NSF Engineering Research Center for Computer Integrated Surgical Systems and Technology

LABORATORY FOR Computational Sensing + Robotics THE JOHNS HOPKINS UNIVERSITY

Robotics Research in JHU CS:

Coupling information to action in the real world

Russ Taylor, Greg Hager
Peter Kazanzides, Rajesh Kumar, Emad Boctor

WHITING SCHOOL OF ENGINEERING
THE JOHNS HOPKINS UNIVERSITY

JHU Laboratory for Computational Sensing and Robotics

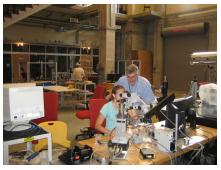
Approximately 95 full-time people:
- 10 faculty
- 15 postdocs
- 60 Graduate students
- 10 administrative and engineering staff
- Hundreds of undergraduates

Total yearly research of > $4M
- NIH
- NSF
- DARPA
- ONR

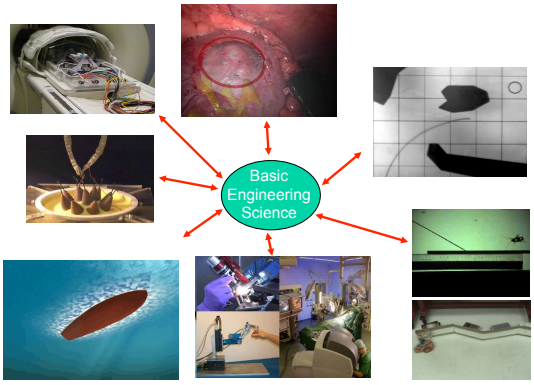
Collaborations with
- CMU, University of Maryland, Morgan State University, MIT, Columbia, U Washington, Harvard, Upenn, NIH …
- TU Munich, Queens University
- Siemens, Medtronic, Intuitive Surgical, Hologic, Sentinelle Medical, Ikona Inc.

LCSR is located in approx. 15,000 sq. ft custom designed space in **Hackerman Hall**, the new Computational Sciences and Engineering Building (CSEB)

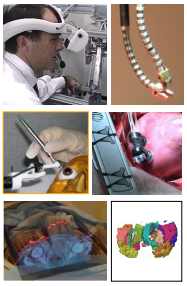
Hackerman Hall



Integrating Research and Education



Engineering Research Center for Computer Integrated Surgical Systems and Technology (CISST ERC)



The CISST ERC is developing a family of surgical systems that combine innovative algorithms, robotic devices, imaging systems, sensors, and human-machine interfaces to work cooperatively with surgeons in the planning and execution of surgical procedures.

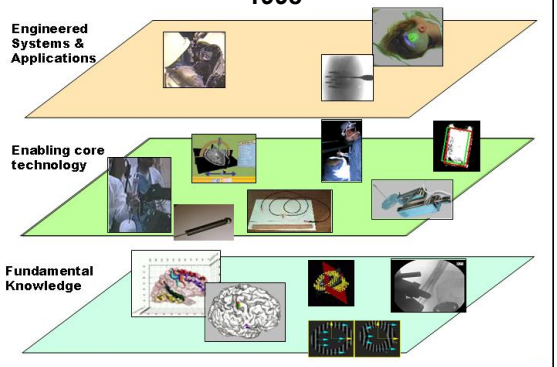
Areas of Research

- Robotic surgical assistants
- Image-guided interventional systems
- Focused interdisciplinary research in algorithms, imaging, robotics, sensors, human-machine systems

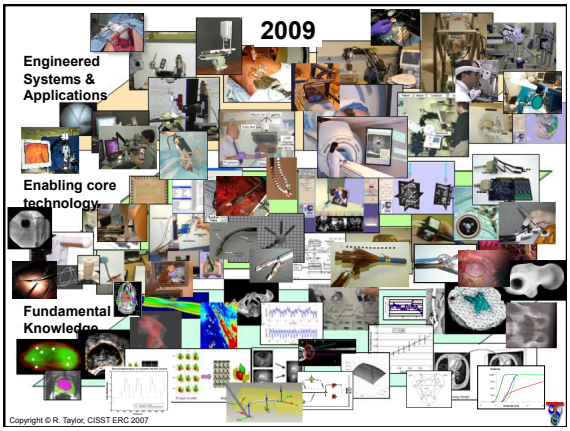
Institutions & Funding
- Johns Hopkins, MIT, CMU, BWH, Harvard, Penn, Morgan State, Columbia
- Years 1-10: NSF = $30.2M; Total = ~$73M

cisstweb.cs.jhu.edu

1998



2009



Who Does What?

- **Russ Taylor**
  - Computer-Integrated Surgery, Robotics, Medical Imaging
- **Greg Hager**
  - Computer Vision, Robotics, HCI, Computer-Integrated Surgery
- **Peter Kazanzides**
  - Computer-Integrated Surgery, Clinical Applications, Robotics, Systems
- **Rajesh Kumar**
  - Computer-Integrated Surgery, Robotics, Computer Vision
- **Emad Boctor**
  - Ultrasound, Medical Imaging, Clinical Applications

Microsurgical Assistant for Retinal Surgery

Goals

- Develop technology addressing fundamental limitations in retinal microsurgery
- Integrate into comprehensive system
- Validate performance
- Transfer to clinical use

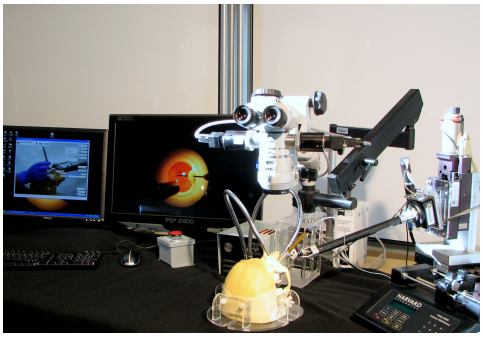
Team

- **WSE:** R. Taylor, G. Hager, J. Kang, P. Kazanzides, R. Kumar, A. Deguet, B. Vagvolgyi, I. Iordachita postdoc, grad students
- **SoM:** J. Handa, P. Gehlbach, E. Gower, L. Pinni

Current Funding

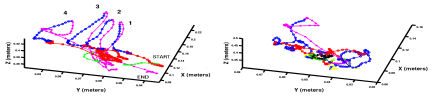
- NIH BRP ($4.8M/5 years)

Microsurgery Assistant Workstation



Language Of Surgery: Hypotheses

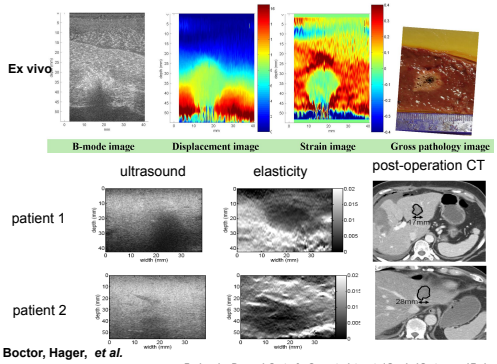
1. There is regularity to motion during surgery that can be modeled without reference to style or skill.
2. This regularity transcends a specific task or a specific user.
3. Such models can then be used to assess or compare level of technical skill.



Expert Surgeon - trial 4 | Intermediate Surgeon - trial 22

Hager, Kumar et al.

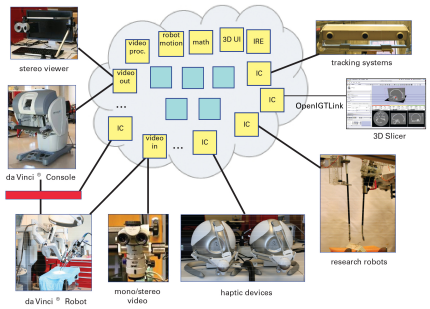
Elastography monitoring of ablations



Boctor, Hager, *et al.*

Surgical Assistant Workstation

SAW application



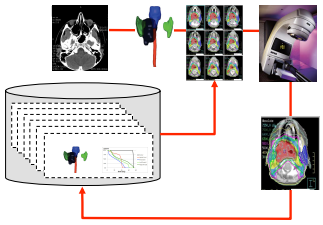
Balazs Vagvolgyi, Simon P. DiMaio, Anton Deguet, **Peter Kazanzides**, **Rajesh Kumar**, Christopher Hasser, **Russell H. Taylor**

Swirnow Mock OR

- **System integration testbed**
  - Research
  - Education
- **Medical robots**
  - da Vinci telesurgical system
  - Robodoc orthopaedic robot
  - Neuromate neurosurgical robot
- **Imaging equipment**
  - X-ray C-arm
  - Ultrasound

Key faculty: Taylor, Kazanzides, Kumar
Key engineers: Deguet, Vagvolgyi

Statistical process control for radiation therapy



Overall Goal: Use a database of previously treated patients to improve radiation therapy planning for new patients

Team:

CS: R. Taylor, M. Kazhdan, P. Simari, A. King

BME: R. Jacques

Rad. Oncology: T. McNutt, J. Wong, B. Wu, G. Sanguinetti (MD)

Support: Paul Maritz, Philips, JHU internal funds

Who Else Does What?

- **Allison Okamura** (ME): Haptics
- **Noah Cowan** (ME): Dynamical Systems and Biology
- **Louis Whitcomb** (ME): Dynamical and Undersea Systems
- **Rene Vidal** (BME): Computer Vision and Dynamical Systems
- **Greg Chirikjian** (ME): Theoretical Kinematics and Dynamics; Molecular Modeling; Self Replication
- **Ralph Etienne-Cummings** (ECE): VLSI, Neuromorphic Systems
- **Iulian Iordachita** (ME): Sensors, Robotics, Design
- **Jeff Siewerdsen** (BME): Medical Imaging, Image-Guided Intervention
- **Jerry Prince** (ECE): Medical Imaging

Courses

- **Taylor**
  - CIS I/II
- **Hager**
  - Computer Vision
  - Algorithms for Sensor-Based Robotics
- **Kumar**
  - Visual Imaging in Surgery and Medicine
- **LCSR Seminar**