Editorial: Languages, Compilers, and Tools for Embedded Systems

As the complexity of embedded systems increases, new research challenges are encountered for achieving the desired design goals, such as programmability, reliability and security, size, energy and power, timing constraints, and scalability. Furthermore, embedded systems are increasingly used in networked (wired, wireless, as well as mobile) environments which enable a variety of new applications. These new trends motivate designers to take a holistic view of embedded systems as the best solutions may require a combination of hardware and software techniques to best fit the target applications.

1. CHALLENGES

In recent years, the research communities of programming languages, compilers, and software design tools have identified many areas where the state-of-the-art must be improved in order to meet the challenges. Programming language designers need to design new programming models and language features to exploit emerging computing platforms such as multicore microprocessors, single-chip SIMD, and reconfigurable architecture among others. New models and features are also needed for distributed real-time control, media players, and other complex embedded applications.

For compiler designers, there is a strong need for better understanding of the interaction between embedded computer architecture, operating systems, and compilers. Execution speed is no longer the only important optimization goal for the compiled code. The code must also be optimized for low energy consumption and low code and data size. To achieve such goals simultaneously, issues such as efficient use of the memory system, including the registers, are highly important. Furthermore, the wide variety and fast changing pace of embedded processor designs require high adaptability from the compiler. Lastly, software analysis and development tools are in great need for timing analysis, system integration and testing, and for performance monitoring and tuning.

2. THIS SPECIAL SECTION

The articles in this special section represent an important part of the community's progress in addressing the issues mentioned. The article titled "Low-Latency Time-Portable Real-Time Programming with Exotasks" by Auerbach et al. presents a new Java programming construct aimed at achieving deterministic timing even in the presence of other Java threads, which is important to the adoption of Java on real-time embedded systems. This article

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appeared in *TECS* 8(2) and is available now in the ACM Digital Library (DOI 10.1145/1457255.1457262).

Murray et al., in their article “Code Transformation and Instruction Set Extension”, investigate compiler support for extensible embedded processors which allow user defined instruction set extensions (ISE). They explore a combination of code transformations and ISE identification. This article appears in this issue of *TECS*.

The article “Register Coalescing Techniques for Heterogeneous Register Architecture with Copy Sifting” by Ahn and Paek targets embedded processors which divide the register file into different groups to serve difference purposes. Their experiments show a reduction in both spills and code size by a register allocator which exploits the heterogeneity. Ahn and Paek [2009] appeared in *TECS* 8(2) and can be accessed in the ACM Digital Library (DOI 10.1145/1457255.1457263).

In the article “Analyzing the Worst-Case Execution Time for Instruction Caches with Prefetching”, the authors, Yan and Zhang, address the long-standing issue of time predictability faced by compilers for real-time embedded systems. Their new contribution is to examine the impact of instruction prefetching and the prefetching distance on time predictability for embedded processors which employ an instruction cache. The article appeared in *TECS* 8(1) and is available in the ACM Digital Library (DOI 10.1145/1457246.1457253).

This special section continues the tradition of the *ACM Conference on Languages, Compilers, and Tools for Embedded Systems (LCTES)*. After the LCTES 2007 conference which we chaired, the top papers identified by the technical program committee were invited to submit a substantially extended version for this special section. An open Call for Papers was also announced to the community. We are glad to see the final line-up of the special section and are grateful to all reviewers and authors for their significant effort. We would like to thank both the former Editor-in-Chief, Wayne Wolf, and the current Editor-in-Chief, Jörg Henkel, for their support.

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