Interactive medical 3D-simulations by means of stereoscopy and standard hardware

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Abstract: Using stereo-3D hardware in its different solutions is not new, but most available applications use these Hardware only for a better visualization of 3d-reconstructions. It is an optional feature. In our research we principally use stereoscopic Hardware, because of the different manipulation-methods - especially in virtual medical simulators. The methods of planning and simulating medical operations in an virtual environment is also an important point in these research.

1 Purpose

When looking at the area of 3D-reconstruction of medical image data, virtual patients and simulation environments are important topics. But what does this really mean and how is it solved? A simulation, however, would have to be substantially more. True operation in the three-dimensional virtual space is not possible without additional hardware and software. A three-dimensional dataset loses any depth by the projection on the monitor, so that it becomes more difficult or impossible for the user. For example, the localization of a certain area in a complex world is almost impossible, even if a preselection occurs on the basis of the two-dimensional data. Here, the stereoscopy [Ba99] reduces the problems connected with a simulation. Aim of these research is to implement or enlarge methods in a reference application [ML01] with the necessary hardware for a qualitatively and quantitatively acceptable interactive stereo-3D view for medical application purposes. In this respect the question which hardware and software are needed is also interesting. Therefore it would be a solution for small devices with small resources or non-accelerated graphic boards such as mobile devices (e.g. Notebooks, Webpads, Pda´s).

2 Material and Methods

Different PC systems and mobile devices were selected as development and test environments. They represent the currently popular hardware [1-4]. For the stereo-3D view the Elsa Revelator eyeglasses (Pageflipping-technique), 2-Color filter glasses (anaglyph), chromatek glasses (prism-technique), the new Dresden 3D-Display (D4D), Elumens Visionstation and compatible systems are being used [5-10]. The 3D-functionalities are implemented under OpenGL with additional libraries [11-13] and vrml (for every vrml97 enabled device). The visualisation is based on the surface oriented Marching-Cube Algorithm.

3 Results

The development of the system [14] offers first standard functionalities such as different Image Data Import (ACR/Nema, Dicom, SomatomDR, Jpeg)[15,16], the detailed Image description, display and manipulation of the 2D-Dataset. Print functions are implemented as well as a non-stereo 3D View. In the second - here primarily most important - step different, optionally insertable stereo modes [5-9,19,20], navigation, selection, animation and manipulation possibilities of the regarded object under stereo-3D (figure 1,2,3,6) view are being considered as well as stereo-3D-interactice-VRML export [17,18] (figure 4,5). Apart from that both inexpensive and high-end input-devices are being supported to offer versatile and combinable interactions [21,22]. The selectable display mode (soft and hardware based multi-display operation [23] and different windowing techniques) and a non-standard adaptable user-interface [24] are adapted to the different site conditions. The additional display of technical details about the reconstruction enables a comparison of different Systems.

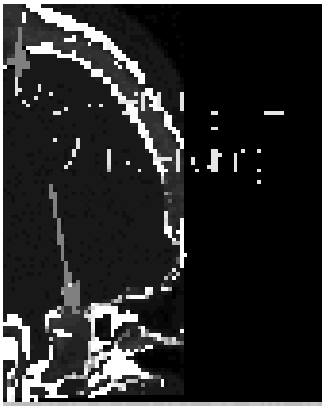

Figure 1: selections

Figure 2: 3D-View with marked regions

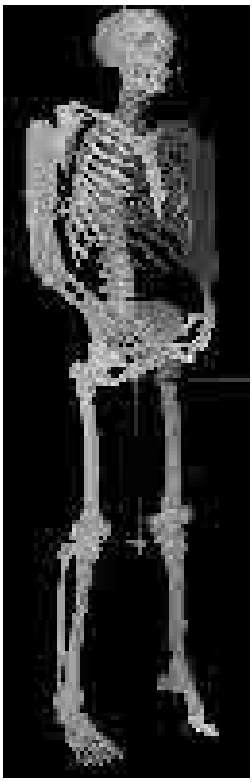

Figure 3: interactive stereo view of the visible human data with 3 million triangles

Figure 4: visualisation on mobile devices

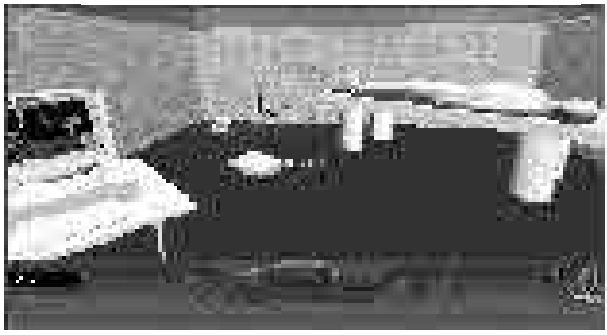

Figure 5: exported 3D-Data in an virtual interactive medical environment

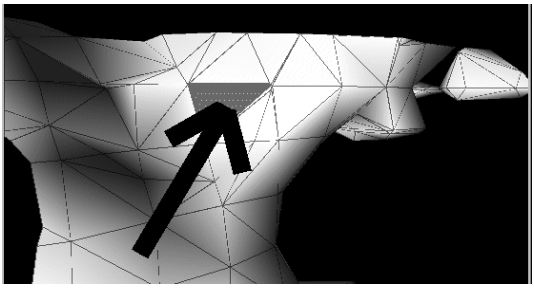

Figure 6: interactive 3D-view: 3D-selection and manipulation based on the calculated triangles

4 Conclusion

The stereoscopy simplifies the orientation, navigation and finally manipulation in virtual space. The different interaction-techniques and the implemented preprocessing and (Stereo-VRML-) export functions enable the use of most diverse (also slower) system configurations. Especially the Chromatek Stereo View is very interesting. The user gets a high-quality reconstruction without flickering and only small performance losses wihout special hardware (the only quality solution for all LCD-based systems like Notebooks and PDA´s).

5 Internet Resources

[1] http://www.forum3d.de (3D-Hardware, Tests)
[2] http://www.tweakpc.de (PC-Hardware, Tests)
[3] http://www.intense3d.com (3D-Hardware)
[4] http://www.pc.ibm.com/de/intellistation.html (Highend-Workstations)
[5] http://www.stereographics.com (3D Hardware)
[6] http://www.stereo3d.com (different stereo hardware)
[7] http://www.inf.tu-dresden.de/D4D/index.htm (3D-Display)
[8] http://www.elsa.de (stereo glasses)
[9] http://www.chromatek.com (stereo filter glasses)
[10] http://www.elumens.com (3D-Hardware)
[11] http://www.opengl.org (OpenGL-Api)
[12] http://www.xmission.com/~nate/index.html (Window Toolkit)
[13] http://www.cs.unc.edu/~rademach/glui (extensions for GLUT)
[14] http://welcome.to/DicomGL-real3D (my project and research homepage)
[15] http://www.hds.utc.fr/~barre/medical/samples (Dicom Image Examples)
[16] http://idt.net/~dclunie/medical-image-faq/html (image file formats)
[17] http://www.web3d.org (Vrml, X3d, Java3d)
[18] http://www.npac.syr.edu/projects/3Dvisiblehuman/3dvisiblehuman.html (NPAC Visible-Human-VRML3D-Viewer)
[19] http://www.sdsc.edu/~mjb/chromadepth (Michael Bailey, OpenGL and Chromatek)
[20] http://www-vrl.umich.edu/sel_prj/chroma3d (Vrml with Chromatek)
[21] http://www.labtec.com/product/family.cfm?CategoryID=4 (3D-Controller)
[22] http://www.microsoft.com/germany/produkte/overview.asp?siteid=817 (3D-Contr.)
[23] http://www.matrox.de/mga/dev_relations/home.cfm (Hardware-Multi-Monitor-Support)
[24] http://www.sozialnetz-hessen.de/Ergo-Online (user-friendly Application Design)

References

[Ba99] Bach, Michael: 3D-Sehen, Räumlich durchs Auge - Wie kommt die greifbare Welt in den Kopf? - Computermagazin c't 7/99, S. 158, (http://www.heise.de/ct/99/07/158)

[ML01] Melzer K., Lipinski H.G.: Interaktive stereoskopische 3D-Rekonstruktion medizinischer Bilddaten, In: Handels H, Horsch A, Lehmann T, Meinzer H P (Hrsg.) - Bildverarbeitung für die Medizin 2001. Algorithmen - Systeme - Anwendungen. Proceedings des Workshops vom 4- 6. März 2001 in Lübeck (Informatik aktuell. Im Auftrag der Gesellschaft für Informatik (GI)) - Springer Berlin Heidelberg; ISBN: 3540416900, pp. 152