Abstract:

Interactive visualization and segmentation of volumetric data are quite limited due to the increased complexity of the task and size of the input data in comparison to two-dimensional processing.

A special interactive segmentation workflow is presented, based on minimal graph-cut search. The overall execution time was lowered by implementing all the computational steps on GPU, which required a design of massively parallel algorithms (using thousands of threads). To lower the computational burden even further the graph is constructed over the image subregions computed by parallel watershed transformation.

As a suitable formalism for a range of massively parallel algorithms was chosen cellular automata. A set of cellular automata extensions was defined, which allows efficient mapping and computation on GPU. Several variants of parallel watershed transformation are then defined in the form of cellular automaton.

A novel form of 2D transfer function was presented, to improve direct volume visualization of the input data, suited for discriminating image features by their shape and size.

CUDA Generic Image Processing (CUGIP) library was created to wrap common image processing patterns implemented for CUDA devices and presented algorithms were implemented as part of it.

By combination of all these components a fast responsive system for interactive segmentation was created, where all computationally expensive operations are executed on CUDA-enabled graphics card.

Keywords: minimal graph-cut, segmentation, transfer functions, cellular automata, GPGPU, parallel algorithms, statistical models