Glyphenbasierte Visualisierung neuronaler Bahnen mit Diffusions-Tensor-Feldern

Glyph Based Visualization of Neural Pathways using Diffusion Tensor Fields

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Purpose

The visualization of DTI-MR data has attracted increasing attention in neurosurgery. Throughout existing approaches presented for the visualization of diffusion tensor data, two strategies are of predominant importance: (1) fiber tracking and (2) glyph based visualization. Based on this, we propose a new approach combining these two strategies using glyphs situated along tracked fibers. Thereby, the local information of the tensor field along the pathways is better visualized.

Material & Methods

All images were acquired using a Siemens MR Magnetom Sonata Maestro Class 1.5 Tesla scanner. The imaging parameters were TR = 9200, TE = 86 ms, b_high = 1000 s/mm^2, b_low = 0 s/mm^2, field of view 240 mm, voxel size 1.875 x 1.875 x 1.9 mm^3, 1502 Hz/Px bandwidth, acquisition matrix 128 x 128. Sixty slices with no intersection gap were measured, the diffusion-encoding gradients for the six diffusion weighted images were directed along the following axes: (+/-1,1,0), (+/-1,0,1) and (1,+/-1,0). A standard PC (Intel 3.0 GHz) with NVidia GeForceFX 5950 graphics card providing 256 MB graphics memory was used for the fiber tracking and the visualization utilizing the glyphs.

After the calculation and filtering of the tensor field we perform a fiber tracking using second order Runge-Kutta integration. Each resulting node of a fiber serves as origin for a glyph. This leads to a non-uniform distribution of the glyphs avoiding clustering that occurs when situating the glyphs along the data voxels. For the tensor representation itself we use ellipsoidal glyphs due to the ability of hardware accelerated rendering on modern PC graphics cards.

The ellipsoidal shape thereby gives the common display of the tensor data, thus oriented along the eigenvectors and scaled by the corresponding eigenvalues. In addition to that the glyphs are colored in the conventional way, which means that the components of the principal eigenvector are used as RGB color values.

Results

For the evaluation of the approach fiber tracking and the visualization have been performed for 19 datasets. The time consuming preprocessing for the fiber tracking takes between 15 and 20 seconds. In all cases an initial seed region of 15 x 15 x 15 voxels enclosing the internal capsule was selected. As stop criterion a fractional anisotropy threshold of 175 in a range from 0 to 255 was defined. Using this parameters more then 1000 fibers including over 160000 nodes could be tracked for all datasets. After that, the visualization of the fibers combined with glyphs was performed. The resulting framerate varied between 4 and 6 fps depending on the amount of nodes.

Discussion

Overcoming the graphical restriction of common streamline representations the suggested strategy based on glyphs along fibers shows the entire local tensor information. This assists to get additional information about the diffusion in addition to the principal direction. Therefore, it is comparable to the hyperstreamline representation that carries similar information. However, contrary to that the suggested glyph based approach avoids the time consuming mesh generation required for hyperstreamlines.

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