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Discrimination between Conventional and Modified P&O Algorithm for Solar PV Cell Application Using MATLAB

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ABSTRACT

This paper deals with the discrimination analysis between conventional and modified perturb and observe algorithm for solar PV cell. Basically perturb and observe algorithm is the most widely used algorithm because it contains less maintenance and less complexity. But due to sudden change in weather conditions this algorithm cannot work properly and efficiency reduces. So there is an algorithm which reduces the drawbacks of conventional perturb and observe algorithm is called modified perturb and observe algorithm.

Key words: Perturb and observe, MPPT, Solar PV cell, MATLAB, Photovoltaic

INTRODUCTION: SOLAR PV CELL

The output characteristics of solar PV cells are basically non-linear and theses change with according to atmospheric conditions e.g. solar irradiance and temperature. Hence maximum power tracking controller is integrated in PV system to extract maximum power of PV array. There are many techniques such as perturb and observe, incremental conductance, constant voltage, short current pulse methods etc. But perturb and observe method is most widely used in solar PV cell application because of its flexibility and compatibility. In this paper a modified version of perturb and observe method is used to discriminate the performance of conventional perturb and observe method [2].

Equivalent Circuit of Solar PV Cell

An equivalent circuit of solar PV cell contains a light emitted source in parallel with a combination of one diode and a shunt resistance. The current source which delivers its short circuit current I_{SC}. There is a diode shunt connected across the current source representing the diffusion current through the p-n junction. Internal series and parallel resistances are represented by R_S and R_{Sh} respectively [7].

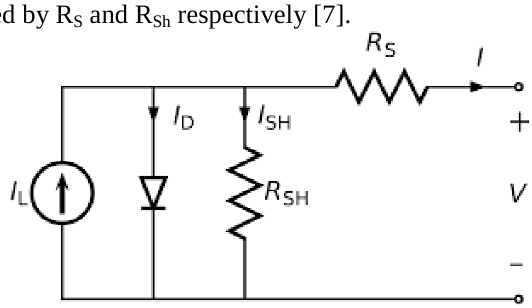

Fig. 1 Equivalent circuit of solar PV cell

Fig.1 shows the equivalent circuit in which: I_L = I_{sc} = short circuit current, I_D = diode current, I_{sh} = shunt current, R_s = series resistance, R_{sh} = Shunt resistance

Manufacturer of the solar module gives other parameters needed to model the solar cells. The parameters that can be found inside the datasheet are: Voc: open circuit voltage (V), Isc: short-circuit current (A), P_{mp}: power at maximum power point, V_{mp}: voltage at maximum power point and I_{mp}: current at maximum power point

The output current is given as: $I = I_{PV} - I_D$ (1)

Where, I_{PV} = photon current produced by cell and I_D = diode current

The diode current I_D is given by- $I_D = I_O$ [exp (qV_d/kT) - 1] (2)

Where, I_0: reverse saturation current of diode, q: elementary electron charge (1.602x10^-19 C), V_d: diode voltage, k: Boltzmann constant 1.381x10^-23 (J/K) T: temperature in kelvin (K)

The solar cell is model first, then extends the model to a PV module, and finally models the PV array.
An equation represents about solar cell- $I = I_{PV} - I_D = I_{PV} - I_O$ [exp (qV_d/kT) - 1] (3)

PERTURB & OBSERVE TECHNIQUE

The perturb and observe or hill-climbing MPPT algorithm is based on the fact that, on the voltage-power characteristics, variation of the power against voltage dP/dV > 0 on left of the MPP, while on the right, dP/dV < 0 as shown in Fig.2 If the operating voltage of the PV array is perturbed in a given direction and dP/dV > 0, the perturbation moves the array's operating point toward the M The P&O algorithm is continued to perturb the PV array voltage in the same direction. If dP/dV < 0, then the change in operating point moves the PV array operating point away from the MPP, and the P&O algorithm reverses the direction of the perturbation [8].

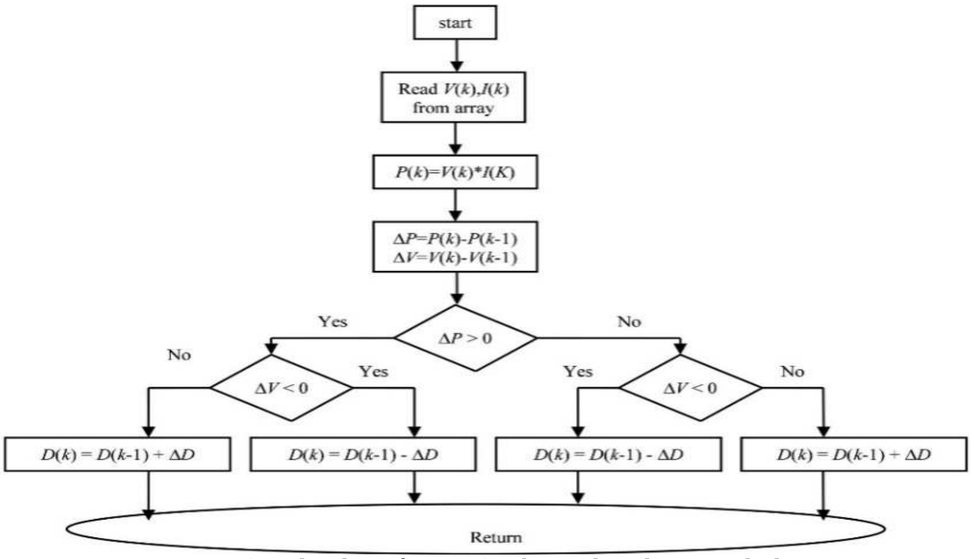

Fig.2 Flowchart of conventional perturb & observe method

MODIFIED PERTURB & OBSERVE METHOD

In modified perturb and observe algorithm, we measure an additional measurement of power at mid- point control. The flowchart of modified perturb and observe method is shown below [10].

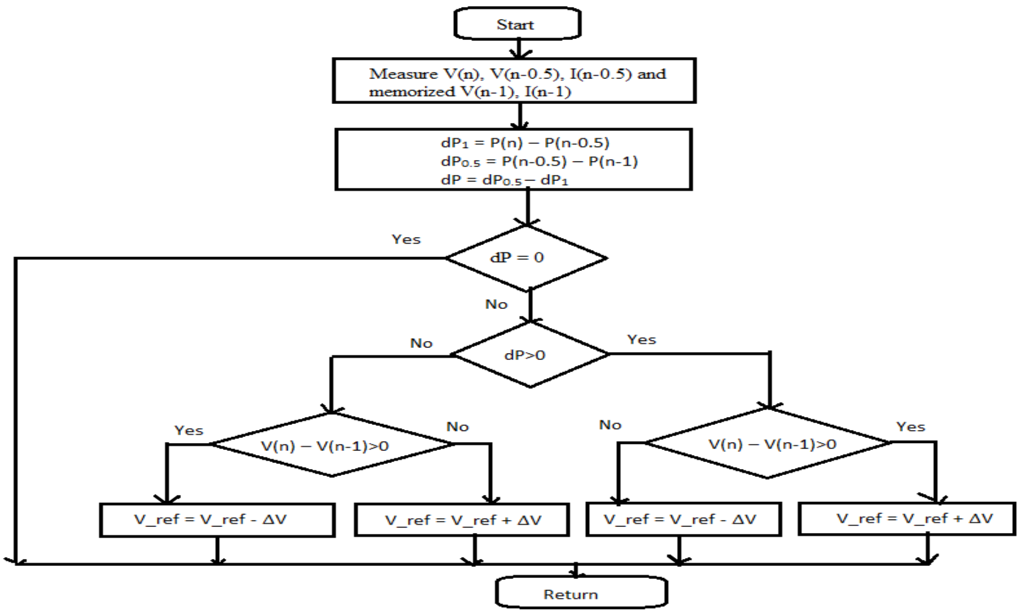

Fig.3 Flowchart of modified perturb & observe method

As a result, a power difference dP caused by the only MPPT control command can be calculated.
We have three different equations such as: -

$$dP_{0.5} = P\,(n-0.5) - P\,(n) \tag{4}$$

$$dP_1 = P\,(n) - P\,(n-0.5) \tag{5}$$

$$dP = dP_{0.5} - dP_1 \tag{6}$$

SIMULATION RESULTS

Fig.4 shows the Simulink model of conventional perturb and observe technique.

If $\Delta P>0$: left to the MPP If $\Delta P<0$: right to the MPP If $\Delta P=0$: at the MPP

In perturb and observe method, the perturbation continues goes on until to reach at maximum power point. After reaching at maximum power point, the operating point oscillates around it [5]. So this method has also drawback that it cannot perform under sudden changes in weather conditions such as solar insolation, temperature etc. This method has less efficiency [9].

Fig.5 shows the modified perturb and observe method which reduces the drawbacks of conventional P&O method. In this method we have done an additional measurement of power between control period and irradiance change. Basically voltage and current are delayed by 0 and 1. Then finally we have measured power for both delayed function. After that we have find the power difference by using three basic equations as mentioned in the technique [10].

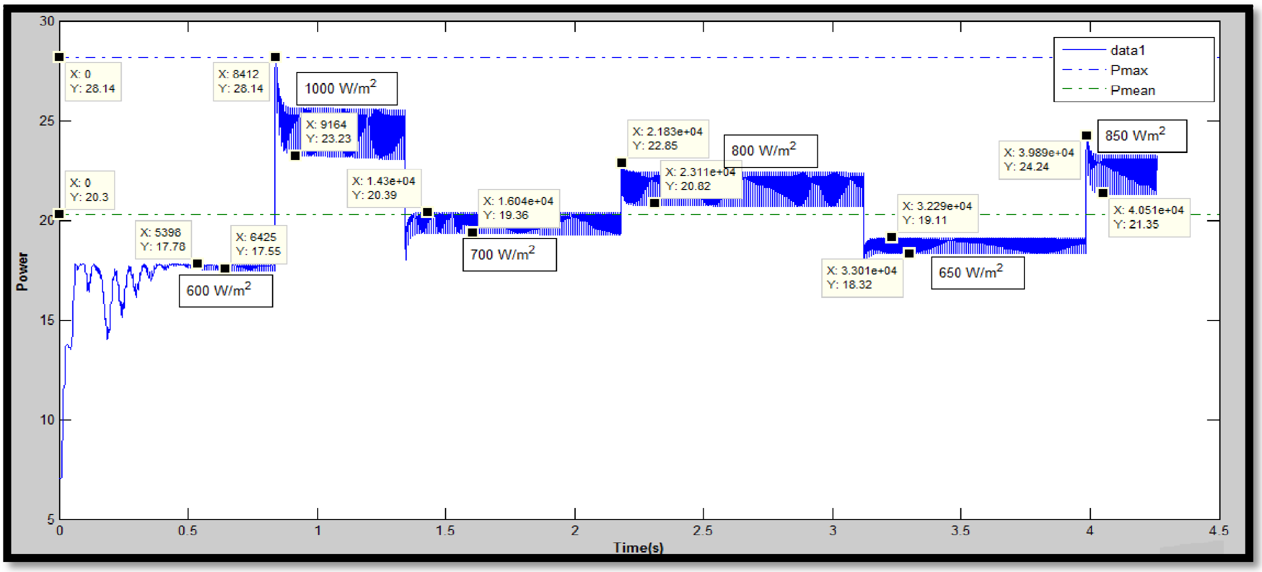

Fig.4 Conventional P&O method

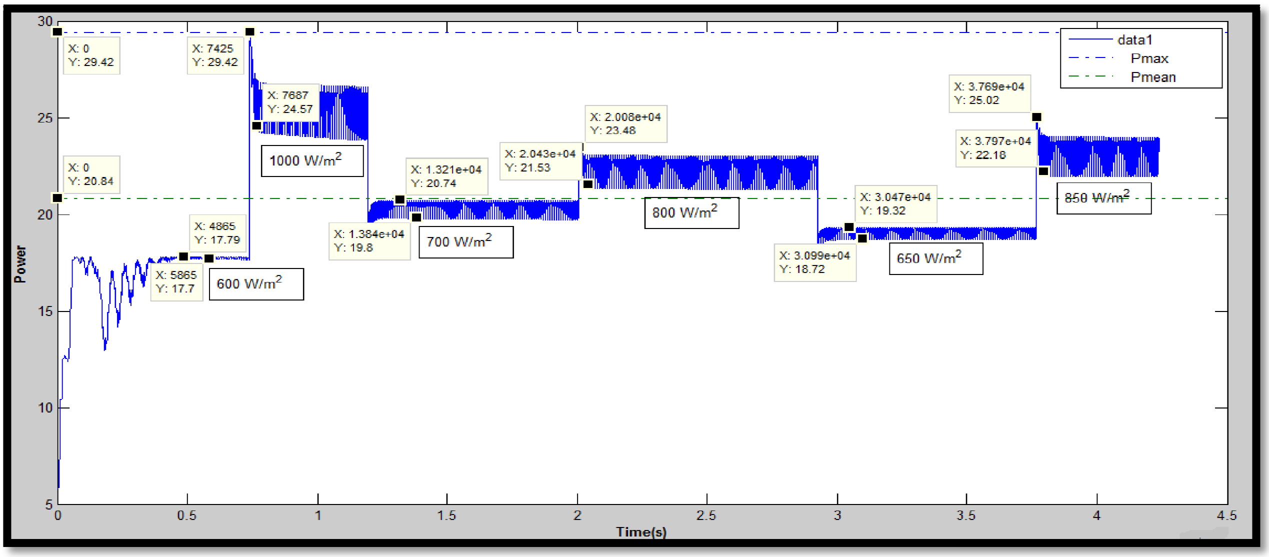

Fig.5 Simulation model of modified P&O method

Table -1 shows the power variations at different irradiance for both conventional and modified perturb and observe method whereas Table-2 shows the values of average power and maximum power for both conventional and modified P&O method. The modified perturb and observe method have average power and maximum power of 20.84 watt and 29.42 watt respectively which are higher than the conventional perturb and observe method.

Table- 1 Power Variations between Conventional & Modified P&O Method

S. NO.	Irradiance(W/m^2)	Conventional P&O	ΔP	Modified P&O	ΔP
1.	600	17.55-17.78	0.23	17.7-17.79	0.09
2.	1000	23.23-28.14	4.91	24.57-29.42	4.85
3.	700	19.36-20.39	1.03	19.8-20.74	0.94
4.	800	20.82-22.5	2.03	21.53-23.48	1.95
5.	650	18.32-19.11	0.79	18.72-19.32	0.6
6.	850	21.35-24.24	2.89	22.18-25.02	2.84

Table- 2 Average power and Maximum power of conventional & modified P&O method

Method	Average Power(W)	Maximum Power(W)
Conventional P&O	20.3	28.14
Modified P&O	20.84	29.42

CONCLUSION

The conclusion is that the modified perturb and observe method has overcome the drawbacks of conventional perturb and observe method. In modified perturb and observe method there are less oscillations comparable to conventional perturb and observe method. The modified P&O method has better response and can get fast tracking than conventional P&O method. From above table we can see at each irradiance level, The power variations in modified P&O method are less than that the conventional P&O method. This modified P&O method has higher efficiency rather than the conventional P&O method.

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