**Introduction**

Seismic attributes are quantities derived from seismic data to highlight features of interest. In seismic interpretation seismic attributes are key to better understand structural and sedimentary features present in seismic images. Use of GPUs to speedup attributes computation should ideally be interactive. Seismic attribute computation algorithms are parallel. Interpretation workstations are usually equipped with powerful GPUs for visualization.

Several attributes have been ported to CUDA and show significant performance boost.

**3D Gaussian Smoothing**

Gaussian smoothing is applied as 3 independent one-dimensional filters implemented as a unique CUDA kernel. Data is simply transposed after each step. An efficient 3D transpose kernel is thus required to transform seismic datasets from the original trace oriented data layout (suited for visualization) to any convenient layout for computation. The proposed algorithm uses 3D grids and shared memory to perform the transpose operation. It achieves 3X speedup over CPU implementation.

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Compared to an optimized OpenACC implementation, the CUDA version of the coherence attribute shows a 3X speedup.

**Cross-Correlation based Seismic Attributes**

The coherence measures the correlation between adjacent seismic traces and hence evaluates their difference. This attribute detects major faults, but subtle faults are usually poorly defined with this technique.

**Gradient Correlation Cube™**

GCC™ attribute optimizes the detection of subtle faults and fractures especially in carbonate environments where seismic quality is generally poor. GCC™ captures the local variation of the coherency. The Fault location is not longer defined by the local extrema of the coherence attribute but by the zero-crossing of the GCC™ attribute. This is more visible and accurate compared to the local extrema.

GCC™ also computes the lateral variation along different azimuths. The multi-azimuthal property is needed to adjust the GCC™ kernel to the local fault azimuth and hence maximize its detection and location.

Due to the algorithm’s complexity, huge CPU time – matter of days – is required to process a typical seismic dataset on an interpretation workstation. This is not compatible with the interactive nature of interpretation. GPU computing largely reduces the required time and allows GCC to be used on a daily basis by interpreters.

**Dip/Azimuth**

By performing a linear regression on the positions of maximum correlation for the neighboring traces, we can infer the orientation of the geologic features.

10X speedup over CPU implementation

**Experimental Setup**

Interpretation Workstation:
- Intel Westmere (2 sockets X 6 cores), 2.94GHz, 48Go RAM
- Fermi C2075 6 Go RAM 448 CUDA cores.
- CUDA 5
- Performance reported for test Dataset: 2Go (Inline) × 1024 (Xline) × 512 (time) in single precision float format
- Cross-correlation based attributes CPU parallel implementation: 2 MPI processes X 6 OpenMP threads - Smoothing implementation is sequential

**References**

