Simulation Techniques for High Performance and High Definition Computer Aided Tomography

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The computational and data complexity of Computed Tomography reconstruction algorithms make them suitable for its study and optimization employing different paradigms and programming models. This type of application also serves as an example of algorithms that are classified as embarrassingly parallel, when executing their basic operators, but complex enough in their execution flow due to their iterative characteristics.

We have explored the adaptation of this kind of algorithms to two different paradigms: HPC (High Perfomance Computing) and Big Data paradigms. In the first case, we have adapted the algorithm to work with two of the most popular programming models for HPC: CUDA and a hybrid model of MPI+OpenMP, being capable of scaling by means of parallelizing at all levels: from fine grained parallel architectures (GPGPUs) to distributed environments. Regarding the Big Data approach, we have created a heterogeneous architecture based on the usage of NVidia GPGPUs and Spark.

The last step of this thesis will be to work with a mixed approach: a convergent HPC and Big Data solution that can overcome the disadvantages of both paradigms. Ideally this approach should provide to our application of: fault-tolerance, data-locality, easy-to-learn API and native support for accelerators.