Project 9
Data Integration during Robotic Ultrasound-Guided Surgery

Team Members
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Mentors
Colin Lea, Theodoros Katsichtis

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Overview

- Background
- Current interface
- New design
- Deliverables
- Technical approach
- Dependencies
- Timeline
Laparoscopic Ultrasound

- minimally invasive procedure in abdominal cavity
- augment with ultrasound probe

Applications
- Biopsy, ablation
- Liver and kidney scanning and staging
- Lesion detection

European Eurology, http://www.eurohifu.com/sona600i.htm
Advantages

- provides real-time imaging
- enhances perception
- improve manipulability
- minimally invasive procedures
Current Interface

Real Time Video

Real Time Ultrasound

3D Lesion Mapping tool

Da-Vinci + RealTime Ultrasound

Lea '13
Problems with Current Interface

- 3D lesion mapping tool not ready for clinical use.
- Improper information display.
- Surgeon cannot see measurements.
  a. Operative tool.
  b. Lesion size in the ultrasound.
- Surgeons must switch between screens for preop images.
We propose the development and utilization of a novel Da Vinci interface, integrating and displaying live intraoperative ultrasound as well as additional preoperative data to improve the ergonomy and efficacy of robotic procedures.
Deliverables (minimum)

1. Acquire software dependencies, Mock OR access.
2. Remove 3D lesion mapping tool.
3. Implement real-time measurement of operative tool.
4. Ultrasound images save and browse on console.
5. Preliminary clinical study design (task experiments, user feedback survey).
Deliverables (expected)

1. Contact surgical collaborators for clinical study.

2. Have participating surgeons scheduled and confirmed.

3. Assist in testing and deployment of the software in the mock OR.

4. Features/changes requested from clinical tests.

5. Tool to measure lesion size on the ultrasound image.
Deliverables (maximum)

1. Incorporate DICOM reader with Masters as Mice into the interface.

2. Use 3D fiducials to show previously viewed areas.

3. Ability to manipulate a 3D model of a lesion or organ.

4. Build 3D model of organs from CT.
Possible follow-ups

1. Speech-to-text intraop notes.

2. 3D representation of the US probe in the UI.

3. Enable 3D fiducial placement on the 3D models, not just the US images.
BLOCK DIAGRAM

Camera 1

Camera 2

Tile Pro

UltraSound

User Interface

Surgical Assistant WorkStation
Technical Approach (Software)

- Remove the 3D lesion mapping tool.
- Real Time Operative tool measurement
  - Da Vinci read API
- Lesion measurement tool
  - Perform calibration between the US image and user interface
- User friendly interface
  - Less disruptive color scheme
  - Save and Browse Ultrasound images, with lesion description
Technical Approach (Clinical)

- Prepare IRB and budget proposals.
- Contact surgeons to participate in study.
- Determine tasks (i.e. lesion detection) for study.
- Clinical study part 1 (baseline interface):
  - UI, live da Vinci camera and real-time ultrasound included.
- Clinical study part 2 (enhanced interface)
  - Test 3D lesion mapping, 3D model manipulation.
## Objective Satisfaction Questionnaire

<table>
<thead>
<tr>
<th>Feature</th>
<th>Excellent</th>
<th>Good</th>
<th>Fair</th>
<th>Poor</th>
<th>Very poor</th>
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</thead>
<tbody>
<tr>
<td>Reliability</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Probe positioning</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Lesion localization</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Comfortable</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Image quality</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Overall</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
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</table>

Katsichtis. '13
## Supplemental Questionnaire

<table>
<thead>
<tr>
<th>Feature</th>
<th>Hopkins GUI</th>
<th>Tile Pro</th>
<th>None</th>
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</thead>
<tbody>
<tr>
<td>Better probe positioning</td>
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<td></td>
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<tr>
<td>Most comfortable</td>
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<td></td>
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<tr>
<td>Confidence in finding lesions</td>
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<td></td>
<td></td>
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<tr>
<td>Use over long periods</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Overall most useful</td>
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</table>

*Katsichtis. '13*
Dependencies (Software)

   ○ Install the video grabber.
   ○ QT Creator IDE
   ○ CISST

2. Intuitive API.

3. LapUS code
1. Possible IRB proposal already written by Theodore.

2. Liver phantom
   - Gelatin phantom w/ pseudolesions recommended by Dr. Choti

3. Surgical/clinical collaborators

4. Mock OR and Da Vinci robot access
# Project Timeline

<table>
<thead>
<tr>
<th>Minimum Software Deliverables</th>
<th>February</th>
<th>March</th>
<th>April</th>
<th>May</th>
</tr>
</thead>
<tbody>
<tr>
<td>Software dependencies, mock OR access.</td>
<td>Everyone</td>
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<tr>
<td>Operative field measurement tool.</td>
<td>Vineeta</td>
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<td></td>
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<tr>
<td>Save and browse US images on console.</td>
<td>Vineeta</td>
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</table>

<table>
<thead>
<tr>
<th>Minimum Clinical Deliverables</th>
<th>February</th>
<th>March</th>
<th>April</th>
<th>May</th>
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</thead>
<tbody>
<tr>
<td>Preliminary clinical study design.</td>
<td>Andrew, Tiffany</td>
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<tr>
<td>Contact surgical collaborators for clinical study.</td>
<td>Andrew, Tiffany</td>
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<tr>
<td>Schedule and confirm participating surgeons.</td>
<td>Andrew, Tiffany</td>
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<tr>
<td>Testing of baseline interface.</td>
<td>Andrew, Tiffany</td>
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<tr>
<td>Clinical study design for enhanced interface.</td>
<td>Andrew, Tiffany</td>
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<td>Testing of enhanced interface.</td>
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<th>March</th>
<th>April</th>
<th>May</th>
</tr>
</thead>
<tbody>
<tr>
<td>Real-time measurement of tool for US images.</td>
<td>Vineeta</td>
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<tr>
<td>Incorporate DICOM reader Mice into interface.</td>
<td>Vineeta</td>
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<tr>
<td>Manipulate a 3D model of a lesion or organ.</td>
<td>Everyone</td>
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<tr>
<td>Implement placeable virtual 3D fiducials.</td>
<td>Everyone</td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>
Reading List


- Caitlin M. Schneider, B. P. D. P., MD; Russell H. Taylor, PhD; Gregory W. Dachs II, MS; Christopher J. Hasser, PhD; Simon P. DiMaio, PhD; Michael A. Choti, MD, MBA, FACS Surgical Technique: Robot-assisted laparoscopic ultrasonography for hepatic surgery.


- Craig G. Rogers, M. R. L., MD; Akshay Bhandari, MD; Louis Spencer Krane, MD; Daniel Eun, MD; Manish N. Patel, MD; Ronald Boris, MD; Alok Shrivastava, MD; Mani Menon, MD (2009). “Maximizing Console Surgeon Independence during Robot-Assisted Renal Surgery by Using the Fourth Arm and TilePro.” Journal of Endourology 23(1): 115-121.
