GIST: An Interactive, GPU-Based Level Set Segmentation Tool for 3D Medical Images

Joshua E. Cates, Aaron E. Lefohn , Ross T. Whitaker

UUCS-04-007

School of Computing
University of Utah
Salt Lake City, UT 84112 USA

February 27, 2004

Abstract

While level sets have demonstrated a great potential for 3D medical image segmentation, their usefulness has been limited by two problems. First, 3D level sets are relatively slow to compute. Second, their formulation usually entails several free parameters which can be very difficult to correctly tune for specific applications. The second problem is compounded by the first. This paper describes a new tool for 3D segmentation that addresses these problems by computing level-set surface models at interactive rates. This tool employs two important, novel technologies. First is the mapping of a 3D level-set solver onto a commodity graphics card (GPU). This mapping relies on a novel mechanism for GPU memory management. The interactive rates level-set PDE solver give the user immediate feedback on the parameter settings, and thus users can tune free parameters and control the shape of the model in real time. The second technology is the use of region-based speed functions, which allow a user to quickly and intuitively specify the behavior of the deformable model. We have found that the combination of these interactive tools enables users to produce good, reliable segmentations. To support this observation, this paper presents qualitative results from several different datasets as well as a quantitative evaluation from a study of brain tumor segmentations.