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Project 1: Interpolation and Color Visualization

EXTENSION 3 extension days

Introduction Interpolation and delaunay triangulation are two methods of data reconstruction used for high dimensional data. Additionally the mapping of color to reconstructed data allow for the meaningful interpretation and communication of these data

Methods

Interpolation Two data sets for the topography of the Grand Canyon were provided for its reconstruction and visualization. One data set contained a point cloud, containing polydata, the second contained high resolution image data.

Geometry from the image data were extracted and warped. A shepard kernel was used alongside an interpolation filter to probe the point cloud against the warped image.

Delaunay triangulation was also used. Triangulation was performed against the polydata. Polydata were then warped and then mapped.

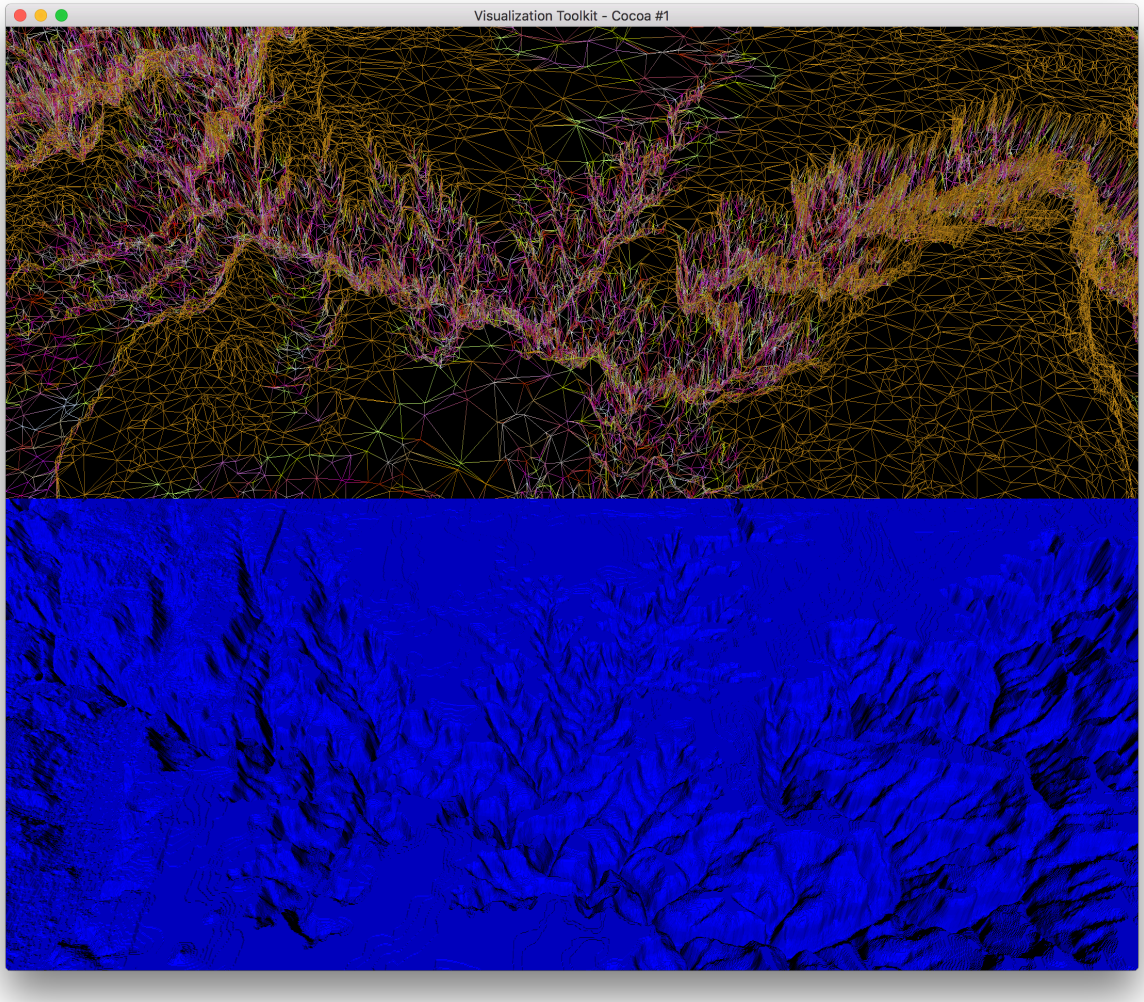
Color Visualization Two data sets were provided for color visualization. An axial slice of the head, ”axial1.vtk”, with the top of the head proximal to the viewer. The second dataset provided flow pressure data.

Colors in the mri data set were initially mapped in a linear gray scale to signal intensity as defined by scalar values. A second color mapping using a redundant, linearly optimized color scheme was created to visualize isointense and hyperintense signal intensity with greater contrast.

A color map using increasing brightness for flow pressure data were mapped to point values with a piecewise function at the minimum, $\frac{1}{4}$, $\frac{3}{4}$, $\frac{7}{8}$ and 1 times the maximum value.

Results

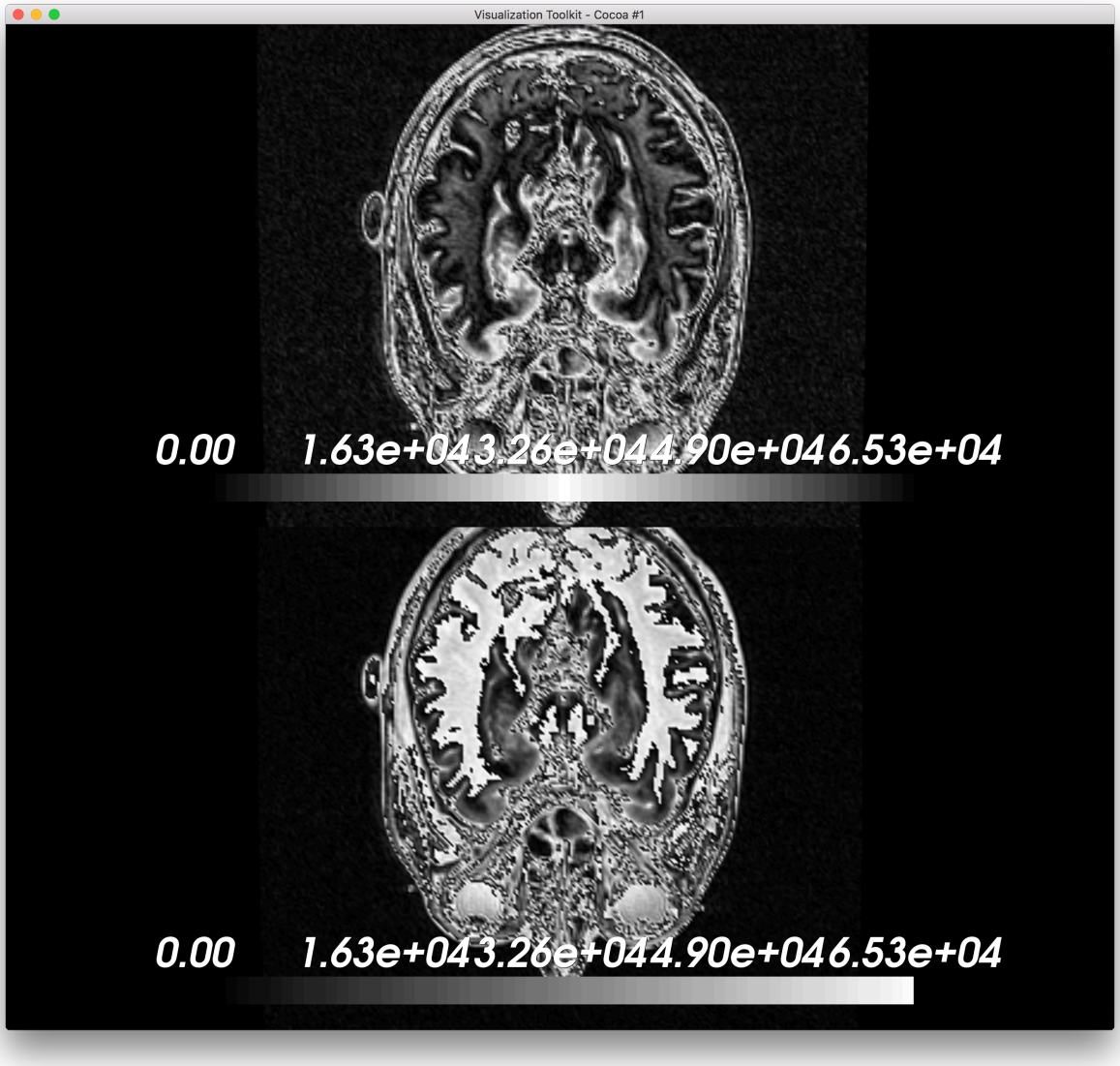
Interpolation



Interpolation of data provided for a smoother topography when compared to triangulation. Height mapping was incomplete for interpolation and the color mapping for triangulation is incorrect.

Color Visualization

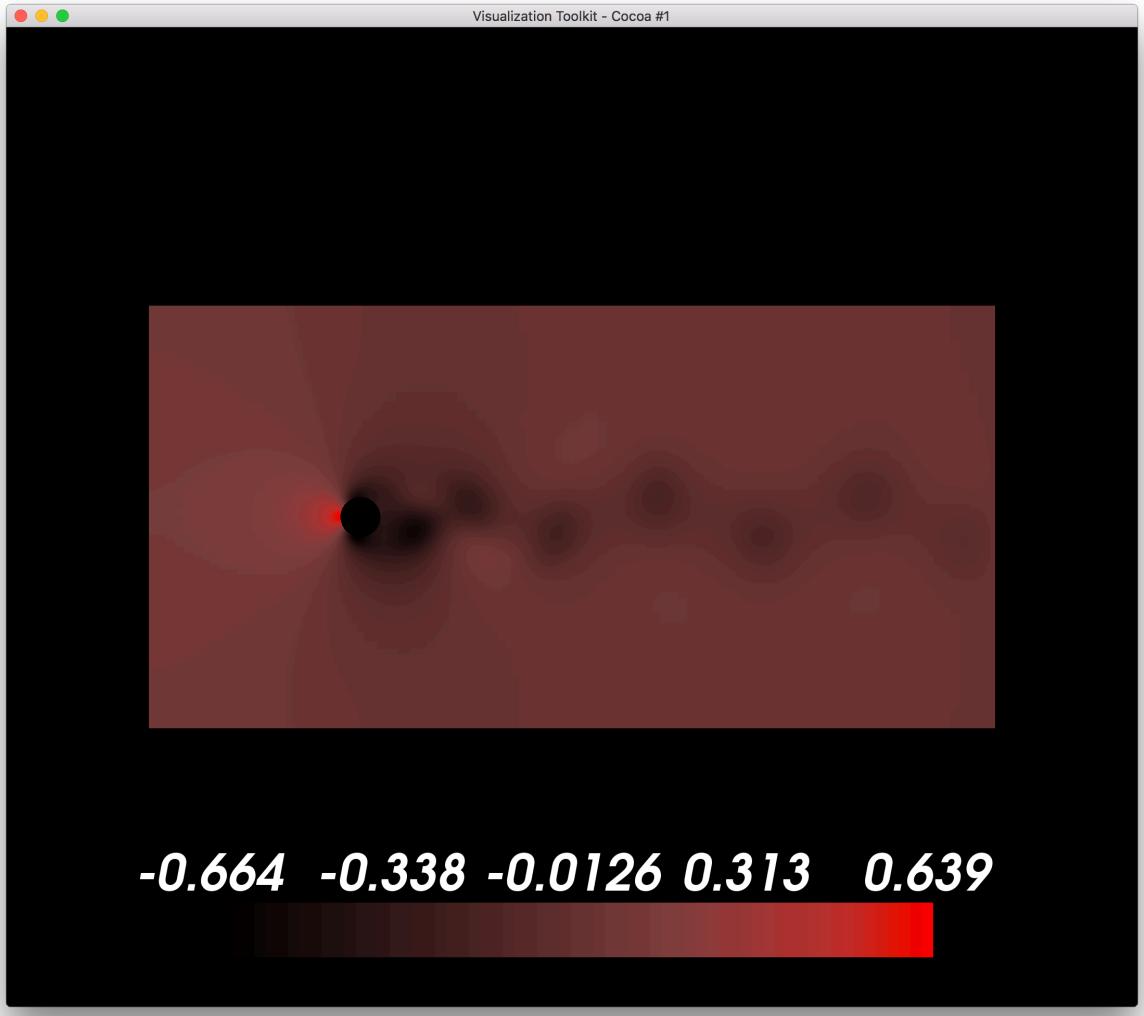
MRI



Color mapping of the MRI is separated into two visualizations A traditional and modified

visualization. The bottom viewing port represents a traditional MRI visualization. Brightness increases with signal intensity. Gray matter, typically intermediate signal intensity is depicted as gray. Additionally, white matter in the traditional MRI is hyperintense to white matter and contrast within white matter is lost. The top viewing port depicts a modified color mapping where gray matter maintains color mapping appropriate to traditional color mapping with white matter becoming hypointense to the grey matter. Lower intensity portions of the MRI become more visible in the modified image such as fat, muscle, cartilage, and fluid.

Flow Pressure



The piecewise function for color mapping defined allows for distinct resolution of pressure behind the object residing in the image at the location with respect to approximately $\frac{1}{4}$ of the maximum x-axis value. Pressure within the object in the image is defined as the minimum of point values. Directly in front of the object pressure is at a maximum. Pressure behind the object is mapped to darker colors. As presented in the above image, as pressure increases, brightness increases.

Discussion The quality of data reconstruction is determined how each technique is performed. Delaunay triangulation connects each point to its natural neighbors compared to interpolation, which analytically determines the values between two geometric points. The structured grid on which points reside is traversed, determining the interpolated values respective to each set of axes. Interpolation reconstructs data through the use of the above analysis, thus resulting in a smoother reconstruction of data.

Visualization mechanisms including color mapping and interaction mechanisms are incomplete and thus cannot provide an evaluation of their usefulness. However the current color mapping of the delaunay triangulation, as currently provided, provides for no distinct information of altitude.

The modified color mapping of the MRI allows for greater determination of structures within the white matter while maintaining visual acuity and integrity of the rest of the image. Compared to the traditional color mapping, the modified mapping also maintains the traditional mapping of intensity of cranial images.

The decrease in pressure behind the object can be justified by an increase in velocity of the trailing fluid. As per Bernoulli's principle, an increase of speed in a fluid decreases its pressure. The above visualization provides a mapping of this principle and the color mapping follows the this principle accordingly: as the fluid pressure decreases, brightness decreases.

The perception of the red and black color scheme is color blind safe and simultaneously provides a means of interpreting high pressure values as more intense. Stagnant fluids, while not desaturated, are a mid-range value of the HSV colorspace to provide an intermediate between high pressure and low pressure values.