A Novel Current Sensor less MPPT based Approach for PV Applications Using PSO Technique

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Abstract. As an increased demand in power resources and to reduce global warming, Renewable Energy Sources (RES) are preferred over the conventional sources. Among various available RES, solar energy is the effective and efficient one. The solar energy is also clean and free energy. The use of Maximum Power Point Tracking (MPPT) is one of the techniques to get maximized output power from the Photo Voltaic (PV) system. The proposed method uses a voltage sensor by eliminating the need of current sensor based on selected technique using Partial Swarm Optimization (PSO) technique interfaced with DC-DC boost converter. PSO technique is one of the methods which has high conflux speed, to precisely track the maximum power. The result of the planned methodology is studied with the assistance of an acceptable simulation applied in MATLAB/Simulink setting for experiment to valid of microcontroller which is employed. The result obtained from the simulations studies showed that current sensor less methodology using PSO technique can extract the maximize power from PV systems.

1. Introduction

A growing environmental concern of clean power generation, solar energy is a promising alternative technology of one of the natural resources to generate electricity from thermal energy. The usage of non-conventional energy sources will overcome a problem of carbon consist which in turn causes to reduce global warming; solar photovoltaic (PV) system usage is more because of its simple structure [1]. Solar PV panels are the devices that works with technology that has the property to convert thermal energy into electrical energy. The main advantage in a PV system in which the 70-80% of expense will reduce due to PV module [2]. In past twenty years the reduction in the prime cost of solar PV systems has effective impact on the cost per unit. When compared to the other conventional energy sources were like free of cost, the PV system uses less time to generate electricity [3]. The main pros of solar energy system is stationary there are no rotating parts this will reduce the vibrations noise and free of wear because of this no carbon output footprint on environment, [7].

Actually, the PV system is current source, i.e. it create electric current that its value on the irradiation illuminate on the top of PV module [3]. In order to gain and extract the maximum output power from the PV Module can be obtain through MPPT Controller [1]. The MPPT varies with the change in temperature and irradiation on the PV Module. The harmonics are obtained at the output of MPPT controller because to its feedback control nature it will traces the irradiation from the sun light. To overcome the ripples filter circuits are used. By means of filter circuit output is given to the DC-DC boost converter. The efficiency of the Photovoltaic are increased by several techniques are present by Perturb and Observation and Incremental Conductance algorithms [1].
The prior mentioned MPPT algorithms, which the conventional techniques of PV system give an output inform of voltage and current to sense them we required two sensors, which necessitates for pair of sensors for voltage and current. The requirement of two sensors will make system complicated, bulkier and increase in cost. Moreover, having fewer components will also increase the system reliability. To using effectiveness of MPPT technique using model of Particle Swarm Optimization (PSO) with eliminating the current sensor. The main motive of this paper is to operate the MPPT performance to improve PV system with easy maintenance and even reduction in the overall installation process will removal of current sensor by use of Microcontroller.

2. Methods and course of the study

A standard current sensor less MPPT based Particle Swarm Optimization technique with using Microcontroller block diagram as shown in Figure 1. The PV array block is connected to Microcontroller which the coding of it three iterations of initialization. The PV array block has inputs of temperature and irradiation with different parameters. The output of PV array which gives with the output of voltage and current with 1 parallel and 6 series module which are operate with clock pulse given to the Pulse Width Modulation(PWM) by the use of Microcontroller.

![Figure 1 Block Diagram of Selected technique](image)

The MPPT is modeled using two approaches namely Microcontroller and Pulse Width Modulation. Microcontroller model is used with PSO technique of coding with the iterations of the different duty ratio of 25%, 50% and 75% of full load value. It negotiates to overcome the partial shading effects to track the maximum power Point in order to increase effect of the power extraction through PV arrangements [5].

Where the PWM is operated with the P&O algorithm is used which refine the step response and will reduces the ripple of the PV system has dynamic fast response to irradiance and temperature. Several stable equations are required for numerically model of PSO in the Microcontroller coding.

It uses each ray to keep on tracking of these co-ordinates which are linked with the best solution. This is known as P_best. Due to the optimal of process particle take up of objective functions value. While their global best power G_best and P_best are saved.

A fundamental of proposed technique coding in Microcontroller that will regulate the upcoming position that are able to detect the velocity by the equation as,

\[
v_j^{k+1} = w \times v_j^k + s_1 \times q_1 \times (P_{best} - x_j^k) + s_2 \times q_2 \times (G_{best} - x_j^k) \quad (1)
\]

\[
x_j^{k+1} = x_j^k + v_{j}^{k+j} \quad (2)
\]

In the above mentioned expression where, \( j \) represents the varying of upgraded vector, \( k \) is the number of iterations, \( v_j^k \) and \( x_j^k \) respected to the velocity and position of \( jth \) variable of the \( k \) iterations are as in Microcontroller coding, \( w \) represents and maintains interia a stable between the
best global and local power of search $q_1$ and $q_2$ are used for acceleration. $s_1$ and $s_2$ are the values used for definite numbers that are generated by steady divided into intervals of $[-1,0,1]$. Value of $P_{\text{best}_i}$ holds the good place that changes are done with $j$th term upto the perfect time intervals. The below expression is indicated that the positions are stored only if the condition satisfies.

$$P_{\text{best}_i} = x_i^k \text{ if } f_i(x_i^k) \geq f_i(P_i) \quad (3)$$

3. Proposed Method

In order to verify the proposed techniques, modeling is carried out based on the different environment conditions which the boost converter was modeled with the help of component values shown in Table.1. An extra diode is connected parallel to the capacitor during the cause of short circuit. The model of PV panel is done with the simple model of one PV elementary cell. By merging the number of solar cells can be formed for requirement module and string to get better result.

The system contains a power converter of DC-DC. from the Figure 1, shows the control system which consists of a MOSFET the switching signal is fed by PSO code written on the microcontroller and inductor L with value of 0.1 henry, and a smoothing capacitor C with value of 500µF, and diode D. A microcontroller is employed to regulate the DC/DC converter instantly through PV panel output power. The power requirement is engaged by the connecting of PV cells in series manner. A load is connected at the system by increasing the PV cell voltage i.e. through boost converter. It is a bent of that inductor will oppose the varying in current and by creating and destroying the magnetic field. As use of converter output voltage value is more when compared to the input values. By Figure 2 the PV array with the inputs of Irradiation and temperature which the output voltage and current is given to the control unit.

The PSO technique has simple shape, easy to implement, and fast problem-solving capability. It will easily trace the MPP for any sort of P-V curve no matter environment variation and traces the PV system because the searching of spaces of the proposed technique will reduces in turn to the time interval remains stable to converge can be enormously decreased. It uses to detect the I-V and P-V characteristics curves under some portion of PV system is progress and the design will encircle the converter power and by MPPT controller.

The converter basically gives however high power because that removes the ripple at the output. So, the controller designed such a way that the highest power taken out from PV system from the topology of boost converter is sown in Figure 2.

Figure 2. Simulink model of proposed method

Microcontroller used with the duty cycle which is helpful to operate PV array. The Figure 2 shows that which contain with blocks of initialization and iterations and the delay with the embedded function and the output is fed with the zero-order hold with the value of $1e-4$ and saturation output was connected PWM generator with the switching frequency of 5000 Hz.
Figure 3. Simulink Model of The Microcontroller

The Figure 3 shows which consists of initialization sequence which makes the process to reset state and to state where the operating systems can startup. The reset vector is a special location within the memory to usual configures the controller and processor caches. Whereas delay is important to perform time actions between the two iterations that are created by the using technique of loops or by in built delay function. The output of MATLAB function block is given to the saturation block will performs arithmetic operations also enables overflow bit or excessive computation of maximum and minimum.

Figure 4. Output of boost converter

4. Research Results

The PV module characteristics are conduct by normal test conditions (NTC: solar irradiance =1kW/m², temperature =25deg.C). In which the six series modules connected to one parallel string. The PV array parameters are mentioned in table.1. The current vs voltage and Power vs Voltage characteristics illustrated in the fig.5. The autocratic of chosen method is modeled in MATLAB simulation; the sampling time of 20 microseconds and with the 100*10³Hz frequency for the sampling purpose. In this paper based on the proposed current sensor less MPPT technique using Microcontroller which are capable of handling PSO technique code for three iterations. Unlike the controllers in the PWM the switching signals are given to operate directly thus the “switching
frequency “can be varied from one secure sampling interval to the next. By means of the PSO has the better method which was in simple and easy to model are shown in simulation in terms of accuracy.

Table 1 Parameters for system Model

| System Model Parameter Table                      |                  |
|---------------------------------------------------|------------------|
| Average switching Frequency(F)                    | 5kHz             |
| Sampling Time(Ts)                                 | 10 µs            |
| Resistance value(R)                               | 45ohm            |
| Capacitor output value(C)                         | 500µF            |
| Voltage of MPP(V_{MP})                            | 187V             |
| Current of MPP(I_{MP})                            | 4.15A            |
| Power of MPP(P_{MP})                              | 776.9V           |

![Graph 1](image1.png)

**Figure 5** I-V and P-V characteristics of the PV array.

The output of PV array with which the six series modules are designed with in one parallel string, where irradiance and temperature are used with clock to operate with the No converter where the output voltage of 37.2v and maximum power of 244.62w and output current of 8.62amps and different irradiation as shown in Figure 6.
Figure 6 Output Voltage and Current from PV array with different irradiation and constant temperature of 25°C

The simulation results of the load model in the chosen technique is analyzed by harmonic gain to control the effectiveness of the variation in the nominal values of before and after the PSO technique was executed was shown in figure 5.

The answer obtained by using the MATLAB/Simulink. The PV module is evaluated for the different duty ratio and variation in irradiation and constant temperature. The solution can obtain by PSO technique to extract maximize power which are achieved by the DC-DC converter. Which will eliminate the current sensor, the performance remains the same. Which means to difficult when the real objective are required of Photovoltaic system when the environment changes rapidly.

Figure 7 Harmonic gain of with and without PSO of PV array output

5. Conclusions

The analysis of merits of Maximum Power Point Tracking of solar PV system modeled and simulated practically by the use of MATLAB/Simulink. The load is given to the boost converter which is main attributes of the paper. By the practical analyze of simulation results the proposed technique of PSO algorithm as the advantage of converging of speed, highly precision and be accurately traces the maximum power compared to the other conventional methods.
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