ABSTRACT

Ph.D. thesis: Programming of Coarse-Grained Reconfigurable Architectures

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Coarse-grained reconfigurable architectures, which offer massive parallelism coupled with the capability of undergoing run-time reconfiguration, are gaining attention in order to meet not only the increased computational demands of high-performance embedded systems, but also to fulfill the need of adaptability to functional requirements of the application.

This thesis focuses on the programming aspects of such coarse-grained reconfigurable computing devices, including the relevant computation models that are capable of exposing different kinds of parallelism inherent in the application and the ability of these models to capture the adaptability requirements of the application. The thesis suggests the occam-pi language for programming of a broad class of coarse-grained reconfigurable architectures as an intermediate language; we call it intermediate, since we believe that the application programming is best done in a high-level domain-specific language. The salient properties of the occam-pi language are explicit concurrency with built-in mechanisms for inter-processor communication, provision for expressing dynamic parallelism, support for the expression of dynamic reconfigurations, and placement attributes.

To evaluate the programming approach, a compiler framework was extended to support the language extensions in the occam-pi language, and backends were developed to target two different coarse-grained reconfigurable architectures. XPP and Ambric. The results on XPP reveal that the occam-pi based implementations produce comparable throughput to those of NML programs, while programming at a much higher level of abstraction than that of NML. Similarly the two occam-pi implementations of autofocus criterion calculation targeted to the Ambric platform outperform the CPU implementation by factors of 11-23. Thus, the results of the implemented case-studies suggest that the occam-pi language based approach simplifies the development of applications employing run-time reconfigurable devices without compromising the performance benefits.

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