Automatic registration for percutaneous vertebral body tracking

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1. Overview

The registration of cross-sectional medical images with patient anatomy is an important problem in image-guided surgery. Current registration methods such as paired-point matching can be tedious and require large incisions. Improved methods of registration for percutaneous spine procedures could potentially improve the accuracy of minimally invasive spine procedures. In this poster, we will describe a combination of hardware and software for the automatic registration of a vertebral body with cross-sectional medical images. The technique is based on a fiducial carrier attached directly to the spinous process and does not require the user to identify anatomical landmarks.

2. Methods

The fiducial carrier is a plastic tracking frame (Traxtal Technologies, Toronto, Canada) containing nine radio-opaque fiducials. The frame also holds three passive retro-reflective spheres, which can be automatically tracked by an infrared camera localizer (hybrid Polaris, Northern Digital, Waterloo, Canada). For these tests, the carrier was rigidly attached to the spinous process of an abdominal interventional phantom (CIRS, Norfolk, VA) using a locking pin. In a simulated biopsy procedure, the phantom was then placed on a CT table and a series of axial slices were scanned. These axial slices were then registered

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with the coordinate system of the localizer. This registration enables the operator to track any point on the phantom with a pointer and overlay the position of the pointer on the CT scans, as done in commercial image-guided surgery systems.

The registration process consists of the following steps: (1) thresholding; (2) connectivity checking; (3) fiducial identification; and (4) transformation matrix computation.

3. Summary

The registration method has been implemented as part of a robotically assisted biopsy testbed incorporating a mobile CT scanner, an infrared camera, and a "needle driver" robot. Preliminary studies showed good correlation. More detailed experiments are in progress.

Acknowledgements