Tensor Field Filtering: Theory and Medical Applications

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In this talk we discuss various ways of filtering tensor field data and relate the methods to real world medical applications. At Harvard Medical School and Brigham and Women's Hospital we have a large image guided therapy program. Here we detail some of our applications using Diffusion Tensor MRI data for surgical planning and intraoperative guidance in brain surgery.

We further outline our work in distance-connectivity where the inverse of the diffusion tensors define the local Riemannian metric, we describe filtering of tensor fields using normalized convolution, and contrast it to a stochastic multiivariate MRF regularization method. We conclude with describing a novel representation of rotations in 3D using outer products of quaternions.

Keywords: DTMRI, tensor signal processing

Locating Closed Hyperstreamlines in Second Order Tensor Fields

Thomas Wischgoll (Univ. California - Irvine, USA)

The analysis and visualization of tensor fields is a central problem in visualization. Topology based methods based on investigating the eigenvector fields of second order tensor fields have gained increasing interest in recent years. Most algorithms focus on features known from vector fields, such as saddle points and attracting or repelling nodes, for instance. But, more complex features, such as closed hyperstreamlines are usually neglected. In this presentation, a method for detecting closed hyperstreamlines in tensor fields as a topological feature will be presented. It is based on a special treatment of cases where a hyperstreamline reenters a cell to prevent infinite cycling during hyperstreamline calculation. The algorithm checks for possible exits of a loop of crossed edges and detects structurally stable closed hyperstreamlines. These global features are not detected by conventional topology and feature detection algorithms used for the visualization of second order tensor fields.

Robust Structure Tensors

Rein van den Boomgaard (University of Amsterdam, NL)

Structure tensors can be used to estimate the dominant orientation of laminar patterns in images. The classical structure tensor suffers from the fact the smoothing occurs on the edges where differently oriented patterns meet. In this talk we present a robust estimator of the dominant orientation. The resulting orientation estimation based on the 'robustified' structure tensor proves to suffer much less from smoothing.

Joint work of: van den Boomgaard, Rein; van de Weijer, Joost