



**Helwan University**

**Faculty of Engineering**

**Dept. of Electronics, Communications, and Computers Engineering**

**SOFTWARE PROFILING USING FPGA  
FOR HARDWARE/SOFTWARE CO-  
DESIGN**

*A thesis submitted by*

**Kareem Ezz El-Deen Rabea**

In partial fulfillment of the requirements for the degree of  
**Master of Science in Computer Engineering**

*Supervised by*

**Prof. El-Sayed M. Saad**

(Faculty of Engineering, Helwan University)

**Dr. Medhat H. A. Awadalla**

(Faculty of Engineering, Helwan University)

**(2009)**

## **Abstract**

Embedded systems are a mixture of software running on a microprocessor and application-specific hardware. There are many co-design methodologies that are used to design embedded systems. One of them is Hardware/Software co-design methodology which requires, in the design steps, an appropriate profiler to detect the software portions that contribute to a large percentage of program execution and cause performance bottleneck. Detecting these software portions improve the system efficiency which these portions are either reprogrammed to eliminate the performance bottleneck or moved to the hardware domain gaining the advantages of this domain. There are profiling tools used to profile software programs such as the well-known GNU Gprof profiler. GNU Gprof integrates an extra code with the software program to be profiled causing inaccurate reported results and a significant performance overhead. To address this issue, this research proposes a software profiler called AddressTracer. The AddressTracer is accurately able to evaluate some performance matrices of any specific software portion. Set of benchmarks, Dijkstra, Secure Hash Algorithm, and Bitcount are profiled using AddressTracer and other software profiling tools, Airwolf and GNU software profiling tool (Gprof), for a quantitative comparison and their performance overhead are measured and studied. The achieved results show that

AddressTracer reports accurate profiling results compared to the results that are obtained from Gprof and Airwolf profilers. AddressTracer provides up to 50.15% improvement in accuracy of profiling software compared to Gprof and 6.89% compared to Airwolf. Furthermore, AddressTracer is a non-intrusive profiler which does not cause any performance overhead. However in some of the software benchmarks, collecting performance metrics information about software functions using Gprof profiler can cause up to 49.80% of the program's total execution as a performance overhead, while Airwolf causes a low remarkable performance overhead compared with that incurred by Gprof. Airwolf profiler can incur performance overhead up to 5.65% of the program total execution.

**Keywords:** Embedded Systems, FPGA, Hardware/Software co-design, Software profiling, Gprof, Airwolf, AddressTracer.