Parallel algorithm of 3D wave-packet decomposition of seismic data: implementation and optimization for GPU

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Recent Challenges for Computational Science – to Young Generation

Recent advances in experimental techniques such as detectors, sensors, and scanners have opened up new vistas into physical and socio-economic processes on many levels of detail. The complete cascade from the individual components to the fully integrated multi-science systems crosses many orders of magnitude in temporal and spatial scales. This is changing the way we do science into data intensive scientific discovery. The ultimate challenge is to study not only the fundamental processes on the various scales, but also their mutual coupling across scales in the overall system. The sheer complexity and range of spatial and temporal scales on which natural and anthropogenic systems seem to operate defies any existing numerical model or computational capacity. The only way out is by combining data on all levels of detail. This is an open research area. The challenges include understanding how one can reconstruct multi-level systems and their dynamics that connect models to massive sets of heterogeneous and often incomplete data. Conceptual, theoretical and methodological foundations are necessary for understanding these multi-scale processes and associated predictability limits of such large scale computer simulations.

In 2011 we announced a competition for young scientists in the Russian Federation working in the field of computational science and supercomputing to present us their most interesting research results. From the many submission received we selected 20 winners whom all received a ticket and stipend to Amsterdam to present their work at the University of Amsterdam during the International Young Scientists Conference «High Performance Computing and Simulation» 2-6 April, 2012: YSC-2012.

The Conference aims to develop a dialogue on the present and future of computational science, research and applications. The key conference themes are: mathematical modeling of multidisciplinary systems, supercomputer technologies to solve complex computing problems, problem solving computational systems, numerical studies in social sciences and life sciences, etc.

The YSC-2012 presents, in addition to the 20 Russian price winners, PhD students and Postdocs from the computational science research group at the University of Amsterdam (http://uva.computationalscience.nl/) and from the Leading Scientist research group on Advanced Computing at the research institute ITMO in St. Petersburg

Especially we are proud to have the following keynote speakers and invited speakers:

Keynote Speakers:

- Prof. Dr. Jack Dongarra (USA)
- Prof. Dr. Bastien Chopard (Switzerland)
- Dr. Mike Lees (Singapore)
- Dr. Anwar Osseyran(SARA, Amsterdam)

Invited Speakers:

- Prof. Dr. Guz Eiben (VU, Netherlands)
- Prof. Dr. Han La Poutre (CWI and Uni Eindhoven)
- Prof. Dr. Maarten van Steen (VU, Netherlands)
- Prof. Dr. Marian Bubak (AGH Poland and UvA Netherlands)
- Prof. Dr. Cees de Laat (UvA, Netherlands)
- Dr. Jaap Kaandorp (UvA, Netherlands)
- Dr. Alfons Hoekstra (UvA, Netherlands)
- Dr. Robert Belleman (UvA, Netherlands)
- Dr. Valeria Krzhizhanovskaya (StPb Polytech and UvA)

This booklet presents abstracts of invited speakers' presentations and abstracts of young computational scientists from Russian Federation and the University of Amsterdam, The Netherlands.

This international conference is the first of its kind. We hope that it will serve as a regular basis for the internationalization of Russian research and will help to build strong ties within the international community in the field of Computational Science.

Professor Peter Sloot

Professor Alexander Boukhanovsky

PARALLEL ALGORITHM OF 3D WAVE-PACKET DECOMPOSITION OF SEISMIC DATA: IMPLEMENTATION AND OPTIMIZATION FOR GPU

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Seismic data sets are characterized by multidimensionality, large volume and irregular sampling. Here we address optimal representation of 3D seismic data volumes using wave-packet basis (curvelet-type redundant representation). It can be further used for seismic data compression, de-noising, and interpolation. The wave-packet decomposition appears to be a computationally-intensive operation. We have implemented a forward and inverse 3D wave-packet transform on GPUs using NVIDIA CUDA technology. The code was tested on different types of graphical processors achieving the average speedup up to 46 times on Tesla M2050 compared to the sequential code on CPU. Also we analyzed its scalability for several GPUs. The code was tested for processing synthetic seismic data set.