Seeing the Unseen: AR Visualization Powered by State Estimation for Breast Conserving Surgery

Jacqueline Tsai, MD, FACS; Yuxuan Wu; and Bruce Daniel, MD

Stanford University, Redwood City, CA; Stanford University, Stanford, CA

Introduction: Breast-conserving surgery, presents the ongoing challenge of thoroughly excising tumors while preserving healthy tissue. Despite progress in imaging and guidance, intraoperative identification of tumor boundaries remains problematic, resulting in positive margins and repeat surgeries for 16-40% of patients. Augmented reality (AR) visualization, combined with state estimation, offers a novel approach to this issue by overlaying MRI data and real-time localization onto the surgical field.

Methods: In our institutional pilot study, patients with biopsy-confirmed tumors undergoing lumpectomy received a SAVI Scout wireless marker for localization. A preoperative supine MRI was segmented to reconstruct breast and tumor meshes. Surgeons, equipped with a Hololens AR device, used probe tracking and SAVI distance readings to create a particle filtration state estimation of the tumor and SAVI location. This then aligned the segmented MRI with the patient and enabled precise intraoperative visualization of tumor size and shape. (Figure1)

Results: To date, five patients have undergone AR-guided lumpectomy. The AR system successfully displayed the tumor's location and contour intraoperatively, with only one patient requiring re-excision due to close positive margins. When evaluating the use of the AR system, it was equally effective or better than clinical guidance of the tumor in, 4 out of the 5 cases.

Conclusions: Our next steps include enrolling more patients, particularly those with larger lesions, and using pathological data to refine excision accuracy. This technology shows promise in enhancing surgical precision and minimizing the removal of healthy tissue.