Resampling of Volumetric Data with GPU Generated Distance Field

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In volume visualization applications it can be necessary to use a reconstruction method, which interpolates between the voxels of the volume. The most convenient strategy is to use a reconstruction filter (cubic B-Spline, for example) on the discreetly sampled data. Another way is to use Approximated Distance Function. This method has two steps. At the first step, 3D approximated distance fields are generated from the 2D slices, at the second step we can interpolate between these distance fields. At the visualization stage, we can get a resampled image, by extracting the zero level-set of the interpolated 3D distance function. The bottleneck of the method is the algorithm which is used to generate the distance fields. There are fast algorithms for this purpose (chamfering, fast marching methods), but these methods lack the desired accuracy. More accurate methods are known, but the usages of them are limited by their computational cost. It is proven by many examples, that the computational time can be highly reduced, if we use the parallel and scalable architecture of the modern graphics processor. But according to our experience, developing an efficient GPU re-implementation can be far from being evident, due to the GPU's special SIMD architecture. Despite that, this work attempts to create a tool to approximate a Distance Function with the NVIDIA CUDA C technology. This tool would benefit of the speed of the GPU, and it would be at least as accurate as the previous fast methods. Then the tool would be used to resample volumetric data, such as CT and MRI scans.