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Control of a DC/DC converter by fuzzy controller for a solar pumping system

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ABSTRACT

The exploitation of the solar energy is very significant for the very sunny countries. Moreover the dryness phenomenon in these country is imposes more and more the use of pumping plants. The storage of the water in insulated basins from the wells has a double advantage. On the one hand, it is a technical storage solution of the solar energy collected by the photovoltaic panels. On the other hand, it is a hygienic way out to supply water for the rural population.

In our work, we propose a technique for the identification of the maximum power point (MPP) based on fuzzy logic. This method is used to generate the cyclic ratio to operate the switcher within the maximum power of a photovoltaic array (PVA).

For simulation purpose we made a complete modeling of the entire system. The system carried out consists of a photovoltaic array supplying, through a DC converter, a direct current (DC) engine coupled to a centrifugal pump. Our experimental bench consists of two principal units. A DC converter module composed of IGBT power transistors. And a processing module connected to a PC serial port, handling the input signals delivered by photovoltaic generator and controlling the power unit.

The obtained experimental results confirm the simulation result which is very satisfactory and show the utility of the fuzzy controller for the optimization of the system.

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1. Introduction

The PVA is a system providing a non-linear power. It is required a real time identification and the tracking of the maximum operation point. This maximum power point varies largely in time according to the climatic conditions such as the sunning and the temperature.

When we connect a load at the outputs of a PVA, this load imposes a point of operation which is not necessarily the point of maximum power. To ensure an optimal adaptation of energy between the PVA and the load it should be introduced an adapter so that the PVA operates at its maximum power point. In our case the adapter is a DC/DC converter whose we control the cyclic ratio by regulation.

The first used method of regulation is a traditional technique. It has disadvantages, such as the oscillations around the point of operation, and the choice of the step of the tracking of the maximum point. To go beyond these problems we chose a technique more powerful, the fuzzy logic. In this technique, we used two method of regulation, the first one that of the variation of the input voltage by fixing the optimal voltage, and the second one that of the variation of power per the current (dP/dI), the two methods led to good results (i.e. good adaptation). The simulation of the system (Fig. 1) was carried out in [1].

2. Followed process

2.1. Structure of the developed set up

The system consists of a PVA supplying a DC engine coupled to a centrifugal pump, through a DC converter, allowing the tracking of the optimum operation point. The developed controller is a microcontroller based board connected to a PC through the serial port for monitoring purpose (Fig. 3).

2.2. Presentation of the simulated system

The block diagram of the maximum power point tracking (MPPT) system is composed of a PVA, a DC converter and a load represented by an engine coupled to a pump. The point of optimum power is controlled by the cyclic ratio generated by the fuzzy controller whose the inputs are the voltage and the current of the PVA (Fig. 1).

Before any synthesis of a control law, it is necessary to analyze the process to be controlled and establish an appropriate model.

Regarding the PVA, we considered as an inputs, the current and the voltage measured experimentally (I_1,V_1) with specific climatic conditions of operation, sunning and temperature, respectively.

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