Distributed Pararell Processing Laboratory

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Refereed Journal Papers

[hitoshi-01:2014] Hitoshi Oi and Sho Niboshi. Power-Efficiency Study using SPECjEnterprise2010. *IEEE Systems Journal*, page TBD, 2014.

Submitted and currently under review. `http://www.ieeesystemsjournal.org/`

[hitoshi-02:2014] Hitoshi Oi. Effectiveness of DFS Tuning on Java Server Workload. *Journal of Circuits, Systems, and Computers*, page TBD, 2015.

Submitted and currently under review. `http://www.worldscientific.com/worldscinet/jcsc`

[sedukhin-01:2014] M. Ganzha, M. Paprzycki, and S. Sedukhin. Generalized Matrix Multiplication and its Object Oriented Model. *Scalable Computing: Practice and Experience*, 15(2):181–200, 2014.

Since the beginning of the 21st century, we observe rapid changes in the area of, broadly understood, computational sciences. One of interesting effects of these changes is the need for reevaluation of the role of dense matrix multiplication. The aim of this paper is two-fold. First, to summarize developments that point toward a need for reconsidering usefulness of matrix multiplication generalized on the basis of the theory of algebraic semirings. Second, to propose generalized matrix-matrix multiply-and-update (MMU) operation and its object oriented model.

[sedukhin-02:2014] M. Ganzha, M. Paprzycki, and S. Sedukhin. Image scrambling on a "mesh-of-tori'' architecture. *Scalable Computing: Practice and Experience*, 15(1):79–87, 2014.

Recently, a novel method for image scrambling (and unscrambling) has been proposed. This method is based on a linear transformation involving the Kroneker-delta function. However, while quite interesting, the way it was introduced, leaves some open issues concerning its actual usability for information hiding. Therefore, in this paper, we extend the original proposal and show how it can be used to securely pass image-like information between the users.

Refereed Proceeding Papers

[hitoshi-03:2014] Hitoshi Oi. Case Study: Effectiveness of Dynamic Frequency Scaling on Server Workload. In *Proceedings of 2014 International Symposium on Integrated Circuits (ISIC)*, pages 332–335. IEEE Singapore Section, December 2014.

DOI: `http://dx.doi.org/10.1109/ISICIR.2014.7029572`

[sedukhin-03:2014] I. Lirkov, M. Paprzycki, M. Ganzha, S. Sedukhin, and P. Gepner. Performance analysis of scalable algorithms for 3D linear transforms. In *Computer Science and Information Systems (FedCSIS), 2014 Federated Conference on*, page 613—622, Warsaw, Poland, Sept 2014.

Practical realizations of 3D forward/inverse separable discrete transforms, such as Fourier transform, cosine/sine transform, etc. are frequently the principal limiters that prevent many practical applications from scaling to a large number of processors. Specifically, existing approaches, which are based primarily on 1D or 2D data decompositions, prevent the 3D transforms from effectively scaling to the maximum (possible / available) number of computer nodes. Recently, a novel, highly scalable, approach to realize forward/inverse 3D transforms has been proposed. It is based on a 3D decomposition of data and geared towards a torus network of computer nodes. The proposed algorithms requires compute-and-roll time-steps, where each step consists of an execution of multiple GEMM operations and concurrent movement of cubical data blocks between nearest-neighbour nodes (directly using the logical arrangements of the nodes within the torus). The proposed 3D orbital algorithms gracefully avoids the, required, 3D data transposition. The aim of this paper is to present a preliminary experimental performance study of the proposed implementation on two different high-performance computer architectures.

[sedukhin-04:2014] S Sedukhin, T Sakai, and N. Nakasato. 3D Discrete Transforms with Cubical Data Decomposition on the IBM Blue Gene/Q,. In Editor L. Miller, editor, *Proc. ISCA 30th International Conference on Computers and Their Applications 2015 (CATA-2015)*, pages 21–29, Honolulu, Hawaii, USA, March 2015. International Society for Computers and Their Applications, Cambridge Univercity Press.

This paper presents the implementation and performance evaluation of some three dimensional ($3D$) $N \times N \times N$ discrete transforms with cubical data decomposition. The proposed algorithms for these transforms can be extremely scaled up to N^3 computer nodes. In these algorithms, only local communications between nearest neighbor toroidally interconnected nodes are required and

overlapping of computation and communication is possible. As an example of the $3D$ transform algorithms with cubical data decomposition, we implemented and evaluated the performance of the forward and inverse 3D $N \times N \times N$ Discrete Fourier transforms on the IBM BG/Q. The scalability of the $3DDFT$ algorithm is tested for the case when the number of nodes is less than N^2.

[sedukhin-05:2014] S. Sedukhin and M. Paprzycki. Generalized Matrix Fused Multiply-and-Add as a Workhorse of Scientific Computing. In *Advanced Mathematics, Computations and Applications, International Conference on*, page 51, Novosibirsk, Russia, June 2014. Institute of Computational Mathematics and Mathematical Geophysics, Siberian Branch of Russian Academy of Sciences, Academizdat.

Recent advances and observed development directions in high-performance hardware and software used in solution of large-scale scientific problems suggest the need to re-evaluate the role of dense matrix multiplication. The aim of this paper is to argue that, the same way as scalar fused multiply-and-add operation has changed computing in the last twenty years, the matrix fused multiply-and-add is going to influence the way we design computers and write cods for scientific computing in the future. Furthermore, we will show that a well-established general matrix multiply-and-add operation should be extended through the theory of algebraic semirings, to allow for unification of solvers for a large class of computational problems (within the scope of the discussed Algebraic Path Problem). We will also demonstrate that extended and generalized matrix multiply-and-add operation can be used not only for computing of the linear and multi- linear transforms but also for matrix data manipulations, such as reordering of matrix rows/columns, matrix rotation, transposition, etc. This data manipulation is an integral part of a large class of matrix algorithms, regardless of parallelism.

Academic Activities

[hitoshi-04:2014] Hitoshi Oi, Since 2009.

Academic member of the T-Engine Forum (representative for the University of Aizu). http://www.t-engine.org/

[hitoshi-05:2014] Hitoshi Oi, Since 2005.

Professional Member, ACM

[hitoshi-06:2014] Hitoshi Oi, Since 2005.

Member, IEEE/Computer Society

[hitoshi-07:2014] Hitoshi Oi, Since 2006.

Academic Member, EEMBC http://eembc.org/

[hitoshi-08:2014] Hitoshi Oi, Since 2009.

Senior Member, IACSIT http://www.iacsit.org/

[hitoshi-09:2014] Hitoshi Oi, December 2014.

Reviewer for the 14th IEEE International Conference on Scalable Computing and Communications (ScalCom2014), Bali, Indonesia

[hitoshi-10:2014] Hitoshi Oi, December 2014.

Organized a special session "Performance and Power Issues in Multi/Many Core Architecture," at 2014 International Symposium on Integrated Circuits (ISIC), December 2014, `http://p2m2ca.oslab.biz/`

[sedukhin-06:2014] S. Sedukhin, 2014.

Parallel Processing Letters, Regional Editor

[sedukhin-07:2014] S. Sedukhin, 2014.

HPCS, FedCSIS, CATA, International Conferences, IPC Member

[sedukhin-08:2014] S. Sedukhin, June 2014.

The Journal of Computing and Informatics, Reviewer

Patents

[sedukhin-09:2014] S. Sedukhin, T. Miyazaki, and K. Kuroda. Array Processor, JP 2009-094620, April 2014.

Others

[hitoshi-11:2014] Hitoshi Oi.

Journal reviewer for Microprocessor and Microsystems (Elsevier)