Experiences with Matlab and VRML in Functional Neuroimaging Visualizations

Finn Årup Nielsen[1 2] and Lars Kai Hansen[1]

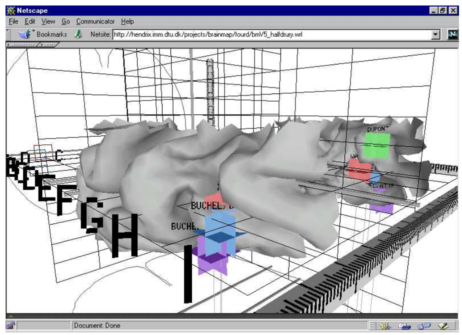
[1]*Department of Mathematical Modelling, Technical University of Denmark, Lyngby, Denmark*

[2]*NEC Research Institute, Princeton, New Jersey, USA*

Introduction

Neuroinformatics is the task of organizing, analyzing and presenting the knowledge of neuroscience. In the part of neuroinformatics that is associated with functional neuroimaging ("brain mapping") visualization plays an important role. Functional neuroimaging utilizes brain scanners to examine the inner workings of the human brain, usually by mapping the relationship between cognitive components and specialized brain regions. fMRI and PET brain scanners can produce sequential volumetric scalar data. The functional neuroimaging study sometimes incorporate a complicated design making the "time axis" multi-dimensional. This data is seldom viewed directly, but instead it is put through rigorous processing, the result being one or more scalar volumes. Center of mass points of "hot spot" areas are tabelized and included in scientific publications as so-called "Talairach-coordinates" [1]. A database exists with these coordinates: The BrainMap database [2]. The typical visualization task is to display the scalar result volumes sometimes in comparison with other volumes and almost always with some kind of reference, e.g., anatomical images or "Talairach" grid. Our experience is with VRML visualizations and some minor experiences with Matlab for 3D visualization. We aim at a GUI Matlab program able to display several volumes together and integrating BrainMap data, rendered both in Matlab and in VRML, with possible extended display on virtual reality devices. Both original data, program and "finished" visualizations should be distributable over the Internet.

VRML



We have used VRML for visualization of functional neuroimaging results. Prior to Matlab 5.3 we used our own program `polyr` for isosurface generation. However, a simple isosurface program could not suffice for the interactive visualizations we would like. Small controllers can be built, but as VRML, e.g., lacks keyboard interface complex interaction is limited, and CGI-script and java/javascript did not provide a consistent interface. Our conclusion is that VRML is not a good scientific visualization *development* environment, but it should serve more as a kind of Postscript for 3D interactive visualizations. Virtual reality headset displays with VRML could be obtained, and the VRML-file did not have to be "extended" in any way for it to be displayed within the virtual reality setup. We had access to WorldToolKit, but as the package did not fully integrate VRML and it is certainly not widespread in the functional neuroimaging community we did not pursue it further.

Matlab

Matlab is widespread in the functional neuroimaging community partly due to the program SPM [3]. We have had some experiences with building graphical user interfaces and simple 2D visualizations in connection with our lyngby toolbox [4] and found Matlab to be a quite convenient environment for this. As BrainMap data is quite heterogenous the visualization environment calls for small-scale database-like capabilities, which has to some extent been honored with Matlab 5. From version 5.3 Matlab includes some proper 3D visualization functions, e.g., isosurface generation, and data pipes easily to VRML: The figure shows a screenshot from a VRML-browser with a file constructed by a non-GUI Matlab program. Data from the BrainMap database is displayed together with some "context", e.g., a part of the cortex. We have not tried to integrate any virtual reality setup with matlab and have not examined if matlab is suited for realtime visualization. (Display update in matlab is done when the mouse-button is released, contrary to typical VRML-browsers which continuously render the visualization)

User experiences

Our user experience has been sparse: The visualizations have been appreciated for their visual appearance, but, though the typical functional neuroimaging researcher will be prepared to write small Matlab scripts, she is not likely to edit VRML files, e.g, to include the small library of VRML components we have made. A GUI interface is necessary (with what humorously has been called "doctor's buttons") before it will become useful for the typical functional neuroimaging researcher, and we will pursue that further with a combination of Matlab and VRML.

References

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