

# Evaluation of HMD-Based Navigation for Ventriculostomy

Maia Stiber

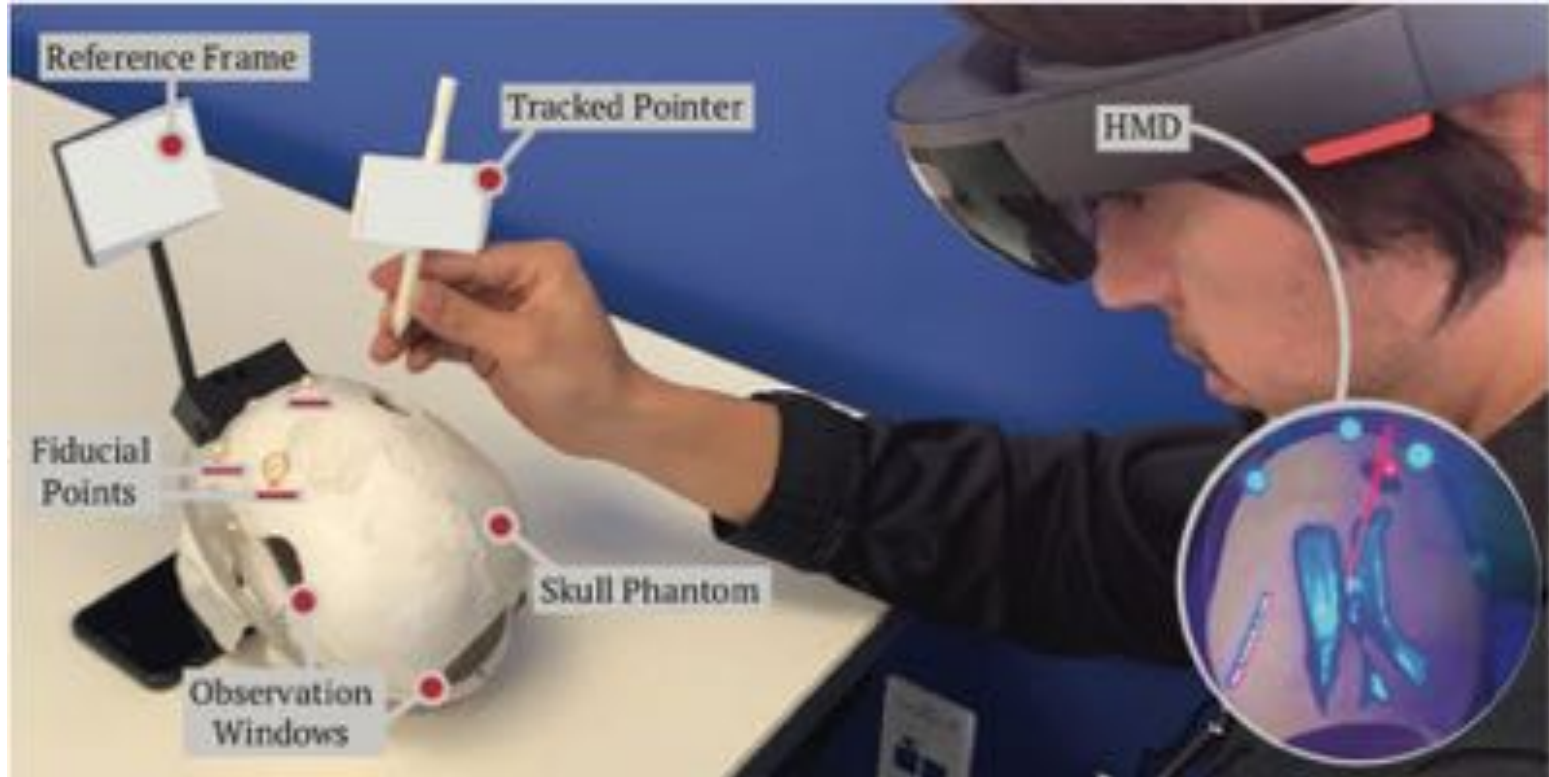
**Mentors:** Ehsan Azimi, Peter Kazanzides, Chien-Ming Huang, Dr. Judy Huang, and Dr. Camilo Molina

# Importance of Ventriculostomies

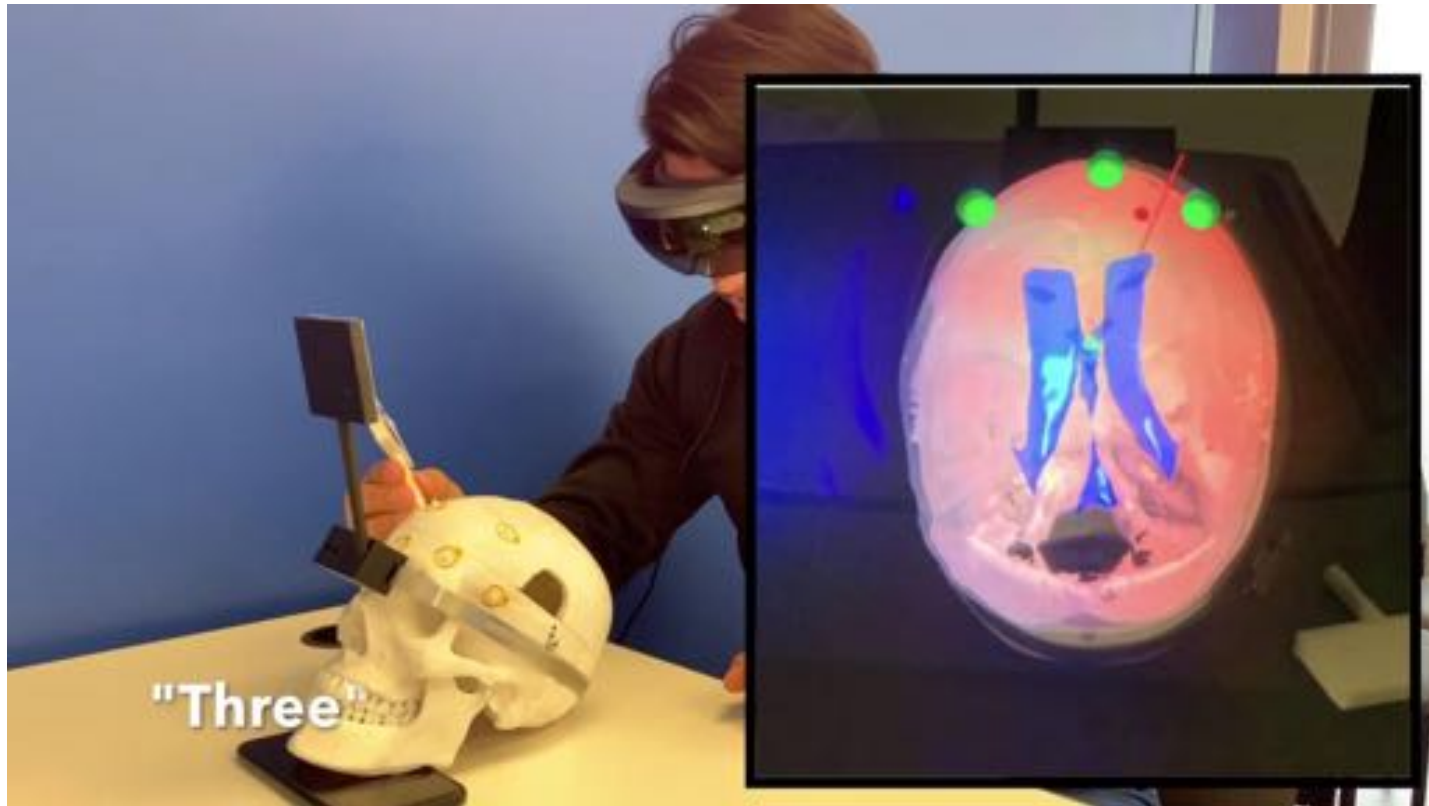


Ghandorh, Hamza & Mackenzie, Justin & De Ribaupierre, Sandrine & Eagleson, Roy. (2017). Development of Augmented Reality Training Simulator Systems for Neurosurgery Using Model-Driven Software Engineering. 10.1109/CCECE.2017.7946843.

# Current HMD Navigational System



# HMD Workflow: Registration



# HMD Workflow: Path Planning and Insertion



# Project Goals/Aims

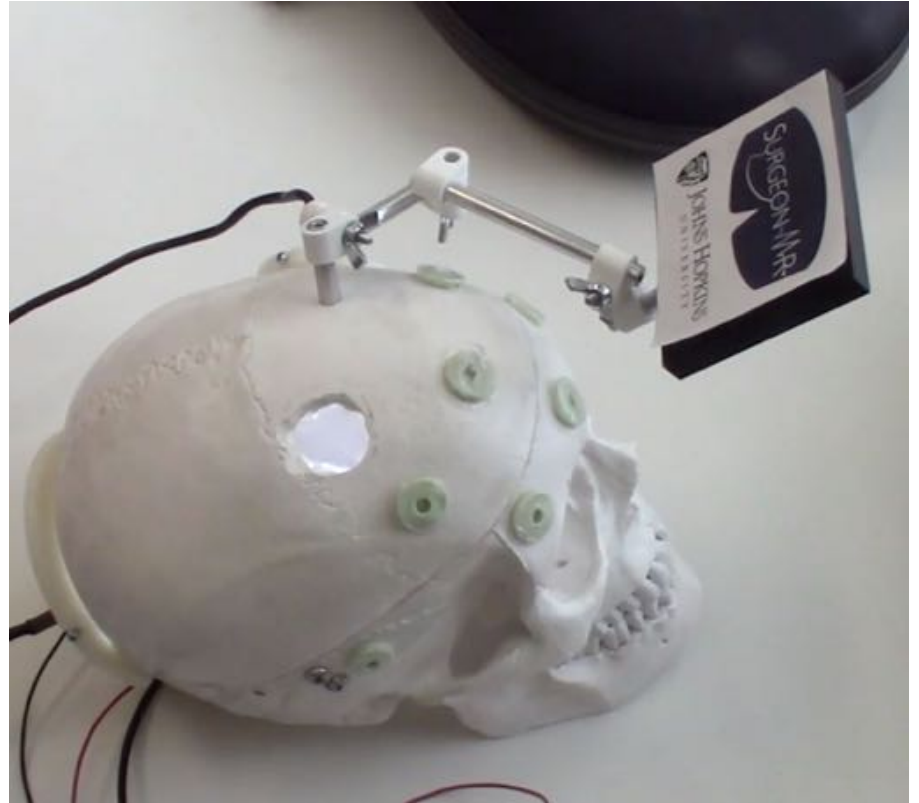
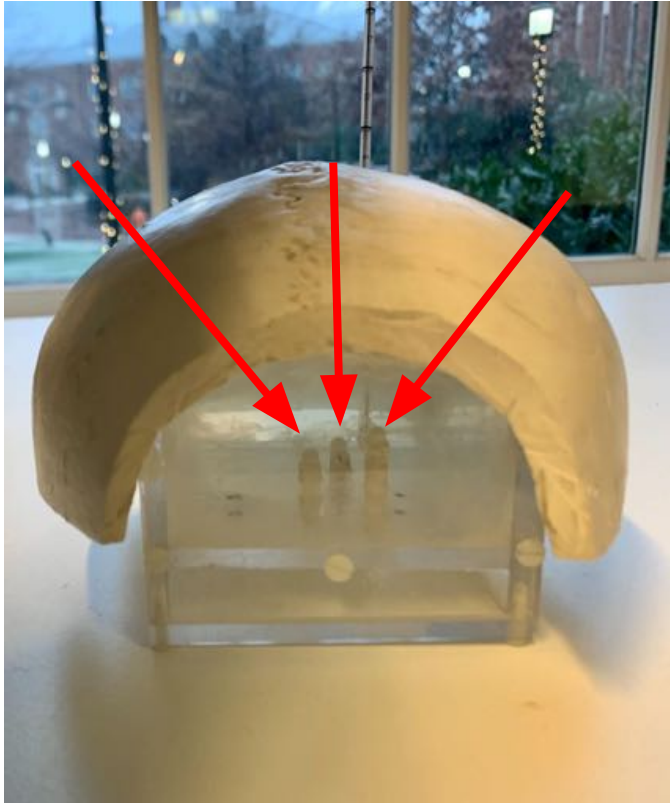
- Evaluate HMD Navigational system
- See if AR-guided ventriculostomy is preferred by neurosurgeons

Minimum:	<ul style="list-style-type: none"><li>● User Study Results written as part of a submitted MICCAI 2020 paper</li></ul>
Expected:	<ul style="list-style-type: none"><li>● Video Analysis Results</li></ul>
Maximum	<ul style="list-style-type: none"><li>● Script to improve aid in depth perception<ul style="list-style-type: none"><li>○ Adaptive prompts based on wearer's behavior</li><li>○ Improved visualizations</li></ul></li></ul>

# Technical Approach: User Study

- **Hypothesis:** AR-Guided ventriculostomy improves accuracy and decreases mental task load compared to baseline
- Within-subject study (with and without AR guidance)
- 3 targets
- 10 participants
  - All Medical or Engineering backgrounds
  - Somewhat familiar with MR devices (M = 2.7, SD = 0.82 on a 5-point scale)
- **Note:** One of the participants is a neurosurgeon

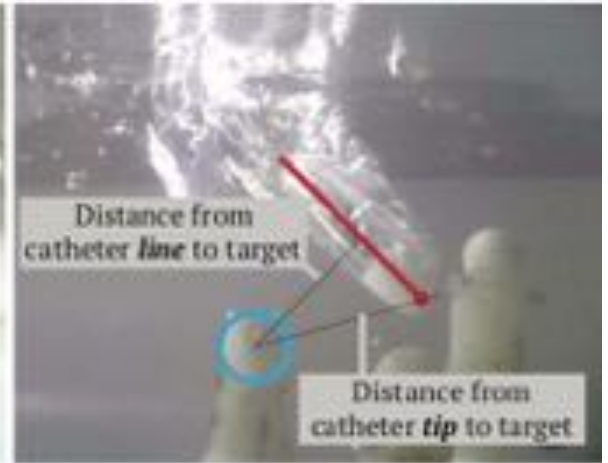
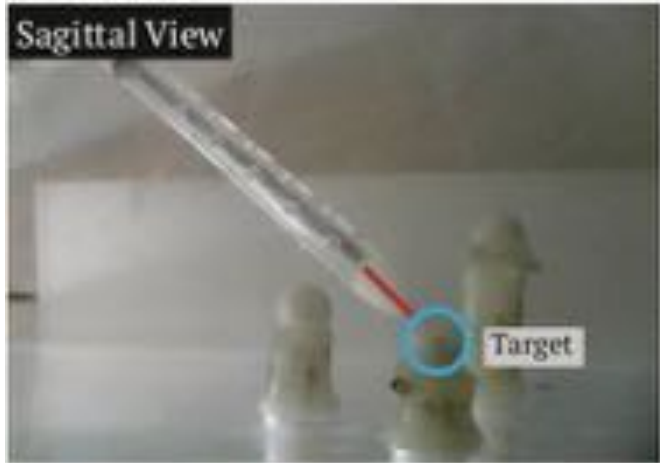
# User Study: Phantom





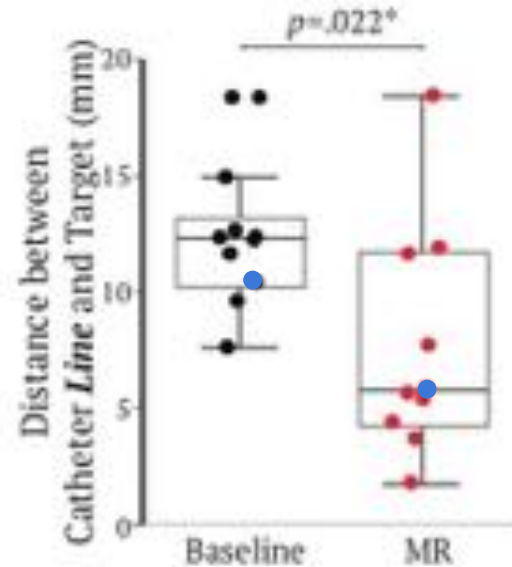
# User Study: Task Accuracy

- Distance between catheter **tip** and target
- Distance between catheter **line** and target



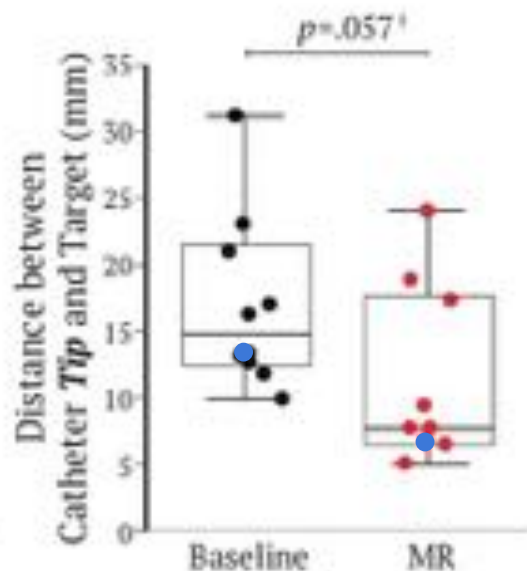
# Results: Task Accuracy (Line)

- Significant improvement from Baseline to MR
  - $F(1, 18) = 6.24, p = .022$
- Average MR Distance: 7.63mm
  - Neurosurgeon Average: 7.7mm
- Average Baseline Distance: 12.21mm
  - Neurosurgeon Average: 10.4mm

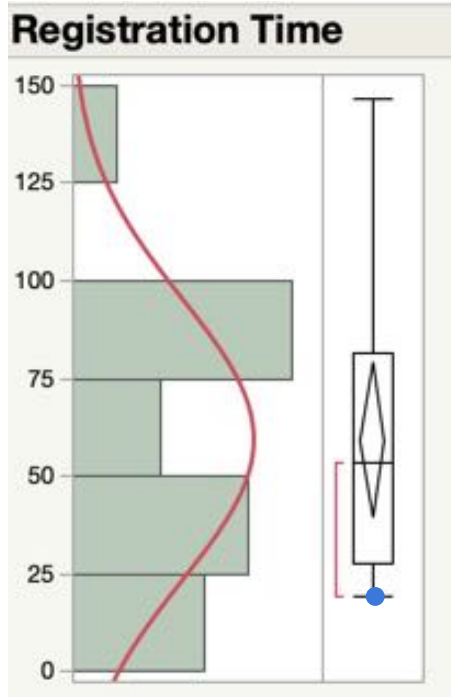


# Results: Task Accuracy (Tip)

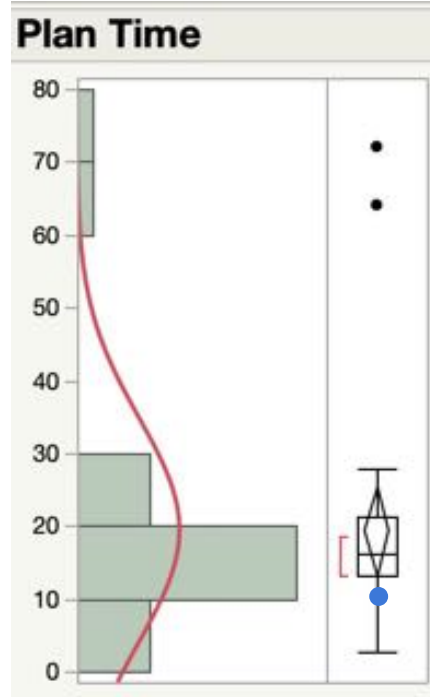
- Marginal improvement from Baseline to MR
  - $F(1, 18) = 4.14, p = .057$
- Average MR Distance: 10.96mm
  - Neurosurgeon Average: 9.37mm
- Average Baseline Distance: 16.93mm
  - Neurosurgeon Average: 13.3mm



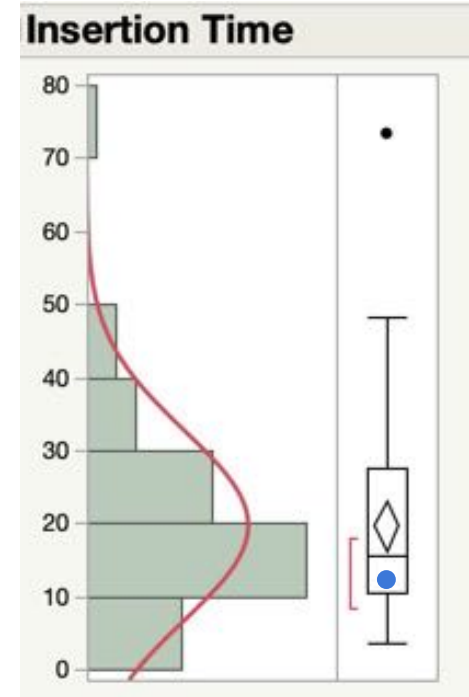
# Workflow Timing



Average: 59.1s  
Neurosurgeon: 18.99s

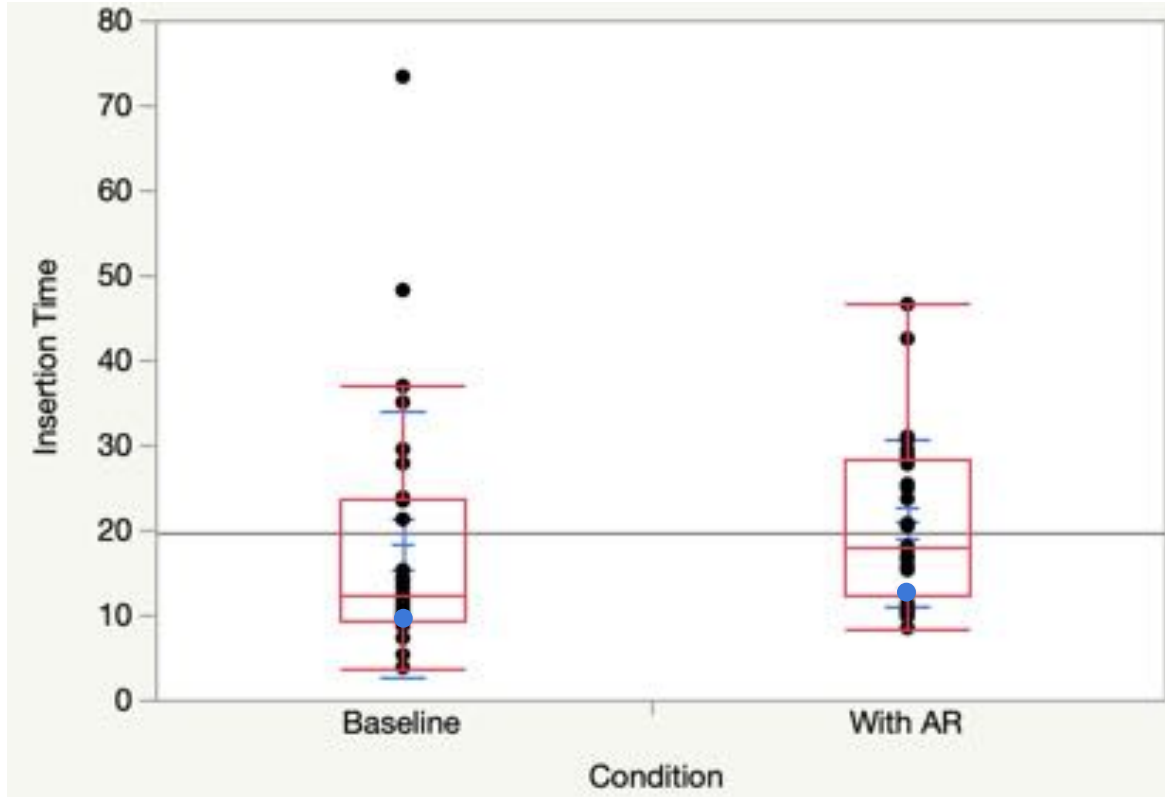


Average: 19.44s  
Neurosurgeon: 10.14s



Average: 19.67s  
Neurosurgeon: 11.72s

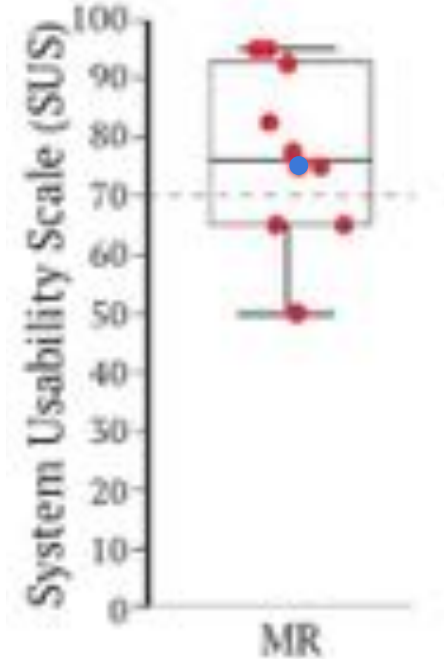
# Insertion Time Per Condition



- Baseline Average: 18.4s
  - Neurosurgeon Average: 10.44s
- MR Average: 20.9s
  - Neurosurgeon Average: 13.44s
- Noticeable difference
  - $p = 0.039$

# User Study: System Usability Scale

- MR system reasonably usable for performing procedure
  - M = 77.25, SD = 14.69
  - Suggested usability score of 70\*
  - Neurosurgeon Reponse: 75



\* Brooke, J.: Sus-a quick and dirty usability scale. Usability evaluation in industry 189(194), 4-7 (1996)

# Future Work

- Finish script which adaptively prompts user to move head when inserting catheter
- Run user study with all neurosurgery residents
- Real-time catheter tracking:
  - Catheter Alignment Feedback
  - Insertion Depth
- Adaptive training for users

# Lessons Learned

- AR in medical procedures
- Design and run a user study
- Data analysis



# Thank you to

- **Ehsan Azimi**
- **Dr. Peter Kazanzides**
- **Dr. Chien-Ming Huang**
- **Dr. Camilo Molina and Dr. Judy Huang**
- Zhiyuan Niu
- Ruby Liu
- Nicholas Greene
- Nikhil Dave

Questions?