Using Augmented Reality to Interact with 3D Holographic Images of Intracardiac Geometry and Catheter Positions During Cardiac Ablation Procedures

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Introduction: Minimally invasive catheter-based ablation procedures are the current standard of care for many arrhythmia patients, but require the interventionalist to rely on multiple coordinated systems and other personnel to manage multiple data streams, including projections of the cardiac model. We hypothesize that empowering interventionalists to directly interact with a true patient-specific 3D representation of electroanatomic data will improve their understanding of the patients electroanatomic relationship and shorten overall procedure time. We have developed an augmented reality (AR) system based using the Microsoft HoloLens visor to provide a shared, interactive, 3D holographic display of real-time cardiac geometry and catheter positions with sterile hand gesture and head directed control interfaces for intra-procedural use without otherwise interfering with the visual field.

Materials and Methods: The AR system consists of three subsystems; geometry input, user interaction, and state sharing. Geometry data construction can occur from either: 1) preprocedural imaging (either CT or MRI) data that is processed using commercially available software (Mimics, Materialise), or 2) cardiac geometry and catheter data from an electroanatomic mapping system (EAMS, EnSite Velocity, Abbott) either in real-time or historical playback. The state sharing subsystem uses wireless communication to provide a common operating model for participating users. A phantom cardiac model was used to demonstrate real-time processing capability and historical case data was used to demonstrate electroanatomic isochrone mapping.

Results and Discussion: Initial tests on a phantom cardiac model (**Fig. 1**) show that the interventionalist can manipulate the scale, rotation, and translation of the geometry to observe the anatomy and catheter positions using either hand or head directed gestures to generate an initial cardiac geometry while maintaining sterility and without requiring a secondary EAMS operator to manipulate the view projection. Software testing shows a high-density map with a standard suite of catheters at 30 frames per second for 4 concurrent participants.

Conclusions: The AR system demonstrates the feasibility of using an interactive 3D display of EAMS data during cardiac catheterization. Future work will include focusing on direct physician control of the EAMS to optimize treatment, procedure duration and workload distribution.

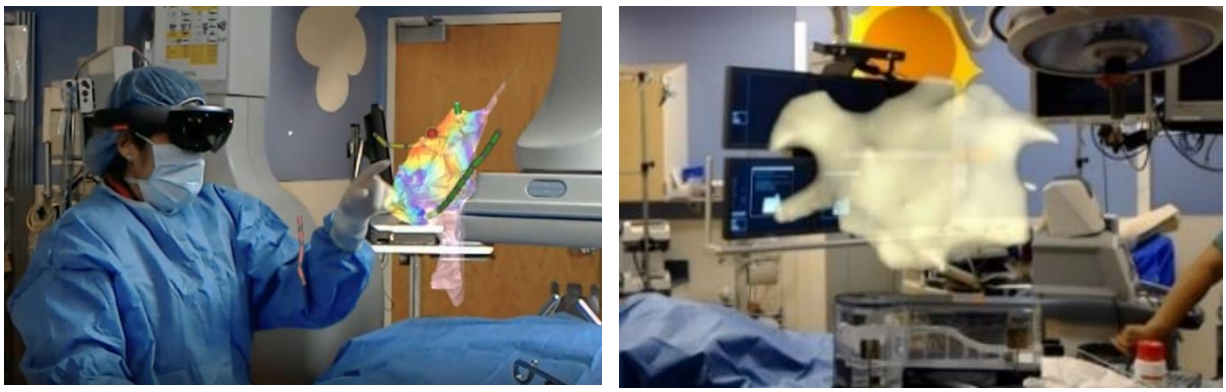

Figure 1: Left: EAMS isochrone in playback. Right: Geometry of cardiac phantom in anterior projection.