Special Issue on Parallel Computing

Guest Editorial

Parallel computing, for many years the key technology of high end machines, is now the standard way of computing. There are numerous state-of-the-art developments, applications and future trends in parallel computing for all platforms. It is common knowledge that parallel computing covers an extremely wide variety of domains, each with stringent requirements. This breadth of domains results in a deep diversity of requirements, including highly flexible and high performance parallel architectures, parallel and distributed algorithms and diverse emerged parallel applications.

A major part of creating such high efficient embedded computing platforms is spent in the often complex Parallel Architecture development, integration, verification, and validation of the resulting systems. Therefore it is essential that the production of parallel computing embedded systems exploit the hardware architectures that simultaneously enable high performance and productivity with highly robust structures and resource management. To be more specific, these areas include Processor and Multi/many-core architectures, Interconnection networks, Parallel/distributed architectures, Reliability and fault-tolerance, Ubiquitous computing systems, Communication and telecommunication, Cloud Computing, Cluster and Grid computing systems, Reconfigurable architectures, tools and systems, Accelerators (ASICs, GPUs, ASIPs,...).

In mainstream parallel computing domains, the Parallel Algorithms have become an attractive choice because of its contributions to achieve multiple targets such as efficiency, safety, productivity, low maintenance costs, as well as the wide availability. Up to now, researches on parallel algorithms are still being conducted at great interest. Some significant literatures on various aspects have been introduced, such as Parallel/distributed algorithms, Task mapping and scheduling, Parallel/Distributed databases and knowledge discovery, High-performance scientific computing, High-performance reconfigurable computing, Power-aware Computing, Secure distributed computing, Resource allocation and management, Network routing and traffic control, Bioinformatics, Quantum computing, Social Computing, Cloud Computing.

In addition, there has been rapid progress in Parallel Programming technologies in both single-node and distributed applications. This progress, combined with the expanding diversity of applications domains, is placing enormous demands on the facilities that the run-time environment must provide. In particular, the parallel application areas cover following aspects: Multi/many-core programming, Parallel programming theory and models, Formal methods and verification, Middleware for parallel systems, Parallel programming languages, Compilers and runtime systems, Automatic parallelization, Parallel libraries and application frameworks, Performance analysis, Debugging and optimization, Parallel applications, Applications of high-end machines including exascale, Applications of multicores, GPU-based applications, Cloud applications, Concurrent data structures, Synchronization and concurrency control.

This issue presents some recent progresses on all aspects of parallel computing, including parallel architectures, algorithms, programming models, hardware and software applications as well as languages and development environments. This special issue is divided into three groups of related articles. The first group contains articles dealing with general issues in aspects of parallel hardware and architectures. The second group deals with the algorithms in parallel/distributed systems, and the third group investigates problems and applications related with embedded parallel systems.

We received 20 submissions. After a careful review process, seven of the submissions have been selected to appear in this special issue after revisions based on reviewer feedbacks and further revisions.

1. ARTICLES RELATED TO PARALLEL ARCHITECTURES

The article “Intelligent Spatial-based Resource Allocation Algorithms in NoC” by Jingling Yuan, Xin Fu, Tao Li and Minlong Yang proposes a spatial-based NoC resource allocation algorithms to reduce the communication congestions so that efficiently improve the overall performance. This article also reports both offline and online algorithms for NoC resource allocation. The offline algorithms include online greedy, one-corner, four corner approaches while the online ones consist of probability-based searching, genetic-based searching schemes.

Fang Zheng et al. in “GPU-Based Parallel Researches on RRTM Module of GRAPES Numerical Prediction System” describes a GPU (Graphics Processor Unit) accelerator for RRTM (Rapid Radiative transfer model) module in Global and Regional Assimilation and Prediction System. GPU general-purpose computing and CUDA technology on RRTM long-wave radiation modules are employed in GRAPES_Meso model for parallel processing. In this article the authors rewrite the RRTM module with CUDA Fortran according to the characteristics of the GPU architecture, enhance the computational efficiency with optimization strategies.

In the article “Hardware Implementation of Back-Propagation Neural Networks for Real-Time Video Image Learning and Processing” H. Madokoro and K. Sato discuss a real-time learning in the field of video image processing. The model is a layer parallel architecture with a 16-bit fixed point specialized for video image processing. In the article the proposed architecture is compared with a standard BP model that used a double-precision floating point with simulation and FPGA board.

doi:10.4304/jcp.8.3.539-540

2. ARTICLES ON DISTRIBUTED AND PARALLEL ALGORITHMS

In order to enforce both the embedded system real-time constraints and conventional functional requirements, while assuring modularity and flexibility of developed components in a distributed application, the distributed and parallel algorithms middleware must enable integration and validation in a robust and productive way.

The article "A Fine-grained Hop-count Based Localization Algorithm for Wireless Sensor Networks" by Xueyong Xu et al. presents the concept of fine-grained hop-count which refines the coarse-grained one close to the actual distance between nodes. Based on this idea, this article proposes a fine-grained hop-count based localization algorithm (AFLA). In AFLA, the authors first refine the hop-count information to obtain fine-grained hop-counts, then use the Apollonius circle method to achieve initial position estimations, and finally further improve the localization precision through confidence spring model (CSM).

In "Task Partitioning and Load Balancing Strategy for Matrix Applications on Distributed System" Adeela Bashiry et al. discusses an adaptive load-balancing strategy for data parallel applications to balance the work load effectively on a distributed system. The article studies its impact on computation-hungry matrix multiplication application. The proposed strategy enhances the performance with features such as intelligent node selection, pre-task assignment, adaptive task sizing and buffer allocation, and load balancing. The ALB strategy exhibits reduced nodes idle time and inter process communication time, and improved speed up as compared to Run Time task Scheduling strategy.

In "An Improved Ant Colony Optimization Applied in Robot Path Planning Problem" Xiangyang Deng et al. presents an improved Ant colony optimization algorithm to solve the robot path planning problem. In PM-ACO, ants deposit pheromone on the nodes but not on the arcs, resulting in that the trails of pheromone become the form of marks, which consist of a series of pheromone points. After ant colony's tours, the iteration-best strategy is combined with an r-best nodes rule to update the nodes' pheromone. The stability of PM-ACO is analyzed and some advancement to the algorithm is proposed to improve the performance. In addition, this article also reports an azimuth guiding rule and a one step optimization rule to shorten the time wasted in constructing the first complete solution.

3. ARTICLE DEALING WITH PARALLEL PROGRAMMING AND APPLICATIONS

Kiem-Hung Nguyen et al. in "An Efficient Implementation of H.264/AVC Integer Motion Estimation Algorithm on Coarse-grained Reconfigurable Computing System" propose REMUS system, and shows that it is possible to implement a high complexity application as H.264/AVC full-search VBS-IME algorithm with competitive performance on platform of REMUS system. The approach can be utilized to attack high computational complexity and huge memory access bandwidth for VBS-IME in H.264/AVC applications.

We are particularly grateful to the authors that submitted their work to this special issue for their efforts. We express our deepest gratitude to the reviewers, whose careful reviews and valuable suggestions helped to improve the quality of the final result. Our thanks go to Professor Prabhat Mahanti and the Editorial Board of the Journal of Computers for the exceptional effort they did throughout this process. Finally, in a special way we thank all the people whose dedication ensured a good selection of articles and made this special issue possible. In closing, we sincerely hope that you will enjoy reading this special issue.

Guest Editor

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