Design and Implementation of a Fuzzy Logic Based Maximum Power Point Tracker for a Photovoltaic System

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ABSTRACT

This thesis presents a method used to optimize the energy extraction in a photovoltaic (PV) power system. The maximum power of a PV module changes with temperature, solar radiation, and load. To increase efficiency, PV systems use a Maximum Power Point Tracker (MPPT) to continuously extract the highest possible power and deliver it to the load. An MPPT consists of a dc-dc converter and a controller. The MPPT finds and maintains operation at the maximum power point using a tracking algorithm. Many such algorithms have been proposed. However, the existing methods have drawbacks in terms of efficiency, accuracy, and flexibility. Due to the nonlinear behaviour of PV module current-voltage characteristics and the nonlinearity of converters due to switching, conventional controllers are unable to give a good response in the presence of wide parameter variations and line transients.

The objective of this research was to design and implement an MPPT that uses a fuzzy logic control algorithm. Fuzzy logic, by dealing naturally with nonlinearities, offers a superior controller for this type of application. The technique also benefits from the heuristic approach to the problem that overcomes the complexity in modeling nonlinear systems. In order to achieve this goal, an MPPT model consisting of a PV module, a dc-dc converter, and a fuzzy logic controller was developed. Analysis of buck, boost, and buck-boost converter

characteristics was carried out in order to identify the most suitable topology. An integrated model of the PV module and the identified converter was simulated and

the results used to derive the expert knowledge needed to formulate and tune the fuzzy logic controller. The controller was coded as a real-time control program and the MPPT implemented using a dc-dc converter controlled by a microcomputer. The proposed method shows improved performance in terms of oscillations about the maximum power point, speed, and sensitivity to parameter variation. The results indicate that a significant amount of additional energy can be extracted from a photovoltaic module by using a fuzzy logic based maximum power point tracker. This results in improved efficiency for the operation of a photovoltaic power system since batteries can be sufficiently charged and used during periods of low solar radiation. The improved efficiency is expected to lead to significant cost savings in the long run.