RBF-Based Volumetric Construction for Fibre Orientation Analysis using Diffusion Data

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Diffusion-weighted (DW) magnetic resonance imaging (MRI) provides information regarding to the orientation and arrangement of white matter fibres. In this paper, the RBF- based volumetric construction technique was presented as a novel, reliable and robust to noise method for analysis of DW MR images, regardless of any prior knowledge about the number of fibre populations and also assumption of any underlying model. In this method, the 3D construct of a voxel was interpolated using RBF technique, which enabled us to identify the intensity of a voxel in multiple directions in a spherical coordinate framework. The fibre orientation in a voxel was presented by the orientation corresponding to the minimum signal intensity in the 3D construct since the maximum signal loss occurs where the diffusion gradient and the fibre population within a voxel have the similar orientations. In regions of fibre crossing, the orientations corresponding to different local minimums of the 3D construct represented the orientation of different fibre populations within a voxel. In addition, a novel Fractional Anisotropy value was developed to represent the integrity of a fibre within a voxel. The obtained orientations were colour coded and modulated by the proposed FA map. This method holds promise for applications such as tractography.