A Comparison of Two MPPT Techniques for PV System in Matlab Simulink

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Abstract—*In the context of renewable energy, this study treats the case of the conversion of solar energy, which is one part of non pollutant energy, to electrical one. In this paper, two different methods are used to maximize the generated power. Thus, a comparison between the 'perturb and observe' control method and the 'incremental conductance' control method are given, analyzed and discussed.*

Keywords—*Renewable energy, solar panel, photovoltaic cell, modeling and control.*

I.   INTRODUCTION

In general, the Earth has two global movements that affect the reception of the solar energy to its surface: the rotation that it does once on itself per day and the yearly revolution that it does around the sun. The combination of these movements implies daily changes in the receipt of the solar light to particular places. The reason for which the energizing flux received to soil hardly passes 1000 W/m2 is that the atmosphere modifies in an important way the direct radiance of the sun. The phenomenon named "photovoltaic effect" consists mainly in transforming the solar light in electric energy by means of the semiconductor devices named photovoltaic cells. The solar panel, or photovoltaic generator, is itself constituted of an association of series and parallel of the necessary number of modules to assure the requisite energy. Maximum Power Point Trackers (MPPTs) play an important role in photovoltaic (PV) power systems because they maximize the power output from a PV system for a given set of conditions, and therefore maximize the array efficiency. Thus, an MPPT can minimize the overall system cost. MPPTs find and maintain operation at the maximum power point, using an MPPT algorithm. Many such algorithms have been proposed. However, one particular algorithm, the perturb-and-observe (P&O) method, continues to be by far the most widely used method in commercial PV MPPTs. Part of the reason for this is that the published MPPT methods do not include comparisons between multiple existing algorithms. [4][8][10]

II.   IMPLEMENTATION IN SIMULINK (PROGRAMMING & ALGORITHMS OF TWO TECHNIQUES.)

Implementation of Perturb & Observe Method using MatLab Simulink. [4][5][6][7][9]

Applying a variation on the voltage (or on the current) towards the biggest or the smallest value, its influence appears on the power value. If the power increases, one continues varying the voltage (or the current) in the same direction, if not, one continues in inverse direction as shown in figure 1.
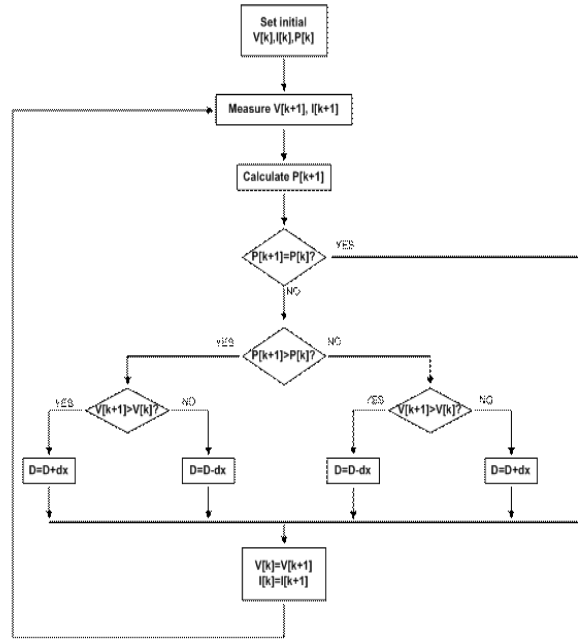
Fig. 1 Flow diagram of P&O MPPT method

Figure below shows the block diagram of this MPPT method and the coding of P & O block is shown below the figure. In this coding, the duty cycle (D) of used DC – DC converter is calculated by the following expression.

D = Dold ± deltaD

Where deltaD is the duty cycle step.

The different steps of the 'Perturb and Observe' method are :
1. Take current and voltage measurements, power calculation,
2. If the power is constant, return to take new measurement,
3. If power decreased or increased, test the voltage variation,
4. According to the direction of voltage variation, modify the current.

The simulink block of MPPT technique (P & O) is shown below in fig. 2.
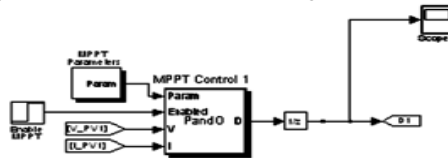

Fig. 2. **Block Diagram of P&O MPPT method**

Coding of P & O Block

```
function D  = PandO(Param, Enabled, V, I)
% MPPT controller based on the Perturb & Observe algorithm.
% D output = Duty cycle of the boost converter (value between 0 and 1)
% Enabled input = 1 to enable the MPPT controller
% V input = PV array terminal voltage (V)
% I input = PV array current (A)
% Param input:
Dinit = Param(1);  %Initial value for D output
Dmax = Param(2);   %Maximum value for D
Dmin = Param(3);   %Minimum value for D
deltaD = Param(4); %Increment value used to increase/decrease the duty cycle D
% ( increasing D = decreasing Vref )

persistent Vold Pold Dold;
dataType = 'double';
if isempty(Vold)
    Vold=0;
    Pold=0;
    Dold=Dinit;
end
```

```
P= V*I;
dV= V - Vold;
dP= P - Pold;

if dP ~= 0 & Enabled ~=0
   if dP < 0
      if dV < 0
         D = Dold - deltaD;
      else
         D = Dold + deltaD;
      end
   else
      if dV < 0
         D = Dold + deltaD;
      else
         D = Dold - deltaD;
      end
   end
else D=Dold;
end

if D >= Dmax | D<= Dmin
   D=Dold;
end

Dold=D;
Vold=V;
Pold=P;
```

Implementation of Incremental Conductance Method using MatLab Simulink.

This method consists in using the slope of the derivative of the current with respect to the voltage in order to reach the maximum power point. To obtain this point, dI/dV must be equal to $-I/V$ as shown in figure 3
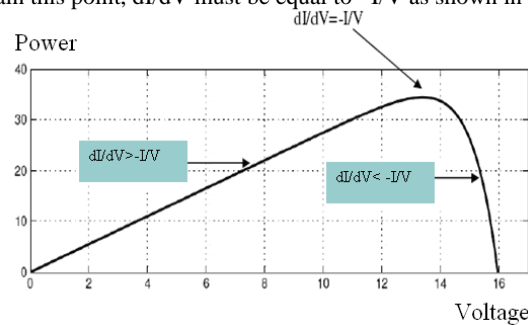

Fig. 3. V-P Characteristics of PV module (IC method)

In fact, applying a variation on the voltage toward the biggest or the smallest value, its influence appears on the power value. If the increases, one continues varying the voltage in the same direction, if not, one continues in the inverse direction. The simplified flow chart of this method is given in figure 4.
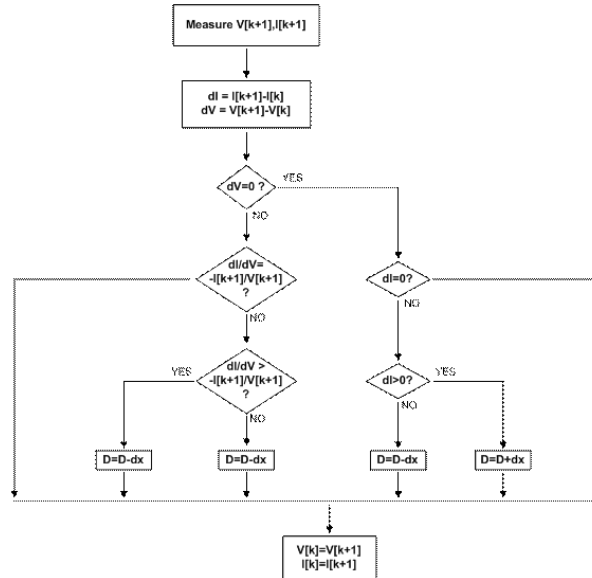
Fig. 4. Flow diagram of Incremental Conductance method

In addition, by using power formula, P=V.I, its derivative becomes :

dP = V dI + I dV

In general, the duty cycle (D) of used DC – DC converter is calculated by the following expression.

D = Dold $\pm$ deltaD

Where deltaD is the duty cycle step.

The simulink block of MPPT technique (IC method)
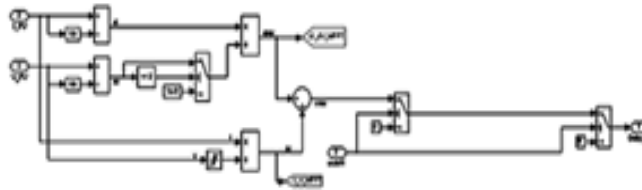The simulink block of MPPT technique (IC method) is shown below in fig. 5.

Fig.5. Simulink Block of MPPT technique (IC method)

Comparison of Two MPPT Techniques (P&O method and IC method) [3][4][5][8][10]

This paper presents in details comparative study between two most popular algorithms technique which is Perturb & Observe algorithm and Incremental Conductance algorithm. The Boost converter is used for comparison. Few comparisons such as voltage, current and power output has been traced. Multi changes in irradiance by keeping voltage and current as main sensed parameter been done in simulation. Matlab simulink tools have been used.

In order to compare the accuracy and efficiency of two MPPT algorithms selected in this paper Matlab/Simulink is used to implement the task of modeling and simulation. The specifications of PV model used in PV system is shown in following Table tested by the factory under 1000W/m^2, AM 1.5 and 25^{0}C conditions.
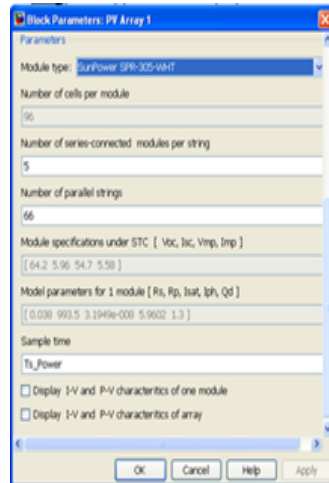
The block diagram of the PV simulation system used in this paper by using Perturb & Observe Method and Incremental Conductance Method is shown in fig. 6 and fig. 7
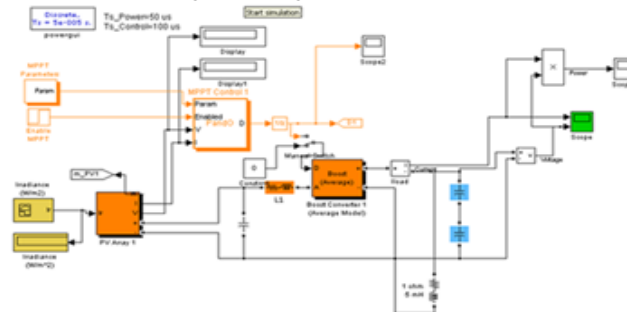

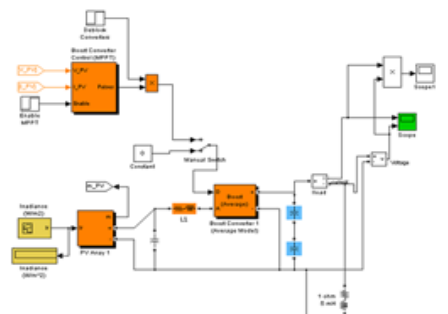**Fig. 6.** The block dia. Of PV simulation using Perturb & Observe Method

Fig. 7. The block dia. of PV simulation using Incremental Conductance Method

Fig 6 & 7 are comparison diagrams of output current, voltage and power for the PV system with two selected MPPT algorithms under the conditions $1000W/m^2$, 25^0C and the load $10\square$ by using the boost converter.
It can be observed that output power s with MPPT algorithm are obviously greater than those without MPPT algorithms.

III.   RESULT

Result of comparison of o/p current, voltage and power with and without Perturb and observe method and Incremental conductance method is shown in figure below.
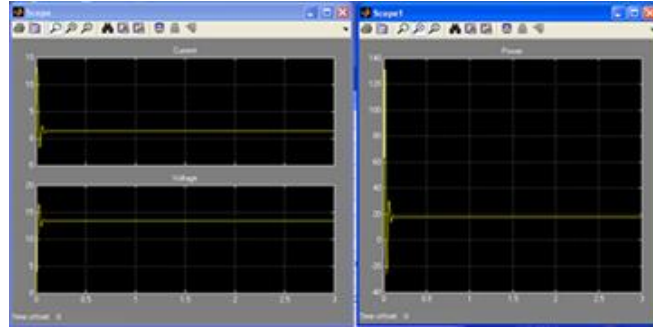
Fig. 8 Comparison diagram of o/p current, voltage & power without perturb & observe method
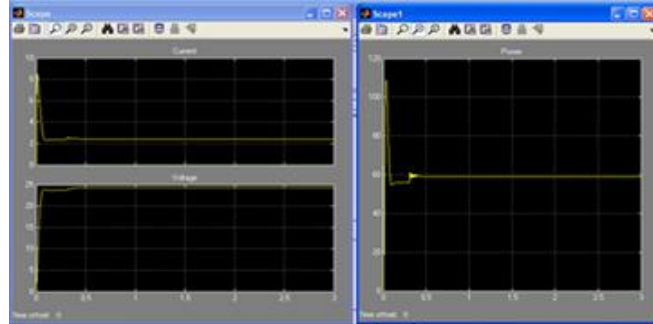

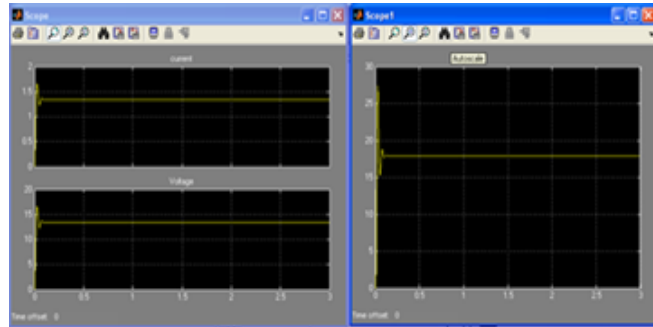*Fig. 9.* Comparison diagram of o/p current, voltage & power with perturb & observe method

Fig. 10. Comparison diagram of o/p current, voltage & power without Incremental conductance method
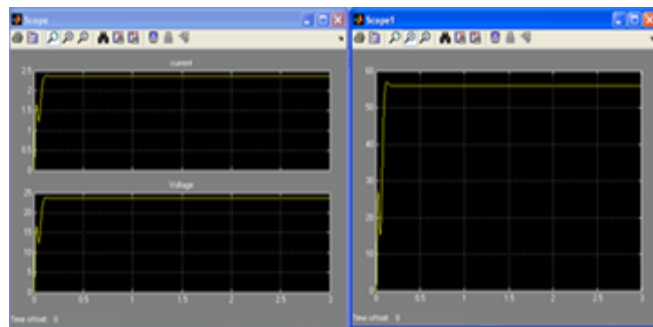

Fig. 11. Comparison diagram of o/p current, voltage & power with Incremental conductance method

From the simulation show that voltage input for both controller is almost the same. Perturb and Observe Controller shows a not stable condition. During the simulation the current and voltage decrease rapidly and lastly came to same value at the initial stage. From the simulation result is shows that controller that connected with Boost converter which will give a stable output is the incremental conductance controller. Perturb and Observe controller can achieve maximum output value at 23.66 V that better than incremental conductance controller.

IV.   CONCLUSION

This paper has presented a comparison of two most popular MPPT controller, Perturb and Observe Controller with Incremental Conductance Controller. This paper focus on comparison of two different MPPT techniques using Boost converter which will connected with the controller. One simple solar panel that has standard value of insolation and

temperature has been included in the simulation circuit. From all the cases, the best controller for MPPT is Perturb & Observe controller.

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