necessary to tailor the learning contents to the user needs. To avoid social isolation of learners, online discussion groups and feedback mechanisms have to be provided to allow student–tutor communication [4]. Currently, we are working on a web 2.0 surgical collaboration platform. The goals of the platform are: enabling access to user-generated teaching materials, sharing medical knowledge, and the collaborative discussion of novel surgical techniques/equipment between experts, assistants and students.

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Open-source surface mesh-based ultrasound simulator

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Keywords Ultrasound Simulation · Surface Mesh · Training · PLUS Toolkit

Purpose

Ultrasound imaging is often chosen for guiding interventions. Patients are not required to undergo any radiation, or enter into any magnetic fields, and it is also significantly less expensive than other modalities, such as computed tomography (CT) and magnetic resonance imaging (MRI). However, extensive training is necessary to make use of its full potential. Ultrasound is notorious for providing images with features that are only discernible with experience. This is problematic in that an ultrasound machine, as well as access to a patient on a regular basis, would be needed for every trainee in the process of acquiring the skills of ultrasound diagnosis. Financially, this training scenario is not feasible. Simulation could be the solution to this problem. In the case of ultrasound simulation for spinal interventions, it is argued that background noise may not be necessary and in fact may even prove to be a distraction from recognizing the shapes of the spine forms in the ultrasound image. The shape could be difficult to detect especially if the trainee does not know what he or she should be looking for.

Methods

The objects to appear in the simulated ultrasound (US) image are defined geometrically. Anatomical data is acquired from segmentations of CT or MRI data converted into surface meshes. Other objects, such as surgical tools, are also represented using surface meshes, allowing for the preservation of model details. The pose of the objects is represented using linear transformations, which could be specified either as constants, in a configuration file, or coming from a tracker. Transducer parameters, such as radius, imaging depth, number of elements and shape (curvilinear vs. linear) are also defined, as are the material properties associated with each model. Next, the points of intersection between the surface meshes and the scan lines of the US image are determined. For time efficiency, a binary space partitioning (BSP) tree is used. The intersection points divide the scan line into segments, which are then filled with a grey value; the result of an intensity calculation [1], based on the material properties defined earlier. The scan lines are finally converted to a regular brightness-mode US image. All of the above steps were implemented in C++, as part of the open-source PLUS (Public Library for Ultrasound) software toolkit [2], available at www.plustoolkit.org.

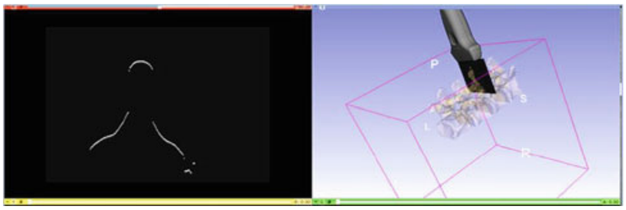

Fig. 1 The ultrasound simulator in the 3D Slicer workspace

Results

The simulator was tested in an US-guided spinal injection training scenario. The anatomical object (spine), tools (US transducer, needle), and simulated US image were visualized in 3D Slicer (www.Slicer.org), shown in Fig. 1. An electromagnetic tracker was connected to the computer and provided position information. The spine mesh consisted of over 97,000 points in 195,000 cells. The US images were generated at a speed of 50 frames per second, and a resolution of 820 × 616 pixels on a PC with a 3.4 GHz processor.

Conclusion

A basic US simulator has been implemented and integrated into the open-source PLUS toolkit, to aid teaching US-guided musculoskeletal procedures and for producing test data for various US image processing and analysis algorithms, such as volume reconstruction and spatial and temporal calibration. Groundwork has been laid for the integration of the simulator with the Perk Tutor [3]. This surface-based simulation approach also questions whether an all-out soft tissue simulation is truly necessary for an effective musculoskeletal sonography training tool. A human subject study, currently underway, with the Perk Tutor will answer this question.

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Predictive model for functional consequences of oral cavity tumour resections

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Keywords Oral cancer · Computer simulation · Finite element analysis · Prognosis

Purpose

The prediction of functional consequences after treatment of large oral cavity tumours is mainly based on the size and location of the tumour [1]. However, patient specific factors play an important role in