FACULTY OF INDUSTRIAL TECHNOLOGY

DEPARTMENT OF ELECTRONIC ENGINEERING

Master of Philosophy Thesis

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Field of Study : **Embedded Computer Systems**

TITLE : Field Programmable Gate Arrays (FPGA) Embedded Microprocessor Design

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Abstract

The introduction of microprocessors in design of digital equipment has presented a plethora of technology developments in Electronic Engineering and related fields. The current microprocessors applications have resulted in high redundancy use of the devices as they have all possible functions for different applications included in their designs, thus increasing their cost as their real functions uses do not exceed ten per cent. The designs of microprocessors were previously the prerogative of first worlds because of complexity. The thesis situates the Electronic Engineering design levels namely primary, secondary and tertiary designs, applications, the technology, knowledge and skills gap between first worlds and third worlds; and how humble efforts such as using FPGAs to do electronic engineering designs can assist in minimizing and or closing that gap. Embedded microprocessor has been widely used as a tool for technological innovations and cost reduction. Its speed and programmability are the main characteristics determining its performance. Therefore, for a design to be competitive, the processor has to fit the following characteristics: relatively inexpensive, flexible, adaptable, fast and reconfigurable. A solution to this is the use of Field Programmable Gate Arrays (FPGAs) as a design tool. This thesis describes the realization of an 8-bit FPGA simple soft-core processor. The microprocessor was implemented on the Xilinx Spartan 3A XC3S200A using Xilinx ISE Design Suite 14.6 and Very High Speed Integrated Circuit Hardware Description Language (VHDL). Simulations for different FPGA microprocessor functions and 7x5 LED Matrix display practical manipulations were achieved. A maximum frequency of 107.492MHz was reached with minimum period of 9.303nS.

The soft-core processor was studied and a VHDL implementation of soft-core processor has been developed, called SkoCpu. The SkoCpu was described; its performance dependence on various architectural parameters were investigated and then compared to the Discrete Cosine Transform (DCT) soft-core processor implementation. Experiments showed that the performances of SkoCpu and DCT processor types were similar and applications vary significantly depending on the architectural parameters. The performance comparison shows that SkoCpu achieves performance comparable to the DCT implementation. Recent advancements in Field Programmable Gate Array (FPGA) technology have resulted in FPGA devices that support the implementation of a complete computer system on a single FPGA chip. A soft-core processor is a central component of such a system. A soft-core processor is a microprocessor defined in software, which can be synthesized in programmable hardware, such as FPGAs.