An Interactive iPad Simulation of Torso Ultrasonography

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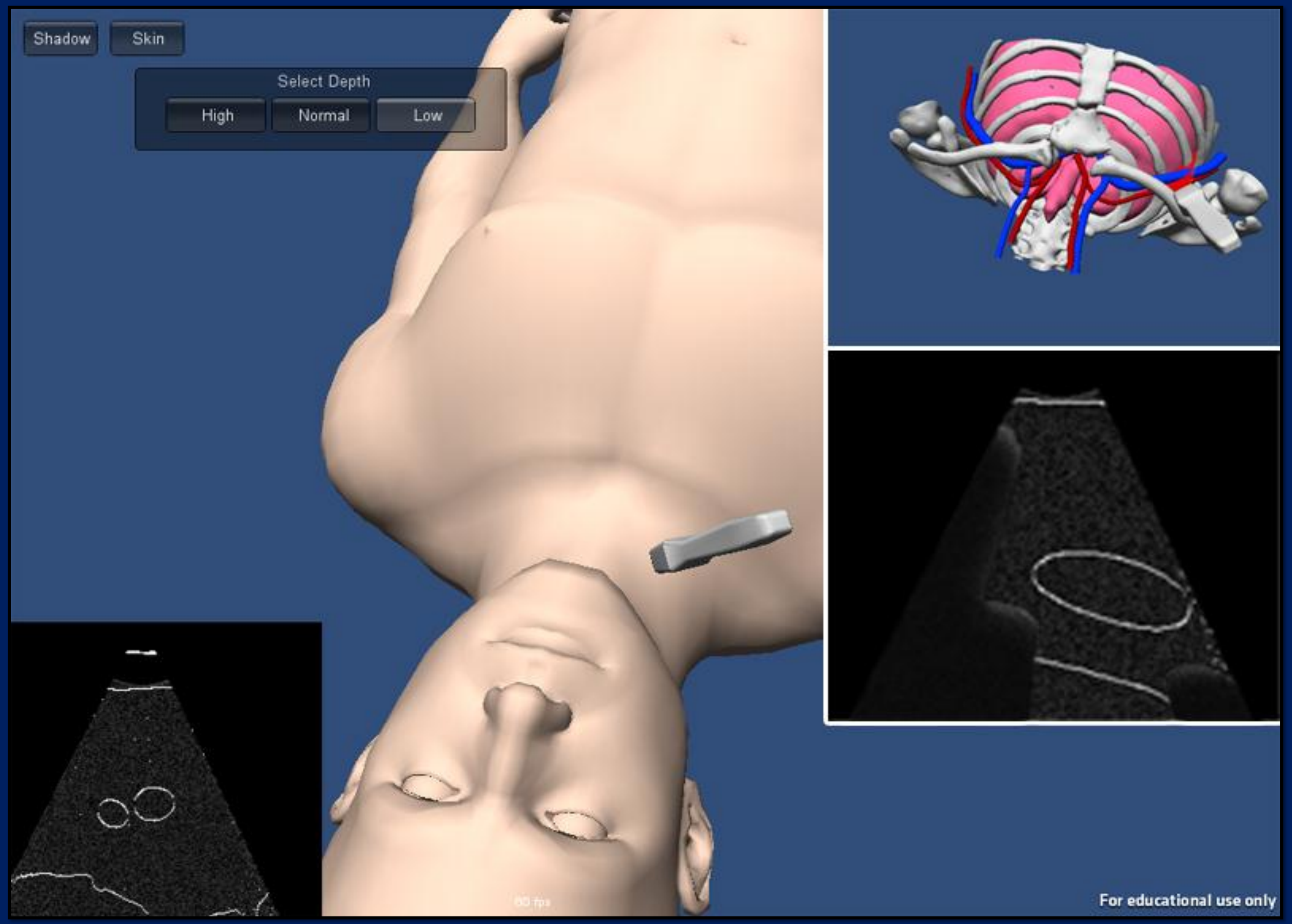
Introduction

- Ultrasonography (US) is a complex, high level skill that depends, among others, on a set of fundamental aptitudes such as sound knowledge of anatomy, proper interpretation of a cross-section (what an ultrasound scanner and other medical imaging modalities such as MRI produce), spatial ability in 3 dimensions and relinquishing an egocentric perspective (interpreting the US image not from the perspective of where one actually is but from the vantage point of the US probe). Guiding a needle or other instrument via ultrasound imaging can add another level of difficulty to an already complex real-time task, especially if the needle is not properly aligned to the imaging plane and does not have an echogenic tip.
- The recent availability of pocket-sized, personal ultrasound imaging devices [1,2] has led to speculation that they might become as common as personal stethoscopes and eventually replace them. To the extent that there may be room for improvement in the training of clinicians in the use and interpretation of US imaging / guidance, the potential proliferation of US imaging that might be ushered by the advent of pocket-size US scanners might also increase the frequency of misuse/misdiagnosis and thus increases the urgency to provide and/or enhance such training as well as accessibility to training.
- Simulation can be a useful training tool for achieving competence in interpreting and using ultrasound imaging/guidance [3]. Commercial ultrasound simulators such as Heartworks (Inventive Medical Ltd., London, United Kingdom) and Vimedix (CAE Healthcare, Sarasota, FL) already exist but these relatively expensive simulators are generally tied to a mannequin and housed in simulation centers that may limit their portability and/or accessibility. The advent of affordable mobile computing devices such as the iPad (Apple, Cupertino, CA) has led to their rapid adoption by clinicians (for example, all residents in our anesthesia residency program are provided an iPad) and also the sales personnel of healthcare companies. We implemented an US simulator optimized for the iPad 2 display such that clinicians could have individual simulators available 24/7 at their fingertips and increase the likelihood of the simulation being used at the point of care or during "teachable moments".

Description

- The simulation was optimized for the iPad 2 touchscreen display. Users move a 3D ultrasound probe directly via their fingers (instead of a pointing device) over a 3D (140,715 polygons) representation of an anatomically correct torso (obtained from a 3D scan). Users can select the depth of imaging and whether to display the torso with the opaque skin on or removed so that the 3D lungs, bones and major vessels become visible and color coded – top right of figure. Similarly, users can toggle between having bones cast shadows or not and can also opt to have a noisy or clean US image. The US images are generated in real time from the 3D anatomical model instead of having predetermined, discrete cross-sections stored in a library and using the slice that matches best to the probe position and orientation.



A video of the simulation can be viewed at http://vam.anest.ufl.edu/videos/UltrasoundiPadSim.wmv.

Conclusions

- Even though it was handling a 3D torso with complex internal structures and generating the cross-sections on the fly based on the ultrasound probe position and orientation, the simulation was able to achieve a refresh rate of about 15 frames per second. We have demonstrated that an iPad2 can generate cross-sections with no noticeable delay from an anatomically correct 3D model in an ultrasound simulator.

References

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