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APPROXIMATE COMPUTING BASED PROCESSING OF MEA SIGNALS ON FPGA

by

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Abstract

The microelectrode array (MEA) is a collection of parallel electrodes that may measure the extracellular potential of nearby neurons. It is a crucial tool in neuroscience for researching the structure, operation, and behavior of neural networks. Using sophisticated signal processing techniques and architectural templates, the task of processing and evaluating the data streams obtained from MEAs is a computationally demanding one that needs time and parallel processing.

This thesis proposes enhancing the capability of MEA signal processing systems by using approximate computing-based algorithms. These algorithms can be implemented in systems that process parallel MEA channels using FPGAs. In order to develop approximate signal processing algorithms, three different types of approximate adders are investigated in various configurations. The objective is to maximize performance improvements in terms of area, power consumption, and latency associated with real-time processing while accepting lower output accuracy within certain bounds.

On FPGAs, the methods are utilized to construct approximate processing systems, which are then contrasted with the precise system. Real biological signals are used to evaluate both precise and approximative systems, and the findings reveal notable improvements, especially in terms of speed and area. Processing speed enhancements reach up to 37.6%, and area enhancements reach 14.3% in some approximate system modes without sacrificing accuracy. Additional cases demonstrate how accuracy, area, and processing speed may be traded off.

Using approximate computing algorithms allows for the design of real-time MEA processing systems with higher speeds and more parallel channels. The application of approximate computing algorithms to process biological signals on FPGAs in this thesis is a novel idea that has not been explored before.

Keywords: Approximate Computing, Digital Systems, e-health, FPGA, Micro-electrode Arrays.