

Automated 3D Video Documentation for the Analysis of Medical Data

S. Iserhardt-Bauer¹, C. Rezk-Salama², T. Ertl¹, P. Hastreiter³, B. Tomandl⁴,
und K. Eberhardt⁴

¹Visualization and Interactive Systems Group, University of Stuttgart, Germany

²Computer Graphics Group, University of Erlangen-Nuremberg, Germany

³Neurocenter, University of Erlangen-Nuremberg, Germany

⁴Division of Neuroradiology, University of Erlangen-Nuremberg, Germany
Email: Sabine.Iserhardt-Bauer@informatik.uni-stuttgart.de

Abstract. The usual way to document medical data is using 2D images and textual transcription as medium. But for analysing the position and the spatial dimensions of an aneurysma 3D information is mandatory. This information can be provided by digital videos that show the visualized 3D medical data set. However, to generate such videos usually is a very inconvenient and time-consuming procedure. To automate this it is necessary to define a standardized way of observing the medical data set. The following paper presents an approach to automatically record a digital video sequence of an aneurysma in CT-data sets which is based on hardware supported texture mapping.

1 Introduction

Direct volume rendering based on hardware supported 3D texture mapping is an approach which produces images of high quality and interactive frame rates [1]. These features facilitate the practical use in medical applications. The drawback of this technology is that it is limited by the high cost of purchase of the necessary high end computer graphics hardware.

3D visualization is a useful approach for surgery analysis and planning. However, in the field of medical documentation, 3D documentation is currently not frequently used. This could be changed if digital videos of the 3D data set would be used for documentation. Usage of videos has two main advantages. First, the video shows a moving scene which provides much more information than a collection of images. Second, the video, other than the direct usage of interactive visualization tools, delivers repeatable information. In conventional visualization applications special software tools or manual doing of snapshots is necessary to produce videos. Both approaches need a lot of resources and time. Additionally these tools are usually not integrated into the visualization tool which is very inconvenient for the user.

In this paper we present a hardware supported approach integrated in our visualization tool. SGI offers an OpenGL extension the so-called pixel buffer [3]. The pixel buffer is a hardware accelerated nonvisible (off-screen) rendering

buffer. The combination of these features allows us to record digital videos in a fast way and without time delaying. In our application the produced video will be integrated into an HTML document which contains the patient data and information about the disease.

To use automatically generated videos it is necessary to define the content of this video. Usually clinicians examine individual patient data in similar ways. Therefore, using standardized video sequences to record the examination is a feasible approach to use 3D visualization results in documentation.

Like aforementioned we want to avoid that all physicians need the expensive special graphics hardware. For that we want to offer a secure web service where the user will send the medical patient data and receive a document which contains all data together with the produced video.

2 Methods

In the medical field the conventional way to document the patient data is to use 2D-images and the transcription of the analysis and diagnose. The missing feature is the 3D-impression of the position, orientation and the dimension of the diseased organ. Especially in case of an aneurysma it is mandatory that these informations are available. To get a real impression of the aneurysma it is necessary to have a sequence of images from different viewing points. This can be realized if we are using a volume visualization tool and take images from different points and append them to a digital video sequence. In order to define the viewing points of the camera and make this path understandable for all users a standardized camera path is required. Usually, clinicians examine individual patient data in a similar way. At first, an overview of the complete data set is used for the purpose of orientation and in order to search for pathologic regions. Starting with a posterior overview (Fig. 1 B) around 180° , the user will get a first impression of the volume data. But to get a meaningful result it is necessary to consider more than one viewing point. A further sequence represents the lateral way around 180° also (see Fig. 1 C).

Frequently an overview is not sufficient for the analysis of an aneurysma. It is required to have a more detailed view of the diseased region. For that the camera will move into the direction of the interesting region. Most times the CT-images are recorded in a way that the aneurysma lies at the center of the volume. If this is not the case or if the user wants another point to be the point of interest, it is also possible to define this point manually. Selecting a point in a 3D volume is difficult on a 2D screen. Therefore we decided to use a two step procedure. First the user defines an arbitrary clipping plane through the center of the interesting region. Now on this 2D clipping plane the user can select the actual point of interest. This is a very convenient and accurate way to select a point in a 3D space. Another approach is to reduce the volume and to cut out unimportant areas. For that the user can select a subvolume and place it around the region of interest.

After the camera has been moved towards the point of interest the posterior overview will be repeated and gives the user a more detailed overview of the aneurysma.

The above explained examination uses a predefined camera path which is defined as a sequence of key frames specifying the position and orientation of the camera at different time steps. To smooth the camera path the control points of the path have to be set on a circular path sampled in small angle steps.

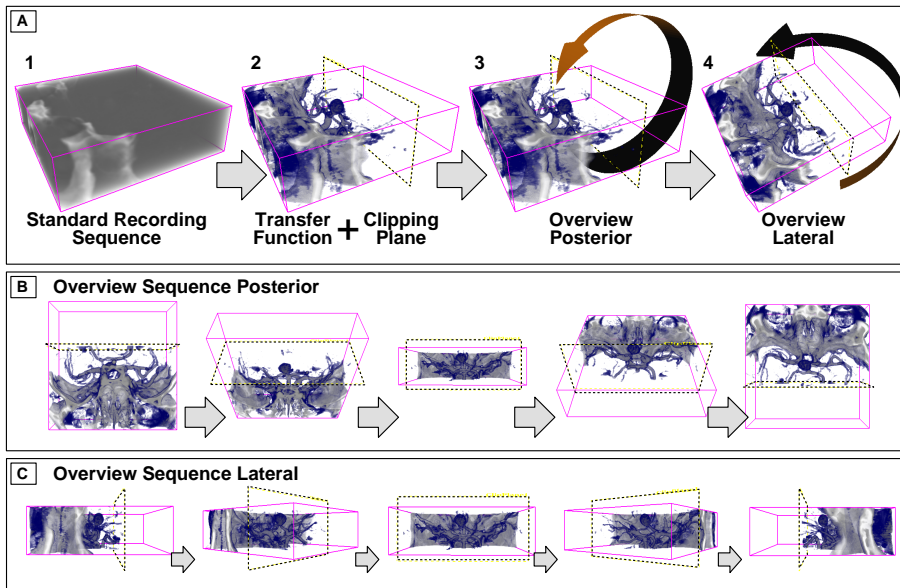


Fig. 1. Standardized Procedure for analyze intracranial aneurysma. [2]

CT-data sets usually contain a lot of noise which often hides the important information. Therefore it is necessary to segment the interesting data. One efficient method is using transfer functions (see Fig. 1 A). After using this method we have a clear view on the aneurysma. To further reduce the quantity of information in the volume data set we can use clipping planes (see Fig. 1 A) and clip the unimportant region.

After the user preprocessed the volume data manually and the camera path is automatically predefined the rendering process can be started. To produce the video sequence the camera follows the defined control points. To speed up the rendering the scene will be rendered into the hardware accelerated pixel buffer. This kind of buffer is a special SGI frame buffer which allows to render off-screen and therefore very fast. The scene will now be read out from this pixel buffer and will be saved as images. Finally the images will be converted to a digital video

(Fig. 2). For making the video available on different platforms and for low-end machines the video can be saved in different video types and will be integrated into an HTML document which also contains the patient data.

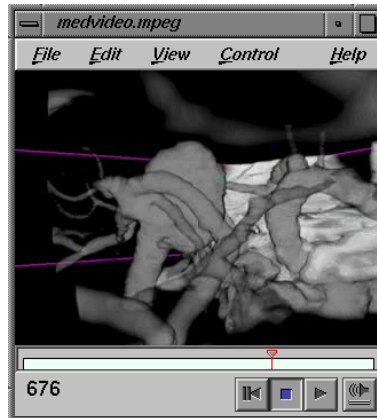


Fig. 2. A sequence of closer detailed view of an aneurysma during the recording phase

Summarized we can classify the above approach in 2 phases:

1. the manual phase
2. the automatic phase

The manual phase consists of the setting of the transfer function, the user defined clipping plane and the definition of the point of interest if necessary. The automatic one consists of defining the camera path, setting the camera to different viewing points, read out the single images and convert them to a digital video sequence. Even the last two methods uses a lot of time and patience if they are done manually.

3 Results

The volume visualization was performed on a SGI Octane with the EMXI graphics board which supports the hardware accelerated pixel buffer.

The test data set contains intracranial aneurysms which are frequently located at the internal carotid artery, the anterior communicating artery and the bifurcations of the medial cerebral arteries. For this data we set the center of the volume as the point of interest. Therefore the camera flies around the center like mentioned above. In general, the information contained in the video depends on the resolution of the frames and the number of frames. To smooth the video

we have to keep the angular distances between the recorded images small. For a video like the described one we need approximately 600 frames to reach reasonable quality. The video which you can find at <http://wwwvis.informatik.uni-stuttgart.de/iserhard/medvideo.html> represents 600 frames with size 640 x 480. The recording time of this video was around 25 s. The size of the uncompressed video is around 700 MByte, of the compressed one 11 MByte.

4 Discussion

The result shows a high quality and meaningful video. However, the compressed video contains some artifacts which do not cause a critical loss of information. Besides this there is no more effort necessary due to the automatic generation. This important feature of the presented approach is very helpful in practical use. To automate the approach more than it was described above we can use an automatic generation of the transfer function. The automatic generation of an ideal transfer function supports the clinicians in a very difficult approach which needs a high technical and medical knowledge. In [2] we can find an approach for the automatic generation of the functions which is based on the approach from Kindlmann [4]. In future a webservice is planned so the production of a video is really independent of the expensive special graphics hardware for the clinicians. The webservice will be represented a convenient and easy way to integrate digital videos in the medical documentation.

References

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