

Purpose: To develop a toolkit for automatic 2D/3D medical image registration using graphic processing units (GPUs).

Methods: We adopt the nonlinear least square object function for the registration. We use the L-BFGS algorithm to solve this optimization problem to find the rigid transform parameters so that the summation of squared differences of all pixels between the generated DRR image from rotating and translating the treatment 3D volume and the given portal image is minimum. The open source library libLBFGS is used for this purpose. A faster incremental version of the Siddon ray tracing algorithm was implemented for the DRR generation on both CPUs and GPUs with CUDA 1.2. It is based on ray tracing through the CT volume by integrating the Hounsfield values crossed by the CT voxel. The GPU runs on NVIDIA GeForce GTX 280M with 1 GB video memory. To validate the correctness of the algorithm, a clinical three-field plan was employed as an example. The CT volume image and the RT plan were exported from a commercial treatment planning system and read by our application.

Results: The accuracy of the GPU DRR calculations comparing with the CPU calculation is well acceptable. The preliminary results show that the speed up for 2D/3D registration using the GPU can be a factor of 14.

Conclusions: We have developed a toolkit with a graphical user interface for rapid automatic 2D/3D medical image registration. The accelerated DRR computations in the iteration on the GPU significantly reduce the registration time.