Exploration of OpenCL Hybrid Programming for Numerical Modeling of Solidification

Kamil Halbiniak, Lukasz Szustak, Lukasz Kuczynski
Institute of Computer and Information Sciences,
Czestochowa University of Technology, Czestochowa, Poland
{khalbiniak, lszustak, lkucz}@icis.pcz.pl

Heterogeneous (or hybrid) computing platforms have become powerful HPC solutions, which could be applied to a wide range of application domains. The utilization of a general-purpose CPUs together with specialized computing devices (e.g., Intel Xeon Phi, GPU or FPGA) in many cases allow accelerating the applications significantly, as well as increasing the performance per Watt ratio. However, there is still an open issue as to how scientific applications can efficiently exploit the computing resources of hybrid platforms with accelerators.

In our previous works, we proposed a method for porting and optimizing real-life scientific application for solidification modeling to computing platforms containing Intel MIC accelerators. The proposed approach considers not only overlapping computations with data movements, but also optimization of utilization of computing devices, including cores/threads and vector processing units. As a result, using the parallel resources of two Intel Xeon CPUs and two Intel based coprocessors, the developed approach allowed us to execute the whole application more than 10 times faster than the original parallel version running on two CPUs.

In this work, we take up the challenge of exploration of OpenCL hybrid programming model by adapting the proposed approach to hybrid platform with GPU accelerators. Particularly, we prove that the proposed methodology can be successfully applied for CPU-GPU platforms, in a relatively straightforward way.The main goal of this work is to take advantage of all computing resources including CPUs and GPUs for achieving desired high performance of computation. We present preliminary performance results obtained for various configurations of computing resources. In particular, we explore the performance of executing the optimized code of the solidification modelling applications on the hybrid platform consisting of two 18-core Intel Xeon CPUs (with Haswell architecture) and two NVIDIA K80 GPUs. The proposed methodology definitely improve the efficiency of studied application accelerating its execution when using all CPUs and GPUs resources.

Keywords: OpenCL, GPGPU, NVIDIA K80, Portability.