage dc supply

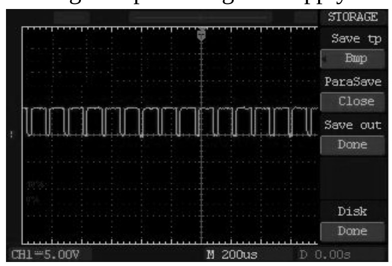


Fig. 6 PWM pulse of boost converter with respect to change in input supply

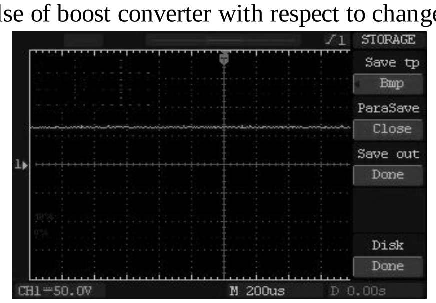


Fig. 7 Output voltage of boost converter

VIII. CONCLUSION

In this paper, a novel improved variable step-size INR MPPT algorithm has been proposed. This method is able to improve not only the steady-state performance but also the dynamic response. The proposed algorithm has a wider operating range than the previous variable step-size MPPT algorithms. Thus, the proposed MPPT algorithm is more suitable to practical operating conditions. The proposed variable step-size and fixed step-size INR MPPT methods are simulated in MATLAB-SIMULINK, and hardware experiments are implemented with a microcontroller.

REFERENCES

[1] Qiang Mei, Mingwei Shan, Liying Liu, and Josep M. Guerrero," A Novel Improved Variable Step-Size Incremental-Resistance MPPT Method for PV Systems", IEEE Trans. on Industrial Electro.n,VOL. 58, NO. 6, JUNE 2011.

[2] 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.

[3] 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.

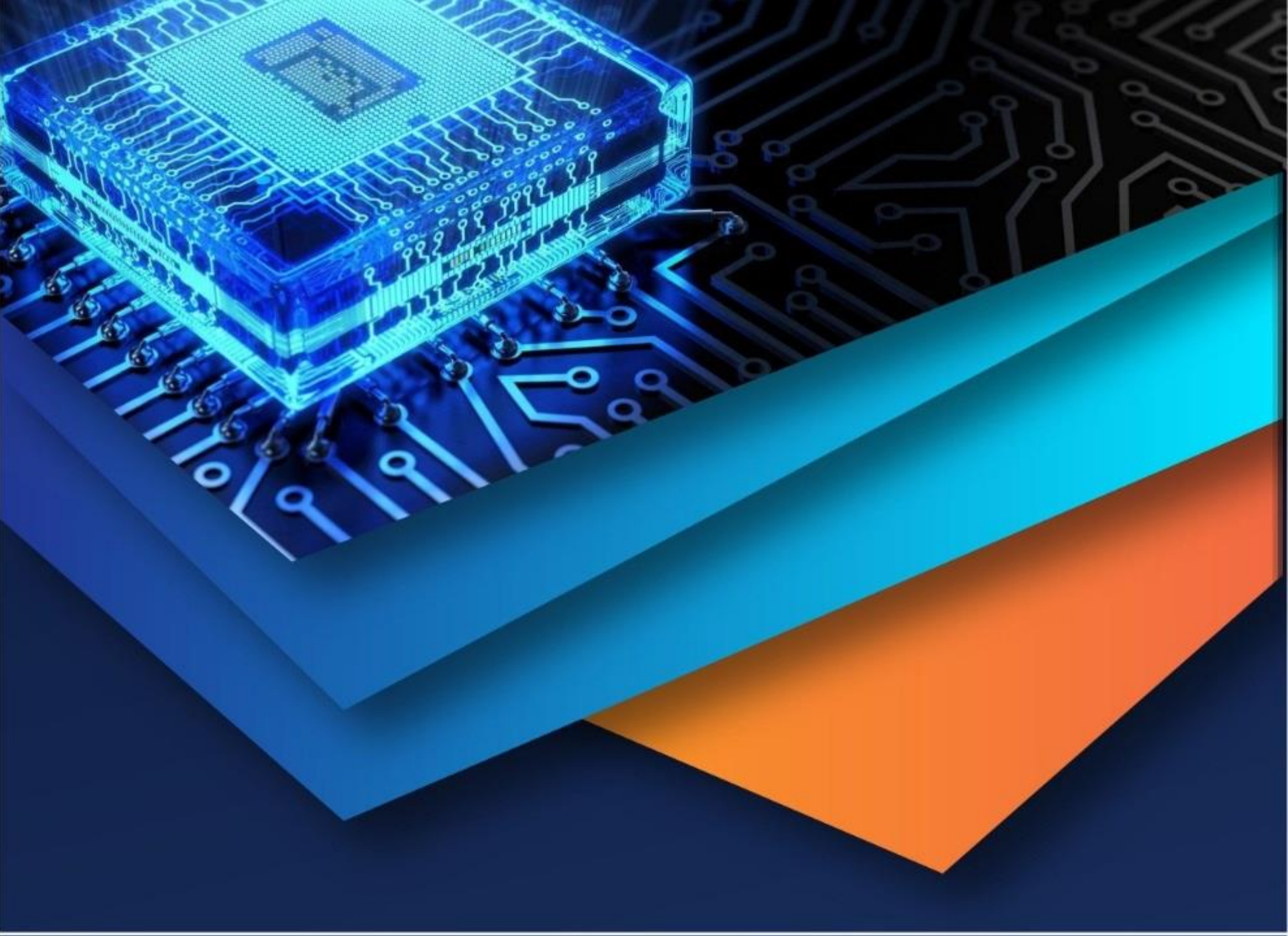
[4] W. Xiao and W. G. Dunford, "A modified adaptive hill climbing MPPT method for photovoltaic power systems," in Proc. 35th Annu. IEEE Power Electron. Spec. Conf., 2004, pp. 1957–1963.

[5] T. Tafticht and K. Agbossou, "Development of a MPPT method for photovoltaic systems," in Proc. Can. Conf. Elect. Comput. Eng., 2004,pp. 1123–1126.

[6] D. Sera, R. Teodorescu, J. Hantschel, and M. Knoll, "Optimized maximum power point tracker for fast-changing environmental conditions,"IEEE Trans. Ind. Electron., vol. 55, no. 7, pp. 2629–2637, Jul. 2008.

[7] 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.

[8] N. Femia, G. Petrone, G. Spagnuolo, and M. Vitelli, "A technique for improving P&O MPPT performances of double-stage grid-connected photovoltaic systems," IEEE Trans. Ind. Electron., vol. 56, no. 11,pp. 4473–4482, Nov. 2009.



10.22214/IJRASET

45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY