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Title

GEOMETRIC TOOLS FOR SHAPE MAPPING IN TOPOLOGICALLY SIMILAR ARTERIAL STRUCTURES

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Introduction: Advances in medical imaging technology have allowed the extraction of 3D anatomic information non-invasively *in vivo*. This information has been used to reconstruct the anatomy of interest and obtain a realistic model of the 3D geometry. Such models provide a parametric shape description which allows for the quantitative comparison of inter or intra individual variability of topologically similar anatomic structures. Here we develop geometric tools and methods to better facilitate this shape comparison in the context of arterial structures.

Methods: The 3D geometry of a set of topologically similar Y-shaped arterial bifurcations termed reference and deformed is reconstructed from 2D medical images. Using tools available in the VMTK [1] framework the Voronoi diagram and an approximation of the medial axis (centerline) of each topological instance are computed. Mapping of the shape features of the reference surface geometry to the deformed centerline geometry is achieved in three steps. First, strong topological reference points based on the bifurcation definition in both geometries are established. Then through appropriate transformations between global and local (Frenet frame) coordinate systems at each centerline point the Voronoi vertices of the reference geometry are robustly mapped around the centerline of the deformed geometry. Finally, the new arterial surface is reconstructed from the mapped Voronoi vertices.

Results and discussion: By appropriate geometric manipulation of the Voronoi diagram we obtain a robust mapping of the primary surface features of the reference Y- shaped arterial bifurcation on a deformed but topologically similar geometry based on its centerline definition. By this we can dissociate the topology of the arterial structure represented by its medial axis approximation from the secondary small scale surface features which are typically associated with acquisition uncertainties in image based reconstructions.

1] Antiga L. and Steinman D.A., Robust and objective decomposition and mapping of bifurcating vessels, IEEE Trans Med Imaging, vol. 23 (6), pp. 704-713, 2004.