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The Perk Tutor Training Platform Integrated with Simulated Ultrasound

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Purpose: To aid in the training of ultrasound-guided needle placement techniques, the Perk Tutor (Fig.1) open-source training platform was previously developed (Ungi *et al*. TBME 2012). Until recently, the Perk Tutor was coupled with an ultrasound machine to acquire the images, making Perk Tutor a rather expensive scheme. We propose to simulate real-time ultrasound imaging from a surface mesh model, thereby removing the need for an ultrasound machine. We hypothesize that mesh-based imaging without elaborate simulation of biological speckle is suitable for spinal musculoskeletal applications, where the target is not covered with thick layers of soft tissue. The work presented here integrates the simulated ultrasound with the Perk Tutor.

Methods: The simulated ultrasound is generated using surface meshes to represent all objects, both anatomy and surgical tools, to appear in the simulated image. The pose of the meshes is represented using linear transforms, in this case, originating from a tracker. This simulation is implemented as a part of the PLUS (the Public Library for Ultrasound, www.plustoolkit.org) software package, which the Perk Tutor already employs for ultrasound image acquisition and position tracking data collection. PlusServer, an application within PLUS, is used to connect the video source, being the simulated ultrasound, with the position information originating from the tracker via the OpenIGTLink network protocol (Tokuda *et al.*, Int. J. Med. Robot. 2009). These two pieces of information are sent to 3D Slicer (www.slicer.org) to visualize the training scenario. In 3D Slicer, the OpenIGTLink connection is established with the use of an OpenIGTLink module, and visualization of the simulated ultrasound is made possible using the Volume Reslice Driver, available as an extension to 3D Slicer.

Results: The integration of Perk Tutor and simulated ultrasound was demonstrated on a spinal needle placement training phantom. An electromagnetic tracker, the Ascension trakSTAR, was connected to the computer and provided position information. The ultrasound images were generated at a speed of 50 frames per second, and a resolution of 820 x 616 pixels on a Windows PC with a 3.4 GHz processor. As the tracking tool moved, the virtual transducer on the screen moved smoothly and it generated the ultrasound images in real-time (Fig 2.).

Fig. 1: Perk Tutor in spinal intervention training

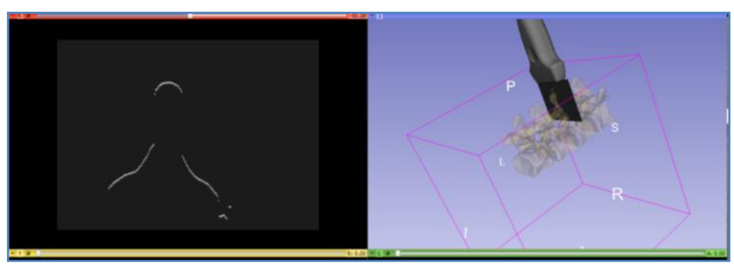

Fig. 2: Simulated ultrasound image of a spine in the Perk Tutor

Conclusion: The Perk Tutor training system has been equipped with simulated ultrasound and is functioning in real-time at 50 frames per second. Real-time simulation and rendering of the surgical tools (such as needles) in the ultrasound image is currently a work in progress. The effectiveness of the simulated ultrasound-enabled needle placement training environment will be determined in the forthcoming human operator performance study. Previous studies with the Perk Tutor (Ungi *et al*., TBME 2012; Moult *et al.*, IJCARS, in press) showed the effectiveness of the Perk Tutor as a training tool in ultrasound-guided spinal needle placement. The forthcoming study will compare the performances of novice trainees in spinal needle placement procedures using the Perk Tutor with real ultrasound versus simulated ultrasound imaging. We expect the simulated ultrasound to be especially suitable for early phase training.