DESIGN OF NEURON ARCHITECTURE ON FPGA FOR ELECTROCHEMICAL SENSOR SIGNALS

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ABSTRACT

Artificial neural networks (ANN) are known to be able to improve electrochemical sensor signal interpretation. The hardware realization of ANN requires investigation of many design issues relating to signal interfacing and design of a single neuron. This report focuses on the design of neuron architecture on FPGA for electrochemical sensor signal. The objective of this project is to translate the data from electrochemical sensor signals and process the data with neuron structure and analyze how different digital module of the neuron could affect the data accuracy and performance of the design. It encompasses interfacing from analogue to digital, data structure and the design process of the simple neuron which includes adder, multiplier and multiplier accumulator (MAC). A major component of the algorithm is the design of the activation function. The chosen activation function is the hyperbolic tangent which is approximated by Taylor Series expansion. The neuron is evaluated on an Altera DE2-70 FPGA. The performances are evaluated in terms of functionality, usage of resources and timing analysis. For the data structure, it was demonstrated that increasing the fractional bits increases the precision. For the MAC was found that by using topology 2, propagation can be reducing up to 19.145ns

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CHAPTER 1

INTRODUCTION

1.0 PROJECT BACKGROUND

There are many real time applications, which require a low-cost, miniaturized and automatic system used for classification and recognition. Frequently such a device is organized around several sensors providing complex data that only an artificial neural network will be able to interpret. In recent years, artificial neural networks have been widely implemented in several research areas such as image processing, speech processing, medical diagnoses and sensing realization. [1]

Artificial Neural Network (ANN) is method that to approximate the specific function from selected data before proceed to the uncertainty analysis. Neural networks have a large appeal to many researchers due to their great closeness to the structure of the brain, a characteristic not shared by more traditional systems. A neural network consists of three main parts. That all part is firstly, processing units. Secondly weighted interconnections between the various processing units which determine how the activation of one unit leads to input for another unit, optionally, a learning rule that specifies how to adjust the weights for a given input or output pair and lastly an activation rule which acts on the set of input signals at a unit to produce a new output signal, or activation. Hardware realization of a Neural Network (NN), to a large extent depends on the efficient implementation of a single neuron. [2]