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Title:

Design and Implementation of Neuro-Fuzzy Controller Using FPGA for Sun Tracking System

Abstract:

In this thesis, neuro-fuzzy based sun tracking and neuro fuzzy- reference model based Maximum Power Point Tracking method (MPPT) are designed and implemented using Field Programmable Gate Array (FPGA) board to boost the energy efficiency of PhotoVoltaic (PV) cells.

The proposed neuro-fuzzy, fuzzy logic and proportional-integral (PI) controllers have been designed, simulated and implemented for dual axis sun tracker based on optical sensors to orient the PV panel by two linear actuators. The experimental results reveal that proposed controller is more robust than fuzzy logic and PI controllers since it has been trained offline using Matlab tool box to overcome the disturbances. The proposed controller can track the sun trajectory effectively, where the experimental results reveal that dual axis sun tracker can collect 50.6% more daily energy than fixed angle panel. Whilst one axis sun tracker can collect 39.4 % more daily energy than fixed angle panel.

The MPPT methods which include the constant voltage, the incremental conductance and the proposed neuro fuzzy-reference model methods have been designed, simulated and implemented. The proposed controller is trained offline by Matlab tool box based on characteristic of the SR-60S PV module under different weather conditions. The experimental and simulation results reveal that the incremental conductance and the neuro fuzzy-reference model methods are more efficient than the constant voltage method under hot weather conditions. However, the irradiation and load variations tests show that the incremental conductance method is less dynamic response and more oscillation about MPP than the two other methods. Hence, the proposed method is more efficient and has better dynamic response than the two other methods. In other hand, its implementation is cost and complex and requires three sensors in addition to training the controller to specific PV module periodically.