1009-53-33 **Kaleem Siddiqi*** (siddiqi@cim.mcgill.ca), McGill University, School of Computer Science, 3480 University Street, Montreal, Quebec H3A 2A7, Canada, and **Peter Savadjiev**, **Jennifer S. W. Campbell** and **Bruce G. Pike**. *3D Curve Inference, Co-Helicity and Diffusion MRI Regularization.*

We introduce a differential geometric framework for regularizing orientation data sampled on a discrete 3D lattice. The key idea is to extend Parent and Zucker's 2D curve inference approach by using a notion of *co-helicity* to model the compatibility of an orientation estimate at each voxel with those in a local neighborhood. In this context, curvature and torsion play key roles in the interpretation of a tangent bundle where average local support is maximized using relaxation labeling techniques. We apply 3D curve inference to the case of diffusion MRI data, where we model white matter fibers as 3D space curves. This provides several advantages over earlier regularization methods including: 1) the possibility of multiple orientations at a location, as in the case of fiber crossings and branchings, 2) applicability to high angular resolution diffusion (HARD) images and 3) numerical robustness in the vicinity of sparse measurements. We present results on data acquired *in vivo* from a human brain, as well as from a biological phantom created using excised rat spinal cords. We also compare these results to those obtained using Tschumperlé and Deriche's orientation diffusion scheme with orthonormal constraints. (Received July 11, 2005)