Recent Advancements in Simulators for Surgical Robotics

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Outline of the talk

- The Scientific Problem
- Surgical Simulators
- Simulators for Surgical Robotics
- Preoperative Planning for Surgical Robotics
- Conclusions
The Scientific Problem

Reducing Medical Errors

- Over half of all medical adverse events are surgical in nature and 75% of these happen in the operating room.
- Many of them may be errors caused by physicians in the process of the learning curve.
- The “Bristol Case” in the U.K. and the “Err is Human” report published by the Institute of Medicine in the United States suggested that better training and objective assessment would be key strategies in attaining the goal of reduced medical errors.

Drawing on the successful paradigm of flight simulation, Satava first proposed training surgical skills in virtual reality (VR) nearly a decade ago.

Source:

EndoCAS – University of Pisa, Italy
**Satava Insight**

**Requirements**

- Accurate Detail
- Highly Interactive

**A Realistic Simulation**

- Fidelity
- Object Properties
- Interactivity
- Sensory Input
- Reactivity

*Source:*

*EndoCAS – University of Pisa, Italy*
Roadmap for Future Simulators

- Haptics Integration
- DaVinci Incorporation
- Intelligent tutors
- Virtual Mentors
- Patient Specific Data for Surgical Planning and Rehearsal
- Judgement Assessment

Source:

EndoCAS – University of Pisa, Italy
The Value of Haptic Feedback

A potential major drawback, comparing robotic assisted surgery (RAS) to conventional endoscopic surgery (CES), is the absence of haptic feedback in RAS.

In CES force feedback is experienced by the surgeon through the laparoscopic instrument handles, resulting from the interaction of the laparoscopic instruments tips with the tissue.

In RAS, lack of force feedback may prolonge operative times and learning curves, and increase the risk of surgical errors. Even experienced surgeons training with RAS often tear apart sutures and damage delicate tissues.

The loss of force feedback in RAS compared with CES may be balanced partly by the restoration of three-dimensional vision.

Source
**Motivations**

Most robotic training occurs during live surgery or during robotic courses on animal models or inanimate objects.

Source:

The cost of the da Vinci Si System is approximately $1.7 million maintenance fee running between $125,000 and $150,000 per year. Adding a second console for training purposes would bring the cost to approximately $2.25 million.
RoSS by Simulated Surgical Systems

Developed in collaboration between Roswell Park Cancer Institute and the University at Buffalo.

RoSS (Robotic Surgical Simulator) to simulate the master console of da Vinci® Surgical System.

Two 6 d.o.f. input devices, stereo head mounted display, pedals for clutch and camera controls.

Unveiled in late February 2010.

Price: about 100,000 $.

http://www.simulatedsurgicals.com

EndoCAS – University of Pisa, Italy
**RoSS by Simulated Surgical Systems**

- **Basic skills module:** tissue cutting, knot tying, needle driving, needle manipulation, suturing, fourth arm manipulation, and vessel clipping.

- **Basic orientation module:** camera navigation, robotic arm control and orientation, safe synchronous camera and arm movement, use and maneuverability of a fourth arm, and clutch and wristed instrumentation.

- **Surgical modules:** Radical Prostatectomy, Hysterectomy, Cystectomy.

**EndoCAS – University of Pisa, Italy**

To improve hand eye coordination and teach basic robotic surgical skills.

To improve: the use and maneuvering of camera, the recognition of visual and depth perception, and the safe use of robotic surgical instruments.

To develop necessary technical and cognitive skills for specific steps during robot-assisted surgeries.
RoSS by Simulated Surgical Systems

Clinical Studies

dV-Trainer™ by Mimic

Commissioned by the Departments of Urology at Indiana University and Mechanical Engineering at Purdue University.

Accurate modeling of *da Vinci* kinematics and instruments.

Simulation exercises were developed in close collaboration with Intuitive Surgical to achieve unparalleled realism.

System training module: surgeon console awareness, endowrist manipulation, camera & clutching, trouble shooting.

Skills training module: needle control, needle driving, energy & dissection, games.

Price: 98,000 $.

http://www.mimic.ws
Simulators for Surgical Robotics

dV-Trainer™ by Mimic

Clinical Studies


SEP by SimSurgery

Clinical Study


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Preoperative Planning for Surgical Robotics

Patient Specific Data for Surgical Planning and Rehearsal

Intelligent tutors

Virtual Mentors

DaVinci Incorporation

Haptics Integration

Judgement Assessment

Source:

EndoCAS – University of Pisa, Italy
Benefits

Integrating the geometrical structure of the individual patient and the surgical scene in virtual space, surgeons can confirm the movability of the robot in the operating room.

Appropriate placement of the trocar ports maximizes the movable range of the robot, and significantly influences the success of the operation.

If surgeons rehearse by using a virtual training system, they can develop an intuitively common perception about how to set up the robot in the operating room and the actual setup time in the operating room will be reduced.

The planning system can be effective as an educational program for doctors who are inexperienced in robotic surgery.

Simulators for Surgical Robotics

- Judgement Assessment
- Intelligent tutors
- Virtual Mentors
- Any Robot Incorporation
- Haptics Integration
- Patient Specific Data for Surgical Planning and Rehearsal

Source:

EndoCAS – University of Pisa, Italy
The ARAKNES Simulator


EndoCAS – University of Pisa, Italy
Conclusions

- The Scientific Problem
- Surgical Simulators
- Simulators for Surgical Robotics
- Preoperative Planning for Robotic Surgery