GPU Based VolumeFlies for Illustrative Volume Rendering

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Duration: 6 months

Volume rendering is a well established technique that is used for the visualization of medical volume data. Most of the techniques are based in the generation of images based on an approximation of a realistic physical model. However, if we look at an anatomic book, we will still see manual illustrations instead of photographs or other more realistic images. Illustrations are able to transmit and concentrate the attention of the reader (user) to what is important and not to details that are not necessarily relevant. It adds a level of abstraction. In the last years, inspired by these illustrations the so called illustrative volume rendering has emerged [1]. Stef Busking (at the BMIA group) [2] has developed a flexible framework (i.e., Volumeflies Framework) based on particle system. The particles have different user selectable rules that affect the position and appearance of these particles. Using this rules different illustration techniques can be generated at the same time (contouring, stippling, hatching,...). Some of these algorithms are quite time consuming. The goal of this project is to extent Stef Busking work by implementing a hardware based VolumeFlies framework, using the flexibility of nowadays Graphics Cards. GPU based particle systems for other purposes, like flow visualization [3], already exist. It is also of interest to improve the specific implementations of the VolumeFlies framework modules.

One of the most interesting applications of illustrative volume rendering is to be able to combine it with Direct Volume Rendering (DVR) techniques. Such a combination can help in generating focus and context metaphors. The context (e.g., brain cortex) is presented in a sketch like form and it is shown to orient the physicians, while the focus (e.g., tumor) or element of interest is shown in more detail using DVR. In the BMIA group, there is an implementation of a GPU based volume rendering [4]. It is important that at the end it is possible to combine the DVR and illustrative volume rendering in one image.

The implementation will be done in C++ and will be adapted to the GPU volume rendering library that is being developed at the BMIA group at BMT.

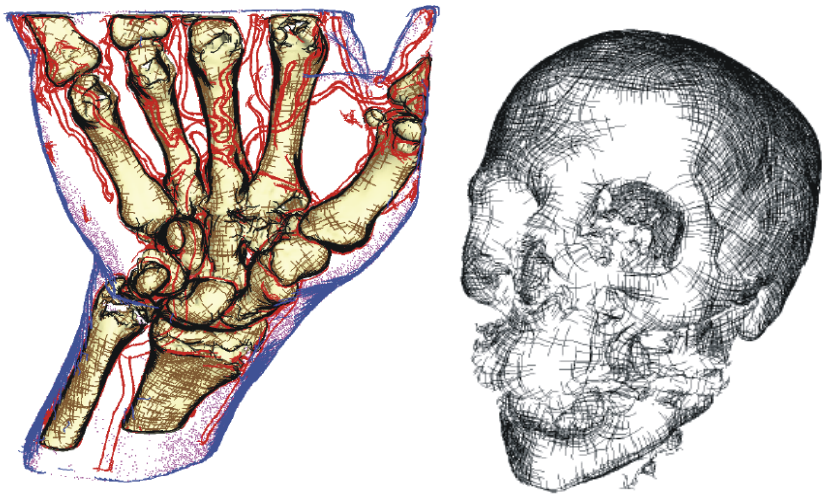

Figure 1 VolumeFlies illustration (left) Hand data set shown with a combination of different illustration techniques (contours (vessels), stippling(skin), hatching (bone)). (right) Head dataset where the skull has been rendered using cross-hatching.

Task

- Literature overview concerning particle systems implemented in GPU and related articles to GPU and illustrative volume rendering.
- Implementation of the GPU based VolumeFlies framework such that real-time interaction is possible
- (optional) Incorporation of improvements in the current modules of VolumeFlies
- Merging of the GPU based VolumeFlies framework and GPU based Volume Rendering
- Evaluation of the results.

Literature

1.- IEEE Visualization 2005 Tutorial 4: Illustrative Visualization

2.- VolumeFlies - a smart-particle-inspired framework for illustrative volume rendering, Stef Busking 2006
http://www.bmi2.bmt.tue.nl/image-analysis/Research/Projects/20010901-Visualization/Projects/IVR/index.php (thesis)

3.- J. Krueger, P. Kipfer, P. Kondratieva, and R. Wetsermann. A particle system for interactive visualization of 3d flows. IEEE Transactions on Visualization and Computer Graphics. Vol. 11, No. 6.
http://wwwcg.in.tum.de/Research/Publications/PartSystem

4.- Real-Time Volume Rendering with Hardware-Accelerated Ray Casting, Ralf Brecheisen 2005.
http://www.bmi2.bmt.tue.nl/image-analysis/Education/Master/Internships/20050503-RTVolRendHW/BRE06_RTVolRendHW.pdf