MAXIMUM LIKELIHOOD ESTIMATION OF CARDIAC FIBERS FROM IN-VIVO DMRI AND INFLUENCE ON BIOMECHANICAL HEART SIMULATIONS

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Abstract. Biophysical cardiac models have the potential to perform predictive computational simulations and hence help to improve therapies like radio-frequency ablation, or cardiac resynchronization therapy. Models of the cardiac input, however, require the knowledge (or the estimation using measured data) of constitutive tissue properties, like electrical conductivity, passive and active mechanical constants. It is however known that cardiac tissue is anisotropic, hence having different properties in the main fiber and cross fiber directions (i.e along and across the myocytes, respectively).

It is widely accepted that fiber arrangement in tissue can be estimated using diffusion MRI (DMRI). The reconstruction of the fibers rely in spatially co-existant diffusion information, what is however not possible to be achieved in moving organs like the heart.

In this talk we will propose to estimate the local fiber direction in ventricles directly from greyvalues of sparse and arbitrarily spaced DMRI. The approach is based on the solution of a non-linear inverse problem using a continuous parametric and space-dependent mathematical representation of the diffusion tensor and histological knowledge of the cardiac fibers architecture. We compare against previously reported methods in terms of accuracy, robustness to noise and spatial location perturbations. We also show the potential of the method for improving the efficiency of the data acquisition by relaxing the requirements of the acceptance window for respiratory navigation during acquisition. We will also discuss the impact of choosing a physiolical spatial variation of cardiac fibers in biomechanical simulations.

Keywords: cardiac fibers, maximum likelihood estimation, diffusion MRI, heart biomechanics

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