Comparing representations of a lung tumor with Paraview and Slicer

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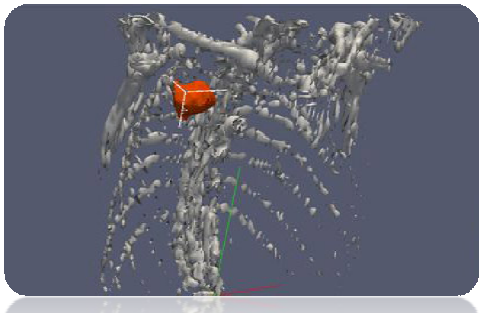

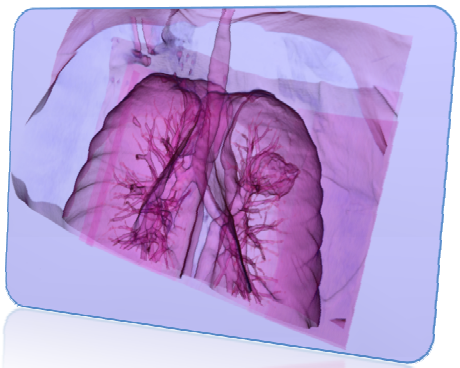

Abstract

In this paper we describe our results for the comparison of two fairly mature open source visualization tools, Paraview and 3D Slicer.

3D Slicer is targeted towards the medical domain while Paraview is more targeted towards flow visualization. This becomes apparent through many things, such as native support for the DICOM format and faster results with minimal tweaking. This gives Slicer an edge over Paraview when it comes to visualizations of medical datasets. Both Slicer and Paraview are not mature enough for advanced visualisations due to instability.

Dataset

We chose the DICOM dataset CARCINOMIX [1], which is a CT scan dataset containing volumetric data from a CT scan of a patient with a lung carcinoma.

Such a carcinoma is a malignant cancerous growth, often life threathning and a high potential to spread to surrounding tissue [2]. A lung carcinoma specifically is the leading cause of cancer-related deaths worldwide [3].

Tools

We have used two tools for visualizing and interpreting the dataset: Kitware's Paraview 3.4.0 [4] and 3D Slicer 3.2 [5]. The DICOM format, which is a data format not uncommon in the medical domain [6], can directly be read in by Slicer but needs to be converted for Paraview. We used Slicer 2.6 [5] to convert it to VTK format and then used Paraview to convert it to VTI format. Slicer is a visualization tool designed for the medical domain and is elaborate on this purpose. Paraview is focused on flow visualization but has multi purpose features. It also benefits a smooth GUI.

Visualization using Paraview

Before analyzing the data we subsampled the dataset to enable faster volume rendering. We then started off analyzing the data using the slice filter on a grayscale colored dataset (figure 1) to find the location of the tumor (right lung). Next was clipping the tumor. We then placed a contour filter to extract the surface. We found the iso-values by inspection using direct volume analysis. We finished segmenting the tumor by smoothening of the surface using a smooth filter. Segmentation of the skeleton and lungs were done using the same approach. For the lung segmentation we set the opacity level to 0.15. The final and most difficult part was finding a suitable transfer function for direct volume rendering. We analyzed the data and derived the t-function by visual inspection (figure 5). The final result was reached by overlaying all the segmented parts (figures 2, 3, 4).

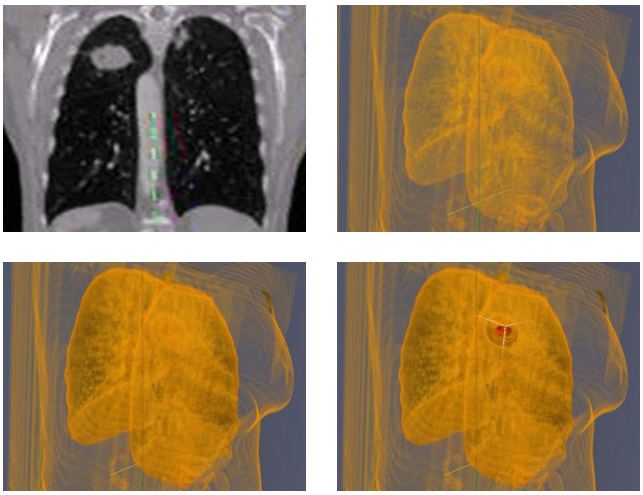

Fig 1, 2, 3, 4 *– Visualization process*

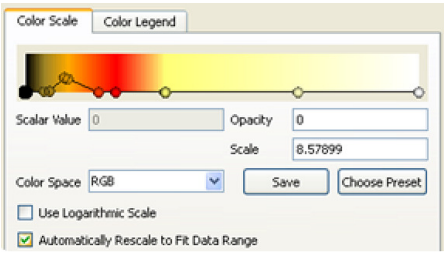

***Fig 5** – Transfer function*

Visualization using Slicer

Slicers approach is slightly different. After opening the source data, Slicer presents the user with three slices, representing the axial view, the saggital view (figure 6) and the coronal view. Slicer's responsiveness in this mode, even with relatively large datasets, immediately stands out. Navigating the slices is easy, and using this view it is easy to spot the lung carcinoma. With little effort the orientation of the slices can be changed (they don't even need to be perpendicular to each other), which helps to do a preliminary analysis of the carcinoma even better.

Things become even clearer when these slices are mapped into a 3D space (figure 7). Slices can be grabbed and easily moved to study all aspects of the malignant tumor. Mapping the location of the cancer on the individual slices into a volumetric position will become easier with experience, but with this view even the laymen can get a pretty good idea of size and location.

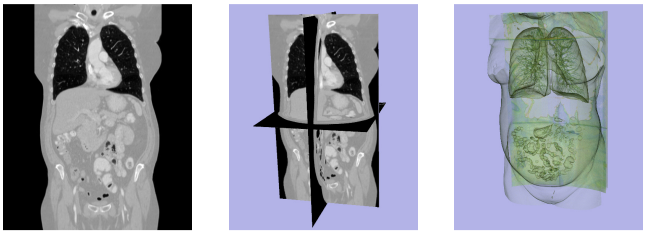

***Fig. 6, 7, 8** – Different representations of the volume*

Although this 2D-3D combined view much better shows the relation between the slices, they are basically nothing more than 2D depictions in a 3D world. To enhance the visualization even further, we experimented with many of Slicer's exotic and less exotic filters and plug-ins. This is where Slicer's specialization towards the medical domain really shows. Different plug-ins specialized towards different parts of the body help to better visualize and segment organs and other bodily tissue. Unfortunately this is also where Slicer's shows its less friendly nature. The user interface was less straightforward, and several filters failed to properly execute.

Fortunately one of the most useful filters was among the main filters, namely VolumeRendering (figure 8). Even at the basic settings the filter would produce a usable result. Tweaking one of the CT presets allowed us to quickly isolate the tumor from the surrounding tissue, where manipulating thresholds and clipping helped us to create an even clearer view of the carcinoma, its location, and most importantly, its effect on other organs.

Sizing the tumor

Slicer's slice view allowed for easy and exact measuring of the carcinoma. Getting the exact size of the tumor may not be essential, there may be other situations where measuring might provide useful information, and Slicer makes this operation painless. Slices can be lined up with the object of interest through shifts and rotation. Fudicial points can be set in both the slice view and the 3D model (figure 9, 10), after which Slicer displays their distance in its status bar. This tumor was shown to be no less than 48 mm (!) across.

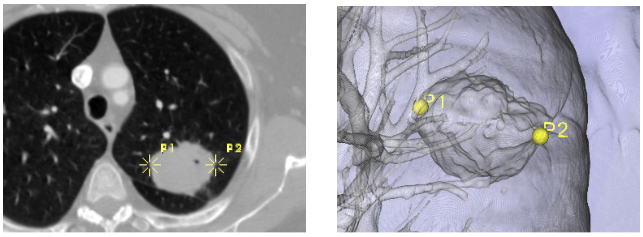

***Fig. 9,10** – Setting fudicial points*

Conclusion

Given a medical dataset, Slicer seems to be a better fit for analysis. Paraview's lack of roots in the medical world becomes immediately apparent when trying to open the DICOM files. Paraview does not natively support the format, and it appears that VTK scripts have to be written to convert the format to something more usable by Paraview.

Stability wise both programs leave quite a bit to be desired. When sticking to the basic uses, Slicer will not let you down, but when venturing into more exotic filters or unusual combination of filters, stability suffers. And even though Slicer never actually crashes, it does get into an irrevertible state, requiring the software to be restarted. Paraview on the other hand seems more mature, but when things go awry it does completely crash, requiring constant state saving to prevent loss of data.

In the user interaction department, both take a totally different approach. Slicer takes on the philosophy of make as much visible as possible. This may come across as daunting at first, but it works quite well. Paraview is much more into visualization rather than visibility. It doesn't convey its possibilities as well as Slicer does, but the state is much better visualized. Navigating Slicer's 3D view seems more intuitive than that of Paraview. Both Paraview and Slicer use "modifier keys" such as Shift and Ctrl, but Slicer appears to be slightly more intuitive in the way it has grouped common navigational tasks.

When it comes to function, Paraview takes on a much broader scope than Slicer does. Even though Paraview's more generic filters can produce a good picture of what is going on, if more empirical data is required, Slicer does seem to make this available more easily. The visualizations

require less tweaking to be usable, and measuring and pinpointing things all seem just a little bit easier. Paraview on the other hand has a much wider scope to emphasize features of the data, and after tweaking produces a more vivid visualization.

For basic analysis in a medical environment and between the open source programs Paraview and Slicer, Slicer would be the tool of choice. The program is however not mature enough to be used for more advanced visualizations due to instability. Slicer also has a steep learning curve when it comes to advanced visualisations, although the movie tutorials on the Slicer website, are a great start.

References

[1] http://pubimage.hcuge.ch:8080/
[2] http://en.wikipedia.org/wiki/Carcinoma
[3] http://www.merck.com/mmpe/sec05/ch062/ch062b.html
[4] http://www.paraview.org/
[5] http://www.slicer.org/
[6] http://medical.nema.org/