Software for an Intra-Operative “Kinect” with a Flexible Endoscope

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Mentors: Dr. Austin Reiter and Dr. Russell Taylor
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Relevance

- “Depth cameras” have spurred the popularity and approachability of real-time 3D reconstruction
- 3D reconstruction based on images captured by endoscope
- Small laser allows for structured light approach with endoscope
Technical Approach

1) Calibration of laser-camera setup
   a. Rigidly affix laser to camera
   b. Obtain laser pattern template from manufacturer OR calibrate on flat surface
   c. Calculate disparity/depth maps of simple objects

2) 3D reconstruction of objects
   a. Reconstruction of simple objects (cubes, spheres)
   b. Reconstruction of complex objects (model of head with CT ground truth)

3) Camera tracking and reconstruction
   a. Track motion of camera relative to assumed static scene using open-source SLAM algorithm

Data collection, testing, and code review

Future work with endoscopes and real patients...
Deliverables

● Minimum
  ○ Rigid fixation method of camera to laser
  ○ Template for laser pattern in appropriate coordinates relative to camera
  ○ Code to compute depth map for camera’s field of view**
  ○ Code to create 3D reconstruction of simple objects based on depth map**

● Expected
  ○ Code to create 3D reconstruction of complex objects based on depth map**

● Maximum
  ○ Code to track camera movement relative to static scene to stitch together static 3D reconstructions**

** Includes testing scripts to verify mm accuracy
Timeline

02/19/17
- Rigid Fixation of Camera and Laser
- Develop Calibration Code
- Collect Laser Pattern Data
- Create Testing Setup for Calibration
- Develop Testing Scripts for Calibration Code
- Collect Data to Test Calibration Accuracy
- Develop 3D Reconstruction Code
- Plan Testing for 3D Reconstruction
- Collect Data to Test Reconstruction Accuracy
- Develop Camera Tracking Code
- Create Testing Setup for Camera Tracking
- Collect Data to Test Camera Tracking

03/21/17

04/20/17

05/20/17
## Dependencies

<table>
<thead>
<tr>
<th>Dependency</th>
<th>Plan for Resolving</th>
</tr>
</thead>
<tbody>
<tr>
<td>Access to laser &amp; camera</td>
<td>Resolved on 2/10</td>
</tr>
<tr>
<td>Access to lab space for storage/testing</td>
<td>Resolved on 2/17</td>
</tr>
<tr>
<td>Reliable fixation method for camera and laser</td>
<td>Work with Tae Soo Kim on 2/23</td>
</tr>
<tr>
<td>Development of testing setup</td>
<td>Work with Tae Soo Kim</td>
</tr>
<tr>
<td>3D reconstruction depends on calibration</td>
<td>Seek guidance from Dr. Reiter if problems arise</td>
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<tr>
<td>Camera tracking depends on 3D reconstruction</td>
<td>Seek guidance from Dr. Reiter if problems arise</td>
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<tr>
<td>Obtaining Tae Soo Kim’s prior work</td>
<td>Reach out to Tae Soo Kim and Dr. Reiter to obtain</td>
</tr>
<tr>
<td>Obtaining calibration code</td>
<td>Dr. Reiter will reach out, otherwise we will develop code</td>
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Management Plan

- Weekly meeting with Dr. Reiter for updates and guidance
- Periodic meetings with Dr. Taylor for guidance
- Elli - physical setup, writing scripts to test accuracy of code
- Shohini - writing code to compute depth map and 3D reconstructions
- Elli & Shohini together - data collection, code review
Reading List

6. Tae Soo Kim’s reports from CIS 2 project (and maybe code and MS thesis)
8. SLAM algorithm: https://github.com/simondlevy/BreezySLAM
Questions?