X3D-Technologies for Medical Image Visualization

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1 Introduction

Interactive 3D Visualization technique represents an important diagnosis and therapy planning tool. It cannot be compensated with simple 2D Pictures or static 3D Views. Multimedia teaching tools which contain textual information, non-interactive videos and restricted pseudo three-dimensional scenarios can considerably contribute to the understanding of medical facts by the completion of interactive 3D Components. Multiuser environments are also an important aspect to recognize coherence of single events in patients physical health and to support medical teachings.
Until now, these techniques are not applicable every time and everywhere. Insufficient software functionality and quality, competitive and proprietary software and hardware as well as different system requirements for visualization aggravated the distribution of interactive 3D Systems. So far, there is no common standard for 3D Geometry in medicine, like the Dicom files. These files include medical 2D Images, patient information and acquisition details in a special syntax.
Besides many simple 3D File formats, there are also considerably "more intelligent" specifications, like the XML compliant X3D [1] specification. For medical diagnosis, therapy and teaching it is important to know how far X3D is usable regarding to the aspects listed above. To clear the questions, we implemented a corresponding reference system.

2 Exposition

For evaluation and testing purposes first we designed manually a X3D-based simulation, which allows to visualize the virtual lumbal and intervertebral-discus puncture.
Based on this (still very simple) medical scenario the visualization platform was deployed. It consists of an expandable, medical X3D-Manipulation framework and a 3D Generator. The 3D Generator produces task oriented interactive 3D Visualizations in X3D from medical 2D Imagestacks and adds the appropriate tools from the framework. For image input standard Dicom files are supported, as well as Somatom, Jpeg, Bmp and Raw image datasets.
Additionally it provides interactive pre- and post-production tools (e.g. segmentation optimization mechanisms and authoring parts, like audio- and video-modules).
The modular framework consists of different 3D Measurement- and 3D Annotation-features. The underlying data exchange functionality and individual adjustments are mainly based on the standard “Proto” and “Inline” features of X3D for widely compatibility.

The Java Servlet based server supports the access-control, reading, writing and synchronization over all Http enabled wireless and wired networks. The server-design facilitates also the more easy integration in existing content management systems of e-learning environments.
Multiview-Enhancements enable local and global synchronization. For the maximum performance on all network standards and low-speed connections we designed an optimized message-structure. Additionally, for direct Dicom file integration we implemented a Dicom-Wrapper-Servlet, which reads individual Dicom data and client parameters. Then it sends a temporary standard-image (e.g. Jpeg) back. These functionality is usable for direct texturing on 3D Objects and also enables standard 2D Image browsing on every networked device. Methods for watermarks optionally print relevant information, as well as security-signs on the image-surface.
Moreover, special hardware (Stereo3D, UI) as well as mobile equipment were evaluated and taken into account by suitable software-methods.

3 Conclusion

The implemented solution [2] represents not only an alternative form of 3D Visualization but unite clear progress in the interactive 3D Visualization. Using the X3D Specification it was possible to develop the desired reference platform with complex interaction support. We were able to port typical tools for 2D image-based diagnosis and therapy to the interactive 3D-Environment. The underlying methods are completely based on X3D. Therefore the system is fully platform-independent and works with most X3D Browsers. For compatibility the generator produces also VRML97 data.
The different internal and external data–compression methods facilitate the usability also on resource poor devices. The modular design can simply be expanded and allows a fast adaptation to special simulation cases. The combination of typical authoring tool elements with medical image processing methods unites individual functionality and interactive, three-dimensional visualization on one data model. It optimizes the workflow during the whole process of acquisition, reconstruction, visualization, data-storage, and dissemination.
For micro-therapy the developed (spinal) simulation is an alternative to the conventionally used, merely static views, and video recordings. Related to other medical problems the developed solution means a reduction of oversized video files towards lossless, vector based animations and interaction.
The gained knowledge and solution represent an important basic constituent in the desired development of the special medical X3D Profile ("Web3D MedX3D" [1]) for the creation of semantics or ontologies between text, 2D or 3D Data.

4 References

[1] Web3D Consortium, X3D spec.: http://www.web3d.org
[2] Project Homepage: http://www.3d-node.com

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