

A Tutorial on Surgical Simulation: Past, Present, and Future

Medicine Meets Virtual Reality 2002

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<http://simcen.usuhs.mil/mmvr2002>

Introduction

- Administrative details
- Presenters
- Scope of tutorial
- Brief intro to tutorial
- Brief survey

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Administrative details

- Tutorial CD
- Tutorial website
 - <http://simcen.usuhs.mil/mmvr2002>
 - For updates, corrections, and additional materials
 - Please take our post-tutorial survey
- Tutorial format

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People

- Frank Tendick, Ph.D.
- Chris Kaufmann, MD.
- Alan Liu, Ph.D.

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Schedule

- Introduction and survey
- A clinical perspective of simulation
- Case study - NCA SimCen
- Issues in Surgical Simulation
 - Deformable models
 - Visual and Tactile displays
 - Collision detection
- Issues in Surgical Simulation (continued)
 - Tissue modeling and characterization
 - Performance metrics
- Case study - A Testbed for Teaching Laparoscopic Surgical Skills
- Wrap up

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Scope of tutorial

- An introduction to the field of surgical simulation
- A clinical perspective
- An overview of key technologies
 - Highlighting areas of current research
- An overview of current research work
 - Not intended to be comprehensive
- A close up look on teaching through simulation

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Why simulation?

- Develop surgical skills and experience through practice
- Current practice is simulation through
 - Animals
 - Cadavers
 - Live humans
 - » Volunteers
 - » Each other
 - » Patients



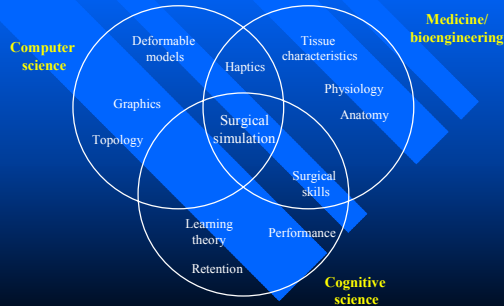
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Medical simulators

- Computer-based
- “Virtual” patient
 - Ability to mimic some tissue properties
 - » Deformation, tearing, cutting
 - Some physiological response
- Part-task trainers
 - » Does not take you through the whole task
- Procedure trainers
 - » Takes student through the surgical algorithm
 - » Possibility of unexpected/undesirable events
 - » Not all skills components are fully simulated

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Foundations of surgical simulation



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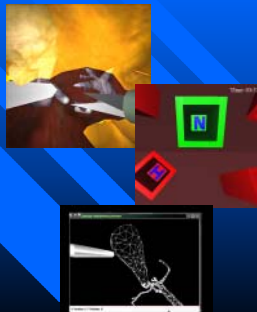
Specific areas being presented

- The clinical perspective
- Deformable models
- Tissue modeling and characterization
- Visual displays
- Tactile feedback
- Performance and training
- Collision detection
- Case studies
 - NCA Simulation Center
 - Project VESTA: Laparoscopic skills testbed

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VESTA

- Virtual Environments for Surgical Training and Augmentation
- Laparoscopy simulation testbed for
 - Algorithm development
 - Study of perceptual motor skills
 - Study the training and learning process



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National Capital Area Medical Simulation Center (Uniformed Services University)

- 11,000 sq. ft. medical simulation facility
- Primary focus
 - Provide support to medical education
- One of the largest assemblage of surgical simulators (research and commercial)
 - Vascular anastomosis, Limb trauma, IV insertion (two versions), Endoscopy, Pericardiocentesis, Diagnostic Peritoneal Lavage, Laparoscopy (two systems)



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LASSO Project Image Science Group (ETH)

- Laparoscopic surgery simulator
 - Bottom up development of a laparoscopic simulation platform
 - Customized parallel processing hardware for
 - » Deformation
 - » Collision detection
 - Tissue characteristics measurement
 - Organ/tissue modeling

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Medical Readiness Trainer (University of Michigan)

- Combines human patient simulator with a virtual environment
- Computer-controlled mannequin reproduces a range of human physiological responses to trauma
- Virtual environment completely surrounds users
 - Simulates different settings
 - Can generate distractions



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CIMIT Simulation Program (USA)

- Center for Integration of Medicine and Innovative Technology
- Common Anatomical Modeling Language (CAML)
 - Common description specification for different tissue/organs
 - Model specification independent of application
- Tissue characteristics measurement
- Development of simulators for trauma-related procedures
 - Chest tube

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EPIDAURE: Medical Imaging and Robotics (INRIA)

- Algorithm development
 - Deformable models for surgical simulation
 - Topology change (e.g. cutting)
 - Collision detection
 - Liver model
- Laparoscopy simulation



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National Biocomputing Center (Stanford University Medical Center/NASA)

- Microvascular surgery
- Virtual glove box
- Visible rat
 - Practice dissection
- Virtual Hysteroscopy
 - Collaboration with Immersion Inc.

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KISMET (Forschungszentrum Karlsruhe)

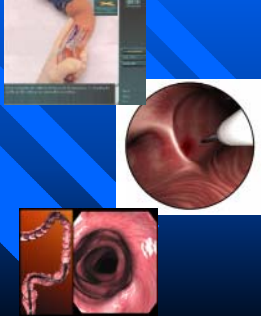
- Kinematic Simulation, Monitoring and Off-Line Programming Environment for Telerobotics
 - Model creation, deformation, visualization, kinematics
- Available commercially
 - www.select-it.de
- Commercial laparoscopic trainers have been developed



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Immersion Medical, USA

- Catheterization simulator
 - IV insertion simulator
 - Pediatric
 - Central line (soon)
- Endoscopy
 - Bronchoscopy
 - Flexible Sigmoidoscopy
 - Colonoscopy
- Endovascular



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MIST VR, Mentice Inc.

- Laparoscopy skills trainer
- Students practice on task abstractions
 - Tasks have been validated through studies

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Surgical-Science, Sweden

- Motor skills trainer
- Navigation
- Grasping
- Cutting
- Suturing (soon)
- Captures performance parameters
 - Time, path length, accuracy



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What makes a good simulator?

- Not graphics
- Not haptics
- Not models
- Not algorithms
- Not hardware

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What makes a good simulator?

- Content
 - What is the skill/knowledge that needs to be transferred?
- Presentation
 - What inputs (visual, tactile, etc.) are vital.
 - What are not.
- Measurement
 - Are the skills learnt?
 - How effective is the simulator?

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