

P 038 - Measuring a proton diffusion tensor field in tissues

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Diffusion Tensor MRI (DT-MRI) (1) is an imaging modality that permits us to measure a proton diffusion tensor field, $D(x,y,z)$, in heterogeneous, anisotropic living tissues and other hydrated media. From a series of diffusion-weighted images (DWIs), we estimate D in each voxel statistically, using a relationship between the spin-echo intensity, the pulsed-gradient sequence, and D (2). From D , we calculate its principal diffusivities and principal directions in each voxel, as well as other scalar invariant parameters, such as the moments of D (e.g., $\text{Trace}(D)$, $\text{Trace}(D^2)$, ...) that are intrinsic properties, indicative of tissue microstructure and its physiological state. To measure macrostructural characteristics and architectural features, we introduce the use of intrinsic scalar parameters of differential geometry (e.g., the principal curvatures) to study normal, pathological, developing, and aging tissues.

Because D is estimated by multivariate regression methods, it, and all quantities derived from it are random variables. We exploit this fact to determine the degree of asymmetry of translational diffusion within a voxel, (i.e., whether diffusion is isotropic, transversely isotropic, or fully anisotropic) and how to smooth a noisy diffusion tensor field by using a posteriori statistical methods. Also, by using matrix perturbation analysis, we show how to calculate the uncertainties in the principal diffusivities and directions. (1) P. J. Basser, et al. *Biophys. J.* 66, 259-267 (1994). (2) P. J. Basser, et al. *J Magn Reson B* 103, 247-54 (1994).

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