Project Overview

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Abstract

This project explored volume rendering and different techniques that can be used to get a picture of the internal structure of an object. The project focused on two techniques: opacity transfer functions and slicing.

Keywords: Volume rendering, transfer function, planar slicing, PyVista

1 Introduction

All volume rendering in this project was done using PyVista. PyVista is an API to the Visualization Toolkit (VTK). The data used for the renders was gathered from a CT scan of an engine block taken by General Electric [1]. Figure 1 shows a volume rendering of the engine block.

To demonstrate opacity transfer functions, different renders were created using different transfer functions.

To demonstrate slicing, renders were first created using manual slicing techniques. This was followed by using the PyVista plane widget to interactively slice the volume.

2 Opacity Transfer Function

Using different opacity transfer functions can highlight and/or reveal different structures within the volume. This can be seen by comparing the volume renders shown in Figures 2 – 5. In these figures, a different transfer function was used for each figure. A graph of the opacity transfer function for each set of volume renders can be seen above the renders.

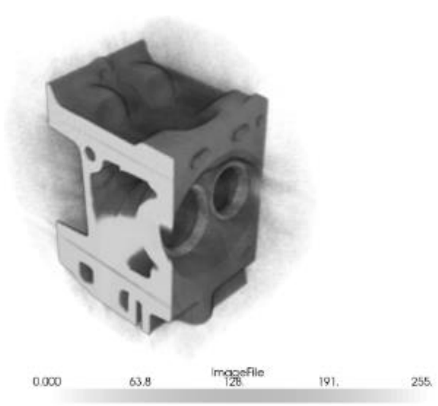

Figure 1: Engine block volume rendered using a linear opacity transfer function.

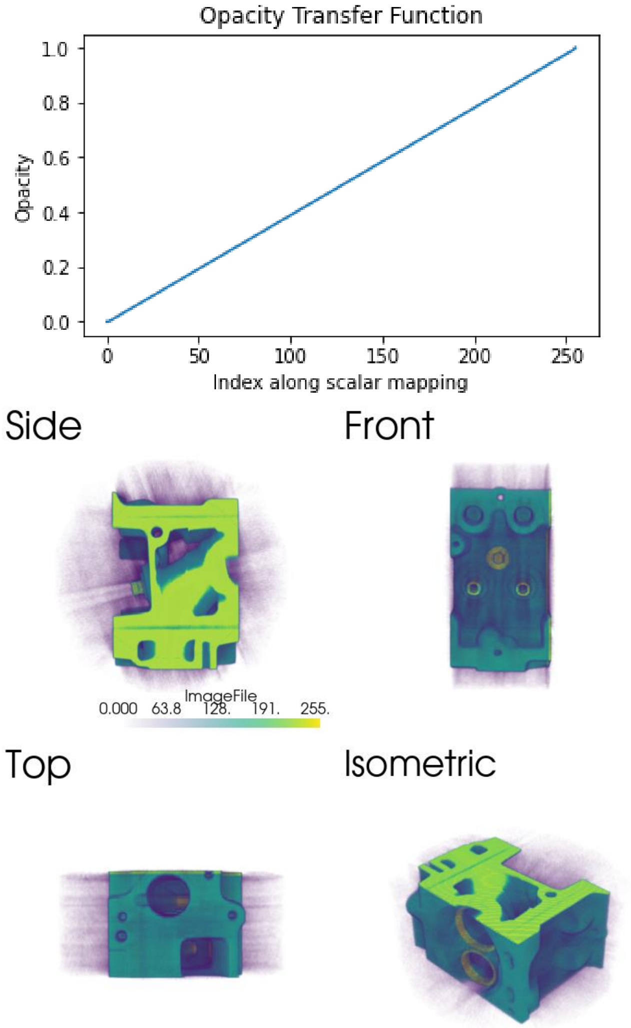

Figure 2: Engine block volume rendered using a linear opacity transfer function and viridis colormap.

3 Slicing

Slicing is another technique that can be used in volume rendering to get a better picture of the internal structure of an object. PyVista has many tools for slicing.

Figure 6 shows a single planar slice of the volume. When using a single slice, you sacrifice perspective of the whole volume, and gain a clear picture of the internal geometry on the plane created by the slice.

Figure 7 was created by rendering half of the object. It is an example of how clipping/cropping can be used to visualize specific information. This example uses the same opacity transfer function used in Figure 4. Removing half of the object creates a less noisy image, and a more detailed view of the internal structure can be seen.

Figure 8 shows multiple slices along the length of the volume. Figure 8 demonstrates another way slicing and opacity can be used to together.

The last example demonstrates the use of a PyVista tool to interactively slice a volume. Figure 9 shows the use of the PyVista plane widget, which can be used to easily create a planar slice of a volume by controlling the origin and direction of a vector orthogonal to the plane.

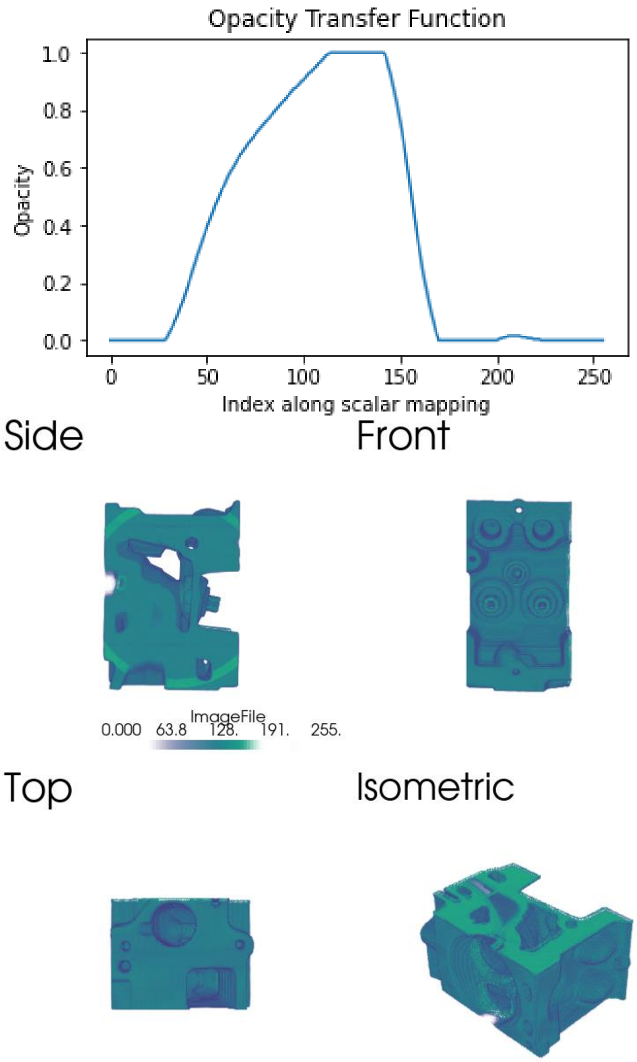

Figure 3: Engine block volume rendered using transfer function shown in the graph and viridis colormap.

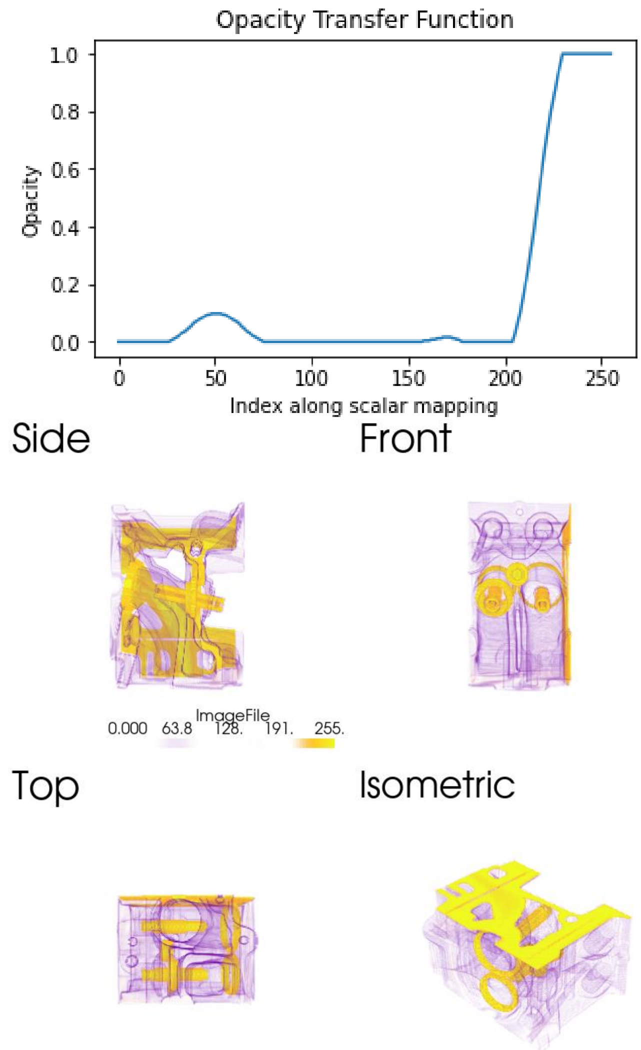

Figure 4: Engine block volume rendered using transfer function shown in the graph and plasma colormap.

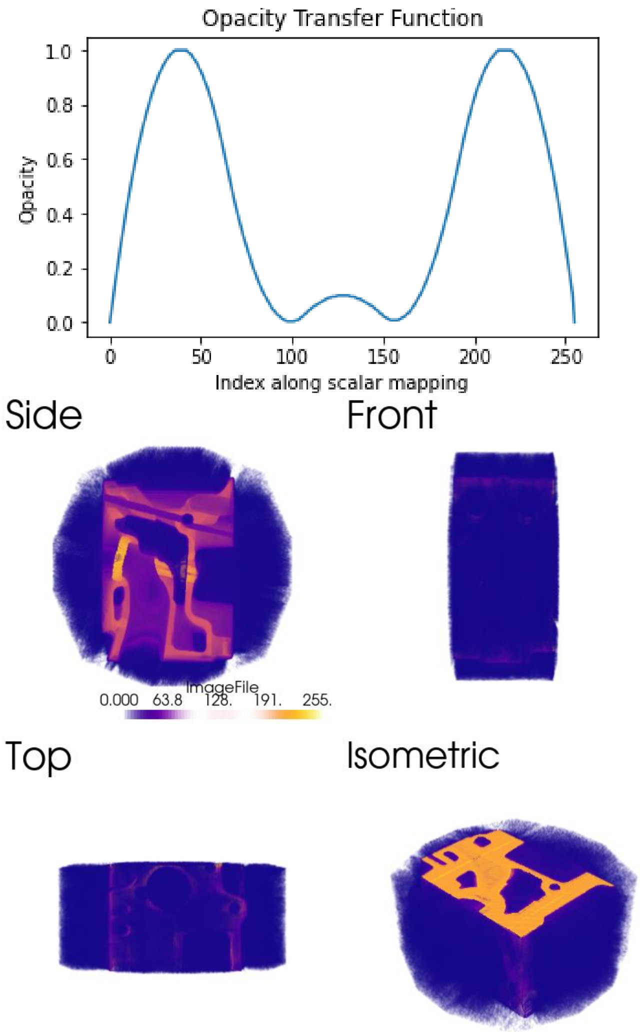

Figure 5: Engine block volume rendered using transfer function shown in the graph and plasma colormap.

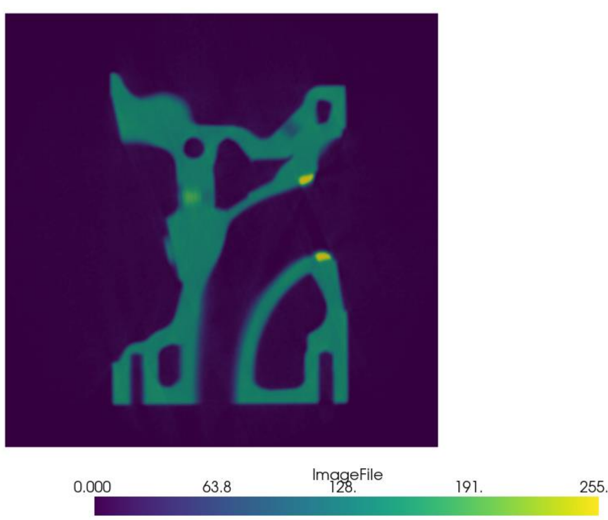

Figure 6: A single planar slice of the engine block volume.

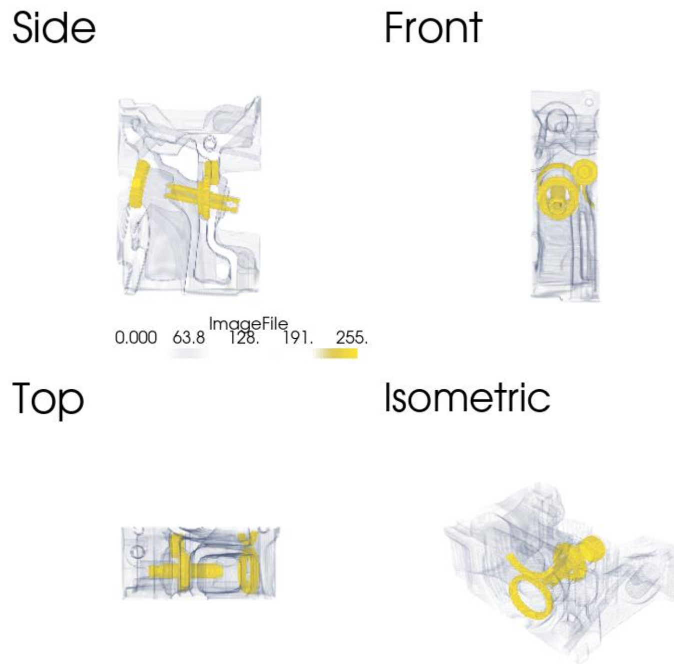

Figure 7: Engine block volume sliced to reveal half of the engine block. The opacity transfer function used is the same as the one shown in Figure 4.

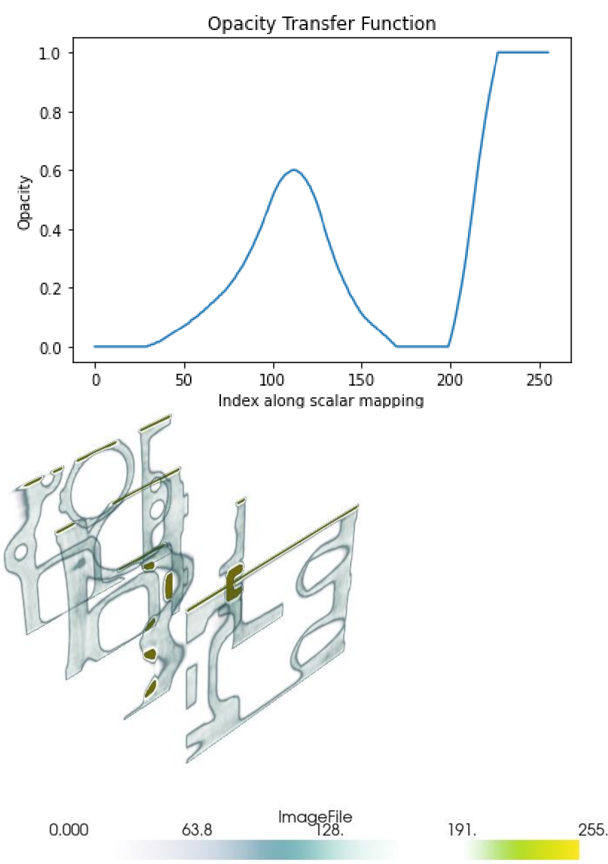

Figure 8: Multiple slices of the engine black volume taken along a single axis. The slices are rendered using the opacity transfer function shown in the graph.

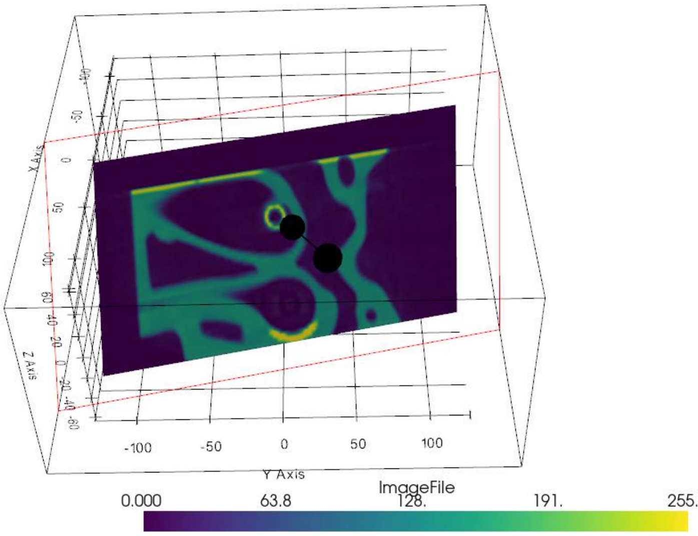

Figure 9: Slicing the volume using PyVista plane widget.

4 Conclusion

There are many methods that can be used in volume rendering to visual an object. By changing the opacity transfer function and colormap used when rendering, we can highlight specific areas of interest within the object. Methods such as clipping/cropping and slicing can also be used to isolate a specific area of interest. All these methods can be combined to produce even better results.

References

[1] General Electric, Engine Block CT Scan Dataset. https://klacansky.com/open-scivis-datasets/.