Evaluation of a mobile, real-time, tracked augmented reality display for surgical navigation

Zachary Baum*, Tamas Ungi, Andras Lasso, Gabor Fichtinger
Laboratory for Percutaneous Surgery, Queen's University, Kingston, Canada

INTRODUCTION: Surgical navigation under Computerized Tomography (CT) and Magnetic Resonance (MR) image guidance is used in practice for various needle interventions. Images are typically acquired throughout the insertion process to track the needle path. This method leads to patient discomfort from procedure length, and the possibility of multiple needle insertions. Augmented reality (AR) image overlay systems have been proposed to limit required images, failed insertion attempts, and patient discomfort. Though they have not been translated to clinical settings due to a lack of portability and robustness; overlaying a single image slice on a patient renders it easier for clinicians to locate targets and insert needles correctly[1, 2]. Our goal was to create a portable, robust, and simple to operate system for intraoperative AR guidance.

METHODS: A mobile AR image overlay system allows users to wirelessly navigate scanned patient images using software built on the open-source 3D Slicer platform. The system can be handheld or mounted to a table at patient bed-side. Once set-up for image exploration and needle navigation, our software provides calibration of the system and other tools, and provides users with a method for registering patients to images. A passive optical tracking camera acquires real-time tracking data and transfers it to our software. With this system, we can provide clinicians with an augmented intraoperative view by overlaying medical images directly onto patients (Figure 1). Medical professionals were asked to navigate patient images while using the image overlay and plan needle insertions (Figure 2).

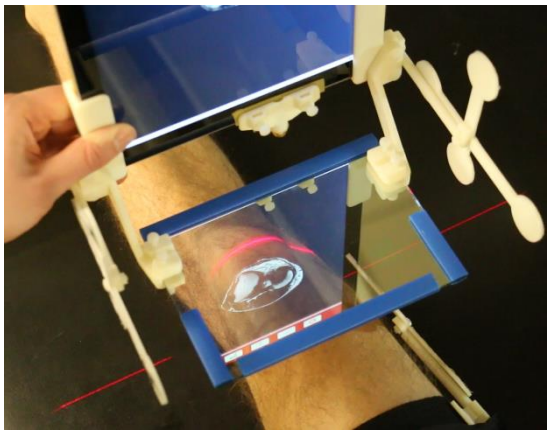

Figure 1: User's view of overlaid image on a patient's leg while using the image overlay system.

Figure 2: Participant using the system and adjustable table-mounted arm to plan a needle insertion path.

RESULTS: In our evaluation study, five physicians responded to a series of questions to assess handheld and table-mounted forms of the image overlay system by rating them on a Likert scale. Responses showed participants felt it was simple to learn how to use the image overlay system, and that it was simple to understand where the projected image was located on the patient. Participants indicated that there was a significant increase in how demanding the handheld version of the system was to use ($p = 0.002$, $n = 5$). Additionally, participants felt they could position themselves more comfortably and navigate images more easily using the table-mounted system.

CONCLUSION: The image overlay system was developed with the goal of bringing clinically usable AR guidance with CT and MR images to minimize radiation exposure and reduce the likelihood of failed insertions. In evaluating the system, participants identified it as being simple to use and understand. By offering real-time browsing of patient images for surgical navigation without pre-planning or image review before the intervention, the image overlay system may save valuable time in CT or MR suites. The system shows promise for use in clinical practice for surgical navigation and further assessment of the image overlay system in a real-world clinical setting is to follow.

REFERENCES: [1] Fichtinger *et al.*, "Image Overlay Guidance for Needle Insertion in CT Scanner," *Biomedical Engineering, IEEE Transactions on*, 52(8):1415-1424, 2005. [2] Fritz *et al.*, "Augmented reality visualization with use of image overlay technology for mr imaging-guided interventions: assessment of performance in cadaveric shoulder and hip arthrography at 1.5 t.," *Radiology*, 265(1): 254–259, 2012.