Washington University in St. Louis
School of Engineering & Applied Science

Washington University in St. Louis
School of Medicine

Children's Hospital • St. Louis
BJC HealthCare

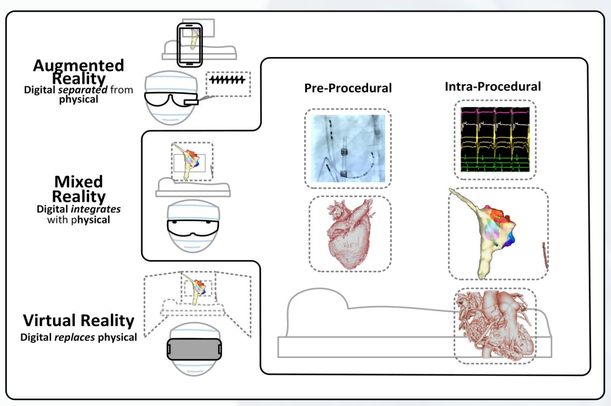
Improving Visualization and Interaction During Transcatheter Ablation Using A Mixed Reality System: First-In-Human Experience

Jennifer N. Avari Silva*, Michael Southworth†, Aarti Dalal*, George F. Van Hare*, Jonathan R. Silva†
*Division of Pediatric Cardiology , †Department of Biomedical Engineering; Washington University in St. Louis, St. Louis MO, USA

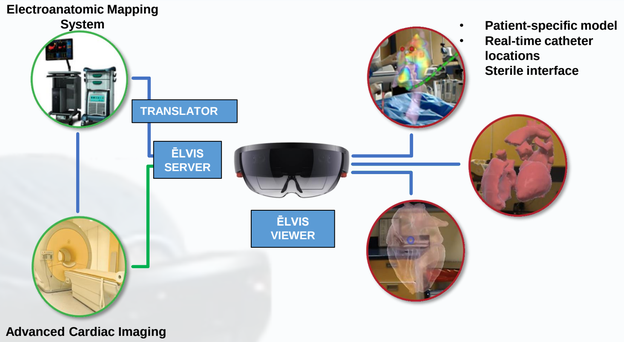
ABSTRACT

Introduction: A novel mixed reality (MxR) based system that displays a real time intraprocedural hologram of cardiac geometry, electroanatomic maps, catheter localization with a controllable via sterile interface was developed. The system improves physician visualization and data interaction, which we expect will improve understanding of patient-specific cardiac anatomy and ultimately improve physician performance resulting in improved patient outcomes. We present the first live case where we have used this system, the Enhanced ELectrophysiology Visualization and Interaction system (**ĒLVIS**).
Methods: Software developed with the Windows Mixed Reality platform was loaded onto the Microsoft HoloLens (HL) augmented reality head mounted display and tested with historic data, prior to use in a live study.
Results: During a standard electrophysiology study and transcatheter ablation, ĒLVIS displayed a holographic projection of real time cardiac geometry during its creation and throughout the case. Local activation time (LAT) map, catheter locations and lesion markers were all overlaid onto this model. Two concurrent observers located outside the electrophysiology suite watched the live case and interacted with the model altering the scale, rotation and translating the geometry using gaze/gesture control.
Conclusion: Display of real time cardiac geometry, LAT map, catheter localization and lesion data in a single hologram within a MxR environment that facilitates physician visualization, interaction and collaboration is feasible. Future studies will include usability testing and prospective in-human validation.

BACKGROUND



SYSTEM

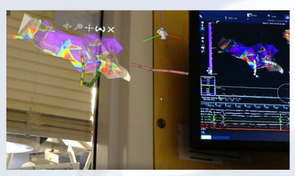


METHODS

- 10 patients undergoing EPS/ablation recruited for observational study
- Patients underwent standard procedure
- 2nd EP team to observe study from control room, including geometry creation, map creation and ablations
  - No feedback to performing physician
  - No patient decisions made using ĒLVIS
- Inclusion criteria:
  - Structurally normal heart

Patient Characteristics	
# of patients enrolled	10
Age (yrs)	13±4.5
EP Diagnoses	
AVNRT	3
Right sided AP AVRT	1
Left sided AP AVRT	6
Geometries Created	
Right atrium	10
Left atrium	6
Maps Created	
Activation Map	7
Voltage Map	5

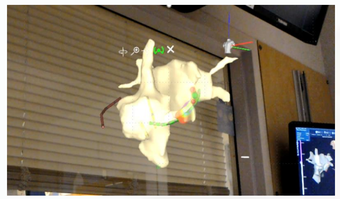
HoloLens Display EAMS Display



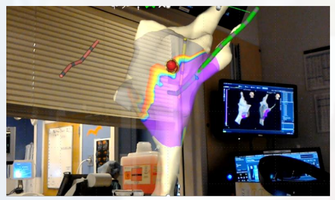
First Person Video Capture

RESULTS

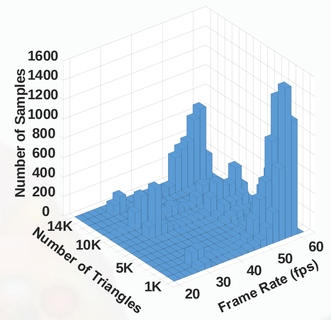
Performance Metrics	
Polygons	.5k-12k
Frame Rate	30-60fps
Battery Performance	191min
Latency	<131msec

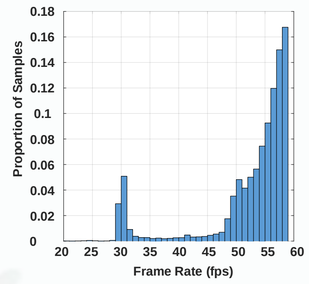


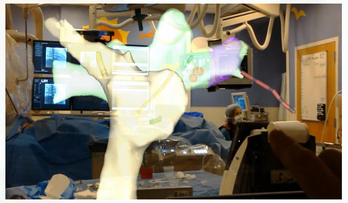
SLCH—08: RA, LA and CS geometry with LAT map from LL WPW ablation

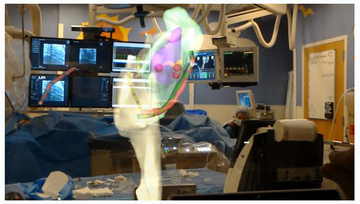


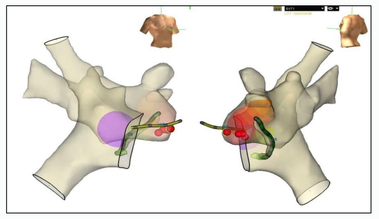
SLCH—01: RA geometry with voltage map from AVNRT ablation











SLCH—06: RA, LA and CS geometry with LAT map from LL WPW ablation – note accuracy of consolidation lesions

CONCLUSIONS

- ✓ Real-time MxR display of EAMS data feasible
- ✓ Current hardware meets minimum performance requirements
- ✓ More accurate latency characterization

Next steps…

- ✓ Quantifying benefits of MxR HMD in EP
  - Workload distribution
  - Time to generate high-density geometries and maps
  - Overall procedure time

ACKNOWLEDGEMENTS

Funded by Children's Discovery Institute CH-II-2017-575

Children's Discovery Institute
St. Louis Children's Hospital
Washington University School of Medicine

Washington University in St. Louis
Skandalaris Center for Interdisciplinary Innovation and Entrepreneurship

CONTACT

Jennifer N. Avari Silva, MD (jennifersilva@wustl.edu)
Jonathan Silva, PhD (jonsilva@wustl.edu)
http://silvalab.bme.wustl.edu

DISCLOSURES

JNAS and JRS are founders of SentiAR, Inc.
MS holds shares in SentiAR, Inc.
SentiAR, Inc is a medical device company pursuing the application of augmented reality in electrophysiology.