Implementation of OpenSource Structural Engineering Application OpenSees on GPU platform

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GPU computing is emerging as an alternative to CPUs for throughput oriented applications because of their number of cores embedded on the same chip and speed-up in computing. GPUs provide general purpose computing using dedicated libraries such as CUDA (for NVIDIA cards, based on a SIMD architecture that makes it possible to handle a very large number of hardware threads concurrently, and can be used for various purposes. This paper explains customization of a well-known open source earthquake engineering application OpenSees on hybrid platform using GPU enabled open source libraries.

Available GPU enabled version of OpenSees provided by Xinzheng Lu, Linlin Xie (Tsinghua University, China) uses CulaS4 and CulaS5, which use the Cula library and currently supported on window's platform. Both of these limits the usage of OpenSees as an open source platform. To overcome this, we have modified existing CuSPSolver to use only freely available CUSP library. Speed up improvement is achieved by diverting analysis component to GPU architecture

GPU enablement will help researchers and scientists to use this open-source platform for their research in structural and earthquake engineering domain using OpenSees. Also as there are minor changes required to be done in the input script and no great programming efforts required to run it using GPU enabled OpenSees, these modifications are very user friendly. Speedup around 2.14x is observed when tested with some examples. Different types of examples were studied to compare the results and it has been observed that performance will increases with increase in complexity of the problem. Nodal displacement results of one of the example were compared with CPU and GPU simulations which were matching. This validates the methodology used for GPU enablement. These modifications were also integrated in the mainstream of OpenSees code at Berkley and now available to all structural engineering community. All the study carried out is for single CPU and single GPU. There is lot of scope to extend this work for multi GPU, using other accelerators and using OpenCL.