Interactive 3D Interface for Guiding an Ultrathin Catheterscope in the Peripheral Lung

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INTRODUCTION

Bronchoscopy involves the insertion of a fiber-optic bundle of CCD camera into the trachea and lower lobes of the central airways. This is the preferred method for visually inspecting the airway surface for irregularities or to biopsy suspicious masses identified on computed tomography (CT) scans. Because of the bronchoscope’s large diameter, it is often restricted to airways that lie with the first 4 generations of branching yielding a total of 2⁴ or 16 airways. Our lab is developing an ultrathin single-fiber scanning catheterscope[1] capable of extending into the peripheral lung where cancer often originates. The current prototype possesses an outer diameter of 1.6 mm, permitting its insertion into 8th generation airways, totaling to 2⁸ or 256 separate airways. This exponential increase in the number of airways now accessible to the bronchoscopist underscores the need for a navigation system that tracks the position of the bronchoscopes tip and assists in guiding the bronchoscopist to a predefined region. We are developing a user-interface that allows the clinician to interact with a virtual surface model of the patient’s airways. The software can be used to perform a virtual bronchoscopy through the airways, examine the radiological CT images, and guide the user to specified location during an actual procedure by using a position sensor that is embedded within the scope’s distal tip.

VIRTUAL BRONCHOSCOPY

Virtual bronchoscopy is useful for pre-procedural planning during which the clinician can select single or multiple routes for obtaining biopsies. The path can be reviewed and altered while consulting the CT scan so that the clinician can come within close proximity of an identified mass. The software automatically defines the path required to navigate to the selected region from the trachea by using the branch connectivity information obtained within the airway tree data structure. The virtual view smoothly weaves its way through the virtual model by evaluating the spline curve equations that define each branch (see accompanying video). The virtual bronchoscopy can be played, stopped, stepped through, and paused, similar to a movie.

DATA VISUALIZATION

The virtual surface model is reconstructed from the CT data directly by segmenting the airways using a previously developed image processing algorithm[2] and computing a triangulated surface mesh using the Insight Segmentation and Registration Toolkit (ITK). The surface model provides realistic renderings of the anatomy so that a user can explore the airway space using the software or to generate a virtual ‘tip view’ perspective using readings from the position sensor.

REFERENCES


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