ANALYSIS OF GPU-BASED CONVOLUTION FOR ACOUSTIC WAVE PROPAGATION MODELING WITH FINITE DIFFERENCES: FORTRAN TO CUDA-C STEP-BY-STEP

Makoto Sadahiro

Department of Geological Sciences
The University of Texas at Austin

ABSTRACT
By projecting observed microseismic data backward in time to when fracturing occurred, it is possible to locate the events in space, assuming a correct velocity model. In order to achieve this task in near real-time, a robust computational system to handle backward propagation, or Reverse Time Migration (RTM), is required. We can then test many different velocity models for each run of the RTM. We investigate the use of a Graphics Processing Unit (GPU) based system using Compute Unified Device Architecture for C (CUDA-C) as the programming language. Our preliminary results show a five-fold improvement in run-time over conventional programming methods based on conventional Central Processing Unit (CPU) computing with Fortran. Considerable room for improvement still remains.
The plot shows performance gain by porting legacy Fortran CPU-based system to CUDA-C GPU-based system. While supporting legacy Fortran routines that requires large amount of additional memory copy input-output (I/O), we achieved five times performance gain in our critical section, convolution-related sections, with CUDA-C GPU-based system. The benchmark consists of GPU related I/O overheads as well as I/O overhead for supporting legacy Fortran code sections. Our preliminary result, with five-times performance gain, does not yet take full advantage of the GPU’s low latency memory structure, shared memory. With the use of shared memory and the elimination of the legacy code sections, we expect further significant performance gain.