



Diffusion Tensor Imaging in CAMPVis

Project Management and Software Development
for Medical Applications

General Info

Project Title: Diffusion Tensor Imaging in CAMPVis

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Project Abstract

CAMPVis is a new medical visualization framework developed at our chair. The goal of the proposed project is to implement a plugin for Diffusion Tensor Imaging.

Background and Motivation

Today, a variety of different body-imaging techniques are available to physicians and medical scientists. Diffusion weighted magnetic resonance imaging (DW-MRI) is one of them and currently the only modality that offers non-invasive in-vivo insight into tissue microstructure. This is achieved by measuring the water diffusion rate in the sample. When applied in multiple different gradient directions, DW-MRI not only provides information about the amount of diffusion, but even measures the diffusion rates in different directions. They can be represented by second order diffusion tensors, which leads to diffusion tensor imaging (DTI). While being completely isotropic in pure water, the diffusion process becomes restricted and shows a high level of anisotropy in fibrous tissue like white matter or muscles. This makes DTI a valuable tool for studying complex anatomy like the human brain or the myocardial muscle.

Since diffusion tensor data has a high dimensionality, many traditional visualization techniques designed for scalar data are not

applicable. Hence, it is necessary to adapt and improve traditional- or develop completely new visualization techniques.

Student's Tasks Description

- Get an overview about the topic and the medical background
- Design basic data structures to get DTI data into the CAMPVis framework
- Implement the tensor estimation
- Implement a set of tools for post-processing DTI data, e.g. generating anisotropy measures, fiber tracking
- Define a set of suitable visualization techniques to be implemented
- Implement them into CAMPVis

Technical Prerequisites

Solid C++ skills, at least basic OpenGL skills are required. Experience in GPU programming is beneficial.

Tensor estimation is an application of Linear Algebra & Numerical Computing, so experience in those fields is highly beneficial.

Administrative Info

Working Time: 10h/week

Project Location: Garching/Home, weekly meeting in Garching

Required Equipment: Computer with dedicated Graphics hardware

Please send the completed document to us (Ralf.stauder@tum.de) before the project proposal deadline, September 30th. Please note that this proposal will be evaluated by the BMC coordinators and will be assigned to a student only in the case of acceptance.



Timeline and Milestones

There are no hard deadlines besides the seminar schedule. The first weeks should be used to get into the topic and design the basic data structures.

To pass the seminar successfully, the student should have implemented at least the basic DTI workflow (tensor estimation, anisotropy measures, basic visualizations) until the end of the seminar.

Furthermore, the student shall provide an adequate documentation for his or her project.

Specific time management is up to the student. Certainly, the project owner will assist/advise the student on this.

References

Survey Paper: A. Vilanova , S. Zhang , G. Kindlmann , D. Laidlaw - *An Introduction to Visualization of Diffusion Tensor Imaging and its Applications* (2006)

Anisotropy Measures: C. F. Westin, S. E. Maier, H. Mamata, A. Nabavi, F. A. Jolesz, R. Kikinis - *Processing and visualization for diffusion tensor MRI* (2002)

Fiber tracking overview: S.Mori, P. van Zijl - *Fiber tracking: principles and strategies - a technical review.* (2002)

MRI Studio: <https://www.mristudio.org/>

Trackvis, DTK: <http://www.trackvis.org/>