Artificial Neural Network Maximum Power Point Tracker for Solar Electric Vehicle

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Abstract: This paper proposes an artificial neural network maximum power point tracker (MPPT) for solar electric vehicles. The MPPT is based on a highly efficient boost converter with insulated gate bipolar transistor (IGBT) power switch. The reference voltage for MPPT is obtained by artificial neural network (ANN) with gradient descent momentum algorithm. The tracking algorithm changes the duty-cycle of the converter so that the PV-module voltage equals the voltage corresponding to the MPPT at any given insolation, temperature, and load conditions. For fast response, the system is implemented using digital signal processor (DSP). The overall system stability is improved by including a proportional-integral-derivative (PID) controller, which is also used to match the reference and battery voltage levels. The controller, based on the information supplied by the ANN, generates the boost converter duty-cycle. The energy obtained is used to charge the lithium ion battery stack for the solar vehicle. The experimental and simulation results show that the proposed scheme is highly efficient.

Key words: artificial neural network; maximum power point tracker (MPPT); photovoltaic module; digital signal processor; solar electric vehicle

Introduction

Photovoltaic (PV) generation is gaining increased importance as a renewable source of energy. The undesirable rapid changes of solar power, which usually occur in a running vehicle, arise as a result of shade from buildings, large trees, and clouds in the sky. Conventional PV systems have difficulties in responding to rapid variations due to shade. The main drawbacks of PV systems are that the initial installation cost is considerably high and the energy conversion efficiency (from 12% to 29%) is relatively low. Furthermore, in most cases, PV systems require a power conditioner (dc-dc or dc-ac converter) for load interface. Therefore, the overall system cost could be reduced drastically by using highly efficient power conditioners, such as the maximum power point tracker (MPPT), to extract and maintain the peak power from the PV module even when the above-mentioned unfavorable conditions occur.

Various methods of maximum power tracking have been considered in PV power applications[1-12]. Among the hill climbing methods[1-3], the perturb and observe (P&O) method tracks maximum power point (MPP) by repeatedly increasing or decreasing the output voltage at MPP of the PV module. This method requires calculation of dP/dV to determine the MPP[1,2,4]. Though the method is relatively simple to implement, it cannot track the MPP when the irradiance changes rapidly. Also, the method oscillates around the MPP instead of

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