Maximum power point tracking for stand-alone PV system based on artificial intelligence techniques

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Abstract

maximum power point tracking (MPPT) algorithm lead an important role in optimization the performance of a photovoltaic (PV) generation systems. To validate the correctness and performance of the MPPT techniques, We have created an fuzzy logic (FLC) controller for the maximum power point tracking (MPPT) of a photovoltaic system and compared it to conventional tracking algorithms Perturb and Observe (P&O) and incremental conductance (INC). The proposed system was simulated and tested successfully by using MATLAB Simulink on a photovoltaic solar panel model. It is demonstrated that the fuzzy logic based MPPT tracking require less time and provide more accurate results under rapidly changing atmospheric conditions. compared to conventional tracking algorithms Perturb and Observe (P&O) and incremental conductance (INC).

Keywords— Photovoltaic (PV), MPP, Perturb and observe, Simulink, MPPT, Perturb and Observe (P&O), incremental conductance (INC), fuzzy logic, controller, boost converter.

PV System Model

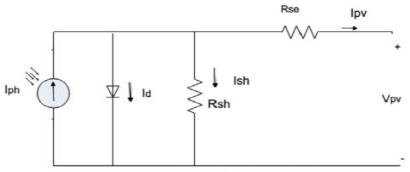


Figure.1: Mathematical modeling of PV module

$$I=I_{ph}-I_0[exp\left(\frac{V+I*R_s}{q}\right)-1]-\frac{V+R_s*I}{R_p}$$

$$I_{ph}=\frac{G}{G_{ref}}(I_{ph,ref}+\mu_{sc}*\Delta T)$$

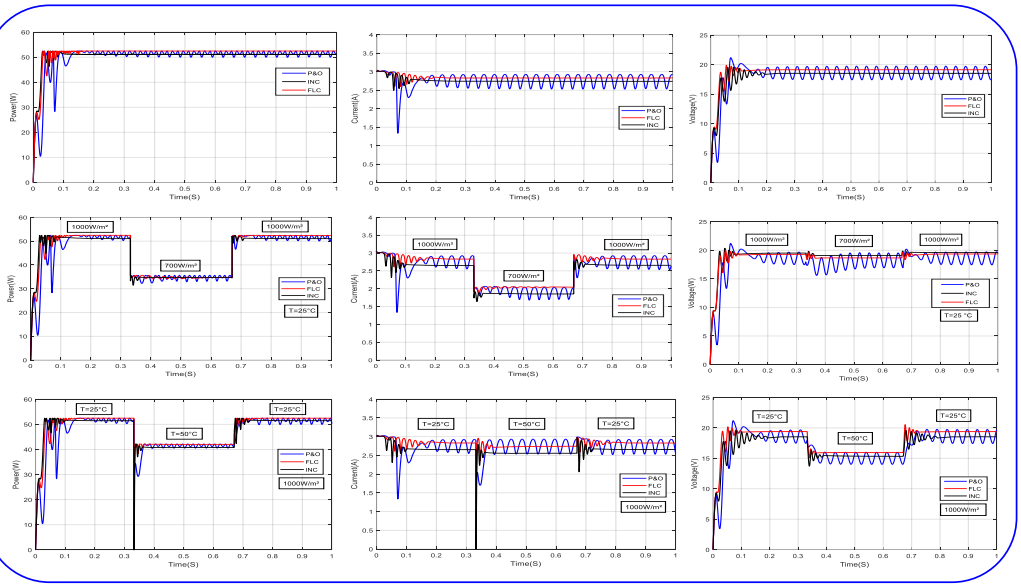
$$I_0=I_{0,ref}\left(\frac{T_c}{T_{c,ref}}\right)^3\exp\left[\left(\frac{qE_G}{A.K}\right)\left(\frac{1}{T_{c,ref}}-\frac{1}{T_c}\right)\right]$$

$$I_d=I_0\left[exp\left(\frac{V_{pv}+I_{pv}*R_s}{q}\right)-1\right]$$

$$I_{sh}=\frac{V_{pv}+I_{pv}*R_s}{R_{sh}}$$

Simulation of Results

In this simulationresults. The 50M (36) solar PV module of the parameters described in Table.1 is modeled using MATLAB/Simulink. Where DC-DC boost converter with an MPPT controller links the PV module to a steady resistive load . Figures from 16 to 24. shows The different performance results of the photovoltaic generator simulated using the fuzzy controller and the Perturb and Observe (P&O) algorithm and the Incremental Conductance (INC) and compared with each other under normal conditions (E=1000W/m2 and T=25 °C) In order to compare the studied MPPT algorithms, we evaluated them at fast changes in irradiance and temperature conditions. In order to demonstrate the efficiency of each algorithm, three different values of irradiance and temperature are provided. Although the solar irradiance and temperature does not change alter as fast as in the simulation, In the first case, the following simulation were presented for two different values of irradiance (700W/m²and 1000W/m²) at fixed temperature of 25°C. In the second case, the simulation were presented for two different values of temperature (25°C and 50°C) at fixed irradiance of 1000W/m². It is obvious from the results Shown above that MPPT method based on the FLC has better performance and much more accurate tracking at different atmospheric conditions faster and with less increased time compared to the other classical methods (P&O, INC). In table 3, comparisons are given between the three algorithms at standard conditions (E=1000W/m² and T=25°C)



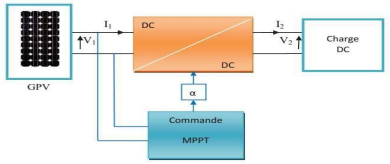


Figure 3 - : PV System Model

MPPT method	E=1000W/m², and T=25°C	
	Efficiency (%)	Response time(s)
FLC	98.02	0.033
P&O	97.99	0.042
INC	97.96	0.039

Table. 4: Comparison between MPPT Algorithms for P&O , InC and Fuzzy Logic Controller (FLC)

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Conclusion

A comparative analysis is presented in this paper between some important traditional and intelligent MPPT algorithms. This comparison is focused on the analysis of these MPPT' results, such as efficiency and response time. Among the methods assessed, an fuzzy logic (FLC) controller for the maximum power point tracking (MPPT) of a photovoltaic system and compared it to conventional tracking algorithms Perturb and Observe (P&O) and incremental conductance (INC). The proposed system was simulated and tested successfully by using MATLAB Simulink on a photovoltaic solar panel model. It is demonstrated that the fuzzy logic based MPPT tracking require less time and provide more accurate results and it has the ability to reduce disturbed voltage when MPP has been recognized under rapidly changing atmospheric conditions. compared to conventional tracking algorithms Perturb and Observe (P&O) and incremental conductance (INC).