Scientific Visualization – Exercise 4

DEADLINE: SUBMIT YOUR SOLUTION BEFORE MONDAY, OCTOBER 19TH, 09:00.

Prerequisites

For this assignment you will need VTK and Paraview. VTK can be downloaded from http://www.vtk.org/ , Paraview from http://www.paraview.org/. Both are also installed on the dual-boot PCs at Science Park (both for Windows and Linux).

This assignment consists of a challenge that needs to be solved through visualization. Solve the challenge and submit a report that explains your approach. Submit your solution through Blackboard.

Submit one report per group pair. Make sure you mention both your names and student numbers in the report.

Introduction

Download the dataset from http://goo.gl/BgTzO4

This is a dataset from Lawrence Berkeley National Laboratories called the "Whole Frog dataset". It consists of two parts:

1. the files that start with "frog" are photographs of a sliced frog;
2. the files that start with "frogTissue" contain a segmentation of the frog based on 15 types of tissue:

Value	Tissue type
1	Blood
2	Brain
3	Duodenum
4	Eye retina
5	Eye white
6	Heart
7	Ileum
8	Kidney

Value	Tissue type
9	Large intestine
10	Liver
11	Lung
12	Nerve
13	Skeleton
14	Spleen
15	Stomach

The empty space around the frog is represented by the value 0. There are additional values present in the dataset, but you can ignore those.

Each part consists of 136 files that are each 500 by 470 pixels. Each pixel is represented by one unsigned byte. The spacing between slices is 1.5 times the width (or height: the pixels are isotropic) of a pixel.

Inspection using Paraview

Let us first take a look at this dataset using Paraview. Because the data is stored as a collection of files that are each of dimensionality 2, reading this data into Paraview requires a bit of wizardry that I will help you with:

- Select File -> Open from the menubar and browse to the location of the dataset.
- You will notice that Paraview collapses the dataset into two parts; select either one of them and click “OK”.
- Open Data With “Raw (binary) Files”.
- In the “Properties” panel on the lower left, the tricky bit is the specification of the “File Prefix” and “File Pattern”:
    - Change the File Prefix so that it ends with “frog.” or “frogTissue.” (depending on the set you choose to open – do not forget the period at the end!);
    - Change the File Pattern to: “`%s%03d.raw`”. Programmers will recognize this as a “printf” pattern: what this does is substitute “%s” for the value in “File Prefix”, “%03d” for the file number (using 3 digits per number, prefixed with 0s) and then add “.raw” at the end. This allows Paraview to find all files in the dataset.
- Set “Data Scalar Type” to “unsigned char”.
- Because the data values are represented by single bytes, the “Data Byte Order” does not matter.
- Set “File Dimensionality” to 2.
- Set “Data Spacing” to 1, 1, 1.5.
- Set “Data Extent” to 0, 499, 0, 469, 1, 136.
- Click “Apply”. A wireframe box should appear. If not, recheck all settings carefully.
- Set “Representation” (now new in the Properties panel) to “Volume”. A volume rendered representation of the frog appears.

By default, Paraview uses a predefined color/opacity lookup table. Experiment with the “Color Map Editor” by clicking the “Edit” button under “Coloring” (in the Properties panel). For example, try this: modify the opacity mapping so that tissues 1..7 are visible but 8..15 are not. Or: modify the opacity mapping so that only the skeleton is visible. Then change the colour mapping so that the skeleton is white. Now modify the tables so that only the skeleton and “Blood” (in red) are visible. Finally; see if you can create an opacity and colour mapping that allows you to clearly discern all 15 types of tissue.

This little experiment is not the objective for this assignment. It is there only to introduce you to the Art of Volume Rendering, which for 99% is to do with tuning the opacity and colour transfer tables. However, you *can* use your findings in the assignment that follows, so make sure you “Export” successful mappings for later use.

Assignment

The objective of this assignment is to visualize the anatomy of this frog through volume rendering, but now using VTK. The first dataset (“frog”) allows you to provide visual context: it includes the frog’s skin which the segmented dataset does not. My suggestion is to use volume rendering with a proper color transfer table (CTF) and opacity transfer table (OTF), but you may decide otherwise. The second dataset (“frogTissue”) contains values that are unique per tissue type. Use these values to visually isolate the different organs, thereby creating a clear visualization of frog anatomy.

Bonus points for implementations that:

- allow you to not only view the frog from any angle but also switch on or off the visualization of tissue types;
- add text labels that identify each tissue, or a key if tissues are coloured;
- provide an interactive “clipping plane” that allow part of the visualization to be obscured;
- provide an interactive “slicing plane” that shows the image content in the “frog” dataset sampled onto that plane;

- provide a combination of a clipping *and* slicing plane where the slicing plane shows the image content at the location and orientation of the clipping plane.