A Novel Approach for Online Monitoring for High Data-Rate Image-Based Instrumentation

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Imaging Detectors at modern synchrotron light sources create large data-sets in the order of 40 GB per 3D Image at high repetition rates. Imaging techniques are widely used in material science. Mechanical properties of nano-structured materials are measured using images captured by performance cameras. All these applications need to analyze large data sets to get the desired information. Up to now these task was performed in complex post processing cycles that made fast turn around time impossible.

Including hundreds of simple processors used to transform vertexes in 3D space modern graphic adapters offer a way to speed up the process of more than one order of magnitude at low cost and with good scalability. The Common Unified Device Architecture (CUDA) developed by NVIDIA extends C language with few syntax constructs allowing to offload resembling operations on the vector and matrix data into the graphic card. In order to provide near real-time visualization of the recorded data we have started optimization of image processing software by migrating all computational intensive parts into the CUDA environment. The maximum performance in our system is achieved by utilization of all available computational resources. All tasks are divided in 3 categories: Input/Output (I/O), computation tasks which can efficiently be performed on GPU, and computational tasks which can only be performed using CPU. The computational tasks are distributed between all available in the system GPU and CPU cores. The I/O streams are executed in parallel with computational tasks.

The presentation will introduce the GPU architecture and discuss performance issues related to typical algorithms. The implementation details for a Digital Image Correlation and Tracking algorithm to take advantage of CUDA computing are presented. The code achieves a tenfold acceleration compared to CPU-only version while running on dual-core workstation equipped with single NVIDIA GTX 280 video card.