AbstractID: 9183 Title: A parallel implementation for fast deformable image registration of large data sets

Title:
A parallel implementation for fast deformable image registration of large data sets

Purpose: One major obstacle for using deformable image registration for online or near real-time applications is its high computational cost. The goal of this study is to implement a practical parallel computing technique for image intensity-based deformable registration of relatively large data sets.

Method and Materials: Taking advantage of the locality characteristic of the deformed images, deformable image registration can be parallelized by dividing the entire volume into smaller sub-volumes. We implemented a parallel solution with the single-program-multiple-data (SPMD) programming model in a cluster. The cluster is composed of one lead computer and 12 nodes. To ensure continuity at boundaries of sub-volumes, we added an overlapping volume, which became a computational overhead. We proposed two techniques to reduce the overlapping volume by applying pre-registration during the coarse levels of a multi-resolution approach, and by handling the boundary condition carefully when applying the smoothing filter during registration. The baseline data for comparison was the deformation result from one CPU. Results were compared in three difficult cases with large deformation and large data set. The scalability was also analyzed.

Results: 8-12 nodes appears to be enough to handle each case. Four overlapping slices combined with pre-registration at coarse level were able to get the correct deformation field at the boundary of each sub-volumes even in the presence of relatively large deformations. Computing times were 20.5s, 44.4s, and 76.5s for a prostate case (matrix size: 294*237*62), a head & neck case (361*414*87), and a breast case (465*371*157), respectively. The same data sets required 54.5s, 150.2s, and 331.6s to compute on a single CPU, respectively.

Conclusion: We have implemented an effective parallel solution for deformable image registration which can handle large data sets in a short time.