CS-530 Project 3 Report

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Task 1

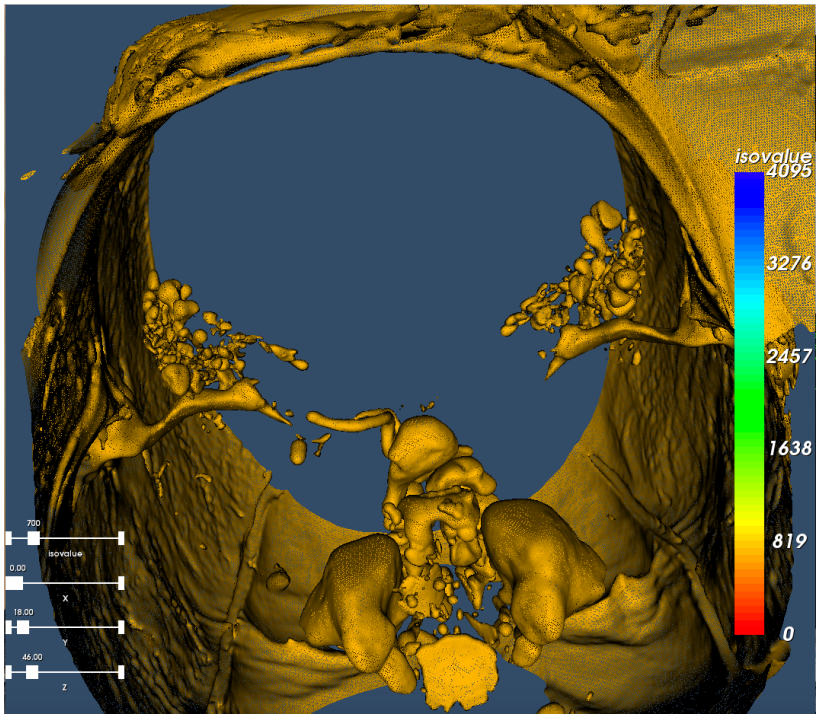

Figure 1.1 (isovalue=700,x=0,y=18,z=46)

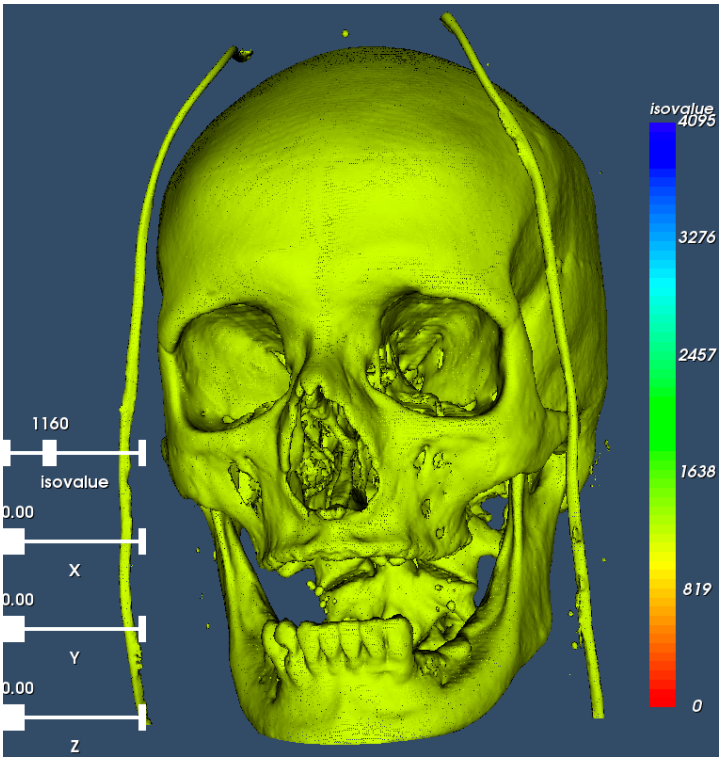

Figure 1.2 (isovalue=1160,x=0,y=0,z=0)

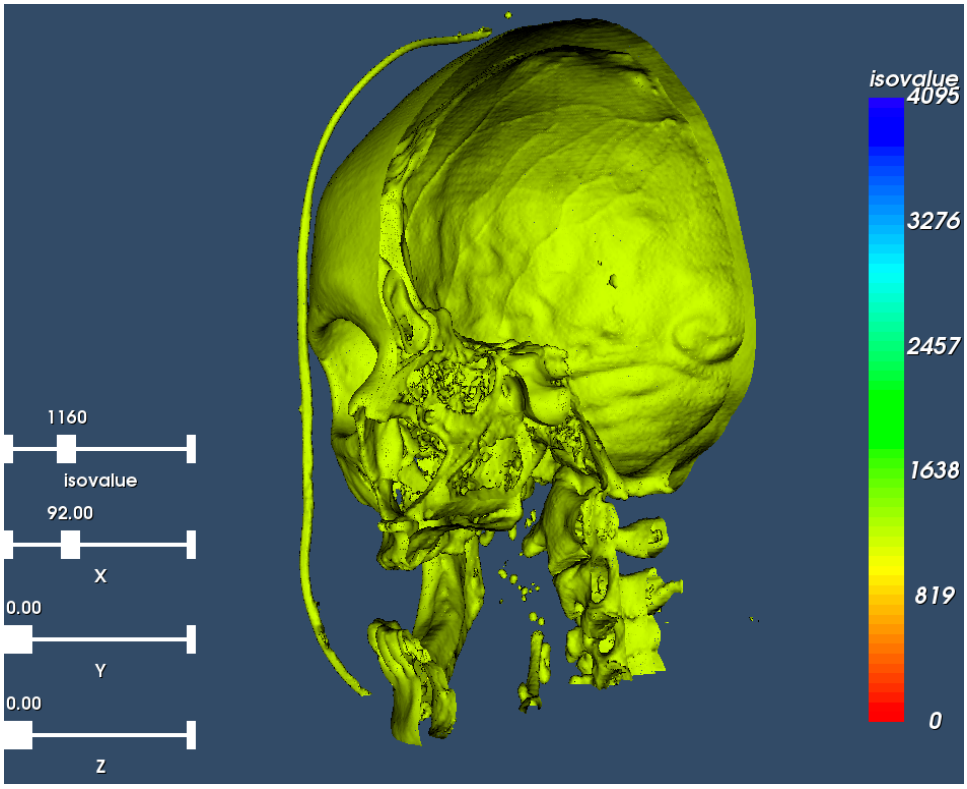

Figure 1.3 (isovalue=1160,x=92,y=0,z=0)

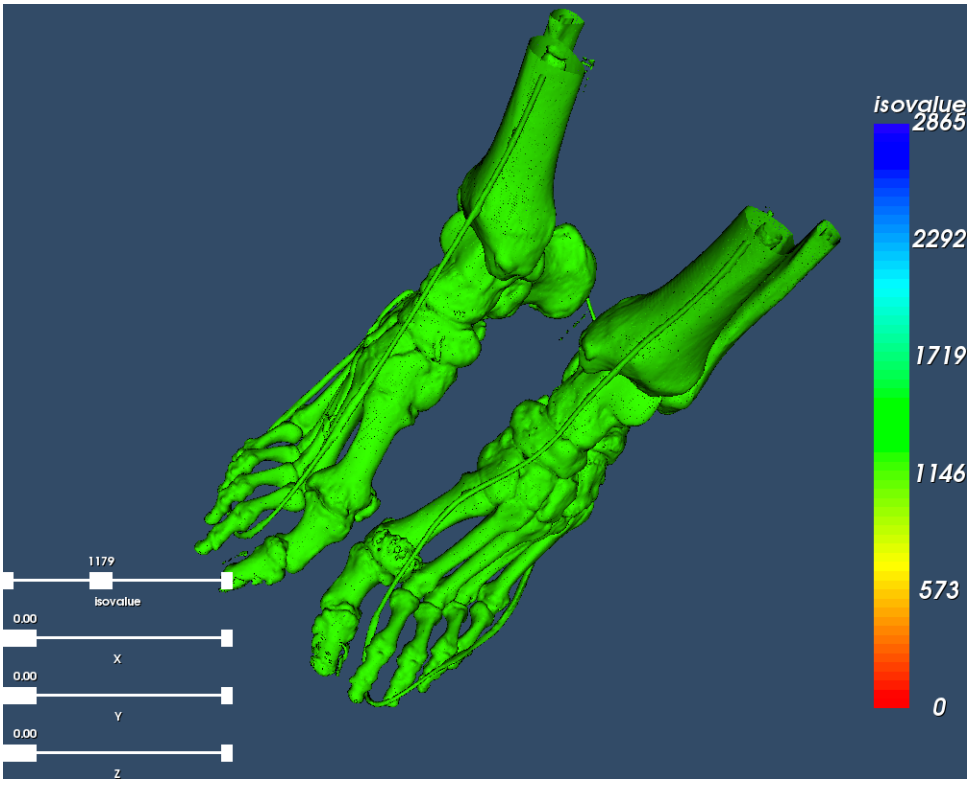

Figure 1.4 (isovalue=1179,x=0,y=0,z=0)

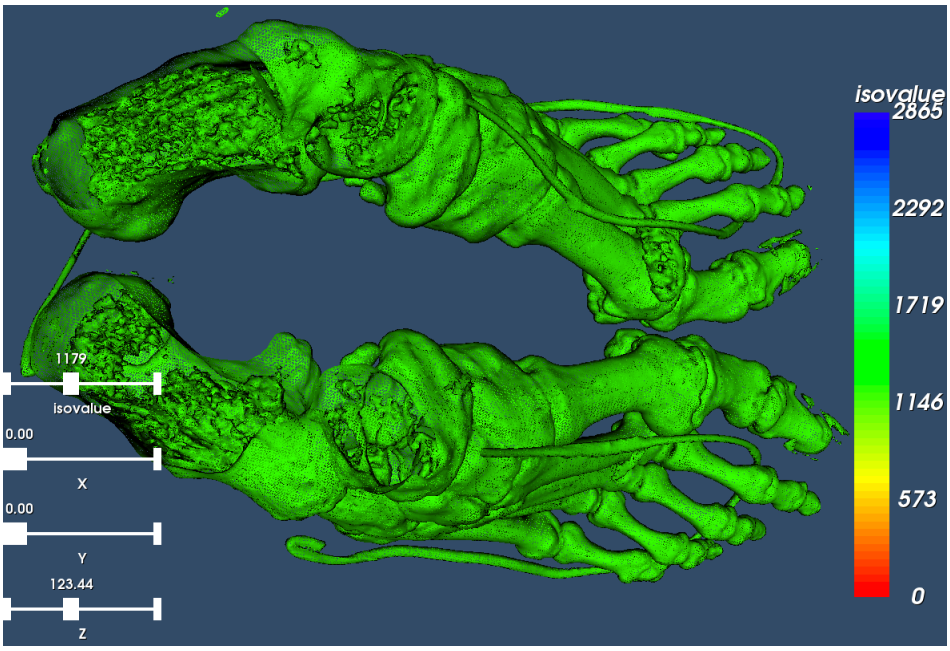

Figure 1.5 (isovalue=1179,x=0,y=0,z=123.44)

In figure 1.1, it is easy to observe the head contour by setting isovalue=700. After using Y-plane and Z-plane for clipping, we can observe the bones of nose and ears.

In figure 1.2, isovalue=1160 is good for observe the skeleton of head. Moreover, by setting X-plane for clipping, we can symmetrically cut the head in half and see the skeletons, as shown in figure 1.3.

In figure 1.4, isovalue=1179 can explicitly display the skeleton of feet. In addition, by setting Z-plane for clipping, we can observe the details of ankle, as shown in figure 1.5. In my experience, setting X-plane and Y-plane for clipping did not perform interesting details in the feet image.

Task 2

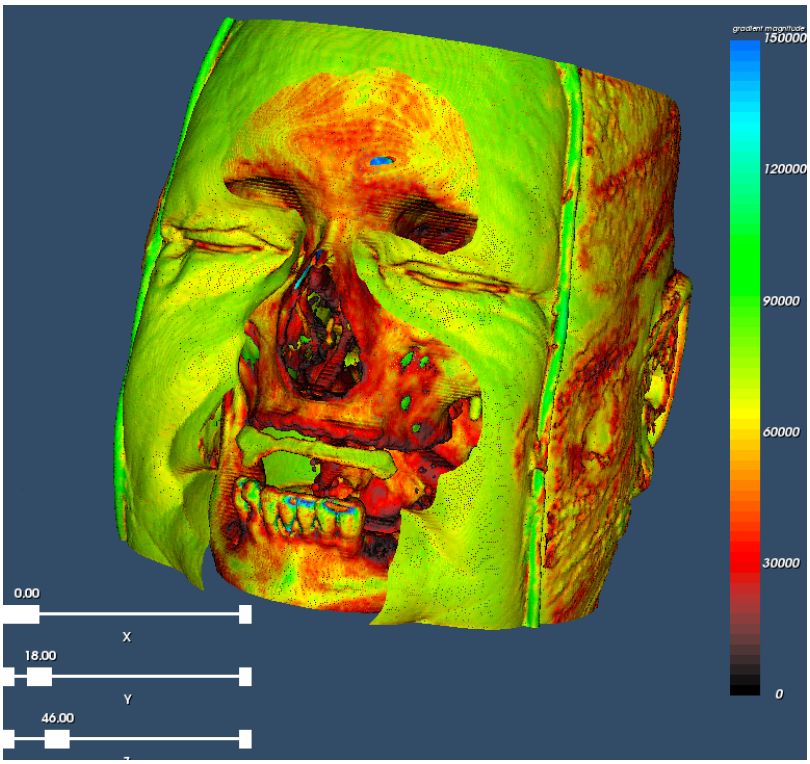

Figure 2.1 (isovalues=[700,1160,1179],x=0,y=18,z=46)

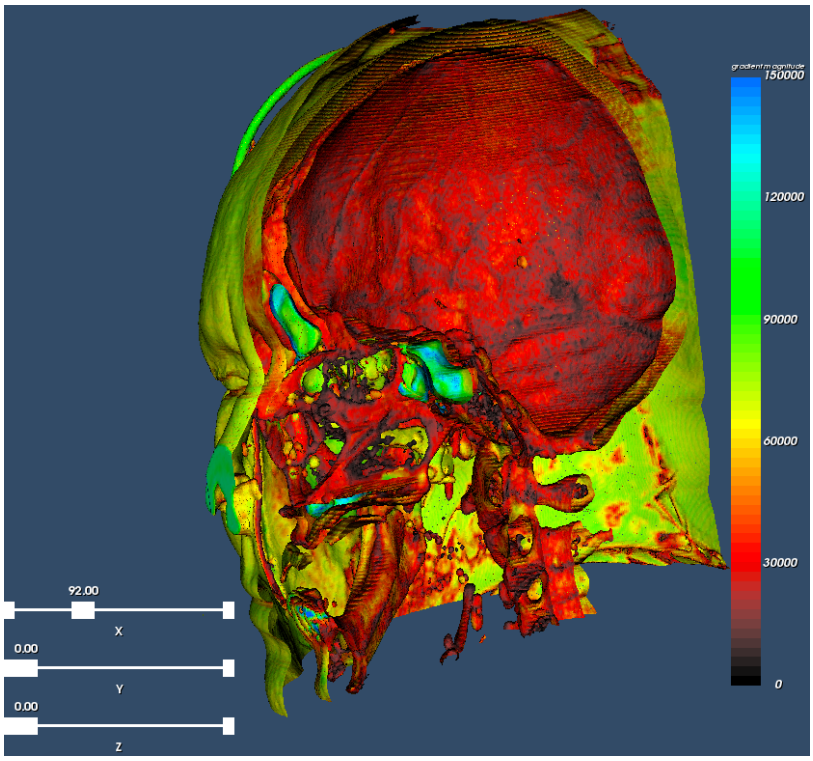

Figure 2.2 (isovalues=[700,1160,1179],x=92,y=0,z=0)

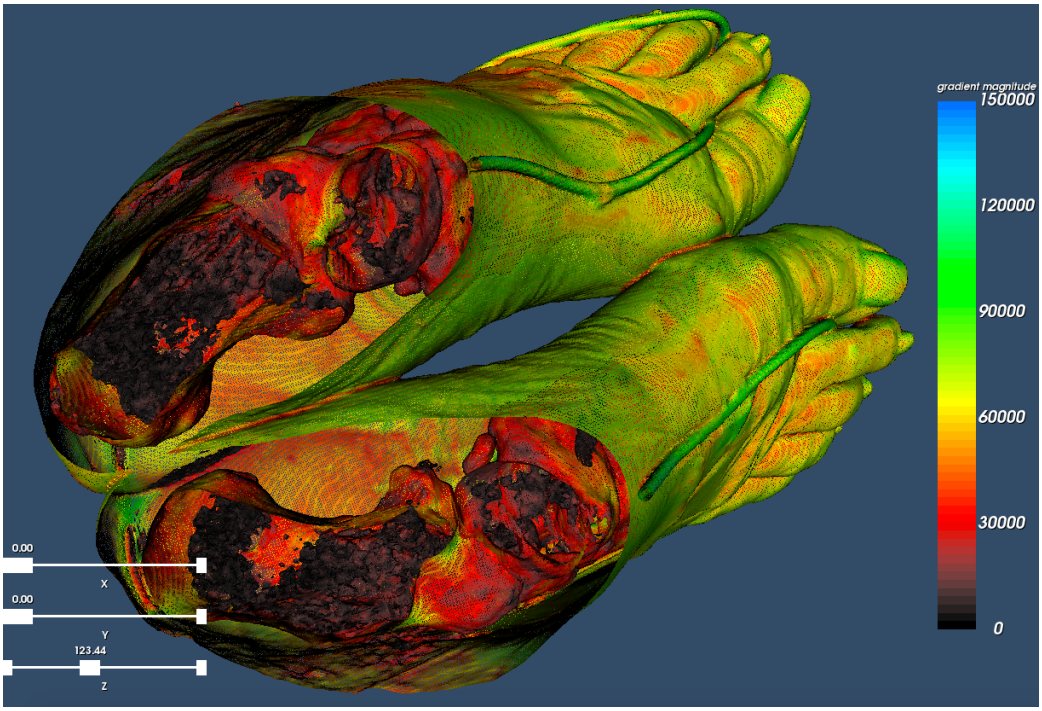

Figure 2.3 (isovalues=[700,1160,1179],x=0,y=0,z=123.44)

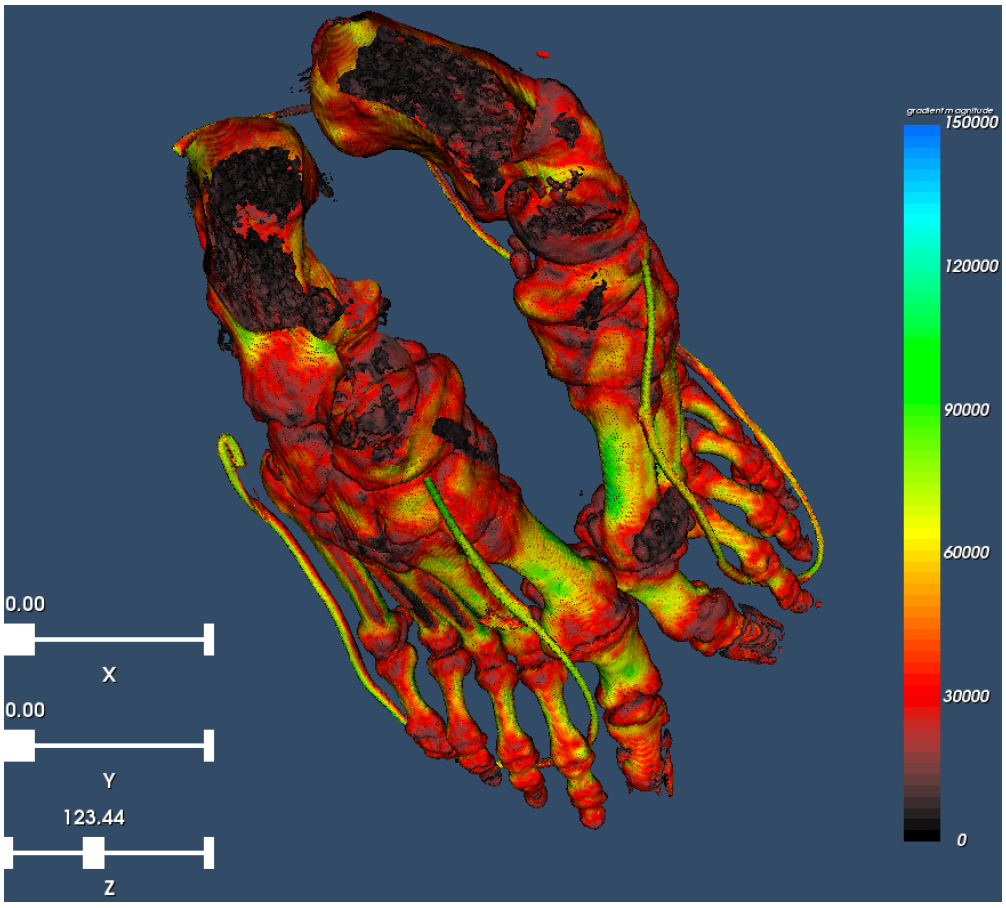

Figure 2.4 (isovalues=[1160,1179],x=0,y=0,z=123.44)

In task 1, the smaller isovalues correspond to the outer surfaces, and vice versa. However, in task 2, the distribution of the gradients is not the same as the distribution in task 1. For example, in figure 2.1, we can see most of the gradients of the isosurface (700) are distributed in the range of (60000,90000). But most of the gradients of the isosurface (1160) are distributed in the range of (0,30000), and some are even in the range of (90000,150000). For other figures (2.2, 2.3, 2.4), the distributions of gradients are also different from the distributions of isovalues. The results tell us that the distribution of isovalues is not aligned with the distribution of gradients.

According to the comparison of figure 2.3 and 2.4, we can also know that the gradients of the bones change much sharper than the gradients of the skin. For the bones, the gradients are mainly distributed in the range of (0,30000) but also in the range of (90000,150000). For the skin, the gradients are more uniformly distributed in the range of (60000,90000).

Task 3

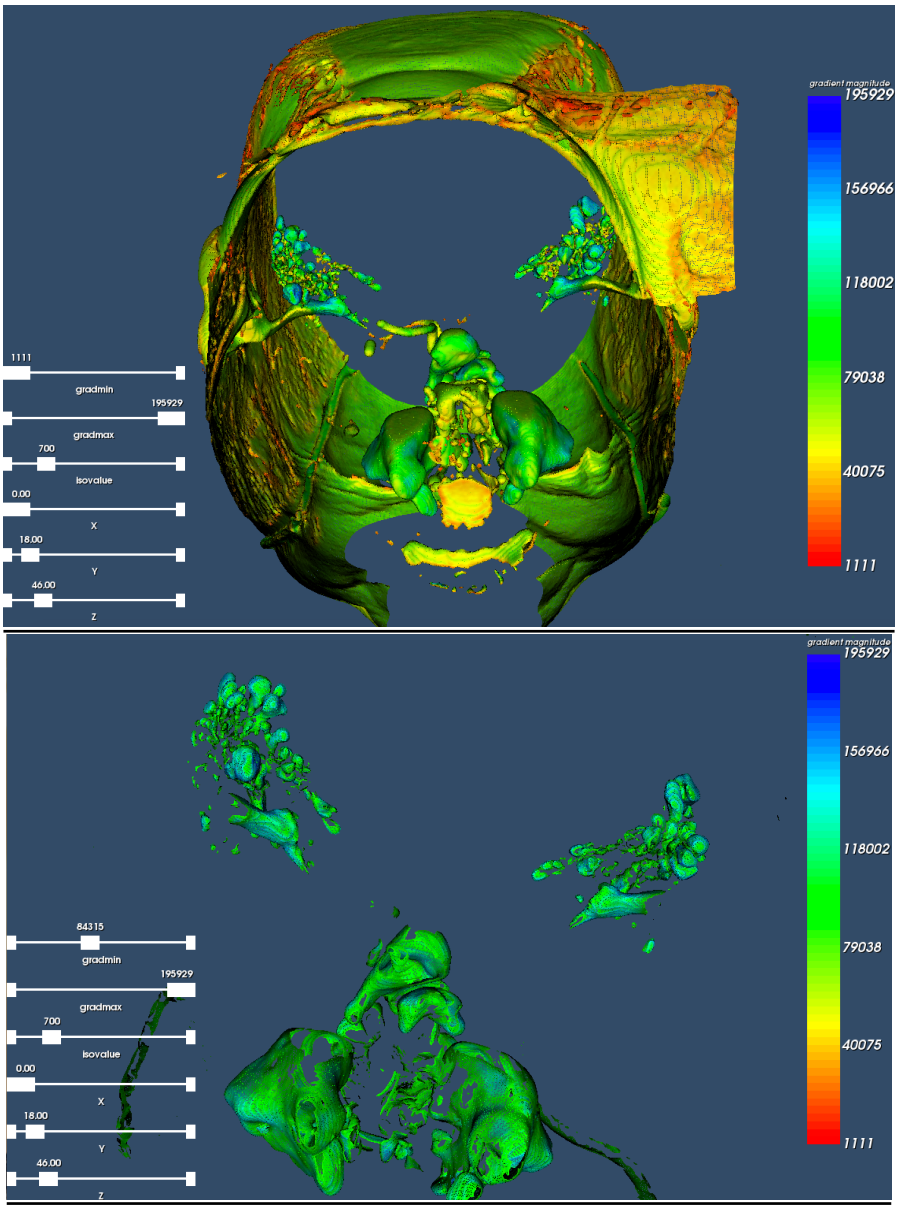

Figure 3.1 (isovalue=700, x=0, y=18, z=46, gradmin=1111->84315, gradmax=195929)

In figure 3.1, gradient magnitude filtering helps when we want to extract the bones from the image with both skin and bones. When adjusting gradmin from 1111 to 84315, it removes most of the skin and leaves the bones of nose and ears.

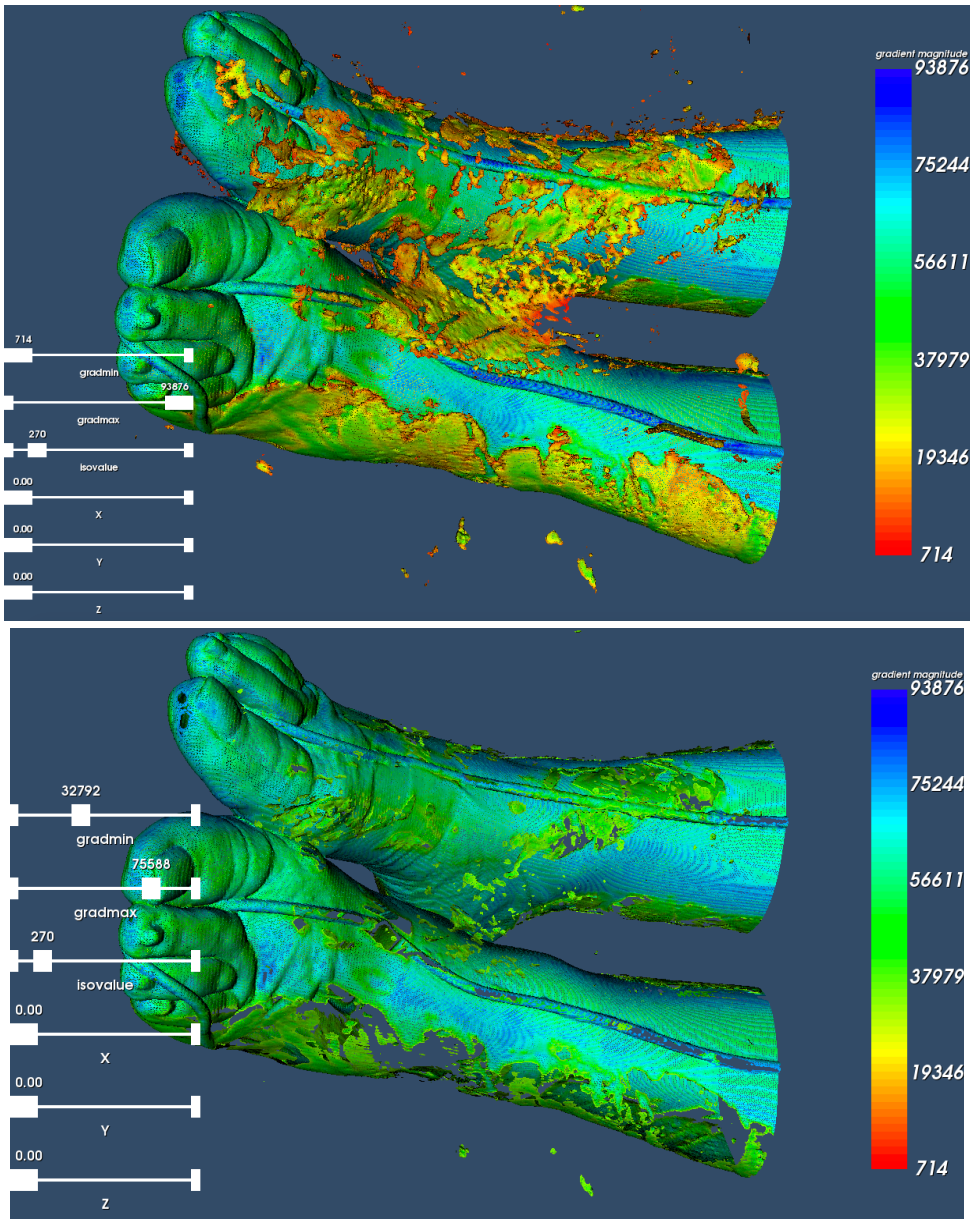

Figure 3.2 (isovalue=270, x=0, y=0, z=0, gradmin=714->32792, gradmax=93876->75588)

In figure 3.2, it helps when we want to eliminate noises from the image. We can see the upper part of the figure has several noises in gradient range of (714,25000), and the wires on the feet have the gradient magnitudes in the range of (75000,94000). When adjusting gradmin from 714 to 32792 and gradmax from 93876 to 75588, it removes most of the noises on the image.

According to the experiments, the isosurfaces with lower isovalues will be benefited more from this filtering.

Task 4

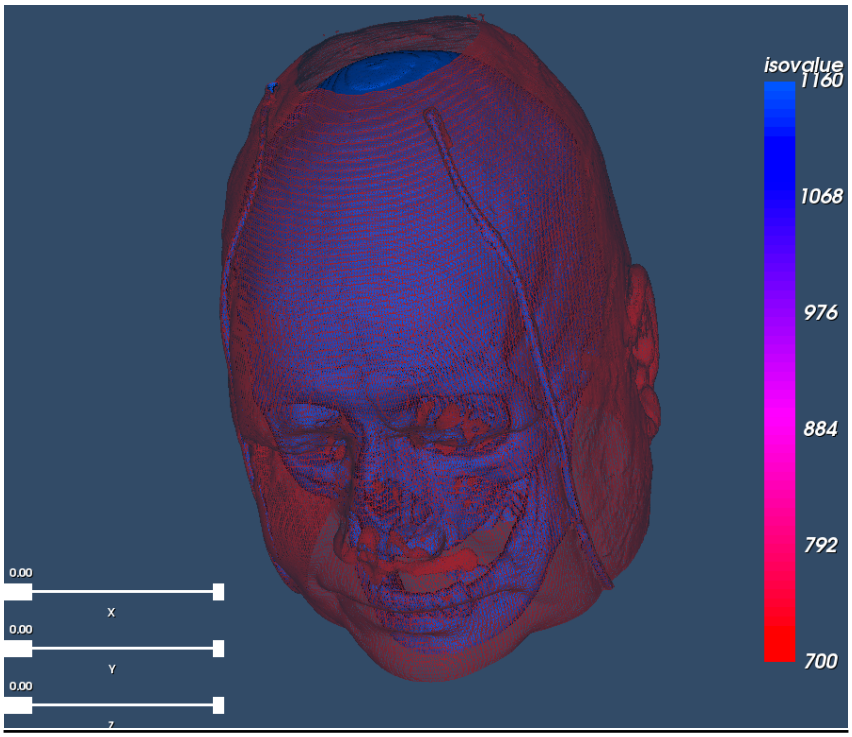

Figure 4.1 (isovalues=[700(opacity:0.3),1160(opacity:0.7)],x=0,y=0,z=0)

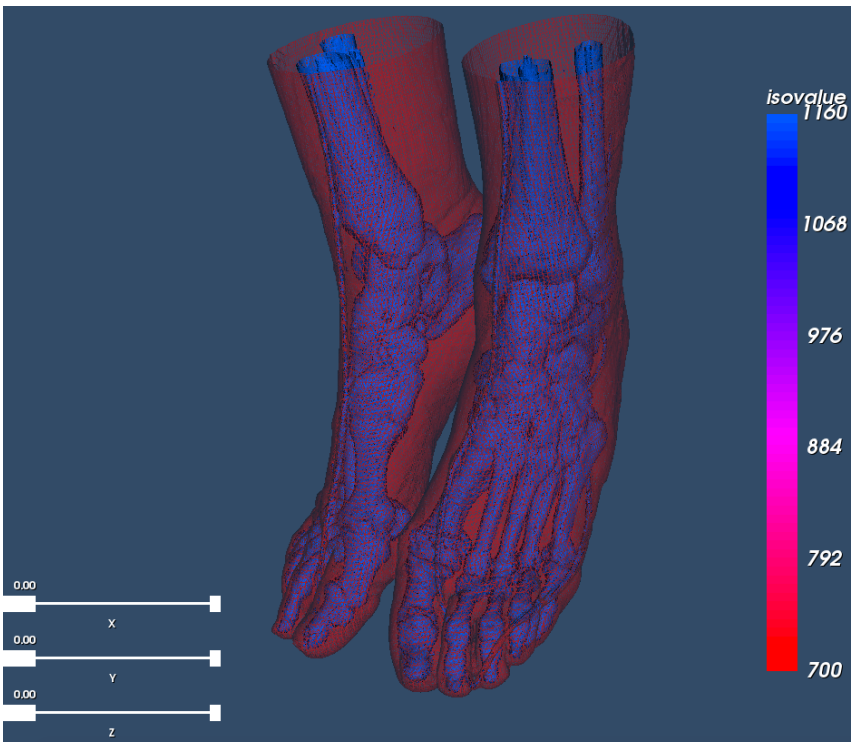

Figure 4.2 (isovalues=[700(opacity:0.3),1160(opacity:0.7)],x=0,y=0,z=0)

Due to the hardware limitation of my computer (CPU: 2.6 GHz Intel Core i5, GPU: Intel HD Graphics 4000 1024 MB, Memory: 8 GB 1600 MHz DDR3), it can only successfully process the images with at most 2 transparent isosurfaces after my experiments.

For figure 4.1 and 4.2, the opacity is 0.3 for the outer layer and 0.7 for the inner layer. In order to make the inner layer clear, selecting a lower opacity for the outer layer and a higher opacity for the inner layer can make the image more clear.

Transparency enables the observers see all the isosurfaces without clipping. Moreover, it is an intuitive approach for human comparing to clipping the images. However, if there are too many transparent layers overlapping in one image, it will be difficult to distinguish the differences between layers.

Summary Analysis

Comment on the effectiveness of isosurfaces for these medical datasets in your report. Isosurfaces in general are widely used in medical applications.

1. What explanation can you propose for this success?

- Isosurfaces enables us to visualize information for different levels of human body by different isovalues, which is more detailed than only the 2D CT slices.
- We can visualize several isosurfaces in one image and highlight the small differences between isosurfaces. It is very useful for doctors to observe the possible symptoms in human body.

2. Comment on the quality of the images you were able to obtain in each case.

- For the head data, we can visualize details of skin, organs and skeletons. For the feet, it is slightly blur when we want to observe the details inside the skeletons.
- It is a pity that I cannot observe the transparency due to hardware limitation. The quality is not good when visualizing multiple transparent isosurfaces.

3. Discuss any shortcomings of the isosurfacing technique you may have come across in this assignment.

- It is difficult to define the relationships between isovalues and actual organs, bones, or skin. For example, in this project, I can only approximately claim that I can visualize the bones or skin. However, it may be incorrect for medial professionals. If no related knowledge, it is hard to know the meaning of an isosurface.

4. Comment on the role and meaning of gradient magnitude to filter isosurfaces.

- The gradient magnitude can be used to filtering the parts we are not interested in or the noises along with the image. For example, in task 3, we can obtain clear images by adjusting the min and max values of gradient magnitude.

5. Comment on the benefits and limitations of transparency and clipping planes to enhance the visualization.

- Transparency and clipping planes can both visualize more information and more surfaces we cannot observe originally. After adopting the transparency, we can observe the connection between skin, muscles and bones. When using clipping planes, we can clearly observe what is inside a bone and what is inside an organ.
- However, it is difficult to set the opacity value for the transparency and the clipping parameters for the clipping planes. If using improper opacity, transparency can hide some meaningful information. If using improper clipping parameters, some important parts will be cut by the planes.