MMVR 2004 - Session C Medical Simulation – The State of the Art and Beyond

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Stephane Cotin, Mark Bowyer

http://simcen.usuhs.mil/mmvr2004

Introduction

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

Administrative Details

- Tutorial CD
- Tutorial website
  - http://simcen.usuhs.mil/miccai2004
  - For updates, corrections, and additional materials
- Tutorial format

People

- M. Cenk Cavusoglu, Ph.D.
- Stephane Cotin, Ph.D.
- Mark Bowyer, MD.
- Alan Liu, Ph.D.

Schedule

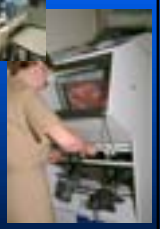
- **Introduction and a survey of medical simulators**
- **A clinical perspective on medical simulation**
- **Graphics and rendering**
- **Haptics and tactile feedback**
- **Deformable modeling**
- **Case study: The CWRU MERCIS Laboratory**
- **Break**
- **Case study: The CIMIT Simulation Group**
- **Clinical validation**
- **Case study: The National Capital Area Medical Simulation Center**
- **Conclusion and open discussion**

Objectives

- Introduce key players in the field
  - Academic
  - Commercial
- Identify research in key areas
- Describe lessons learned
- To stimulate interest

Why Simulation?



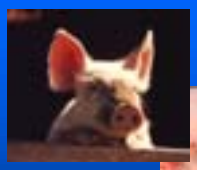
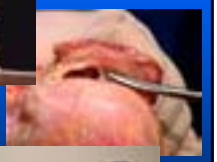
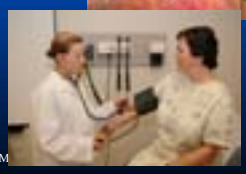



- To increase experience
- To increase patient safety
- To practice medical skills

Current teaching practices have difficulty meeting the challenges of modern medicine

Current Practice

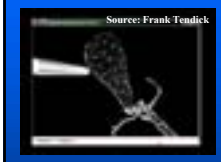
- Animals
  - Incorrect anatomy
- Cadavers
  - Incorrect physiology
- Patients
  - Risk to patient safety
- Each other
  - Can be painful

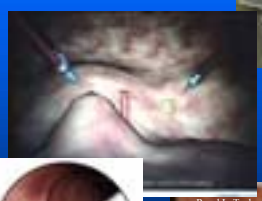




Medical Simulators

- Computer-based
- "Virtual" patient(s)
  - Ability to mimic some tissue properties
    - » Deformation, tearing, cutting
  - Some physiological response
- Focused
  - Teach a specific skill or knowledge

Survey

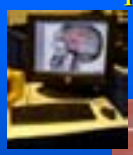
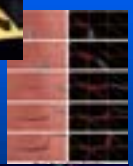
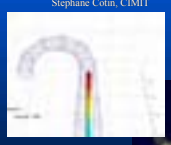
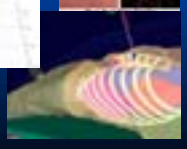







CIMIT Simulation Group (USA)

- Center for Integration of Medicine and Innovative Technology
- Simulators for Training
  - ICTS, VIRGIL, CELTS
- Real-time soft tissue modeling
- Soft tissue properties measurement



Images by courtesy of Stephane Cotin, CIMIT



The CWRU MERCIS Laboratory

- Haptics research
- Software architecture for surgery simulation


Material courtesy of M. Cenk Cavusoglu


Texas Tech University

- Virtual body structures
- Tissue properties
  - Mechanical
  - Visual
  - Haptics

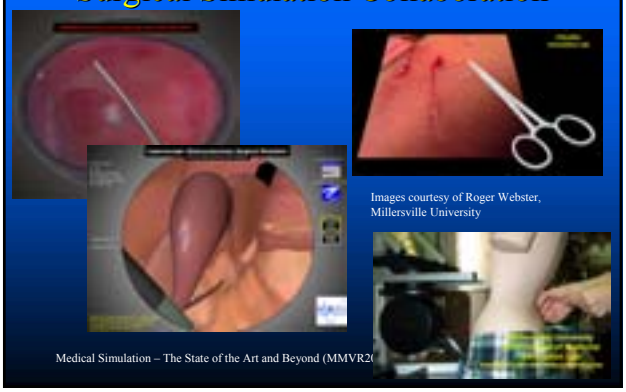
Images courtesy of Bharti Temkin
Dept. of Computer Science
Texas Tech University

Project TOUCH

- Distributed learning environment for trauma management
- Team training

Images by courtesy of Ken Summers
Project TOUCH
http://hsc.unm.edu/touch

Millersville/Penn State University Surgical Simulation Collaboration



Images courtesy of Roger Webster,
Millersville University

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

Images courtesy
of Frank Tendick

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

Research Triangle Institute (USA)

- Simulation of patient physiology
- Facial expressions and body movements
- Applications
  - First responder or paramedic training
  - Mass casualty/triage
  - WMD training

Images courtesy of
Paul Kizakevich

EPIDAURE: Medical Imaging and Robotics (INRIA)

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

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

National Capital Area Medical Simulation Center (Uniformed Services University)

- 11,000 sq. ft. medical simulation facility
- Provide support to USU training mission
- One of the largest collections of surgical simulators (research and commercial)
- 1st facility to use simulators for ATLS

Immersion Medical, USA

- Catherization simulator
  - IV insertion simulator
  - Pediatric
- Endoscopy
  - Bronchial
  - Upper/lower GI endoscopy
- Endovascular
  - Stenting
- Hardware
  - Virtual Laparoscopic Interface
  - Laparoscopic Workstation

Images courtesy of Rick Cunningham Immersion Corporation

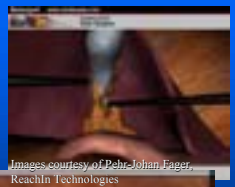
Surgical-Science, Sweden

- Motor skills trainer
  - Navigation, grasping, cutting, suturing
- Procedure training
  - Laparoscopic cholecystectomy
  - Gynecologic procedures
- Captures performance parameters
  - Time, path length, accuracy, etc.

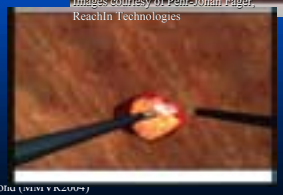
Images courtesy of Anders Hyltander Surgical Science

ReachIn Technologies, Sweden

- Laparoscopic Trainer
- Basic skills
  - Camera navigation
  - Cutting
  - Grasping
- Surgical procedures
  - Cholecystectomy



Images courtesy of Pehr-Johan Fager, ReachIn Technologies



Simbionix, Israel

- Laparoscopy
- Endoscopy
- Percutaneous
- Urology

www.simbionix.com