Medical Simulation for Surgical Training
MICCAI 2001 – Tutorial 3

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http://simcen.usuhs.mil/miccai2001

Introduction

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

Administrative details

- Tutorial CD
- Handouts
- Tutorial website
  - http://simcen.usuhs.mil/miccai2001
  - For updates, corrections, and additional materials
  - Please take our post-tutorial survey
- Tutorial format

People

- Chris Kaufmann MD, MPH, FACS, COL, MC, USA
- Frank Tendick Ph.D.
- Alan Liu Ph.D.
- Kevin Cleary Ph.D.
  - unable to attend

Schedule

- **Introduction and brief survey**
- **A clinical perspective of simulation**
- **Issues in Surgical Simulation I**
  - Deformable models
  - Tissue modeling and characterization
- **Break (15 minutes)**
- **Issues in Surgical Simulation II**
  - Visual displays
  - Tactile feedback
  - Performance metrics
  - Collision detection
- **Break (15 minutes)**
- **Case study – NCA SimCen**
- **Case study – Project VESTA**
- **Wrap up**

Scope of tutorial

- It is
  - An introduction
  - A clinician's view of surgical simulation
  - A primer on key technologies
    - » Modeling, tissue characterization, haptic and visual displays, etc.
  - An overview of areas that need more research
  - A highlight of some (by no means all) of the work currently being done
  - A close up look on teaching through simulation

Scope of tutorial

- It is not
  - Talks on a series of individual projects.
  - An abstract discussion of algorithms.

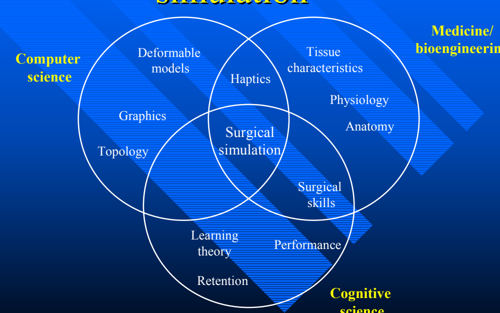
Why simulation?

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

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

Foundations of surgical simulation

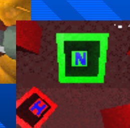


Specific areas being presented

- 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

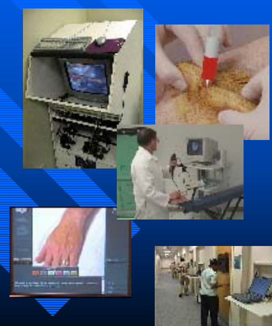
VESTA

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



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 collections of surgical simulators (research and commercial)
  - Vascular anastomosis, Limb trauma, IV insertion (two versions), Endoscopy, Pericardiocentesis, Diagnostic Peritoneal Lavage, Laparoscopy (two systems)



LASSO Project Image Science Group (ETH)

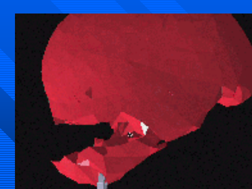
- Laparoscopic surgery simulator
  - Bottom up development of a laparoscopic simulation platform
  - Customized parallel processing hardware for
    - » Deformation
    - » Collision detection
  - Tissue characteristics measurement
  - Organ/tissue modeling

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

EPIDAURE: Medical Imaging and Robotics (INRIA)

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

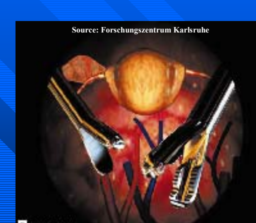


National Biocomputing Center (Stanford University Medical Center/NASA)

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

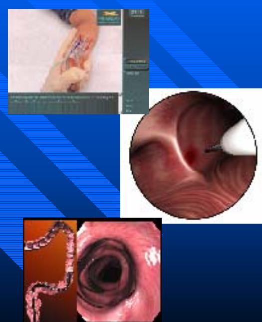
KISMET (Forschungszentrum Karlsruhe)

- 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



Immersion Medical, USA

- Catherization simulator
  - IV insertion simulator
  - Pediatric
  - Central line (soon)
- Endoscopy
  - Bronchial
  - Flexible Sigmoidoscopy
  - Colonoscopy (soon)
- Endovascular



Surgical-Science, Sweden

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

What makes a good simulator?

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

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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