# Real-time self-calibration of a handheld augmented reality overlay system

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**INTRODUCTION**: Augmented reality systems have been designed for image-guided needle interventions but they have not become widely translated into clinical practice. This lack of use stems from their limited portability, low display refresh rates, and tedious calibration procedures. Our proposed mobile image overlay system allows self-calibration without the use of any temporary tracked markers to achieve a consistent and precise calibration workflow. Using an adaptable modular design also allows for different tablet computers to be used interchangeably.

**METHODS**: A modular, handheld augmented reality viewbox was constructed from a tablet computer and a semi-transparent mirror. A consistent and precise self-calibration method, without the use of any temporary markers, was designed in order to achieve an accurate calibration of the system. Markers attached to the viewbox and patient are simultaneously tracked using an optical pose tracker to report the position of the patient with respect to a displayed image plane that is visualized in real-time (Figure 1). The software was built using the open-source 3D Slicer[1] application platform's SlicerIGT extension and the PLUS toolkit[2].

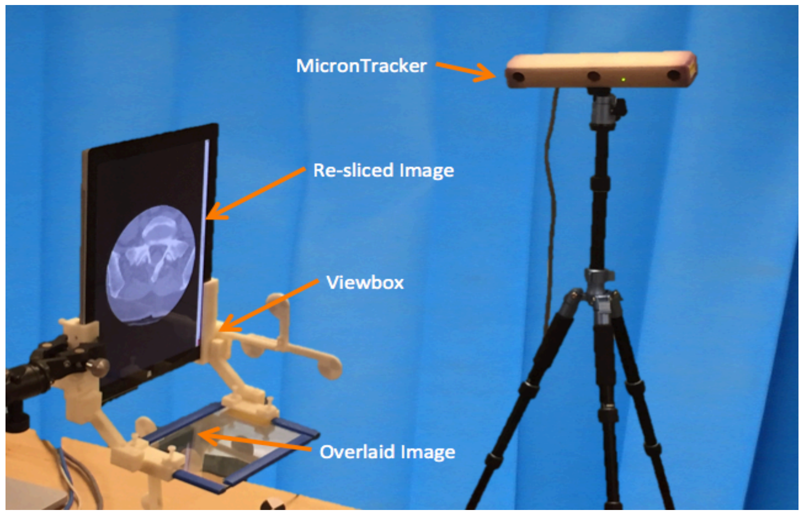

Figure 1: Setup of the system and MicronTracker optical tracking device.

**RESULTS**: The accuracy of the image overlay with image-guided needle interventions yielded a mean absolute position error of 0.99 mm (95th percentile 1.93 mm) in-plane of the overlay and a mean absolute position error of 0.61 mm (95th percentile 1.19 mm) out-of-plane. The differences between the in-plane and out-of-plane distances are attributed to the tracking error resulting from the optical pose tracking system.

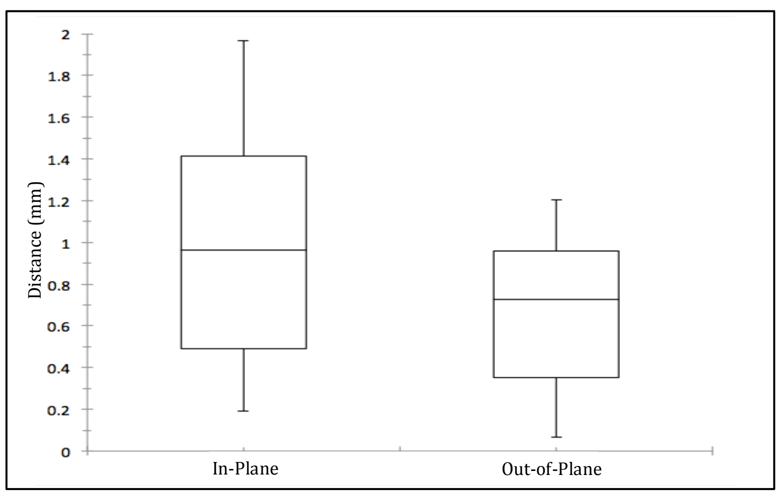

Figure 2: Box and Whisker Plot of in-plane and out-of-plane distances.

**CONCLUSION**: A self-calibration method was developed and evaluated for a tracked augmented reality display. The image overlay system could be used to guide a tool with accuracy that is suitable for facet joint injections or other musculoskeletal needle placements.

**REFERENCES**: [1] Fedorov *et al.*, "3D Slicer as an image computing platform for the quantitative imaging network," Magnetic Resonance Imaging. 30(9), 1323-1341 (2012). [2] Lasso et al., "PLUS: open-source toolkit for ultrasound-guided intervention systems," *Biomedical engineering, IEEE Transactions on*, vol. 61, no. 10, pp. 2527-37, 2014.