JOHNS HOPKINS UNIVERSITY

HMD-Based Navigation for Ventriculostomy

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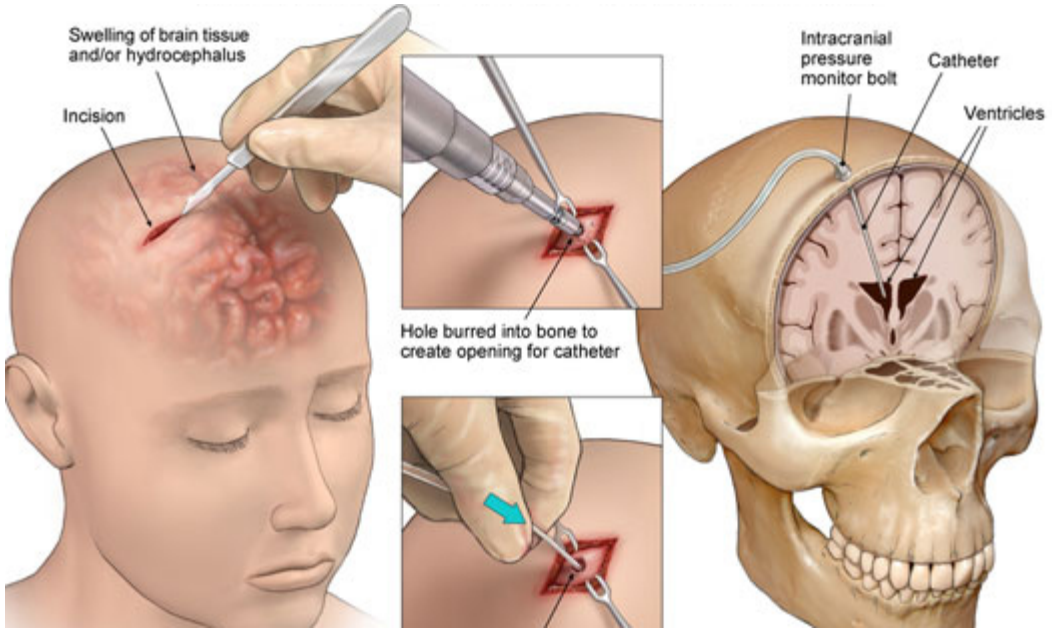
Background

Ventriculostomy:

1. Incision
2. Hole burred into bone to create opening for catheter
3. Insert catheter and drain excess fluid from ventricle



http://www.medicalexhibits.com/medical_exhibits_image.php?exhibit=07066_03X

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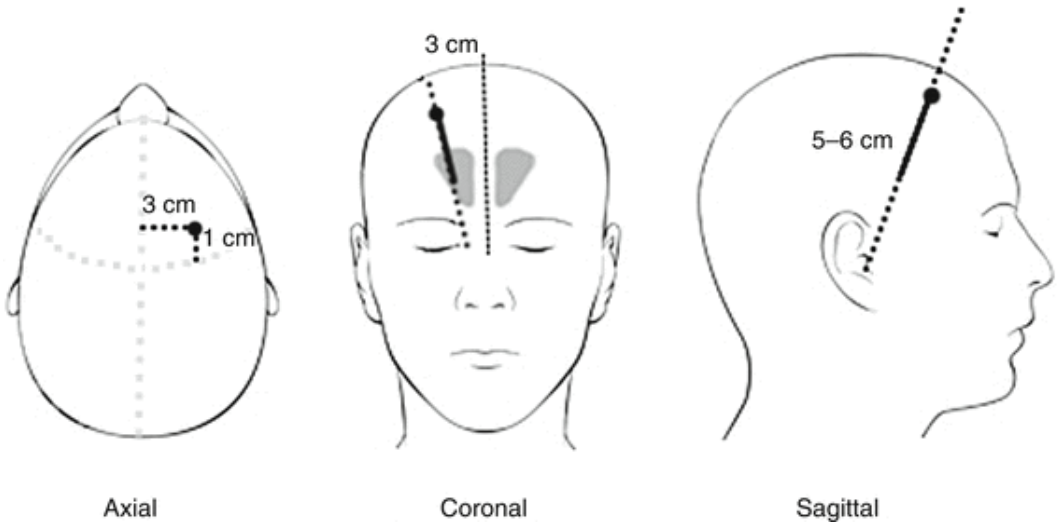
Motivation

- ~30% chance to miss the target
- Catheter insertion is based on anatomy and surgeon's experience.
- Surgeon has to guess the location of ventricle from CT image and anatomic points (glabella and temple)
- Some patient may have ventricle location shift



Shahlaie K., Muizelaar J.P. (2012) Ventriculostomy. In: Vincent JL., Hall J.B. (eds) Encyclopedia of Intensive Care Medicine. Springer, Berlin, Heidelberg

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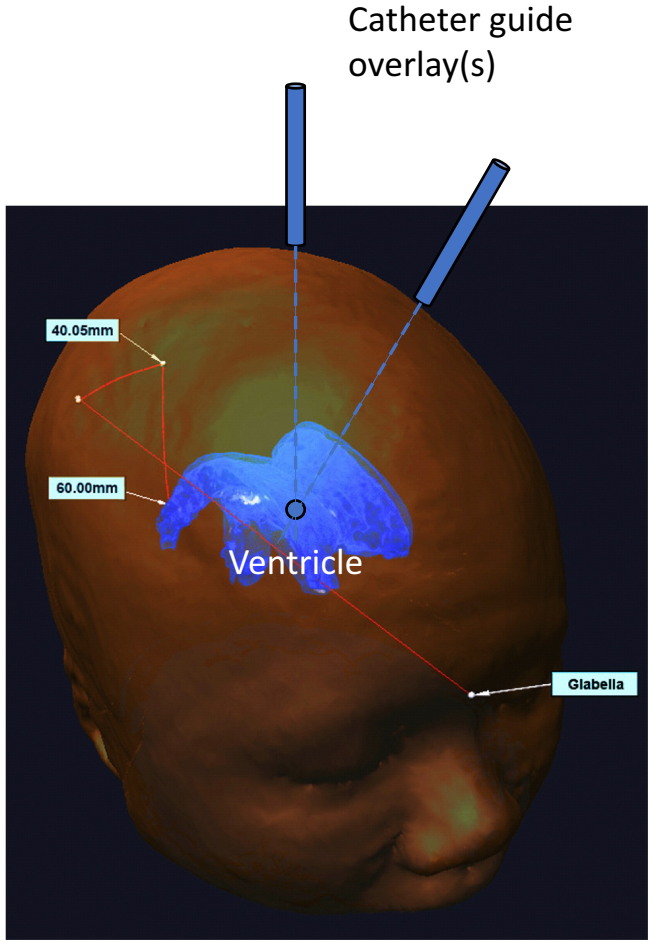
Project Goal

- The goal is to introduce image guidance via augmented reality on HoloLens
- The image guidance is AR overlay of ventricle model from CT image and catheter guide overlay.



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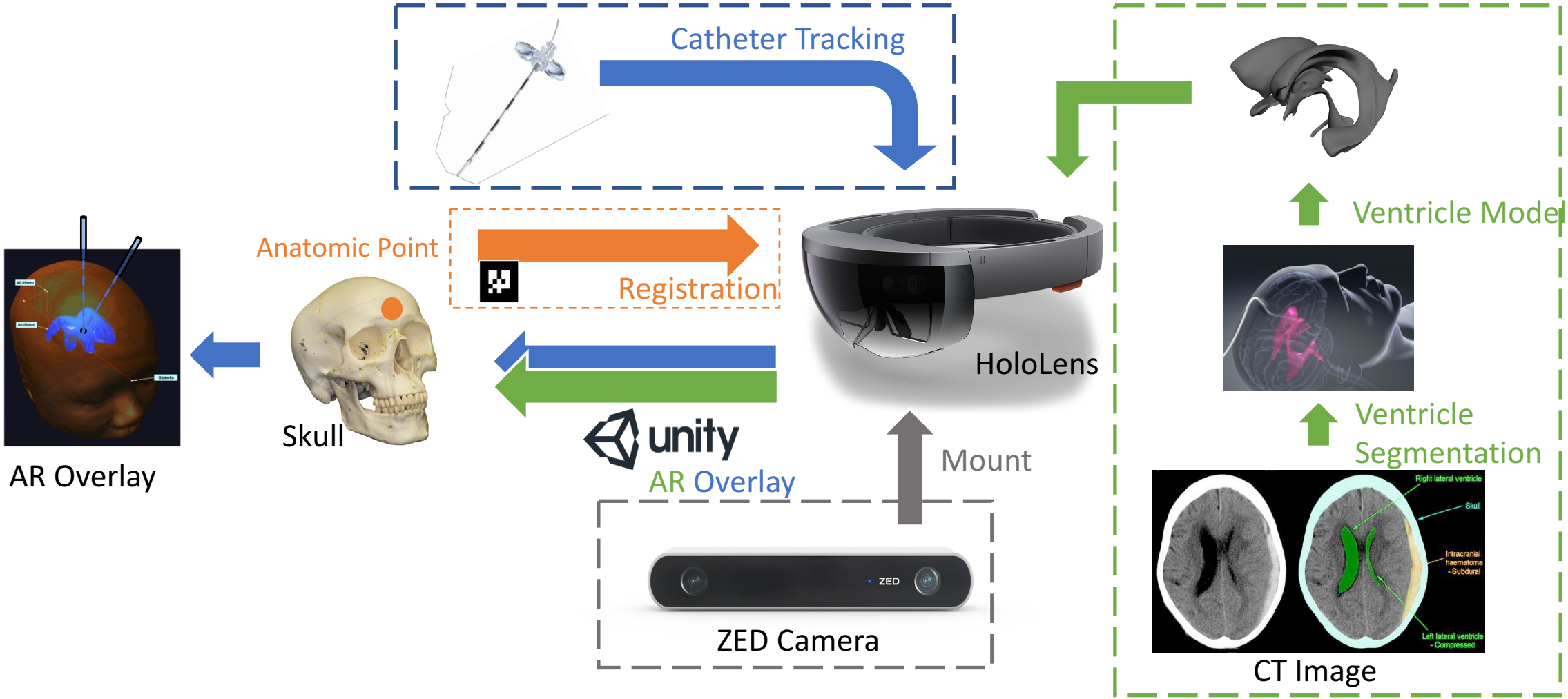
Technical Approach



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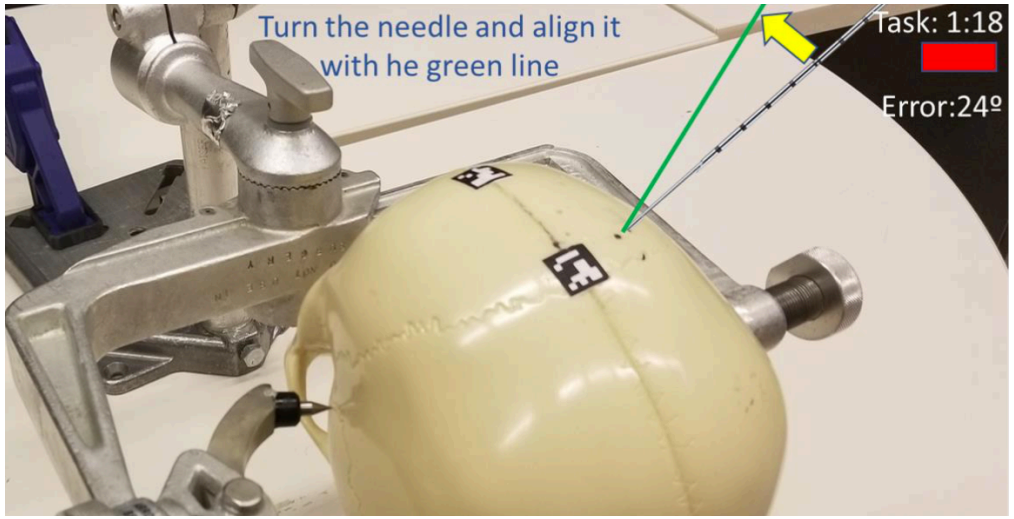
Technical Approach

Workflow

1. Register CT to patient by touching anatomic points (glabella)
2. Camera mounted to HoloLens to track skull
3. Create ventricle model by segmenting CT
4. AR overlay of ventricle model
   - Require accuracy within 3 mm
5. Overlay of catheter guide, with possibility for adjustment



E Azimi, C Molina, A Chang, J Huang, CM Huang, P Kazanzides: Interactive Training and Operation Ecosystem for Surgical Tasks in Mixed Reality. OR 2.0 Context-Aware Operating Theaters, Computer Assisted Robotic Endoscopy

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Deliverables

Minimum

- Documentation and Code for Navigation System 1.0 includes:
  - Anatomic points registration by AR Marker
  - AR overlay system indicating ventricle centroid based on anatomic points
  - Report of accuracy test

Expected

- Documentation and code for Navigation System 2.0 includes:
  - Tool tracking system by touching anatomic points
  - Camera system integrated to HoloLens
  - Semi-automatic ventricle segmentation program
  - Report of accuracy test

Maximum

- Documentation and Code for Navigation System 3.0 includes:
  - fully-automatic ventricle segmentation program
  - Catheter tracking system with guidance of insertion error and insertion depth

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Dependencies

Dependency	Solution	Alternative	Status
Access to SMARTS Lab	Need Prof. Kazanzides sign the form		Resolved
Access to software: Unity, ARToolKit, and HoloLens Emulator	Download from official websites		Resolved
Microsoft HoloLens	Contact Ehsan		Resolved
AR Tags	Get from SMARTS Lab		Resolved
Skull Model	Get from SMARTS Lab		Resolved
Prior Work Code	Contact Ehsan		Due Feb. 26
Access to 3D Printer	Use LCSR Robotarium 3D Printer	Wyman Park Building	Resolved
CT Data	Contact Ehsan/Prof. Kazanzides		Due Mar. 5

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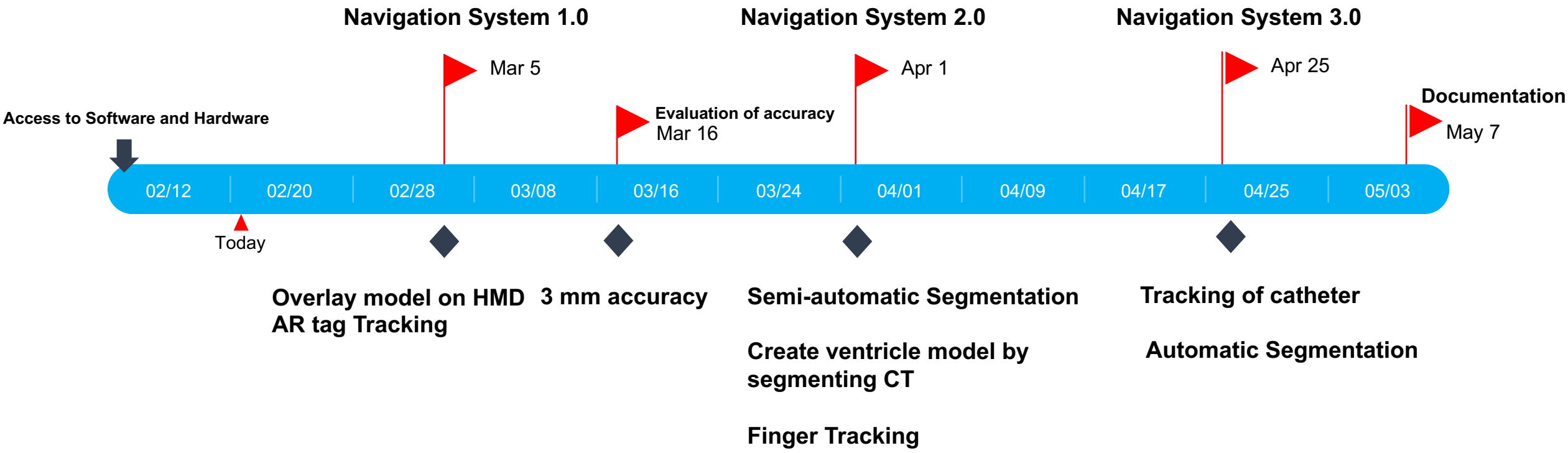
Schedule

	Feb.19	Feb.26	Mar.5	Mar.12	Mar.19	Mar.26	Apr. 2	Apr. 9	Apr.16	Apr.23	Apr.30	May.7
Get familiar with Unity, ARToolKit												
AR tag and Tool Tracking												
Registration and overlay given model on HMD												
Camera setup												
Evaluate Accuracy												
Semi-automatic segmentation of the ventricles												
Create ventricle 3D modeling by segmenting CT												
Catheter Tracking												
System Evaluation												
Documentation												
Final Presentation and Report												

Milestones



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Management Plan

	Member Responsibility
Mingyi	1. Ventricle segmentation 2. Ventricle modeling 3. AR Overlay 4. Accuracy Evaluation
Yiwei	1. Registration 2. AR tags and Tool tracking 3. Catheter tracking 4. Camera Setup

- Weekly Meetings with mentors
  - Wednesdays 3 pm
- Team Meeting
  - Twice a week (Monday and Friday)
- Code
  - GitHub repository
- Documentation, Data and Reports
  - JH Box

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Reading List

1. Azimi, E., Doswell, J., Kazanzides, P.: Augmented reality goggles with an integrated tracking system for navigation in neurosurgery. In: Virtual Reality Short Papers and Posters (VRW), pp. 123–124. IEEE (2012)
2. Azimi, E., et al.: Can mixed-reality improve the training of medical procedures? In: IEEE Engineering in Medicine and Biology Conference (EMBC), pp. 112–116, July 2018
3. Sadda, P., Azimi, E., Jallo, G., Doswell, J., Kazanzides, P.: Surgical navigation with a head-mounted tracking system and display. Stud. Health Technol. Inform. 184, 363–369 (2012)
4. Chen, L., Day, T., Tang, W., John, N.W.: Recent developments and future challenges in medical mixed reality. In: IEEE International Symposium on Mixed and Augmented Reality (ISMAR), pp. 123–135 (2017)
5. Qian, L., Azimi, E., Kazanzides, P., Navab, N.: Comprehensive tracker based display calibration for holographic optical see-through head-mounted display. arXiv preprint arXiv:1703.05834 (2017)
6. Saucer, F., Khamene, A., Bascle, B., Rubino, G.J.: A head-mounted display system for augmented reality image guidance: towards clinical evaluation for imri-guided nuerosurgery. In: Niessen, W.J., Viergever, M.A. (eds.) MICCAI 2001. LNCS, vol. 2208, pp. 707–716. Springer, Heidelberg (2001).
7. Azimi, Ehsan, et al.: Interactive Training and Operation Ecosystem for Surgical Tasks in Mixed Reality. *OR 2.0 Context-Aware Operating Theaters, Computer Assisted Robotic Endoscopy, Clinical Image-Based Procedures, and Skin Image Analysis*. Springer, Cham, 20-29.(2018).

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Thank You!

Any Questions?

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