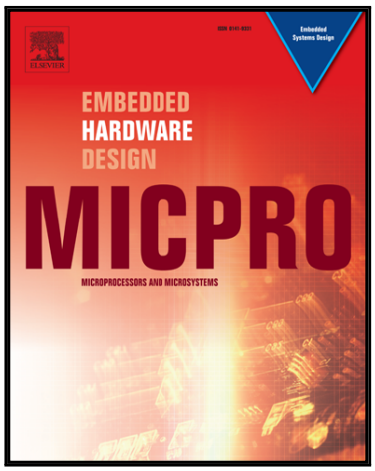

Hardware implementation of an artificial neural network model to predict the energy production of a photovoltaic system

Darío Baptista , Sandy Abreu , Carlos Travieso-González , Fernando Morgado-Dias

PII: S0141-9331(16)30326-X
DOI: 10.1016/j.micpro.2016.11.003
Reference: MICPRO 2473

To appear in: *Microprocessors and Microsystems*

Received date: 26 February 2016
Revised date: 9 September 2016
Accepted date: 4 November 2016

Please cite this article as: Darío Baptista , Sandy Abreu , Carlos Travieso-González , Fernando Morgado-Dias , Hardware implementation of an artificial neural network model to predict the energy production of a photovoltaic system, *Microprocessors and Microsystems* (2016), doi: 10.1016/j.micpro.2016.11.003

Hardware implementation of an artificial neural network model to predict the energy production of a photovoltaic system

Darío Baptista[1a], Sandy Abreu [a], Carlos Travieso-González [c], Fernando Morgado-Dias [a,b]

[a] *Madeira Interactive Technologies Institute, Funchal, Portugal*
[b] *University of Madeira, Funchal, Portugal*
[c] *University of Las Palmas de Gran Canaria, Las Palmas de Gran Canaria, Spain*

Abstract

An artificial neural network trained using only the data of solar radiation presents a good solution to predict, in real time, the power produced by a photovoltaic system. Even though the neural network can run on a Personal Computer, it is expensive to have a control room with a Personal Computer for small photovoltaic installations. A FPGA running the neural network hardware will be faster and less expensive. In this work, to assist the hardware implementation of an artificial neural network with a FPGA, a specific tool was used: an Automatic General Purpose Neural Hardware Generator. This tool allows for an automatic configuration system that enables the user to configure the artificial neural network, releasing the user from the details of the physical implementation. The results show that it is possible to accurately model the photovoltaic installation based on data from a nearby meteorological installation and the hardware implementation produces low cost and precise results.

Key words: Hardware implementation, photovoltaic system, artificial neural network

1. Introduction

The capacity to predict the energy production by a photovoltaic (PV) system is relevant from an economical point of view and when controlling the stability of the electrical grid.

The payback calculation is the prediction of the expected revenue, which is related to the production of the PV system. So, its accurate prediction is very important. Also, the prediction of production of PV system can be useful to monitor and evaluate the PV system to detect eventual PV system faults. So, it is important have a way to calculate, with accuracy, the PV system capacity production easily.

In this paper, a methodology is presented to implement an artificial neural network (ANN) within the hardware to predict the energy production in the PV system. This ANN predicts, in real time, the power produced in the PV system from data of irradiance.

In this work, an artificial neural network trained using only the data of solar radiation from a nearby meteorological station presents a good solution for predicting, in real time, the power produced by the photovoltaic system. Even though an ANN can run on a Personal Computer (PC), it is expensive to have a control room with a PC for a small photovoltaic installation. A FPGA running the ANN will be faster and less expensive (Angepat, Chiou, Chung, & Hoe, 2014) (Yin, Wang, & Guo, 2004) (Sartin & Silva, 2014) (Omondi & Rajapakse, 2006)

To assist the hardware implementation of artificial neural network with a FPGA, a specific tool was used: ANGE (Baptista & Morgado-Dias, 2015). This tool allows for an automatic configuration system that enables the user to configure the ANN, releasing the user from the details of the physical implementation.

Corresponding author. Tel. +351967378952.
E-mail address: fdariobaptista@gmail.com (D. Baptista).