Visual Feedback for Skill Acquisition in Cataract Surgery

Advanced Computer Integrated Surgery
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Mentors: Austin Reiter; Swaroop Vedula
Cataract is clouding of the lens in the eye which in turn affects vision. It is pretty common in older ages.

https://nei.nih.gov/health/cataract/cataract_facts
Capsulorhexis
• Technique by Howard Gimbel to remove the lens capsule during cataract surgery

• Use the same bent needle to begin a tear in the capsule

• Use forceps or needle to remove the lens
Motivation and Background

- Not high risk, sometimes can cause run away tears
- Leakage of vitreous humor
- Skill required to mend tear - **high**!
- Current Feedback for skill acquisition is verbal instruction
- Better to have directed feedback
- **Aim** - Develop visual feedback to support skill training during task performance
“open-source mechatronics” system, consisting of electronics, firmware, and software that is being used to control research systems based on the first-generation da Vinci system.

More information:

https://github.com/jhu-dvrk/sawIntuitiveResearchKit/wiki

Technical overview brief steps

- Operate the dvrk on phantom
- Collect video of the operation
- Collect tool force data using a ROS node from the da vinci research kit
- Determine tool force at each co-ordinate of each frame of the video
- Use regression techniques to determine tool force and direction at any co-ordinate of the image
Brief workflow

- **dvrk operation of capsulorhexis on phantom**
- **ROS node to pull data using dvrk ROS package**
- **Video of operation containing tool force data at each co-ordinate of the frames of the video.**
- **Use regression techniques to find tool force required and direction for operation at each co-ordinate of frames.**

**Minimum Deliverable stage**

- **Compare tool force patterns between novice and expert**

**Expected Deliverable stage**

- **Overlay the image containing magnitude and direction of force during operation.**
Deliverables

Minimum:
- Simple phantom to simulate the task
- Video of tool motion with da vinci research kit
- Visual overlay of tool forces

Expected:
- Compare tool force pattern between experts and novices

Maximum:
- Data of errors in this estimation
<table>
<thead>
<tr>
<th>Dependencies</th>
<th>State (resolved/pending/in progress)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phantom for simulation of the task</td>
<td>In progress</td>
</tr>
<tr>
<td>Setup of Da Vinci research Kit ROS package</td>
<td>In progress</td>
</tr>
<tr>
<td>Access to Da Vinci Research KIT</td>
<td>In progress (have talked with Anton)</td>
</tr>
<tr>
<td>Software setup (misc. i.e script for supervised learning, ROS node for pulling data from dvrk, visual overlay system, relevant OpenCV packages)</td>
<td>Pending</td>
</tr>
<tr>
<td>Force sensor</td>
<td>In contact with Preetham</td>
</tr>
<tr>
<td>Experts for operation</td>
<td>Pending</td>
</tr>
<tr>
<td>Mentors</td>
<td>Resolved</td>
</tr>
<tr>
<td>Regression Technique</td>
<td>Yet to be decided</td>
</tr>
</tbody>
</table>
This could go wrong!!

- Data obtained is insufficient - probably use different sensors, keep occlusion in mind, collect more data
- Cannot obtain experts - try to validate with existing people
## CIS 2

### Minimum deliverables
- Simple phantom to simulate the task
- Understand DVRK software
- Understand how to use DVRK
- Setup ROS node to pull data from dvrk
- Operate on the phantom using the dvrk to collect data
- Video of tool motion with dvrk
- Extract Tool-force vector at each co-ordinate in each frame of video
- Estimate tool-force vector for any point of the procedure
- Visual overlay of tool force vectors

<table>
<thead>
<tr>
<th>Activity</th>
<th>Start</th>
<th>End</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simple phantom to simulate the task</td>
<td>02/22</td>
<td>05/01</td>
</tr>
<tr>
<td>Understand DVRK software</td>
<td>02/22</td>
<td>03/09</td>
</tr>
<tr>
<td>Understand how to use DVRK</td>
<td>02/24</td>
<td>03/06</td>
</tr>
<tr>
<td>Setup ROS node to pull data from dvrk</td>
<td>03/05</td>
<td>03/10</td>
</tr>
<tr>
<td>Operate on the phantom using dvrk to collect data</td>
<td>03/08</td>
<td>03/11</td>
</tr>
<tr>
<td>Video of tool motion with dvrk</td>
<td>03/16</td>
<td>04/03</td>
</tr>
<tr>
<td>Extract Tool-force vector at each co-ordinate in each frame of video</td>
<td>03/16</td>
<td>04/03</td>
</tr>
<tr>
<td>Estimate tool-force vector for any point of the procedure</td>
<td>03/31</td>
<td>04/14</td>
</tr>
<tr>
<td>Visual overlay of tool force vectors</td>
<td>04/16</td>
<td>05/01</td>
</tr>
</tbody>
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### Expected Deliverables
- Obtain video data of operation via experts and novices
- Compare the tool-force patterns between experts and novices

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<td>04/20</td>
<td>04/25</td>
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<tr>
<td>Compare the tool-force patterns between experts and novices</td>
<td>05/02</td>
<td>05/10</td>
</tr>
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### Maximum Deliverable
- Compute errors in tool-forces between estimated and actual

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**Group members:** Abhilash

**Mentors:** Austin Reiter; Swaroop Vedula

**Weekly meetings:** On demand

