Battery Charging System using Soft Computing technique

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ABSTRACT

This paper proposes Deterministic Particle Swarm Optimization (DPSO) is used to track the maximum power in the condition of partial shading condition of Photo Voltaic (PV) system. Particles moves based on environmental condition and maximum power of PV to be tracked which is used to charge the battery. MATLAB software is used to estimate the results.

KEY WORDS: PV, DPSO, SEPIC converter, Charger, Battery.

1. INTRODUCTION

Now-a-days renewable energy plays an important role in power energy generation. Scarcity of power makes to implement new methods to generate the power from renewable energy source. Generation of power is as important as utilization of power. In this scenario solar power generation technology is utilized for both utility side and end user side.

Tracking of solar power is done by Maximum Power Point Tracker (MPPT). Amount of Maximum Power Point algorithm had been created to maximize power to the load. MPPT algorithms are effectively used to track the maximum power from solar panel.

Under normal condition, MPPT algorithm are effectively used to trajectory the power to the load i.e. it tracks the global maxima of Power-Voltage (P-V) curve of solar system. Due to partial shading condition, it fails to track the maximum power.it extracts only local maxima instead of global maxima. In that case, maximum power is not fed to the load. Here, generating power is not utilized fully.

To make use of generated power, soft computing technique has been developed. From that, swarm optimization is effectively used to extract the power under partial shading condition. Particles are moved according to the environmental condition to track the global maxima i.e. corresponding duty signal is given to the power electronic switch which will conduct accordingly.

This paper gives the soft computing approach to track the maximum power and also charging the battery. Depending upon the illumination level the duty signal is given to converter switch i.e. output can be varied from low to higher value.

2. PROPOSED METHOD

In order to track the maximum power effectively in each and every instant, DPSO technique is employed. Over all MPPT algorithm operates based on two conditions. One is normal condition other is partial shading condition.

Particles move based on the environmental condition to get the global maxima. Because of the random search of particles, tracks local maxima instead of global maximum point. Eberhart and Kennedy who were the first to introduce PSO method. Several variants of PSO have been introduced till the date. Each particle has own experience and exchange information among all particles to reach the optimum path.

Particle position is obtained from,

$$x_i^{k+1}=x_i^k+V_i^{k+1}. \quad (1)$$

Velocity equation,

$$V_i^{k+1}=wv_i^k+c_1r_1\{P_{besti}-x_i^k\}+c_2r_2\{G_{best}-x_i^k\} \quad (2)$$

Depending upon the fitness function, performance of each particle is measured.

$$f(x_i)>f(P_{besti}) \quad (3)$$

Particle size is about 20, inertia w=0.5. Initially, the duty cycle of the converter is initiated. Fig.1, represents flow chart of the overall MPPT algorithm. The whole MPPT algorithm operates based on two conditions. When the PV cells are equally illuminated, P&O technique is employed to track the maximum power. At the time of partial shading condition i.e. PV cells are not illuminated, DPSO technique is used to get maximum power with reduced number of iteration. Power loss will be minimum compared to other intelligent control techniques.

Concerning the random number in velocity equation, more iteration needed to reach the optimum solution if change in two duty cycle in two successive iterations is very low. It leads to power loss and also large change in the velocity might cause the particle to escape from the search space.

Once duty signal is generated by MPPT technique, it is given to the SEPIC converter. Fig.1, indicates the block diagram of the proposed method. The SEPIC converter exchanges energy between the capacitors and inductors in order to convert from one voltage to another. The amount of altered energy is controlled by switch i.e. MOSFET which is in the action when the Duty signal obtained from the MPPT technique (either P&O or DPSO).

Several Intelligent control techniques are implemented to track the maximum power point. PSO is the one has advantages compared to other methods to get optimum solution. To overcome the problem of PSO can be eliminated by removing the random number in Eq.2, and velocity of each particle is fixed to a particular value. In this condition, the particle moves like deterministic manner. The velocity of the particle depends on the particle position (xi^k), inertia (w) and particle best (P_{best}) and global best (G_{best}) value. This method called as the Deterministic Particle Swarm Optimization (DPSO).

Initially, d_{max}, d_{min} calculated and number of particles initialized [Np=3]. Once the PV array's voltage is measured, power will be calculated. If P(i) > P (i-1) means, P_{besti} of each particle is calculated and maximum value of P_{best} will be optimal power of the system. Each and every instant $P_{besti}$and G_{best} values updated and corresponding duty cycle of G_{best} will send to the converter switch. With help of MATLAB, Coding for DPSO and P&O techniques developed.

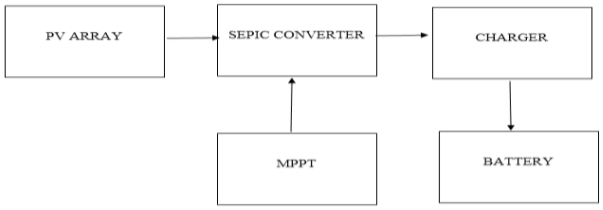

Figure.1. Block Diagram for proposed method

Depending upon the load requirement, PV cells can be added or removed and also output of PV array can be boosted with help of charger. Table.1, represents the design specification of SEPIC converter.

Table.1. Design specification

S. No	Parameters	Value
1	L1	4.89 mH
2	C1	32.4 F

The inductor value is properly selected to get the continuous inductor current at minimum load.C2 value fixed higher value if the load current has high energy pulses. SEPIC topology has the properties of filtering. So the input capacitor can be very small and C1 can be ten times smaller than C2.

3. RESULTS AND DISCUSSION

DPSO has merits that search the particle in random manner compared to other PSO variants. Duty cycle varied based on environmental conditions.

This paper uses P&O and DPSO methods to track the maximum power point of solar array. When PV array receives full illumination, only one global point present in P-V curve. So, random search is not necessary. Hence, in this paper uses P&O method to track global point during fully illumination condition. DPSO technique is employed when PV cells are under partial shading condition. Particles moves based on the velocity during partial shading condition. Velocity of particle updated in every iteration and moves toward the destination path. Therefore, P&O technique is used to track the maximum power in normal condition and under partial shading condition DPSO technique is used.

Fig.2, shows the simulation diagram of proposed method. Here, PV modules are connected to meet the load requirement. PV array irradiation as varry as power extraction. During normal condition, entire PV array system will receive uniform insolation, results only one maximum point which delivers maximum power to the load. In this condition, P&O technique is used to track the maximum power. P&O compares present and previous power. If previous power is greater than present power, moves towards to positive direction otherwise in negative direction, results in maximum point. Once the maximum power is tracked, power remains constant and corresponding duty signal given to the converter which will conduct accordingly.

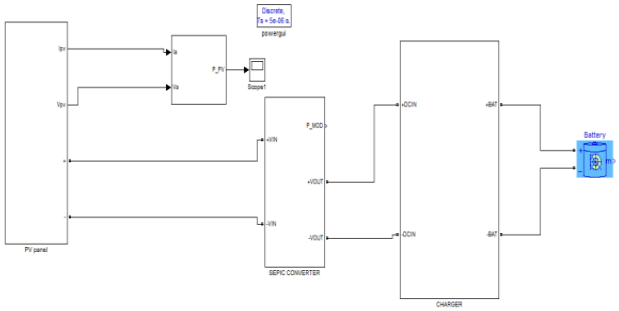

Figure.2. Simulation of DPSO based MPPT based on charging the battery

When PV array system partially shaded, P-V curve exhibits multiple peaks. The presence of multiple peaks makes the P&O technique inability to discriminate between local peak and global peak. In order to track the maximum power in partial shading condition, soft computing technique as DPSO is employed.

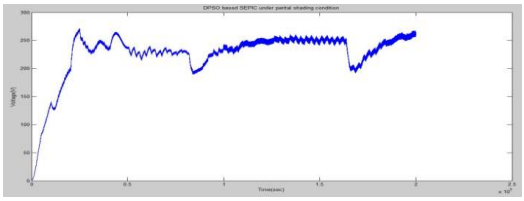

Figure.3. Voltage waveform of DPSO technique

If irradiation is too low, boost converter is activated to boost up the voltage from SEPIC converter. Boost converter is cut off from the circuit when the PV cells are equally illuminated. Table.2, shows the output values of SEPIC converter. Maximum output can be tracked within 8th iteration. But compared to normal condition, tracked power is low in partial shading condition. Output of SEPIC converter is fed to charger. Depending upon the output of converter either boost converter is cut off or not.

In this paper, PV modules connected in series and parallel depending upon the load requirement and Li-ion battery is used. Finally battery gets charged. If any excess power is present, temporarily additional load can be connected. In this application can be applied in communication system, Domestic application i.e. Battery can be connected to domestic load, run the vehicles.

Table.2. Sepic converter output for different environmental condition

Parameters	Normal condition (P&O)	Partial shading condition (DPSO)
V (volts)	600.32	274.652
I (amps)	2.1923	8.821
Power (watts)	3.070×10^3	2.536×10^3
Duty cycle	0.7997	0.8210
No. of iteration	----------	8

P&O method will generate duty signal to the converter in normal conditions. During partial shading condition gating signal generated from DPSO technique. Duty signal can switch over from MPPT (P&O) to DPSO during partial shading condition. So power can be tracked effectively and also reach the MPP with small no of iterations. DPSO method, number of iterations can be reduced. Tuning effort is greatly reduced and also it simplifies the optimization structure compared to the conventional methods.

4. CONCLUSION

This paper presents soft computing technique as DPSO which tracks the global maxima during partial shading conditions. Duty signal obtained from the MPPT technique is given to the SEPIC converter. Depending upon the SEPIC converter output, buck converter is added in charger in order to charge the battery. It can be used to charge the vehicles and also used for domestic applications.

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