Computational Sensing + Robotics
LABORATORY FOR
THE JOHNS HOPKINS UNIVERSITY

Project 9
Data Integration During Robotic Ultrasound-Guided Surgery Checkpoint Presentation

Team Members

Vineeta Khatuja, Andrew Wang, Tifany Yung

Mentors

Michael Choti MD MBA, Colin Lea, Theodoros Katsichtis, Russell Taylor PhD

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JOHNS HOPKINS
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Overview

- Project summary

- Deliverables

- Workflow

- Progress

- Dependencies

- Timeline

Project summary

Laparoscopic Ultrasound

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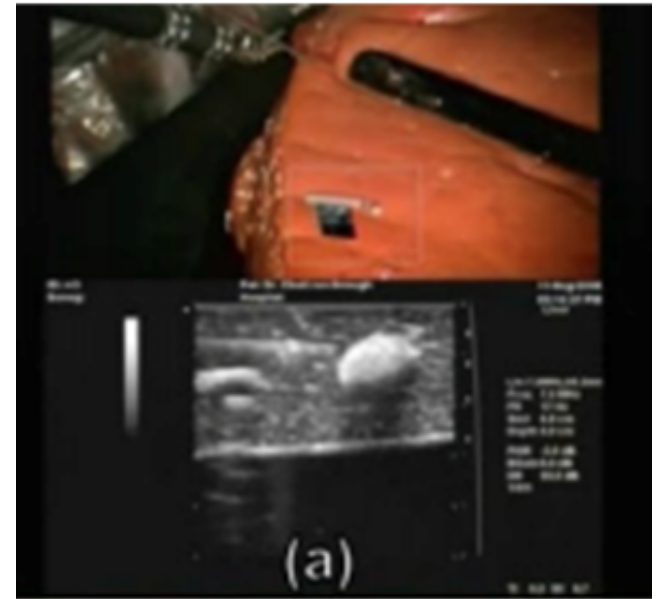
- augment with ultrasound probe

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

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.

Block diagram
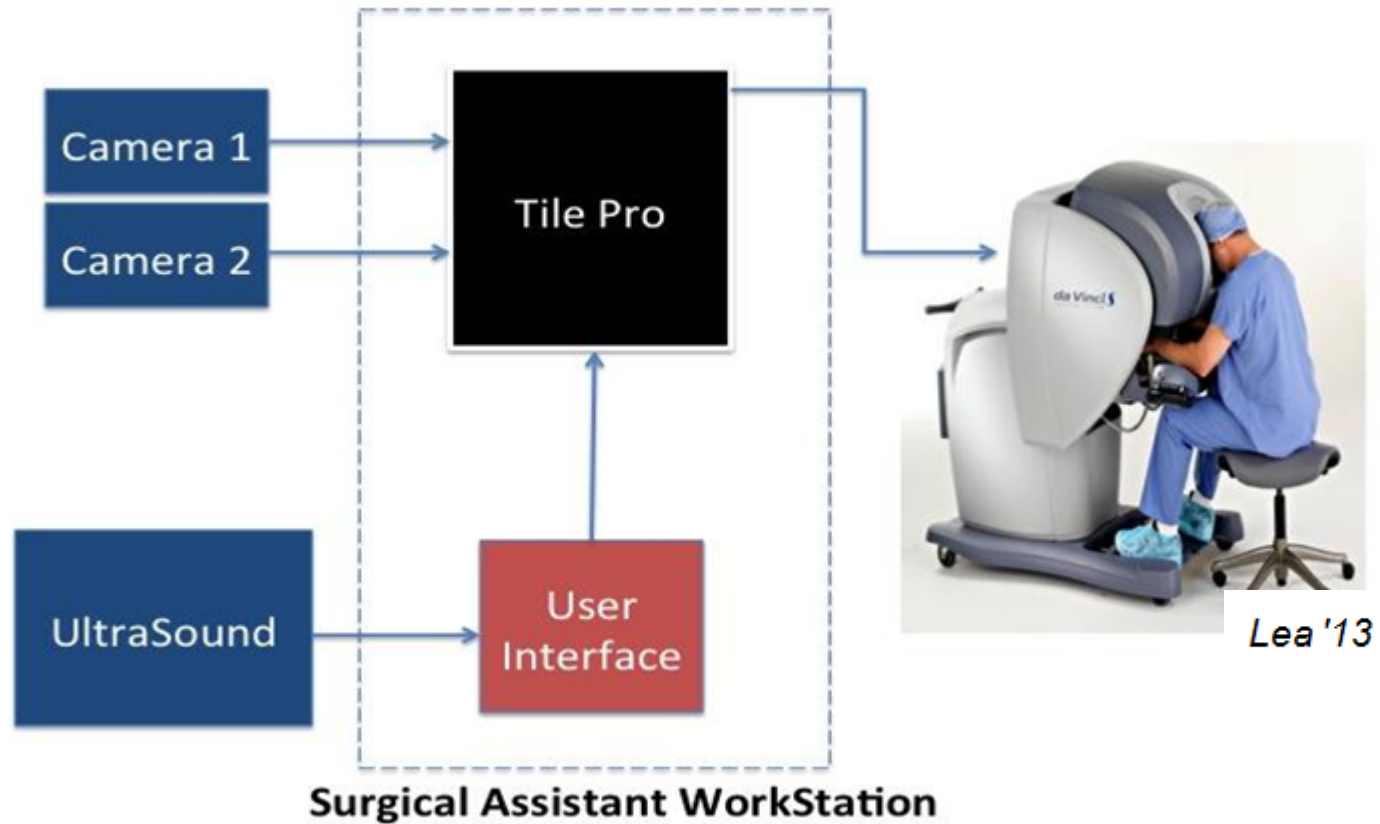
Lea '13

Deliverables

Deliverables (minimum)

1. **Acquire software dependencies, Mock OR access. – Delayed: hardware compatibility, delayed software dependencies.**

2. **Remove 3D lesion mapping tool. – Removed: created interface from scratch**

3. **Implement real-time measurement of operative tool. – Removed; will impinge on live ultrasound space.**

4. **Ultrasound images save and browse on console. – Complete.**

5. **Preliminary clinical study design (task experiments, user feedback survey). – Changed. Now nonclinical, to be performed in mock OR by team members.**

6. **ADDED AND COMPLETE: preoperative image viewer.**

7. **ADDED: Masters as Mice, necessity since starting from scratch.**

8. **ADDED: Maximize/minimize/zoom in windows for easier viewing.**

Deliverables (expected)

1. Contact surgical collaborators for clinical study. – In progress: with Dr. Choti.
2. Have participating surgeons scheduled and confirmed. – In progress: awaiting IRB approval.
3. Perform test and deployment of the software in the mock OR. - Upcoming: after baseline interface development.
4. Features/changes requested from clinical tests. – Moved to maximum: awaiting IRB approval.
5. Tool to measure lesion size on the ultrasound image. – Moved to maximum: priority shift.
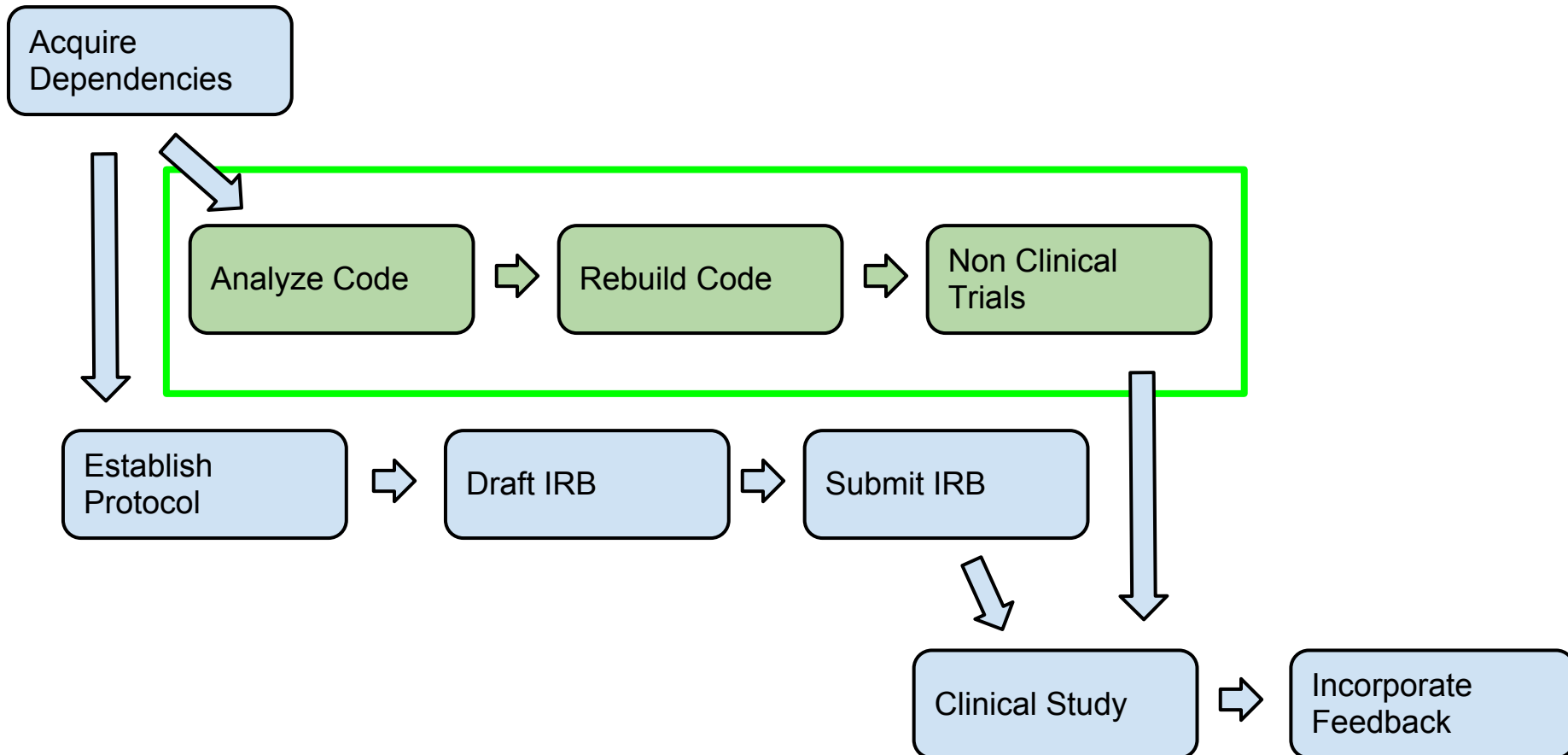
Deliverables (maximum)

1. Incorporate DICOM reader with Masters as Mice into the interface. – Moved to minimum: functional necessity.
2. Use 3D fiducials to show previously viewed areas. - Upcoming.
3. Build 3D model of anatomical structures from CT. - Upcoming.
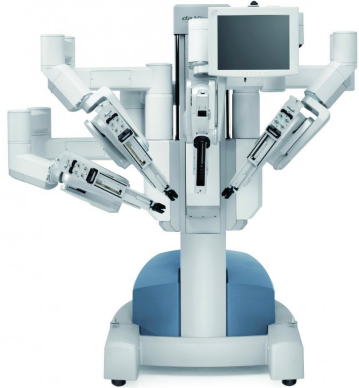4. Provide flexible view manipulation of 3D models. - Upcoming.

Work Flow
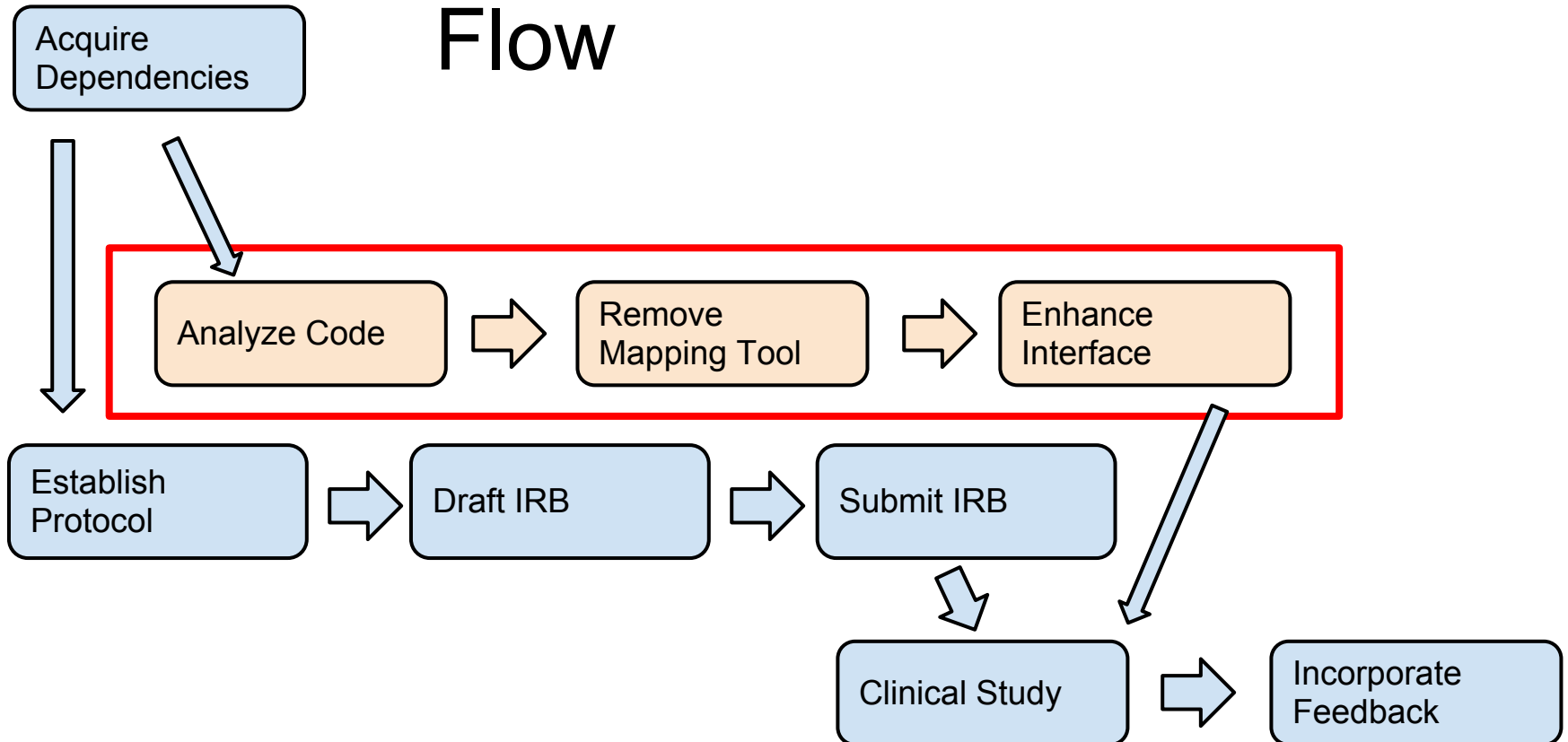
Actual Work Flow

Progress

System Block Diagram

Stereo Video → Frame Grabber

US Video → Frame Grabber → Computer Workstation

Computer Workstation → Da Vinci (Tile Pro)

Image Sources: http://deshawlaw.com/da-vinci-robotic-surgery-lawsuit-lawyers/
http://maplecrestimaging.com/ultrasound/

Progress (software)

- **Obtained compatible computer.**

- **Resolved Software/hardware dependencies.**
    - Video grabber installed.

- **Baseline interface.**
    1) Show the Ultrasound video
    2) Save US + live images
    3) View the saved images
    4) View the preop images in jpeg format

New Interface
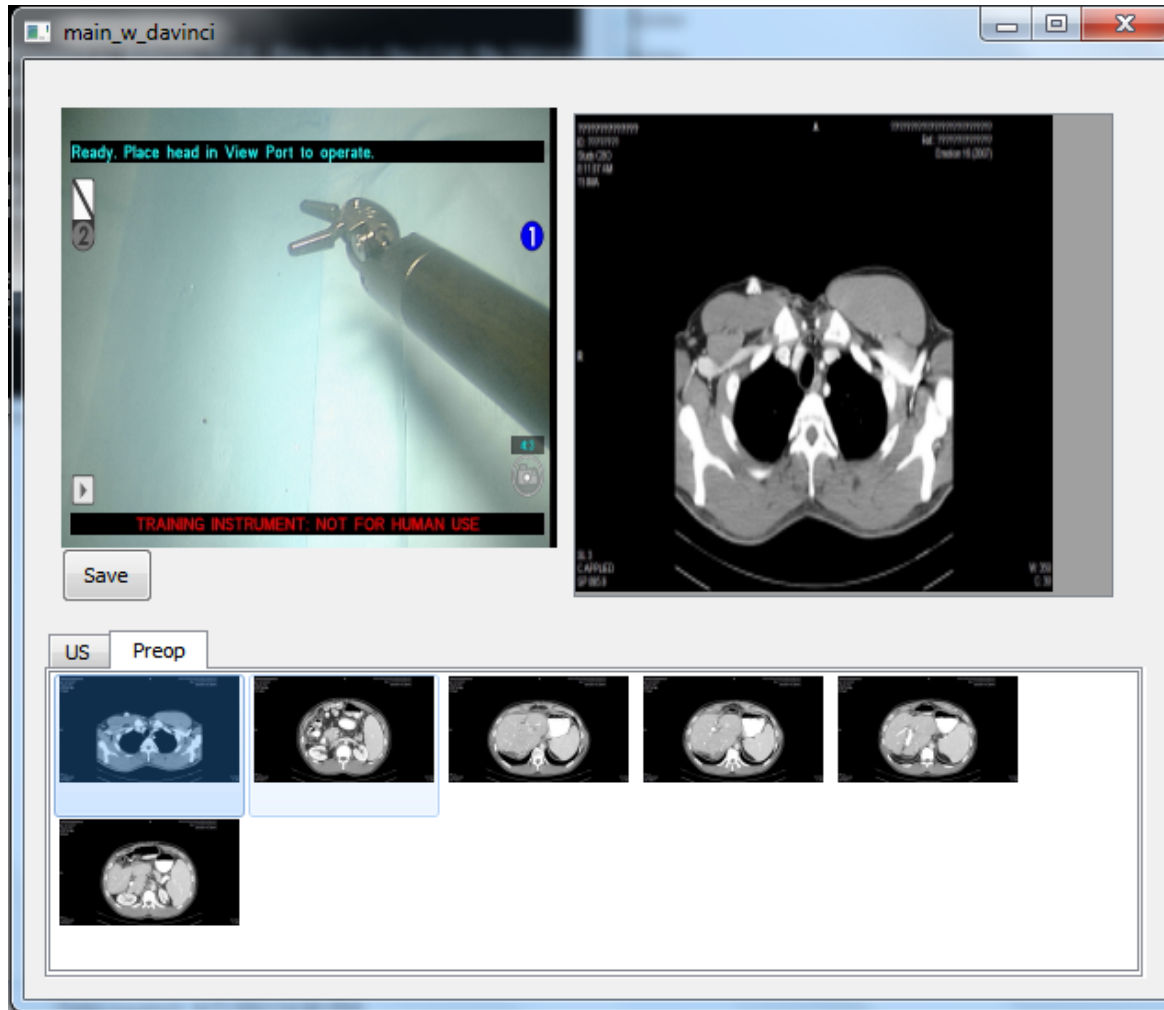
Pre-Operative Image Viewer

New Interface
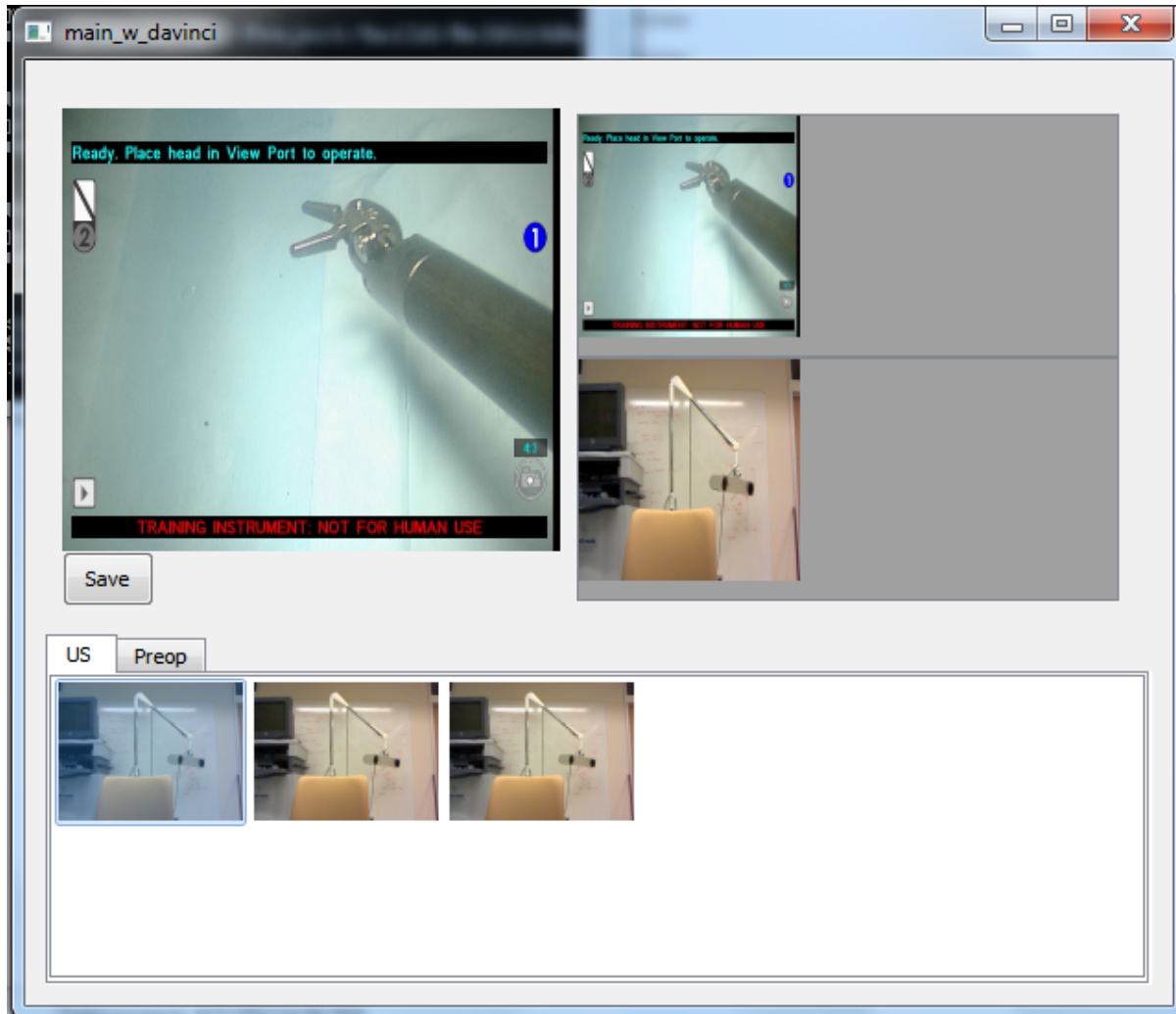
Ultrasound Image Viewer

Progress (software)

In progress

1) Master as mice.

2) Widget sizing, maximize/minimize/zoom in windows.

3) Picture in picture display for the US image viewer.
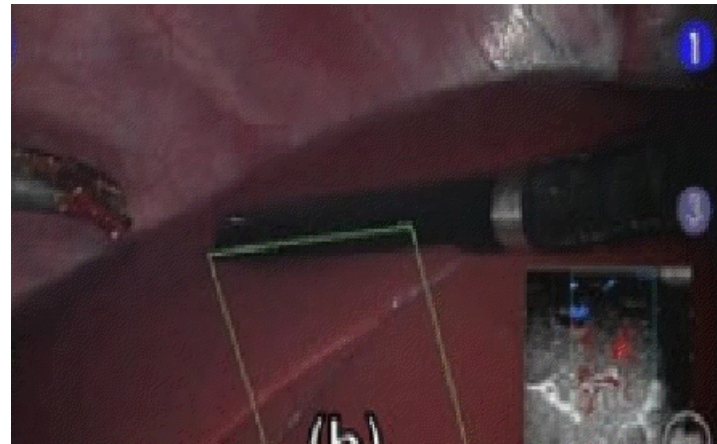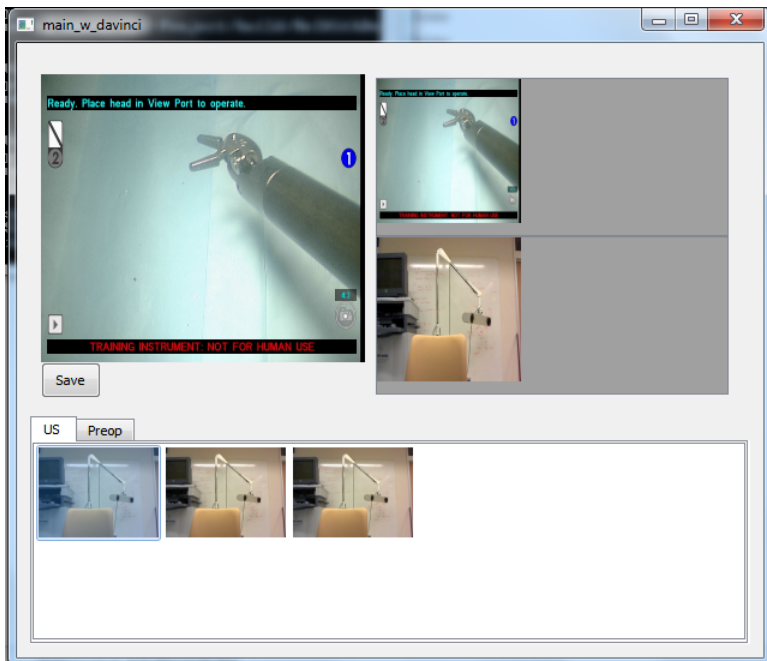
Progress (clinical)

- **Phantom materials obtained.**
    - Gelatin and cast ready.
    - To be cast a few days before mock OR trials.
- **Clinical testing plan designed.**
- **IRB submitted.**

- **In progress:**
    - Awaiting IRB approval.
    - Through Dr. Choti, seeking surgeons who'd be interesting in participating in clinical trials.

Dependencies

Dependencies (Software)

1. Software Environment Set Up.
○ Install the video grabber. – Resolved.
○ QT Creator IDE. – Resolved.
○ CISST – Resolved.
2. Intuitive API. – Resolved.
3. LapUS code. – Resolved.

Dependencies (Clinical)

1. Possible IRB proposal already written by Theodore and Dr. Choti. – Resolved.
2. Gelatin liver phantom. – Resolved (obtained gelatin and mold, to be cast 2 days before mock OR trials).
3. Surgical/clinical collaborators. – In progress.
4. Mock OR and Da Vinci robot access. – Resolved.

Timeline

Timeline (original)

		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					▨					■	■	■

Timeline (modified)

		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							✓					
Implement Masters as Mice	Vineeta												
Window Manipulation	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												
Manipulate a 3D model of a lesion or organ.	Everyone												
Implement placeable virtual 3D fiducials.	Everyone												

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.

Thank you!
Questions?