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Project 9

Data Integration during Robotic Ultrasound-Guided Surgery

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Mentors
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Overview

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

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Laparoscopic Ultrasound

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

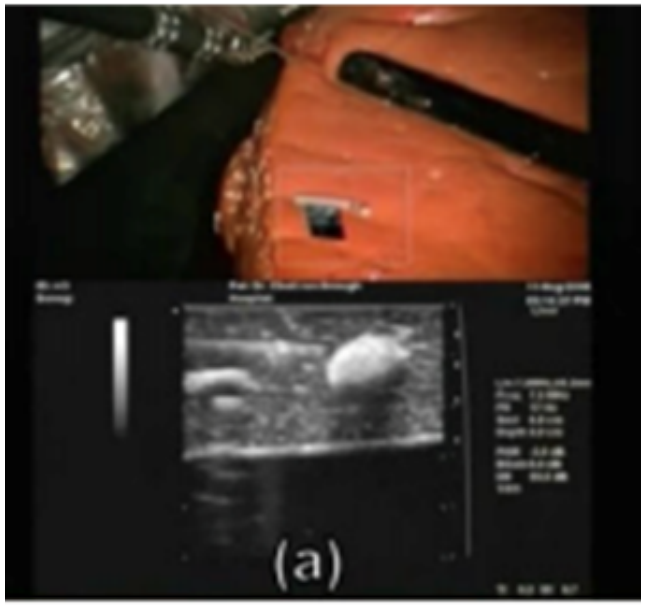
European Eurology, http://www.eurohifu.com/sona600i.htm

Applications

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

Advantages

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



C.M. Schneider '10

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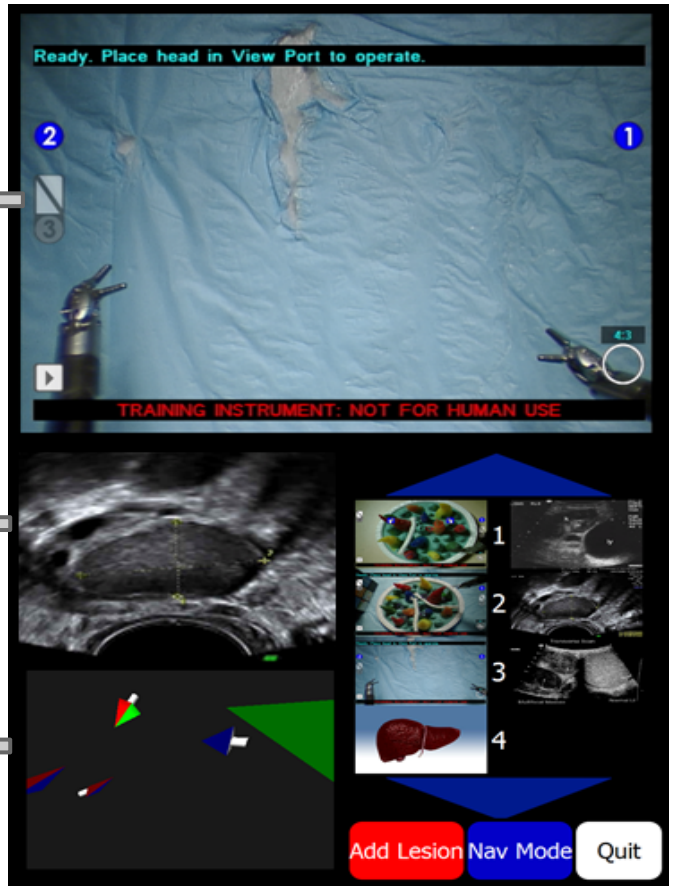
Current Interface

Real Time Video

Real Time Ultrasound

3D Lesion Mapping tool



Lea '13

Da-Vinci
+
RealTime
Ultrasound

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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.

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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.

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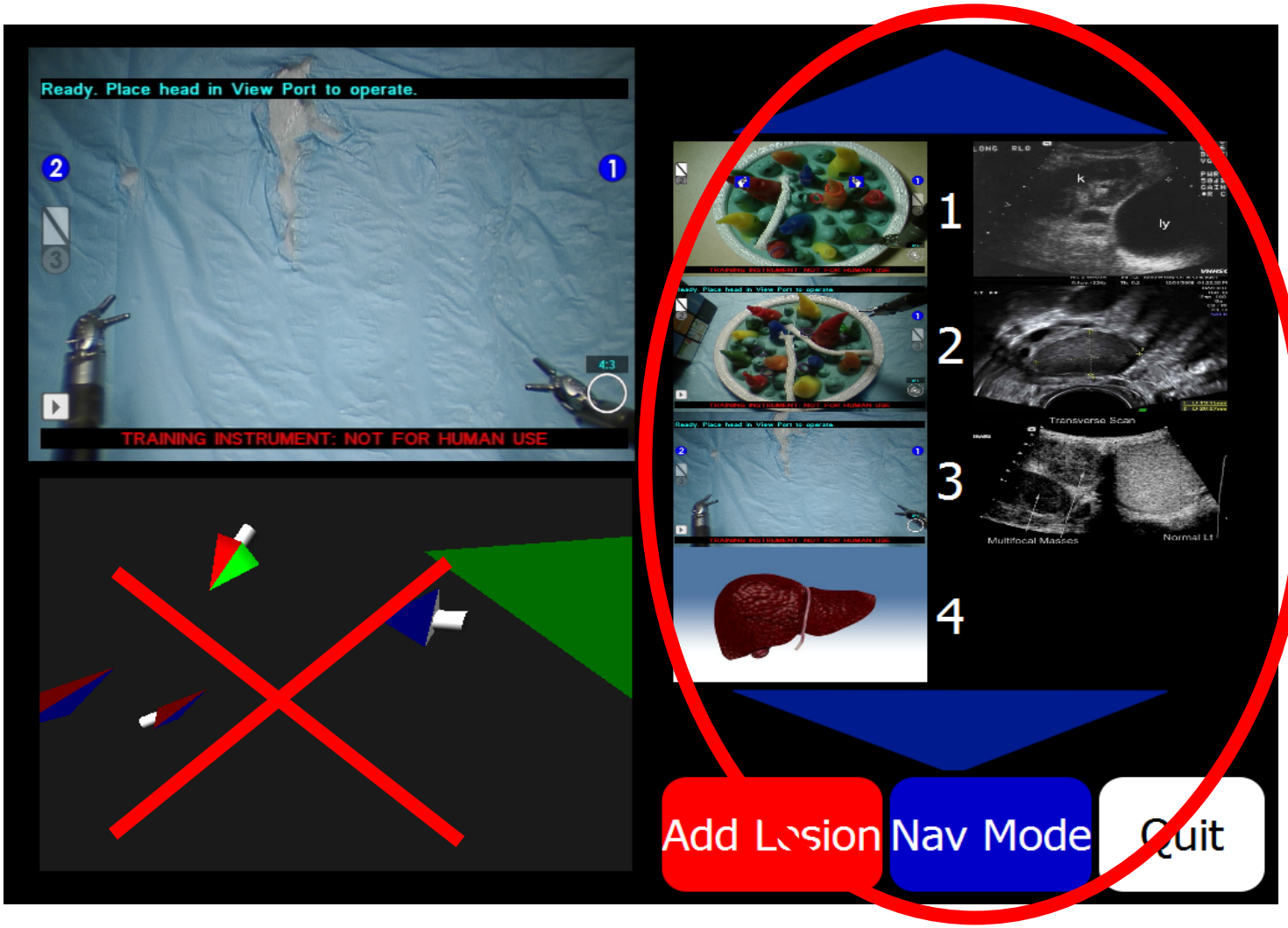
Ready. Place head in View Port to operate.
TRAINING INSTRUMENT: NOT FOR HUMAN USE
1
2
3
4
Transverse Scan
Multifocal Masses
Add Lesion
Nav Mode
Quit

Lea '13

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.

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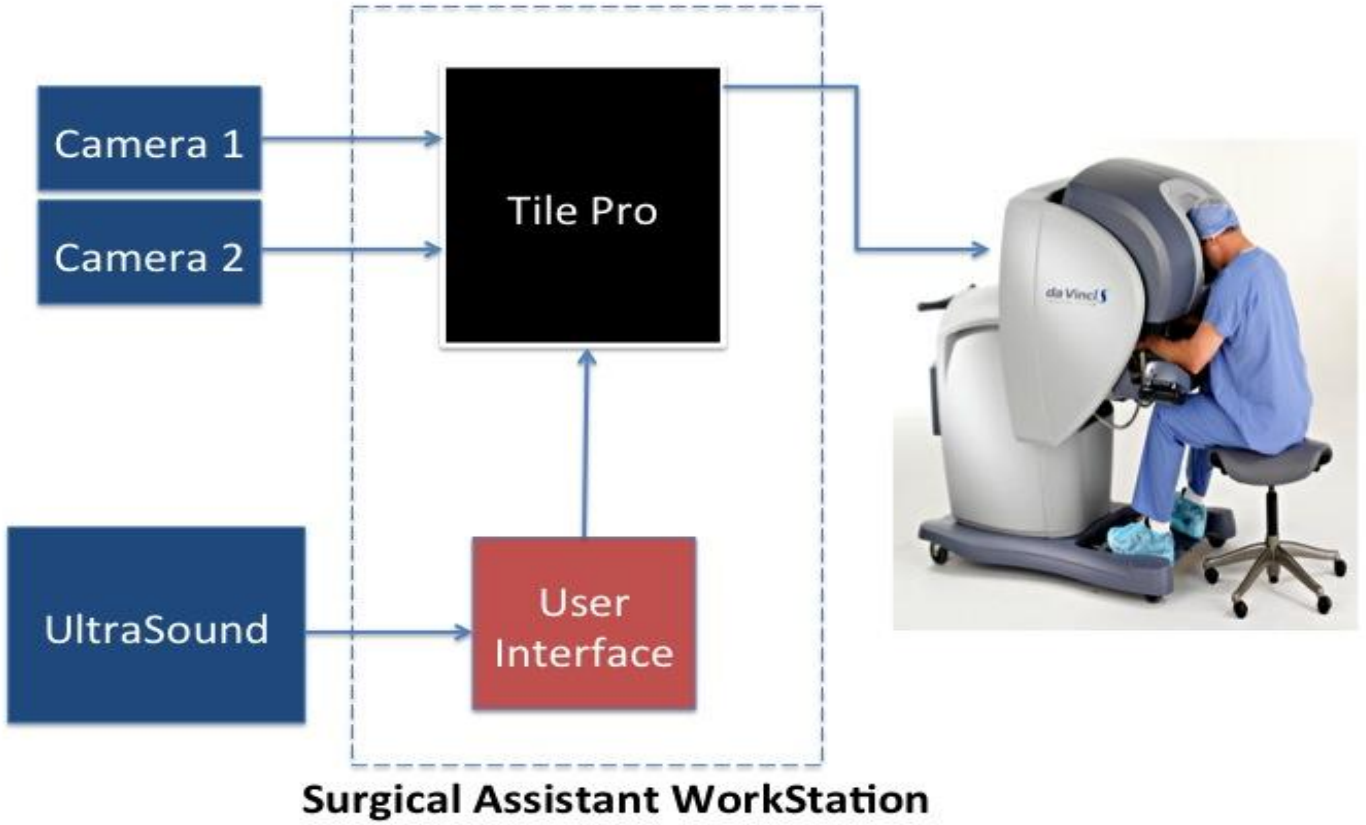
BLOCK DIAGRAM



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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

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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.

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Objective Satisfaction Questionnaire

	Excellent	Good	Fair	Poor	Very poor
Reliability	5	4	3	2	1
Probe positioning	5	4	3	2	1
Lesion localization	5	4	3	2	1
Comfortable	5	4	3	2	1
Image quality	5	4	3	2	1
Overall	5	4	3	2	1

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Supplemental Questionnaire

	Hopkins GUI	Tile Pro	None
Better probe positioning			
Most comfortable			
Confidence in finding lesions			
Use over long periods			
Overall most useful			

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Dependencies (Software)

1. Software Environment Set Up.
   - Install the video grabber.
   - QT Creator IDE
   - CISST

2. Intuitive API.

3. LapUS code

Dependencies (Clinical)

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

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Project Timeline

		February		March					April				May
		15	22	1	8	15	22	29	5	12	19	26	3
Minimum Software Deliverables													
Software dependencies, mock OR access.	Everyone												
Operative field measurement tool.	Vineeta												
Save and browse US images on console.	Vineeta												
Minimum Clinical Deliverables													
Preliminary clinical study design.	Andrew, Tifany												
Contact surgical collaborators for clinical study.	Andrew, Tifany												
Schedule and confirm participating surgeons.	Andrew, Tifany												
Testing of baseline interface.	Andrew, Tifany												
Clinical study design for enhanced interface.	Andrew, Tifany												
Testing of enhanced interface.	Andrew, Tifany												
Maximum Software Deliverables													
Real-time measurement of tool for US images.	Vineeta												
Incorporate DICOM reader Mice into interface.	Vineeta												
Manipulate a 3D model of a lesion or organ.	Everyone												
Implement placeable virtual 3D fiducials.	Everyone												

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Reading List

- Bartosz F. Kaczmarek, S. S., Firas Petros, Quoc-Dien Trinh, Navneet Mander, Roger Chen, Mani Menon, Craig G. Rogers (2012). “Robotic ultrasound probe for tumor identification in robotic partial nephrectomy: Initial series and outcomes.” International Journal of Urology.
- 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.
- Caitlin M. Schneider, G. W. D. I., Christopher J. Hasser, Michael A. Choti, Simon P. DiMaio, Russell H. Taylor Robot-Assisted Laparoscopic Ultrasound, Johns Hopkins University; Johns Hopkins Medicine; Intuitive Surgical, Inc.
- 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 Endourolgy 23(1): 115-121.
- Francesco Volonté, N. C. B., François Pugin, Joël Spaltenstein, Boris Schiltz, Minoa Jung, Monika Hagen, Osman Ratib, Philippe Morel (2012). “Augmented reality to the rescue of the minimally invasive surgeon. The usefulness of the interposition of stereoscopic images in the Da Vinci robotic console.” The Internation Journal of Medical Robotics and Computer Assisted Surgery.
- Joshua Leven, D. B., Rajesh Kumar, Gary Zhang, Steve Blumenkranz, Xiangtian (Donald) Dai, Mike Awad, Gregory D. Hager, Mike Marohn, Mike Choti, Chris Hasser, Russell H. Taylor DaVinci Canvas: A Telerobotic Surgical System with Integrated, Robot-Assisted, Laparoscopic Ultrasound Capability, The Johns Hopkins University; Intuitive Surgical, Inc.

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