AR-Assisted Medical Training:
Tutorial Generation & Eye Gaze Tracking Analysis

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Goals

- Create a software tool to facilitate the **semi-automated creation** of medical training tutorials
  - Capture speech and visual data
  - Provide a user-friendly AR interface through which JSON training files may be generated
- Use **eye gaze tracking data** to facilitate performance analysis
  - Generate heatmap while user is being trained
Background

- HMDs have been used for treatment, education, rehabilitation, and surgery.
- The current framework stores step-by-step instructions for various procedures.
- Instructions and visual aids are displayed as graphical overlays in the HMDs to the trainees.
1) View anatomy and make sure you have the appropriate tools.

4) Firmly insert needle and catheter until 3-1/4 inch (8 centimeters) into the skin. The needle-catheter unit should be at a 90-degree angle with respect to the skin.
Virtual Overlay and Camera Image
Current state

- Microsoft HoloLens
- Currently must have a medical professional manually specify steps and reference images
- JSON files are relatively difficult to create/edit
- Our project seeks to facilitate the generation of training data
Technical Approach

- The content generation tool will be developed on **Unity**
  - Visual Studio with Windows 10 SDK
  - Vuforia (Unity extension)
- Use Pupil Labs HoloLens Binocular Add-on for gaze tracking
  - Functions/libraries are in **C/C++**
  - These are held together with **Python** (Cython)
Planned Modules

- HMD training
  - Training creation UI
  - Gaze tracking
  - Voice commands
  - Speech to text
  - Camera
  - Image capture
  - Marker tracking
  - Indicator creation
  - Expertise level selection
Planned Modules (continued)

- Gaze tracking
  - Tracking Data parsing layer
    - 2D Heatmap Generation
    - 3D Heatmap Adaptation Module
      - Heatmap Visualisation Layer
        - Optimisation Enabling Layer
Deliverables

- **Minimum**
  - Working demo of tutorial editor
    - Speech-to-text
    - Generation of 2D heatmap of gaze

- **Expected**
  - Working demo of tutorial editor
    - Speech-to-text
    - Image capture
  - Generation of 2D and 3D heatmap of gaze
    - Ability to view heatmap data in using a graphical aid - either within the Hololens or some interactive 3D environment

- **Maximum**
  - Working demo of tutorial editor
    - Speech-to-text
    - Image capture
    - Marker creation
    - Expertise levels
  - Using 3D and 2D gaze tracking heatmaps to optimize processes
  - Testing with ventriculostomy procedure under guidance of medical professional
Dependencies

**01**
Access to HoloLens and Pupil Labs HoloLens Binocular Add-on
- Submit LCSR form for Robotorium access
- Contact Dr. Huang for access to his lab
- Complete

**02**
Access to existing codebase (GitLab)
- Email Ehsan for Git invite
- Complete

**03**
Installation of toolkits and Unity SDK
- Visual Studio
- HoloLens Emulator
- Unity
- Vuforia
- Partially complete; 1 laptop
- Contingency - Seek mentors’ aid for setup
- Expected resolution by - February 25

**04**
Neurosurgeon to try out a demo
- Get contact info at next meeting with mentors - February 27
- Email/call neurosurgeon to set up date - March 1
- Have single-user trial of demo - Mid-April
  - Ventriculostomy
Management Plan

- Weekly meetings with collaborating team
  - Tuesdays after class (3pm)
  - Discuss integration
  - Review compatibility

- Biweekly meetings with mentors
  - Updates on progress
  - Conflict and dependency resolution

- Source control
  - Develop on a branch of existing codebase
  - GitLab repository
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<thead>
<tr>
<th>Milestone Date</th>
<th>Milestone Details</th>
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<tbody>
<tr>
<td>March 18</td>
<td>User Interface</td>
</tr>
<tr>
<td>March 31</td>
<td>Text-to-Speech &amp; 2D Heatmaps</td>
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<tr>
<td>April 15</td>
<td>Image Capture, Working Demo &amp; Single User Trial</td>
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<tr>
<td>April 28</td>
<td>Marker Creation &amp; 3D Heatmaps</td>
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<td>May 6</td>
<td>Final Report &amp; Demo</td>
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**User Interface**
- Able to accept voice commands
- Synchronizing with video feed

**Text-to-Speech & 2D Heatmaps**
- Able to generate text-based tutorials
- Gaze-tracking implemented with 2D heatmaps

**Image Capture, Working Demo & Single User Trial**
- Tutorials include both text and images
- Have neurosurgeon create training module

**Marker Creation & 3D Heatmaps**
- Implement ability to create virtual markers
- 3D heatmaps added

**Final Report & Demo**
- Have demo ready for live demonstration
- Complete final report and presentation
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<tr>
<th>Task Name</th>
<th>Duration</th>
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<tr>
<td><strong>Become familiar with codebase &amp; software</strong></td>
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<tr>
<td>- Literature review</td>
<td>2/13-2/28</td>
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<tr>
<td>- Install HoloLens development tools</td>
<td>2/20-2/22</td>
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<tr>
<td>- Familiarize ourselves with Unity</td>
<td>2/22-2/28</td>
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<td>- Prototype design</td>
<td>2/23-3/6</td>
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<td>- Prototype code</td>
<td>3/1-3/31</td>
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<td>- Advanced feature design</td>
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<td>- Advanced feature code</td>
<td>4/1-4/30</td>
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<tr>
<td><strong>Initial implementation of basic prototypes</strong></td>
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<tr>
<td>- Content generator interface</td>
<td>3/2-4/16</td>
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<td>- Voice commands</td>
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<td>- Speech-to-text</td>
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<td>- 2D heatmaps</td>
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<td><strong>Troubleshooting/testing prototype</strong></td>
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<td><strong>Advanced implementations</strong></td>
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References

1. Evaluation of Optical See-Through Head-Mounted Displays in Training for Critical Care and Trauma.
3. Pupil Labs Documentation: [https://docs.pupil-labs.com/](https://docs.pupil-labs.com/)
1. Evaluation of Optical See-Through Head-Mounted Displays in Training for Critical Care and Trauma.