HMD-Based Navigation for Ventriculostomy

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Mentor:
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Prof. Peter Kazanzides
Background

Ventriculostomy:

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

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

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.
Technical Approach

Anatomic Point → Registration → CT Image → Ventricle Segmentation → Ventricle Model

Skull → AR Overlay → ZED Camera → HoloLens → Mount

Catheter Tracking
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
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
## Dependencies

<table>
<thead>
<tr>
<th>Dependency</th>
<th>Solution</th>
<th>Alternative</th>
<th>Status</th>
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<td>Access to SMARTS Lab</td>
<td>Need Prof. Kazanzides sign the form</td>
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<td>Resolved</td>
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<td>Access to software: Unity, ARToolKit, and HoloLens Emulator</td>
<td>Download from official websites</td>
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<td>Microsoft HoloLens</td>
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<td>AR Tags</td>
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<td>Prior Work Code</td>
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<td>CT Data</td>
<td>Contact Ehsan/Prof. Kazanzides</td>
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## Schedule

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<tr>
<th>Task Description</th>
<th>Feb.19</th>
<th>Feb.26</th>
<th>Mar.5</th>
<th>Mar.12</th>
<th>Mar.19</th>
<th>Mar.26</th>
<th>Apr. 2</th>
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<th>Apr.16</th>
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<td>Evaluate Accuracy</td>
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Milestones

**Navigation System 1.0**
- **Access to Software and Hardware**
- **Overlay model on HMD**
- **AR tag Tracking**
- **02/12**
- **02/20**
- **02/28**
- **03/08**
- **03/16**
- **03/24**
- **Mar 5**

**Navigation System 2.0**
- **Evaluation of accuracy**
- **Mar 16**
- **04/01**
- **04/09**
- **Semi-automatic Segmentation**
- **Create ventricle model by segmenting CT**
- **04/17**
- **04/25**

**Navigation System 3.0**
- **Tracking of catheter**
- **Automatic Segmentation**
- **Apr 25**
- **05/03**

**Documentation**
- **May 7**

**Today**
- **02/12**
- **02/20**
- **03/08**
- **04/01**

**3 mm accuracy**

**03/16**
## Management Plan

<table>
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<tr>
<th>Member</th>
<th>Responsibility</th>
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</table>
| 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
Reading List


Thank You!

Any Questions?