C O U R S E  S Y L L A B U S


**JANUARY 29 – FEBRUARY 1, 2008**

THE HYATT REGENCY LONG BEACH
LONG BEACH, CALIFORNIA

# MMVR16

## TABLE OF CONTENTS

## WELCOME

Welcome to the 16th annual **Medicine Meets Virtual Reality.** This year's program includes over 220 presentations by scientists, clinicians, engineers, and students. From up-the-pipeline research to viable commercial products, you will witness a wide range of biomedical design and development. Incremental progress and revolutionary thinking will be shared as creative minds explore the opportunities and accomplishments of computer-based tools for use in medicine.

For the second year in a row, we are featuring sessions on intracellular surgery and design in medicine. The first session presents a technological frontier where health is improved by manipulation at the cellular and molecular level. The latter session considers the role of design and collaboration when confronting the health problems of the developing world. Both these sessions will enrich the traditional MMVR curriculum and encourage fresh approaches to healthcare problems.

This has been a year of change for the MMVR conference. With the aim of promoting new interaction within this community, we have viewed change as an opportunity for growth. We hope you find the outcome both educational and enjoyable.

Thank you for joining us here at MMVR16.

## COURSE DESCRIPTION & OBJECTIVES

MMVR16 is designed as a forum for encouraging and sharing innovative research on information-based tools for clinical care and medical education. The program consists of two half-day plenary sessions, seven half-day parallel sessions, two poster sessions, six independently organized activities, industry exhibits, an exhibitor-sponsored lunch, and a non-commercial demonstration and discussion forum.

Presentations will educate participants on:

- State-of-the-art for biomedical simulation and its supporting technologies, haptics and tissue modeling
- Current issues in computer-enhanced education, including simulator design and validation, and learning objectives, metrics, and skills assessment
- New methods and tools for clinical diagnosis and therapy: imaging tools, data visualization and fusion techniques, pre- and perioperative modeling, surgical navigation, and robotics
- Intelligence networks that inform medical decision-making and patient care
- Developments in computer-aided psychological assessment and therapy, and physical rehabilitation
- The emerging field of intra-cellular surgery and the role of design in medicine

## TARGET AUDIENCE

MMVR16 is designed to educate and inform:

- Physicians, surgeons, and other healthcare professionals interested in emerging and future tools for diagnosis and therapy
- Educators responsible for training the next generation of doctors and scientists
- Computer technologists designing systems for collecting, processing, and networking medical intelligence
- IT and medical device engineers who develop and market state of the art imaging, simulation, robotics, and communication tools
- Military medicine specialists addressing the challenges of warfare and defense health needs
- Biomedical futurists and investors who need to understand where medicine is headed

## ACKNOWLEDGMENTS

We are deeply grateful to our colleagues and friends on the Organizing Committee for their guidance and enthusiasm. They have kept MMVR vigorous during these past sixteen years. Those Committee members who review abstracts during the Call for Papers especially deserve our appreciation. We give yet additional thanks to the Proceedings editors for lending their time and expertise to the volume's production.

We thank TATRC/USAMRMC for its generous support of the Intra-Cellular Surgery and Medicine by Design sessions.

We also thank these organizations for making significant contributions to this year's program:

- The Center for Advanced Surgical Technology (CAST), University of Nebraska
- National Capital Area Medical Simulation Center, Uniformed Services University
- Art Center College of Design, Pasadena, California
- The Center for Innovation, National Board of Medical Examiners

Finally, we sincerely thank all of you who are sharing your research here at MMVR16. It is you who make MMVR an informative and rewarding experience.

## POSTER JUDGING

You are invited to vote for the best poster presentations. Please complete your ballots for Wednesday and Thursday posters, and submit them at the ballot box at the registration desk. The ten winning posters will be displayed Friday and their presenters will receive prizes.

## EVALUATION

We welcome the input of all conference participants. Please take a few minutes to write down your reactions—both negative and positive—to this year's MMVR. Your feedback will inform us as we create next year's program.

## DISCLAIMER

The information provided at this conference is intended for general medical education purposes only. All physicians should fully investigate any new product or device before implementing it in their practice. In no event will the conference organizer, Aligned Management Associates, Inc., assume responsibility for any decision made or action taken as a result of the information provided through this activity.

## ORGANIZER CONTACT INFO

Medicine Meets Virtual Reality c/o
Aligned Management Associates, Inc.
793-A East Foothill Blvd, PMB #119
San Luis Obispo, CA 93405 USA
Phone 1 805 534 0300 Fax 1 805 534 9030
MMVR16@NextMed.com
http:// www.nextmed.com/mmvr_virtual_reality.html

## THE SATAVA AWARD

The 14th annual Satava Award will be presented at MMVR16. Established in 1995, the award acknowledges the work of Dr Richard M. Satava, its first recipient. It is presented each year to an individual or research group that demonstrates unique vision and commitment to the improvement of medicine with advanced technology. Previous recipients are:

Naoki Suzuki PhD (2007)
Nigel W. John PhD (2006)
Brenda Wiederhold PhD MBA (2005)
Steven Dawson MD (2004)
Richard Robb PhD (2003)
SUMMIT Lab, Stanford University (2002)
HIT Lab, University of Washington (2001)
Dave Warner MD PhD (2000)
Faina Shtern MD (1999)
Gerhard Buess MD (1998)
Henry Fuchs PhD (1997)
Victor Spitzer PhD & Michael Ackerman PhD for the Visible Human (1996)
Richard Satava MD FACS (1995)

## TUESDAY MORNING, JANUARY 29

9:00 AM – Noon **SESSION A**

*time* *page#*

**TUTORIAL**
**Virtual Reality Applications in Mental Health and Rehabilitation**
*[Note additional description, page 28]*

**Presenter:**

Albert A. “Skip” Rizzo
*Institute for Creative Technologies, School of Gerontology*
*University of Southern California*

11:00 Behavioral Health Technology Demonstration Session

12:00 Adjourn

## TUESDAY AFTERNOON, JANUARY 29

1:00 – 5:00 PM **SESSION A**

1:00 *Moderator:*
Brenda K. Wiederhold
*Virtual Reality Medical Center*
Welcome & Introduction

**BEHAVIORAL HEALTH – DIAGNOSIS & ASSESSMENT**

1:15 33 Daphna Weinshall
*Interdisciplinary Ctr for Neural Computation, Hebrew Univ of Jerusalem, Israel*
The Distortion of Reality Perception in Schizophrenia Patients, as Measured in Virtual Reality

1:35 33 Thomas D. Parsons
*Inst for Creative Technologies, Univ of Southern California*
A Virtual Environment for Assessment of Neurocognitive Functioning: Virtual Reality Cognitive Performance Assessment Test

1:55 33 Giuseppe Riva
*Applied Technology for Neuro-Psychology Lab., Ist Auxologico Italiano*
Why do You Drink? Virtual Reality as an Experiential Medium for the Assessment of Alcohol-Dependent Individuals

2:15 33 Don Stredney
*Interface Laboratory, OSC*
Evaluating Elicited Anxiety in a Simulated Environment

2:35 33 Melba del Carmen Stetz
*Warfighter Health and Performance Division, US Army Aeromedical Research Laboratory, USAMRMC*
The Usefulness of Virtual Reality Stress Inoculation Training with Coping Strategies on Military First Responder Students

2:55 Break

*Session A Continued*

**BEHAVIORAL HEALTH - STRESS & ANXIETY**

3:15 34 Skip Rizzo
*Inst for Creative Technologies, Univ of Southern California*
Virtual Iraq: Initial Results from a VR Exposure Therapy Application for OIF/OEF Combat-Related Post Traumatic Stress Disorder

3:35 34 Dennis P. Wood
*Virtual Reality Medical Ctr*
Combat Related Post Traumatic Stress Disorder: A Multiple Case Report Using Virtual Reality Exposure Therapy with Physiological Monitoring

**BEHAVIORAL HEALTH - PAIN CONTROL**

3:55 34 José Luis Mosso
*Surgery, IMSS, CONACyT*
Laparoscopic Cholecistectomies and Inguinal Hernia Repairs under Regional Anesthesia and Cybertherapy

4:15 34 Kate Miller
*Royal Children's Hospital*
Preparation & Distraction Using a Multi-Modal Device to Reduce Anxiety & Distress in Children Undergoing Burns Procedures

4:35 Discussion

5:00 Adjourn

## 1:00 – 5:00 PM SESSION B

**WORKSHOP**
**Toward National Standards for Simulation Based Medical Education: Current Initiatives and Future Directions**
*[Note additional description, page 28]*

1:00 Alan Liu
*Natl Capital Area Med Simulation Ctr, Uniformed Services Univ*
Welcome & Introduction

1:15 Mark Bowyer
*Natl Capital Area Med Simulation Ctr, Uniformed Services Univ*
The National Skills Curriculum Project

1:50 Joseph Rosen
*Dartmouth Med School*
Notes from the Association of Academic Chairmen of Plastic Surgery: Simulators for Training and Surgical Specialties

2:25 Gilbert Muniz
*Natl Capital Area Med Simulation Ctr, Uniformed Services Univ*
Military Medical Simulation Policy Initiatives

3:00 Break

3:15 Gerald R. Moses
*MASTRI Ctr, Univ Maryland Med Ctr*
A Framework for the Use and Development of Medical Simulation in the Military

3:50 Alan Liu
*Natl Capital Area Med Simulation Ctr, Uniformed Services Univ*
Implications for Medical Simulation Technology Development

4:25 Discussion

5:00 Adjourn

8:20 AM – Noon **PLENARY SESSION**

8:20 Karen S. Morgan & James D. Westwood
*Aligned Management Associates, Inc.*
Welcome & Introduction

8:30 **PANEL**
**parallel, combinatorial, convergent—Collaboration and Design in the MMVR Community**

**Panelists:**

Greg T. Mogel (Moderator)
*Keck Sch Medicine / Viterbi Sch Engineering, Univ of Southern California*

Alan Liu
*National Capital Area Med Sim Ctr, USUHS*

Roger Phillips
*Computer Science, Univ of Hull*

Richard M. Satava
*Surgery, Univ of Washington*

Robert M. Sweet
*Urologic Surgery, Univ of Minnesota*

Kirby G. Vosburgh
*CIMIT/Brigham & Women's Hospital/Harvard Medical Sch*

9:30 35 Sir Alfred Cuschieri
*Inst of Medical Science & Technologies, Universities of Dundee & St Andrews; Scuola Superiore Sant'Anna di Studi Universitari*
Emerging Technologies for Cellular Surgery

10:00 Break [Exhibits open]

**FEATURED SESSION**
**Intra-Cellular Surgery: Extending the Surgeon's Reach to Genes and Molecules**
*[Note additional description, page 28]*

**Presentations:**

10:30 Richard M. Satava
*Surgery, Univ of Washington*
Introduction to Intra-Cellular Surgery

10:45 Jaydev P. Desai
*Mechanical Engineering, Univ of Maryland*
Mechanical Phenotyping of Transgenic Cells using Haptic Feedback

11:05 Kevin Kit Parker
*Biomedical Engineering, Harvard University; Univ Maryland Biotechnology Institute*
Technical Challenges in Cellular Surgery

11:25 Carol Keefer
*Animal & Avian Sciences, Univ Maryland*
Manipulation of Nuclear Material for Production of Bioproducts by Transgenic Animals

11:45 Discussion

12:00 Adjourn [Exhibits Lunch]

1:25 – 5:15 PM **SESSION A**

1:25 Patricia Youngblood
*Moderator's Welcome*

**EDUCATION & SIMULATION - SYSTEMS**

1:30 36 Marjorie McShane
*Computer Sci & Electrical Eng, Univ of Maryland, Baltimore Cty*
Revealing the Conceptual Substrate of Biomedical Cognitive Models to the Wider Community

1:45 36 W. LeRoy Heinrichs
*SUMMIT & Ob-Gyn, Stanford Univ*
Design and Implementation of Rule-Based Medical Models

2:00 36 Adeline M. Deladisma
*Surgery, Medical College of Georgia*
Medical Student Satisfaction Using a Virtual Patient System to Learn History-Taking and Communication Skills

2:15 36 Roger Phillips
*Computer Science, Univ of Hull*
Virtual Reality Training for Radiotherapy Becomes a Reality

2:30 36 Greg S. Ruthenbeck
*Sch of Informatics and Engineering, Flinders Univ*
A Virtual Reality Throat Examination Simulation

2:45 36 Naoto Kume
*Medical Informatics, Kyoto Univ*
Asynchronous Teaching of Psychomotor Skills through VR Annotations: Evaluation in Digital Rectal Examination

3:00 37 Thomas D. Parsons
*Inst for Creative Technologies, Univ of Southern California*
Objective Structured Clinical Interview Training Using a Virtual Human Patient

3:15 Break

*Moderator:*
Helene M. Hoffman

**EDUCATION & SIMULATION – VALIDATION**

3:30 37 Jennifer Pierce
*Ctr for Telehealth and Cybermedicine Research, Univ of New Mexico*
Comparative Usability Studies of Full vs. Partial Immersive Virtual Reality Simulation for Medical Education and Training

3:45 37 Valeriy V. Kozmenko
*Anesthesiology, LSU Health Sciences Ctr*
Initial Implementation of Mixed Reality Simulation Targeting Teamwork and Patient Safety

4:00 37 Bryan P. Bergeron
*HST Division, Harvard Medical Sch; MIT*
Learning & Retention in Adaptive Serious Games

4:15 37 Patricia Youngblood
*SUMMIT, Stanford Univ Sch of Medicine*
Evaluation of Virtual World Mass Casualty Simulation Exercises for Training and Assessing Hospital Staff

4:30 37 Johan C. Creutzfeldt
*Ctr for Advanced Medical Simulation, CLINTEC, Karolinska Inst*
Effects of Repeated CPR Training in Virtual Worlds on Medical Students' Performance

4:45 38 Benjamin M. Ward
*Education, Royal College of Surgeons, Edinburgh*
An Evaluation of Prototype VR Medical Training Environment: Applied Surgical Anatomy Training for Malignant Breast Disease

5:00 38 Kapil Bajaj
*IINR, Ohio University*
Repeated Palpatory Training of Medical Students on the Virtual Haptic Back

5:15 Adjourn

1:25 – 5:15 PM **SESSION B**

1:25 Ramin Shahidi
*Moderator's Welcome*

**INFORMATION GUIDED THERAPY – SYSTEMS**

1:30 38 Yoshito Otake
*Inst for High Dimensional Medical Imaging, Jikei Univ Sch of Medicine*
Hip Motion Analysis Using Multi Phase (Virtual and Physical) Simulation of the Patient-specific Hip Joint Dynamics

1:45 38 Shiva Mohan
*Univ of Western Ontario Canadian Surgical Technologies and Adv Robotics*
Computer Integrated System for Minimally Invasive Lung Brachytherapy

**INFORMATION GUIDED THERAPY – REGISTRATION & NAVIGATION**

2:00 38 Kirby G. Vosburgh
*CIMIT/Brigham & Women's Hospital/Harvard Medical Sch*
Image Registration Assists Novice Operators in Ultrasound Assessment of Abdominal Trauma

2:15 39 Namjung Kim
*Mechanical Engineering, Carnegie Mellon Univ*
Verifying the Effectiveness of a Computer-Aided Navigation System for Arthroscopic Hip Surgery

2:30 39 Karsten Ø. Noe
*Computer Science, Univ of Aarhus, Denmark*
GPU Accelerated Viscous-Fluid Registration of Radiotherapy Images

**TRACKING**

2:45 39 Johannes Vockeroth
*Neurology, Hospital of the Ludwig-Maximilians Univ Munich*
Handiwork Documentation Using a Wearable Gaze-Driven Camera

3:00 39 Henry Fuchs
*Computer Science, Univ of North Carolina at Chapel Hill*
Choosing a Head-Tracked Stereo Display to Guide Hepatic Tumor Ablation

3:15 Break

*Moderator:*
Richard A. Robb

**ROBOTICS – SYSTEMS**

3:30 39 Peter Kazanzides
*Computer Science, Johns Hopkins Univ*
A Cooperatively-Controlled Image Guided Robot System for Skull Base Surgery

3:45 40 Peter Allen
*Computer Science, Columbia Univ*
in vivo Pan/Tilt Endoscope with Integrated Light Source, Zoom and Auto-focusing

4:00 40 Ming Li
*Cardiothoracic Surgery Reasearch Program, National Heart Lung and Blood Inst, NIH*
A Robotic System to Assist Real-Time MRI Guided Aortic Valve Replacement on the Beating Heart

4:15 40 Pablo Valdivia y Alvarado
*Energid Technologies Corporation*
Tele-Operated Robotic HIFU Manipulator

**SOLID MODELS**

4:30 40 Bruce M. Cameron
*Biomedical Imaging Resource, Mayo Clinic College of Medicine*
Patient Specific Physical Anatomy Models

4:45 40 Mark Vranicar
*Pediatrics, Univ of Kentucky*
The Use of Stereolithographic Hand Held Models for Evaluation of Congenital Anomalies of the Great Arteries

5:00 41 Tomoko Ikawa
*Fixed Prosthodontics, Tsurumi Univ Sch of Dental Medicine*
Evaluation of the Simulation Robot for Mandibular Movements with the Patient-Specific 3D Plaster Model and Mandibular Movement Data—Clinical Application of the Physical Simulation Robot

5:15 Adjourn

8:25 AM– Noon **SESSION A**

8:25 Robert M. Sweet
*Moderator's Welcome*

**SURGICAL SIMULATION – GENERAL ISSUES**

8:30 42 Peter H. Cosman
*Upper Gastrointestinal Surgical Unit, Liverpool Hospital*
Simulated Surgical Training: What is the Denominator?

8:45 42 F. Jacob Seagull
*General Surgery, Univ of Maryland*
Integration of Virtual Reality and Conventional Skills Trainers: A Mixed Resource Model

**SURGICAL SIMULATION – LEARNING & METRICS**

9:00 42 Brent Gillespie
*Mechanical Engineering, Univ of Michigan*
The Instrumented Instrument: Characterization and Training of Manual Skill in Open Suturing

9:15 42 Adam Dubrowski
*Faculty of Nursing, Univ of Waterloo*
Effects of Expertise, Practice and Contextual Interference on Adaptations to Visuo-Motor Misalignment

9:30 42 Carol E. Reiley
*Computer Science, Johns Hopkins Univ*
Automatic Recognition of Surgical Motions Using Statistical Modeling for Capturing Variability

9:45 42 Ben H. Boedeker
*Anesthesiology, Univ of Nebraska Medical Ctr*
A Comparison of Direct Versus Indirect Laryngoscopic Visualization in Endotracheal Intubation

10:00 Break

*Moderator:*
Carla M. Pugh

10:15 43 Marcus K. Schlickum
*CLINTEC, Karolinska Inst*
Transfer of Systematic Computer Game Training in Surgical Novices on Performance in Virtual Reality Image Guided Surgical Simulators

10:30 43 Lars Enochsson
*Ctr for Advanced Medical Simulation, Karolinska Univ Hospital;*
*CLINTEC, Karolinska Inst, Karolinska Univ Hospital*
Visuospatial Ability Affects the Performance of Simulated Gynecological Procedures

**SURGICAL SIMULATION – SKILLS ASSESSMENT**

10:45 43 Jacob Rosen
*Univ of Washington*
Objective Laparoscopic Skills Assesments of Surgical Residents - Five Years Longitudinal Study

11:00 43 Mark Smith
*SimET Ctr, Banner Good Samaritan Medical Ctr*
Collaborative Surgical Proficiency Rating Initiative

**SURGICAL SIMULATION – VALIDATION**

11:15 43 Mark W. Bowyer
*Norman M. Rich Dept of Surgery, Uniformed Services Univ*
Far Forward Feasibility: Testing a Cricothyoidotomy Simulator in Iraq

11:30 44 Phil Blyth
*Anatomy with Radiology, Univ of Auckland*
Virtual Screw Fixation of Slipped Capital Femoral Epiphysis by Advanced Orthopaedic Trainees

11:45 Discussion

12:00 Adjourn

8:30 AM – Noon **SESSION B**

8:30 **WORKSHOP**
**From Image-Guided to Model-Guided Therapy**
*[Note additional description, page 29]*

**Presentations:**

Heinz U. Lemke
*Inst Technical Informatics, Technical Univ Berlin*
Architecture of a Therapy Imaging and Model Management System (TIMMS)

Leonard Berliner
*Radiology, Staten Island Univ Hospital*
TIMMS Use Cases in Interventional Radiology and Surgery

Ramin Shahidi
*CICAS, Stanford University*
Usability Considerations for Information Assisted Therapy

Oliver Burgert
*Innovation Ctr Computer Assisted Surgery, Univ Leipzig*
Steps Towards Open Standards for Medical Virtual Reality Systems

10:00 Break

*Moderator:*
Suzanne J. Weghorst

**TELEROBOTICS**

10:15 44 Gerald R. Moses
*MASTRI Ctr, Univ of Maryland Medical Ctr*
Barriers to Wider Adoption of Mobile Telerobotic Surgery: Engineering, Clinical and Business Challenges

10:30 44 Eran B. Schenker
*Aerospace Medicine Research Ctr, Fisher Inst for Air and Space Strategic Studies*
MedUAV: Medical Resupply & Casualty Evacuation Vertical Take Off & Landing Unpiloted Aerial Vehicle

**TELEMEDICINE**

10:45 44 Robert N. Tan
*Bioengineering, Univ of California, Los Angeles*
Development of an Implantable, Wireless Vital Signs Sensor Suite

**REHABILITATION**

11:00 44 Shih-Ching Yeh
*Signal & Image Processing Inst, Univ Southern California*
VR-Based Interactive System for Stroke Rehabilitation on Wrist-Forearm Synchronized Movement

11:15 45 Oshri Even Zohar
*R&D, MOTEK BV*
Muscle Force Visualization for Virtual Reality Assisted Rehabilitation

11:30 45 Richard E. Fan
*Biomedical Engineering, UCLA*
A Prototype Haptic Feedback System for Lower-Limb Prostheses and Sensory Neuropathy

11:45 45 Alexander C. Koenig
*Sensory-Motor Systems Laboratories, ETH Zurich*
Virtual Gait Training for Children with Cerebral Palsy Using the Lokomat Gait Orthosis

12:00 Adjourn

8:30 AM – Noon **SESSION C**

**WORKSHOP**
**HealthGrid Unconference**
*[Note additional description, page 29]*

8:30 Welcome and Overview

Mary E. Kratz
*HealthGrid US Alliance; Univ of Michigan*
Jonathan Dugan
*HealthGrid.US Alliance; Matson Systems Inc.*
Open Spaces and the Law of Mobility

9:15 Discussion Sessions

Chuck Dages
*Warner Bros.*
Social Networking and the Knowledge Society

Parvati Dev
*HealthGrid.US Alliance*
The Visible Human Experience

Jonathan Dugan
*HealthGrid.US Alliance; Matson Systems Inc.*
Building the Knowledge Society

Adi Gundlapalli
*Univ of Utah*
Networks to Grids: Public Health Informatics

Mary Kratz
*HealthGrid US Alliance; Univ of Michigan*
Let's Talk Virtualization

Jonathan Silverstein
*HealthGrid.US Alliance; Univ of Chicago*
HealthGrid Introduction and Grid Standards 101

Marc Wine
*Telemedicine Advanced Technology Research Center (TATRC)*
HealthGrid Research Roadmap

11:30 Closing Discussion

Mary E. Kratz
*HealthGrid US Alliance; Univ of Michigan &*
Jonathan Dugan
*HealthGrid.US Alliance; Matson Systems Inc.*
Harvest and Sharing of Collective Intelligence

12:00 Adjourn

## 1:30 – 5:15 PM PLENARY SESSION

1:30 Greg T. Mogel
*Moderator's Welcome*

1:40 46 Randall Shumaker
*Inst for Simulation and Training, University of Central Florida*
Virtual Reality and Mixed Reality for Accessibility

2:10 46 Paul Barach
*Utrecht Univ Med Ctr; Univ South Florida*
Strategies to Reduce Patient Harm: Understanding the Role of Design and the Built Environment

2:40 Chip Kidd
*Random House, Inc.*
A Number of People

3:10 **Presentation of the 14th Satava Award**

3:25 Break

3:45 **FEATURED SESSION**
**Medicine By Design**
Organized by Art Center College of Design (Pasadena, California)
*[Note additional description, page 30]*

**Panelists:**

Winston Soboyejo
*Princeton Institute of Science and Technology of Materials*

Mariana Amatullo
*International Initiatives & Designmatters, Art Center College of Design*

Geoff Wardle
*Advanced Mobility Research, Art Center College of Design*

Patrick Kiruki
*Mpala Community Trust*

5:15 Adjourn

## 7:55 AM – Noon SESSION A

7:55 Patrick C. Cregan
*Moderator's Welcome*

**SURGICAL SIMULATION – SYSTEMS**

8:00 47 Ganesh Sankaranarayanan
*Mechanical Aerospace and Nuclear Engineering, Rensselaer Polytechnic Inst*
VBLaST: A Virtual Basic Laparoscopic Skill Trainer

8:15 47 Laura A. Doyle
*Biomedical Engineering, Johns Hopkins Univ*
The Role of Haptic Feedback in Cataract Surgery Training

8:30 47 Howard A. Schwid
*Anesthesiology, Univ of Washington and VA Puget Sound Health Care System*
Open-Source Shared Simulation Case Library

**SURGICAL SIMULATION – HAPTICS**

8:45 47 Yaroslav Tenzer
*Mechatronics in Medicine Group, Mechanical Engineering, Imperial College London*
Investigation into the Effectiveness of Vibrotactile Feedback to Improve the Haptic Realism of an Arthroscopy Training Simulator

9:00 47 David Hellier
*BioMedIA Lab, E-Health Research Centre, CSIRO*
A Modular Simulation Framework for Colonoscopy Using a New Haptic Device

9:15 48 Yi-Je Lim
*Energid Technologies*
MR Fluid Haptic System for Regional Anesthesia Training Simulation

9:30 48 Chris C. Enedah
*Mechanical Engineering, Stanford Univ*
Dealing with Network Delay in Touch-Enabled Teledermatology

9:45 Discussion

10:00 Break

10:15 **PANEL**
**Cognitive Skills in Surgery**
*[Note additional description, page 30]*

Mark Smith *(Moderator)*
*Simulation & Training Ctr, Banner Good Samaritan Med Ctr*

**Presentations:**

Richard M. Satava
*Surgery, Univ Washington*
Incorporation of Judgment Assessment into Technical Skills Assessment

Vimla Patel
*Biomedical Informatics, Arizona State Univ*
Cognitive Foundation for Learning and Skill Acquisition in Surgery

Carla Pugh
*Ctr Adv Surgical Education, Northwestern Univ*
Use of Cognitive Task Analysis to Define Cognitive Learning Objectives in Surgery

Kanav Kahol
*Simulation & Training Ctr, Banner Good Samaritan Med Ctr*
Design, Development and Evaluation of Cognitive Simulators

12:00 Adjourn

## 7:55 AM–12:30 PM SESSION B

7:55 Michael J. Ackerman
*Moderator's Welcome*

**MODELING**

8:00 48 Fernando Bello
*Biosurgery and Surgical Technology, Imperial College, London*
Interactive Finite Element Simulation of the Beating Heart for Image-Guided Robotic Cardiac Surgery

8:15 48 Mario Cheng
*BioMedia Lab, CSIRO, E-health Research Centre*
Towards Anatomical Modelling of Multiple Organs Interaction Using Real Time GPU Based Nonlinear Elasticity

8:30 48 Megumi Nakao
*Graduate Sch of Information Science, Nara Institue of Science and Technology*
Interactive Volume Manipulation for Supporting Preoperative Planning

8:45 49 Ganesh Sankaranarayanan
*Mechanical, Aerospace and Nuclear Engineering, Rensselaer Polytechnic Inst*
An Efficient Dynamic Point Algorithm for Line-based Collision Detection in Real Time Virtual Environments Involving Haptics

9:00 49 Venkat Devarajan
*Electrical Engineering, Univ of Texas at Arlington*
Parameter Optimization for 3D MSD Models

**IMAGING**

9:15 49 Taehyun Rhee
*Computer Science, Univ of Southern California*
Creating an Animatable 3D Volume Hand Model from in vivo MRI

9:30 49 Christos E. Constantinou
*Urology, Stanford Univ Medical Sch*
Visualization of Biomechnical Properties of Female Pelvic Floor Function Using Video Motion Tracking of Ultrasound Imaging

9:45 49 Jannick P. Rolland
*CREOL, College of Optics and Photonics, Univ of Central Florida*
Collaborative Engineering: 3-D Optical Imaging and Gas Exchange Simulation of In-Vitro Alveolar Constructs

10:00 Break

*Moderator:*
Steven Senger

**VISUALIZATION**

10:15 49 Nigel W. John
*Sch of Computer Science, Bangor University*
MedX3D: Standards Enabled Desktop Medical 3D

10:30 50 Andrei L. Turinsky
*Sun Ctr of Excellence for Visual Genomics, Univ of Calgary*
Integration of Genomic and Medical Data into a 3D Atlas of Human Anatomy

10:45 50 Jonathan C. Silverstein
*Surgery and Computation Inst, Univ of Chicago*
Multi-Parallel Open Technology to Enable Collaborative Volume Visualization: How to Create Global Immersive Virtual Anatomy Classrooms

11:00 50 Benny Bürger
*Univ of Heidelberg, Germany, Inst for Computational Medicine*
Simulation of Dynamic Ultrasound Based on CT Models for Medical Education

*Session B continued*

11:15 **PANEL**
**Overcoming Leonardo's Constraint:**
**When Does Stereoscopy Contribute to Medical Visualization?**
*[Note additional description, page 30]*

**Panelists:**

Michael D'Ambra *(Moderator)*
*Brigham & Women's Hosp; D'Ambra Technologies*

Steven Senger
*Comp Sci, Univ Wisconsin - La Crosse*

David Kaplan
*D'Ambra Technologies*

Michael A. Weissman
*TrueVision Systems, Inc.*

Jonathan C. Silverstein
*Surgery & Computation Inst, Univ Chicago*

12:30 Adjourn

---

8:00 AM – Noon **SESSION C**

**TUTORIAL & PANEL**
**Towards Digital Surgery in the New Millennium**
Featuring the Center for Advanced Surgical Technology (CAST), University of Nebraska
*[Note additional description, page 30]*

Dmitry Oleynikov *(Moderator)*
*Univ Nebraska Med Ctr*

**Presentations:**

Amy Lehman
*Univ Nebraska - Lincoln*
In Vivo Robotics for Natural Orifice Transgastric Peritoneoscopy

Sonja Koneczny
*Univ Nebraska – Lincoln; Univ Hosp Tuebingen*
Ergonomic Usability Testing of OR Devices

Carl Nelson
*Univ Nebraska - Lincoln; Univ Nebraska Med Ctr*
Modeling Surgical Tool Selection Patterns as a "Traveling Salesman Problem" for Optimizing a Modular Tool System

Ka-Chun Siu
*Univ Nebraska - Omaha*
Validating Advanced Robot-Assisted Laparoscopic Training Task in Virtual Reality

Jeff Hawks
*Univ Nebraska - Lincoln*
Towards an In Vivo Wireless Mobile Robot for Laparoscopic Surgical Task Assistance

**Panelists**:

Timothy Broderick
*Adv Ctr Telemedicine & Surgical Innovation, Univ Cincinnati*

Jacob Rosen
*Biorobotics Lab, Univ Washington*

Shane Farritor
*Univ Nebraska-Lincoln*

12:00 Adjourn

# WEDNESDAY MORNING, JANUARY 30

7:00 – 8:15 AM

## POSTER PRESENTATION SESSION

Wednesday Posters

*page#*

**BEHAVIORAL HEALTH**

51 Ravinder Reddy
*Psychiatry, Univ of Pittsburgh*
Virtual Reality-Assisted Cognitive Therapy for Schizophrenia (VRACTS) - A Proposal

51 Giuseppe Riva
*Applied Technology for Neuro-Psychology Lab., Ist Auxologico Italiano*
Why You Really Eat? Virtual Reality in the Treatment of Obese Emotional Eaters

51 David B. Stefan
Virtual Reality and the Bariatric Surgery Patient: Confrontation and Collaboration

**BEHAVIORAL HEALTH - PAIN CONTROL**

51 Robert Sweet
*Urologic Surgery, Univ of Minnesota*
Development of a Virtual Saint Paul for Adult Immersion

**EDUCATION & SIMULATION**

51 Jan Cannon-Bowers
*Sch of Film and Digital Media, Univ of Central Florida*
Pulse!! Usability and Playability: Preliminary Findings

51 Vassilios Hurmusiadis
*Research & Development, Primal Pictures Ltd*
Cardiac Simulation for Training and Education

52 James M. Kinross
*Biosurgery and Surgical Technology, Imperial College*
Second Health: Health Care Strategy in the Virtual World

52 Greg S. Ruthenbeck
*Sch of Informatics and Engineering, Flinders Univ*
A Virtual Reality 3D Jigsaw for Teaching Anatomy

52 Mark W. Scerbo
*Psychology, Old Dominion Univ*
Monitoring Simulated Maternal-Fetal Heart Rate Signals

52 Hilary A. Stathes
*Script Development, SIMmersion*
Virtual Standardized Patients for Training Health Professionals on Alcohol Screening and Brief Intervention

52 John R. Stone, Jr.
*eLearning, MountainTop Technologies, Inc.*
Virtual Medical Trainer for Peripheral Nerve Blocks

53 John R. Stone, Jr.
*eLearning, MountainTop Technologies, Inc.*
Forensic Dental Identification (FDI)

53 Bo Sun
*Virginia Modeling, Analysis and Simulation Ctr, Old Dominion Univ*
Medical Student Evaluation Using Virtual Pathology Echocardiography (VPE) for Augmented Standardized Patients

**HAPTICS**

53 Jaydev P. Desai
*Mechanical Engineering, Univ of Maryland*
Soft-Tissue Characterization During Monopolar Electrocautery Procedures

53 Kanav Kahol
*Simulation and Training Ctr, Banner Good Samaritan Medical Ctr*
Physics Based Hybrid Deformation Model for Configurable Haptic Training for Virtual Surgery

53 Yoshihiro Kuroda
*Graduate Sch of Engineering Science, Osaka Univ*
Haptic Rate for Surgical Manipulations with Fingers and Instruments

53 Erik Lövquist
*Interaction Design Ctr, Univ of Limerick*
Utilizing Existing Toolkits for Development of Realistic and Stable Force Feedback at Needle Tip with 3 DOF Haptic Devices

54 Sugeng Rianto
*Applied Physics and Medical Imaging, Curtin Univ of Technology*
Haptic Feedback for the Multilayer Cutting

54 Sugeng Rianto
*Applied Physics and Medical Imaging, Curtin Univ of Technology*
Force Model for Volume Rendering in Immersed Virtual Environment

**INFORMATION GUIDED THERAPY**

54 Venkat Devarajan
*Electrical Engineering, Univ of Texas at Arlington*
Design and Simulation of a Visual and Haptic Assisted Biopsy (ViHAB) System

54 Thomas G. Di Sessa
*Pediatrics, Univ of Kentucky*
The Use of 3-D and Virtual Reality Technology to Project Images of Aortic Arch Anomalies

54 Jürgen Fornaro
*Inst of Diagnostic Radiology, Univ Hospital of Zurich*
Interactive Visuo-Haptic Surgical Planning Tool for Pelvic and Acetabular Fractures

55 Mathias Hofer
*ENT, Univ Hospital Leipzig*
First Clinical Evaluation of the Navigated Controlled Drill at the Lateral Skull Base

55 Ashraf T. Ibrahim
*Electronics, Faculty of Engineering, Alexandria Univ*
A New Ultrasound Phased Array Applicator to Treat Prostate Cancer Using Hyperthermia

55 Shuhei Kubo
*Pediatric Dentistry, Tokyo Dental College*
CT Image Applications for Pre-Surgical Assessment and Surgical Pre-Planning in Pediatric Dentistry

55 Andreas Melzer
*Inst for Medical Science and Technology, Univ of Dundee & St. Andrews*
MRI and CT Guided Robotic System for Image Guided Interventions - Principles and First Clinical Application

55 Andreas Melzer
*Inst for Medical Science and Technology, Univ of Dundee & St. Andrews*
Inductively Coupled MR Visualization of Minimal Invasive Implantable Stent Based Aortic Heart Valve for MRI Guided Implantation

56 Robert Oberreuter
*Mechanical Engineering Department, Carnegie Mellon Univ*
Optimizing Joint Placement and Motion Schedule for 2 DOF Computer-Assisted Distraction Osteogenesis

56 Yuko Shigeta
*Fixed Prosthodontics, Tsurumi Univ Sch of Dental Medicine*
Changes in Three Dimensional Simulation Models of the Airway which are Due to Increases in Age or Body Mass Index

56 Gunther Sudra
*Computer Science (ITEC), Universität Karlsruhe (TH)*
Augmented Reality Assistance for Realization of Incision Planning and Model-based Analysis of the Modified Surface Model

56 Yasushi Yamazaki
*Periodontics and Endodontics, Tsurumi Univ Sch of Dental Medicine*
Dental Fiberscope with Navigation System for Endodontic Treatments

56 Xiaolong Zhang
*Computer Science & Engineering, Arizona State Univ*
Stereoscopic Visualization and Haptic Virtual Exploration of Gastrointestinal Endoscopic Images for Improved Diagnosis

56 Linping Zhao
*Plastic and Craniomaxillofacial Surgery, Shriners Hospitals for Children - Chicago*
Experiences in Virtual Craniomaxillofacial Surgery: Planning, Transferring to OR, and Validation

**ROBOTICS**

57 Miguel L. Franco
*Biomedical Engineering, Univ of California, Los Angeles*
A Mountable Pneumatic Haptic Feedback Actuator Array for the da Vinci“ Surgical Robotic System

57 Fuji Lai
Robotic Telepresence for Collaborative Clinical Outreach

57 Mitchell J.H. Lum
*Electrical Engineering, Univ of Washington*
Objective Assessment of Tele Surgical Robot Systems: Telerobotic FLS

57 Shigeyuki Suzuki
*Inst for High Dimensional Medical Imaging, Jikei Univ Sch of Medicine*
Telecontrol Function of an Endoscopic Surgical Robot with Two Hands for Tele-NOTES Surgery

**SOLID MODELS**

57 Takumi Ogawa
*Fixed Prosthodontics, Tsurumi Univ Sch of Dental Medicine*
Application of a Craniofacial Surgical Multiphase (Virtual and Physical) Simulation System for Jaw Deformities

58 Joerg Wulf
*Anatomy, Univ of Luebeck*
Pectus Excavatum: Silicone Implant Construction Using Computed Tomography and CAD Technology Versus Conventional Plaster Molding

**SURGICAL SIMULATION – LEARNING & METRICS**

58 Christoph Aschwanden
*Telehealth Research Inst John A. Burns Sch of Medicine, Univ of Hawaii*
Performance Measures for Dominant and Non-Dominant Hand Training in a Virtual Reality Motor-Skills Simulator

58 Nathan Delson
*Mechanical and Aerospace Engieering, Univ of California at San Diego*
Anatomically Configurable Mannequin Designed for Laryngoscopy Training and Assessment

58 Adam Dubrowski
*Faculty of Nursing, Univ of Toronto*
Trocar Insertion: The Neglected Child of VR Simulation

58 Nigel W. John
*Sch of Computer Science, Bangor University*
Physics-Based Virtual Environment for Training Core Skills in Vascular Interventional Radiological Procedures

58 Kanav Kahol
*Simulation and Training Ctr, Banner Good Samaritan Medical Ctr*
Surgeons on Wii: Applying Nintendo Wii to Improve Surgical Skills

59 F. Jacob Seagull
*General Surgery, Univ of Maryland*
Perfect Partners: Surgical Ergonomics and Minimally Invasive Training

59 Dennis J. Sessanna
*Ohio Supercomputer Ctr*
Simulation of Punch Biopsies: A Case Study

59 Cyle D. Sprick
*Sch of Informatics and Engineering, Flinders Univ*
Simulation Debriefing and Quantitative Analysis Using Video Analysis Software

59 Don Stredney
*Interface Laboratory, OSC*
Translating Human Simulation Technologies to Veterinary Surgical Practice: Accelerating Adoption

59 Robert M. Sweet
*Urologic Surgery, Univ of Minnesota*
Integration of MMVR Research Laboratories into Simulation Training Centers

59 Xun Zhou
*Shapiro Simulation and Skills Ctr, Beth Israel Deaconess Medical Ctr*
An Interoperable Platform for Evaluating Resident Performance on Virtual Simulators

**TRACKING**

60 Syed M. Ali
*Electrical and Computer Engineering, Wayne State Univ*
Eye Gaze Tracking for Endoscopic Camera Positioning: An Application of a Hardware/Software Interface Developed to Automate Aesop

60 T. “Kesh” Kesavadas
*Virtual Reality Lab, State Univ of New York at Buffalo*
Augmented Reality for MRI-Guided Needle Biopsy of the Spine

**UNIQUE / MISCELLANEOUS**

60 C. Donald Combs
*Planning and Health Professions, Eastern Virginia Medical Sch*
Visualizing the Medical Modeling and Simulation Database: A Comprehensive Analysis of Trends in the Research Literature

60 Rebeccah E. Marsh
*MITACS, Simon Fraser Univ*
Designing a "Virtual Liver" for the Prediction of Drug Transport and Metabolism

60 Panaiotis
*Elect & Comp Eng / Music, Univ of New Mexico*
Transforming an Educational Virtual Reality Simulation into a Work of Fine Art

7:00 – 8:15 AM

## POSTER PRESENTATION SESSION

Thursday Posters

*page#*

### IMAGING



### MODELING



### SURGICAL SIMULATION – SYSTEMS

63 Karsten Ø. Noe
*Inst of Information and Media Studies, Univ of Aarhus*
The Visible Ear Surgery Simulator

63 Cyle D. Sprick
*Sch of Informatics and Engineering, Flinders Univ*
SimTools - A New Paradigm in High Fidelity Simulation

63 Cyle D. Sprick
*Sch of Informatics and Engineering, Flinders Univ*
Virtual Patient Monitors for New User Familiarization

**SURGICAL SIMULATION – VALIDATION**

64 Thomas S. Lendvay
*Division of Pediatric Urology, Childrens Hospital and Regional Medical Ctr*
VR Robotic Surgery: A Randomized Blinded Pilot Study of the dV-Trainer Robotic Simulator

64 Vasile Nistor
*Mechanical & Aerospace Engineering Department, UCLA*
Construct Validity for the UCLA Laparoscopic Training System (LTS)

64 Chandrashekhar S. Sathaye
*Biomedical Engineering, Applied Mechanics Department, Indian Inst of Technology Madras*
Haptic Guided Laparoscopy Simulation Improves Learning Curve

64 Ravikiran B. Singapogu
*Electrical and Computer Engineering, Clemson Univ*
Comparative Study of Haptic Training versus Visual Training for Kinesthetic Navigation Tasks

64 Hyun Soo Woo
*Mechanical Engineering, KAIST*
Improvement of Colonoscopy Skills through Simulation-Based Training

**SURGICAL SIMULATION – TOOLS & DESIGN**

65 Eric J. Acosta
*National Capital Area Medical Simulation Ctr, Uniformed Services Univ*
Collaborative Voxel-Based Surgical Virtual Environments

65 Ehsan Basafa
*Sch of Mechanical Engineering, Sharif Univ of Technology*
A Prototype Laparoscopic Surgery Simulator Based on Real Soft Tissue Behavior

65 Kup-Sze Choi
*CIDH, Sch Nursing, Hong Kong Polytechnic Univ*
An Adaptive Transmission Protocol for Managing Dynamic Shared State in Collaborative Surgical Simulation

65 Thomas S. Lendvay
*Division of Pediatric Urology, Childrens Hospital and Regional Medical Ctr*
The Biomechanics of Percutaneous Needle Insertion

65 Wen Pei Liu
*Electrical Engineering, Stanford Univ*
Representing Fluid with Smoothed Particle Hydrodynamics in a Cranial Base Simulator

65 Sarthak Misra
*Mechanical Engineering, The Johns Hopkins Univ*
Physically Valid Surgical Simulators: Linear Versus Nonlinear Tissue Models

66 Ganesh Sankaranarayanan
*Mechanical, Aerospace and Nuclear Engineering, Rensselaer Polytechnic Inst*
Physics-Based Real Time Laparoscopic Electrosurgery Simulation

66 Ganesh Sankaranarayanan
*Mechanical, Aerospace and Nuclear Engineering, Rensselaer Polytechnic Inst*
CUDA-Based Real Time Surgery Simulation

66 Ganesh Sankaranarayanan
*Mechanical, Aerospace and Nuclear Engineering, Rensselaer Polytechnic Inst*
Novel Virtual Lap-Band“ Simulator Could Promote Patient Safety

66 Mark W. Scerbo
*Psychology, Old Dominion Univ*
Can Principles of User Interface Design Improve the Next Generation of Medical Simulators?

66 Yunhe Shen
*Urologic Surgery, Univ of Minnesota Medical Sch*
Realistic Soft Tissue Deformation Strategies for Real Time Surgery Simulation

67 Kumar K. Tamma
*Mechanical Engineering, Univ of Minnesota*
Challenges and the Path Forward for the Next Generation of Bio-Physical Based Real Time Surgery Simulations with Attention to Laparoscopic Nephrectomy

67 Xiangmin Zhou
*Ctr for Research in Education and Simulation Technologies (CREST), Univ of Minnesota*
The Family of Optimal Time Integration Algorithms for Real Time Virtual Surgery Simulations with Application to Virtual Nephrectomy

**TELEMEDICINE**

67 Eran B. Schenker
*Aerospace Medicine Research Ctr, Fisher Inst for Air and Space Strategic Studies*
Mobile Life Support for Trauma and Transport (MLSTAT)

**VISUALIZATION**

67 Rob A. Aspin
*Ctr for Virtual Environments, Sch of Computing, Science and Engineering, Univ of Salford*
Interactive 3D Volumetric Visualisation of Soft Tissue Injuries

67 Collin D. Brack
*Radiation Oncology, Univ of Texas Medical Branch*
Evaluating the Clinical Utility of Stereoscopic Images Acquired During Clinical Examinations

68 Alessandro De Mauro
*Inst for Process Control and Robotics, Univ of Karlsruhe (TH), Germany*
Improvement of the Concept for an Augmented Reality Neurosurgical Microscope

68 Jung Leng Foo
*Human-Computer Interaction, Iowa State Univ*
A Framework for Interactive Examination of Automatic Segmented Tumors in a Virtual Environment

68 C. William Hanson
*Anesthesiology and Critical Care, Univ of Pennsylvania*
Neurofuzzy Derived Topographies of Cardiac Performance

68 Karsten Ø. Noe
*Computer Science, Univ of Aarhus, Denmark*
A Framework for Shape Matching in Deformable Image Registration

## EXHIBIT HOURS

### WEDNESDAY, JANUARY 30

10:00 – 10:30 AM
Exhibits open. Break in Exhibit Ballroom

12:00 Noon – 1:15PM
Lunch in Exhibit Ballroom

3:15 – 3:30 PM
Break in Exhibit Ballroom

4:00 PM
Exhibits close

### THURSDAY, JANUARY 31

10:00 – 10:15 AM
Exhibits re-open. Break in Exhibit Ballroom

[Exhibits closed during Thursday lunch break]

3:25 – 3:45 PM
Break in Exhibit Ballroom

4:00 PM
Exhibits close and dismantle

---

### EXHIBITORS

**ACS Program for Accreditation of Education Institutes**
**American College of Surgeons - Division of Education**
633 N. St. Clair Street
Chicago, IL 60611
kjohnson@facs.org / mboyle@facs.org
www.facs.org/education/accreditationprogram/index
Phone 1 312 202 5276 / 1 312 202 5535

The vision of the Program for Accreditation of Education Institutes is to create a consortium of ACS-approved regional education institutes that offer practicing surgeons, surgical residents, medical students, and members of the surgical team a spectrum of educational opportunities including those that address acquisition and maintenance of skills and maintenance of certification, along with a focus on new procedures and emerging technologies.

The College is committed to providing accredited education institutes opportunities to collaborate among and between institutes, specifically in the areas of developing new curricula, conducting research and development, and sharing experiences and lessons learned in surgical education.

Currently there are 27 ACS Accredited Education Institutes. An application and on-site interview are required as a part of the process to become accredited. Accreditation decisions are made by the Accreditation Review Committee twice a year, June and December. For more information about the overall program or how to apply, please contact Kathy Johnson or Maura Boyle.

**B-Line Medical**
12510 Prosperity Drive, Suite 320
Silver Spring, MD 20904
info@blinemedical.com
www.blinemedical.com
Phone 1 888 228 3838

B-Line Medical's SimBridgeT and SimCaptureT solutions have been selected by dozens of top medical education institutions as the most advanced, comprehensive and easiest to use solution for managing simulation and Clinical Skills training centers. Through its sophisticated web-based architecture, SimBridgeT and SimCaptureT address the complex set of challenges presented by small and large simulation facilities: automated testing, assessment and video capture, simulator data integration, debriefing, and portfolio assembly.

From the affordable and portable SimCaptureT to the powerful and highly automated SimBridgeT, B-Line Medical solutions maximize resources, allowing faculty and staff to focus on student and curriculum development. For more information visit www.blinemedical.com.

---

**CFD Research Corporation**
215 Wynn Drive
Huntsville, AL 35805
AJP@CFDRC.com
www.CFDRC.com
Phone 1 256 726 4815

Computational Medicine and Biology Division of CFDRC is developing Leonardo - an anatomy/physiology based multiscale model of a virtual human. Leonardo integrates compartmental and 3D distributed models of cardiopulmonary circulation, lung respiration, oxygen/glucose metabolism, neural regulation, and other systemic physiological components. Leonardo is built from a spatially distributed arterial-venous vascular system perfusing several organs. The organs, in the multiscale modeling framework, can be represented as multi compartment reactors, 1D vascular trees embedded in the tissue compartment, or geometrically fully resolved 3D vasculature/tissue models. The multiscale modeling capability spans from systemic, organ, tissue, cellular, to subcellular pathway models. Our goal is to simulate Leonardo's virtual life with “faster than life” speed using novel multiscale modeling and parallel computing. The “Life Editor”, Leonardo's GUI, will allow programming of his daily life including circadian clock, nutrition, exercise, trauma injury, surgical procedures, and pharmacologic treatment. At present, Leonardo is being tested on his responses to traumatic injuries resulting from explosion blasts and on novel resuscitation, reperfusion, and pharmacological treatment ideas. We are working on the integration of top-down system level physiology models with the bottom-up systems biology. Leonardo is available for academic scientific research. For details please contact cmb@cfdrc.com.

---

**Claron Technology Inc.**
120 Carlton Street, Suite 217
Toronto, ON M5A 4K2, Canada
info@clarontech.com
www.clarontech.com
Phone 1 416 673 8175

Claron Technology Inc. designs and markets innovative products to measure and track objects in space using computer vision technology. Our main product line is the MicronTracker, the first truly passive real-time sub-millimeter optical pose sensor specialized for medical applications.

---

**D'Ambra Technologies**
PO 7308
Portland, ME 04112
mdambra@dambratec.com / davegdi@dambratec.com
www.dambratec.com
Phone 1 207 766 3300

D'Ambra Technologies (DTLLC) is dedicated to providing the benefits of elite three-dimensional technologies to the medical community. We have fostered a unique collaboration of software design and optical engineering with state-of-the-art hardware. We exercise total control of illumination, image acquisition, recording, storage, manipulation of content, and 3D display. This process affords precise control of every pixel in time and space. The result is a convincing 3D image rendered in real-time that passes the rigors imposed by clinical medicine.

---

**Fundamentals of Laparoscopic Surgery (FLS) Program**
**A SAGES/ACS Division of Education Program**
11300 W. Olympic Blvd, Suite 600
Los Angeles, CA 90064
Lisa@SAGES.org
www.FLSProgram.org
Phone 1 310 437 0544 x115

Fundamentals of Laparoscopic Surgery (FLS) is a comprehensive, validated educational program that gives surgical residents and practicing surgeons the opportunity to learn the fundamentals of laparoscopic surgery in a consistent, scientifically accepted format, while providing a tool that measures cognitive, clinical and technical skills. Soon to be web-based, two multimedia CD-ROMs present materials on preoperative and intraoperative considerations, basic laparoscopic procedures, postoperative care and complications, and manual skills instruction. The FLS Trainer Box and Accessory Kits allow surgeons to practice technical skills, improve dexterity and psychomotor skills. The assessment component is a two-part, proctored exam consisting of a 75-question multiple-choice test and hands-on skills test utilizing the FLS Trainer Box, administered at over 25 Test Centers across the U.S. and Canada in addition to the SAGES Annual Meeting and ACS Clinical Congress. FLS has been integrated into the U.S. Military and will be mandated in Australia and New Zealand in 2008. For more information on becoming an FLS Test Center, to sign up for the FLS Test, to request a brochure or purchase the FLS program, please contact the FLS Office.

**Mimic Technologies**
119 1st Avenue S, Suite 360
Seattle, WA 98104
info@mimic.ws
www.mimic.ws
Phone 1 206 923 3337

Mimic Technologies provides tension-based force feedback devices and robotic simulation applications. Mimic sells two off-the-shelf haptic devices called the Mantis Workstation (a one handed device) and Mantis Duo (a two handed device). Both systems incorporate high torque motors and on-board haptic processing that enable haptic update rates as high as 10,000 Hz.

The Mimic's dV-Trainer is a "flight simulator" for the da Vinci Surgical System (a product of Intuitive Surgical, Inc.). This simulator is designed to teach system awareness, instrument manipulation, and basic skills, such as suturing. Key components of the system are a compact hardware platform that closely reproduces the look and feel of the da Vinci surgeon's console, and a software simulation platform based on Mimic's proprietary simulation technology.
The dV-Trainer is scheduled to be released this summer. For a sneak preview of this product, be sure to visit the Mimic booth at MMVR on January 30th. You can also find out more about Mimic products by visiting our website at www.mimic.ws or by calling Mimic at 1-800-918-1670.

---

**PhoeniX Technologies Inc.**
4302 Norfolk Street
Burnaby, BC V5G 4J9, Canada
info@ptiphoenix.com
www.ptiphoenix.com
Phone 1 604 321 3238

PhoeniX Technologies Inc. (PTI) is the industry's leading manufacturer of "Active Optical" based 3D Motion Capture systems. PTI offers their Visualeyez™ range of Motion Capture systems, which are highly accurate, reliable and user-friendly, at extremely "cost-effective" prices. With advanced patented wide angle active marker tracking technology, world first and only automatic and adaptive calibration product VZAutoCal™ and several innovative accessories, PTI systems deliver Real Time, problem-free, and now even calibration-free, operation that provide users with instant high quality 3D motion feedback. Our high-end products are used all over the world in a variety of motion capture and measurement areas. Applications for our systems are in research and analysis work in the areas of Virtual Reality, Biomechanics, Robotics, Sports Science & Research, Structural and Vibration Analysis, Crash Test Analysis, and many more. Visualeyez™ systems also find applications and users in Animation, Video & Film development, computer and console Game Development, Special Effects Production, VFX, etc.

---

**Quanser Inc.**
119 Spy Court
Markham, ON L3R 5H6, Canada
info@quanser.com
www.quanser.com
Phone 1 905 940 3575 x223

Quanser Inc. manufactures standard off-the-shelf and customized high-fidelity haptic input devices for various clients in both Academia and in Industry. Our clients include Harris Corp., Sony Japan, McGill University, CSTAR London, Toronto Rehabilitation Institute, and many others. Quanser has been in business since 1990, and its products may be found in over 1300 institutions worldwide. Quanser's other businesses include educational controls products, real-time rapid controls prototyping hardware and software, and manufacturing of high-quality mechatronics sub-assemblies for tier 1 customers in various industries.

---

**SensAble Technologies**
15 Constitution Way
Woburn MA 01801
MTatkow@SensAble.com
www.SensAble.com
Phone 1 781 937 8315

SensAble Technologies provides software and devices that add the sense of touch to the digital world, including 3D touch-enabled modeling systems and the PHANTOM® line of haptic devices and OpenHaptics® toolkit. SensAble modeling systems are used for product design, medical and dental modeling, digital content creation, and fine arts. The PHANTOM force-feedback devices, which enable users to touch and manipulate virtual objects, and the developer toolkit, are used for simulation and training, robotics, and third-party development. In addition to off-the-shelf solutions, SensAble offers contract development to OEMs for new and customized software applications and haptic devices. Selected haptic application development customers include Boeing, CSIRO, General Electric, KAIST, MIT, NTT Research Lab, RIKEN, Sandia National Labs, Stanford University, Tokyo University, University of Glasgow, University of Hong Kong, University of North Carolina, and University of Siena. SensAble maintains headquarters in the United States and a sales office in Japan. SensAble products are available through direct and reseller channels.

---

**SenseGraphics AB**
Isafjordsgatan 22
16440 Kista, Sweden
info@sensegraphics.com
www.SenseGraphics.com
Phone 46 (0)8 750 8070

Do you want to develop cost effective and realistic medical simulators using the latest in Virtual Reality? Maybe you are looking for alternative stroke rehabilitation solutions?
Come see us at MMVR16!

Founded in 2004 in Stockholm, SenseGraphics represents over twenty years of experience in the haptics and graphics industry. The company provides a high performance development platform which enables integration of haptics and 3D stereo visualization into multimodal software applications such as medical training simulators. Its development platform consists of two main components, hardware and software solutions, offering the complete set of technologies needed to initiate 3D or touch enabled application development.

SenseGraphics flagship product, H3D API, is a dual commercial and GPL (open source) licensed software with a user community including more than 2000 registred users (visit www.H3D.org to learn more!). The company also offers professional haptics training, support and consulting services within several industry segments, as well as custom hardware solutions.

---

**The Telemedicine & Advanced Technology Research Center (TATRC)**
MRMC-ZB-T, Bldg 1054 Patchel Street
Ft. Detrick, MD 21702-5012
DeBernardis@TATRC.org
www.TATRC.org
Phone 1 301 619 2413

For the 2008 Annual MMVR Conference, the US Army Medical Research & Materiel Command (USAMRMC) and The Telemedicine & Advanced Technology Research Center (TATRC) have decided to take a novel approach. TATRC will extend the definition of telemedicine and advanced medical technologies, to include an array of technological innovations which impact the provision of healthcare to the military. This exhibit will focus on and highlight the Congressional Partners and their projects who have teamed with TATRC in an effort to improve joint medical readiness, provide greater battle- space medical awareness, and more effectively employ our medical forces in the 21st century. Funded as areas of Special Congressional interest for Army research, over 60 projects totaling more than 300 million dollars have been executed and managed by TATRC, and carried out in universities and private laboratories all over the country. Please stop by TATRC's advanced technology showcase for a thought-provoking and exciting experience demonstrating how technology will enhance life on the battlefield, in military medicine and beyond. For more information about TATRC, please visit us at at MMVR, or visit us at: www.tatrc.org, or call Ms. Lori DeBernardis, Director of Marketing and Public Affairs at 301.619.7927.

---

**TrueVision Systems**
114 E Haley Street, Ste. L
Santa Barbara, CA 93101
ASanchez@TrueVisionSys.com
LMcQuiggan@TrueVisionSys.com
www.TrueVisionSys.com
Phone 1 805 879 5200

TrueVision‘ is a remarkable real-time 3DHD vision system for microsurgery. It converts the stereoscopic optical view of surgical microscopes to a digital 3DHD image, called TrueView‘, and dis-

plays it on a projection screen or monitor. Surgical procedures are now performed without the need to be permanently attached to the microscope oculars.

TrueView‘ delivers over twice the depth of field compared to the microscope view and three times the resolution of standard definition, enabling surgeons to successfully perform “heads-up” microsurgery without looking into the microscope's eyepieces. The 3DHD video recording accurately captures the surgical view. One touch playback replays video of the TrueView‘ in full 3DHD clarity on the TrueVision‘ Image Display System.

Both surgeons, residents and the entire OR staff can view what traditionally only one surgeon could observe through the microscope's binoculars. TrueVision‘ works with surgical microscopes and is ideal in the operating room for pe forming surgery, collaborating and teaching surgical procedures.

By embracing 3DHD visualization as a standard of care and documentation, TrueVision‘ is leading the way to a digital future for all microscopy.

---

**Virtual Heroes, Inc.**
P.O. Box 12749
Research Triangle Park, NC 27709
stephanie.pavlick@virtualheroes.com
www.VirtualHeroes.com
Phone 1 919 459 2599

Founded in January 2004, and located in Research Triangle Park, NC, Virtual Heroes Inc. (VHI), the “Advanced Learning Technology Company,” creates collaborative interactive learning solutions for the federal systems, healthcare and commercial markets. Advanced Learning Technologies leverage simulation learning and digital games-based learning paradigms to accelerate learning, increase proficiency and reduce training costs for next-generation workforce development.

As a global market leader in this field, VHI applications facilitate highly interactive, self-paced learning and instructor-led, distributed team training on the Virtual Heroes Advanced Learning Technology (A.L.T.) platform using the Unreal, Engine 3 by Epic Games. In 2007, VHI was honored by Military Training and Technology magazine as one of the industry's Top 100 companies for a third consecutive year. Virtual Heroes is expanding its experience and success in the defense sector into the healthcare market with the development of HumanSim‘, and into the commercial market with custom solutions.

---

TUESDAY MORNING, JANUARY 29

**TUTORIAL**

**Virtual Reality Applications in Mental Health and Rehabilitation**

*Organizer:*

Albert A. “Skip” Rizzo
*Institute for Creative Technologies, School of Gerontology*
*University of Southern California*

Virtual Reality (VR) has now emerged as a promising tool in many domains of assessment, therapy and rehabilitation (1-8). Continuing advances in VR technology along with concomitant system cost reductions have supported the development of more usable, useful, and accessible VR systems that can uniquely target a wide range of psychological, cognitive and motor science assessment and rehabilitation concerns and research questions. This talk will provide a brief introduction to VR and describe the assets that are available with VR applications in assessment, therapy and rehabilitation. Within that context, examples of virtual environments that illustrate each asset will be presented. The value of an interdisciplinary approach for the design and implementation of VR will be emphasized with examples spanning the fields of rehabilitation, psychology, neuroscience, physical therapy, occupational therapy, special education and social work.

---

TUESDAY AFTERNOON, JANUARY 29

**WORKSHOP**

**Toward National Standards for Simulation Based Medical Education: Current Initiatives and Future Directions**

*Organizer:*

Alan Liu
*National Capital Area Medical Simulation Ctr*
*Uniformed Services University*

Over the past decade, simulation has evolved from a technical curiosity into a legitimate tool for medical education. In addition to playing a role in some medical accreditation programs, simulation is also increasingly part of the medical education curriculum. This workshop looks at the next step in the evolutionary process.

Of note are initiatives that standardize the teaching of core competencies within the medical community. Both the American College of Surgeons and the Association of Program Directors in Surgery have initiatives that seek to develop a national curriculum for the teaching of surgical skills. Integral to their initiative is the use of simulation for both assessment and instruction. The military healthcare system is also moving toward developing a framework for structuring the use of medical simulation for training its personnel.

In this workshop, we examine these and other recent developments. An overview of select initiatives will be provided. Their current status and future directions will be discussed. The impact to medical simulation development will also be highlighted. This workshop will end with an open forum to discuss the material.

---

WEDNESDAY MORNING, JANUARY 30

**SESSION**

**Intra-Cellular Surgery: Extending the Surgeon’s Reach to Genes and Molecules**

*Organizers:*

Jaydev P. Desai
*Mechanical Eng, Univ of Maryland*

Richard M. Satava
*Surgery, Univ of Washington*

There are two fundamental concepts which Intra-cellular surgery will bring to healthcare: 1) the ability to manipulate at the cellular and molecular level, and 2) the ability to influence health and disease by directly changing the biology of individual cells.

In the first case, it has been recently discovered that mechanical manipulation of individual cells can cause specific bio-molecular changes. New tools are being created (such as femto-second lasers, MEMS manipulators, etc.) that will permit direct "surgery" on individual components of the cell, including the genetic material.

To date, the success rate with biochemical manipulation (e.g. transfection, etc.) to change genetic material is about 15% at best. By direct manipulation, it will be possible to have complete control of genetic (metabolic, proteinomic, etc.) manipulation. Additionally, new tools that can change the molecular and genetic arrangements of cells will allow surgeons to augment the performance of healthy individuals as well as provide an entire new toolkit of methods to treat injury (e.g. hemorrhage, burns, etc.) and disease (infections, tropical disease, vaccinations, etc). This fundamental science will revolutionize the way medicine can be delivered.

---

WEDNESDAY, JANUARY 30 &
THURSDAY, JANUARY 31

**THE SALON**

Center for Innovation,
National Board of Medical Examiners
Salon sponsor

Kóan Jeff Baysa
*Vera List Center, The New School University, New York*
Salon curatorial advisor

The Salon is a new feature of MMVR—a novel environment designed to stimulate multi-directional interaction. Attendees are invited to explore, converse, and learn within a loose framework of discussions, demonstrations, electronic presentations, and art.

*Presenters:*

Panaiotis, Composer, musician, and computer scientist
*University of New Mexico*
Kidney Nephron VR

Joyce Cutler-Shaw, Artist-in-Residence
*Sch of Medicine, Univ of California San Diego*
Shadows and The Anatomy Scroll

Chip Kidd, Writer and graphic designer
*Random House, Inc.*
Covering Oliver Sacks

Jennifer Sieck, 3D medical animator
*National Capital Area Medical Simulation Center*
Constructing 3D Anatomical Content for
Cricothyroidectomy and Virtual Environments

The Art Center College of Design
Designmatters at Art Center: Mpala Camel Clinic Project
International Development Design Summit Documentary

Berci Meskó, Medicine blogger & simulation innovator
*Univ of Debrecen, Hungary*
Medicine 2.0

Dave Warner, Medical synergist
*Biodesign Institute & Decision Theater, Arizona State University; MindTel LLC; Inst for Interventional Informatics*
The Cyberarium

The Salon will also feature topical discussion groups, led by the Center for Innovation and others. Please see the separate Salon activity schedule for details.

---

THURSDAY MORNING, JANUARY 31

**WORKSHOP**

**From Image-Guided to Model-Guided Therapy**

*Organizers:*

Heinz U. Lemke
*Inst Technical Informatics, Technical Univ Berlin*

Leonard Berliner
*Radiology, Staten Island Univ Hospital*

Informatics with its tool set for modelling of information structures and digital systems will become an essential discipline for model guided therapy with adaptive assist systems. The workshop will focus on the technical and clinical aspects of research and development in this field. Possible meta architectures for surgical assist systems and use cases from neuro-, cardiovascular- and ENT surgery as well as interventional radiology will be introduced.

Different imaging modalities and a wide spectrum of other information sources need to be digitally integrated to build a suitable patient model. New patient modelling methods and tools are required to position a Therapy Imaging and Model Management System (TIMMS) as the key system for an integrated patient care philosophy. An IT model-centric world view, however, needs not only to be applied to the patient data, but also to a TIMMS and its interfaces.

A possible physical realization of interfaces required between major functional groups within and outside TIMMS will be outlined. Appropriate use of standards (for example a surgical DICOM) allows for the implementation of flexible pilot systems and in turn contributes to their further developments. Examples from the efforts of DICOM Working Group 24 “DICOM in Surgery” will be presented.

---

THURSDAY MORNING, JANUARY 31

**WORKSHOP**

**HealthGrid Unconference**

*Organizers:*

Mary E. Kratz
*HealthGrid US Alliance; Univ of Michigan*

Jonathan Dugan
*HealthGrid.US Alliance; Matson Systems Inc.*

This session will explore a different meeting format, referred to as an unconference. The idea is that there is a better dynamic for exchange of information than endless droning through PowerPoint slides. Sans the typical presentation formats, which provide for one:many exchange of information (one speaker to an audience), this session will be radically different in that the format will harness the collective expertise of many:many discussion topics in our area of interest: HealthGrid.

The session will begin with our discussion leaders providing all participants with a brief technology overview of the HealthGrid and unconference guidelines, setting the session ground rules and explaining this new unique conference format.

Additional topics will be determined during the unconference opening. Participants are encouraged to provide topics that cross-pollinate and connect diverse perspectives.

---

THURSDAY AFTERNOON, JANUARY 31

**PANEL**

**Medicine By Design**

*Organizer:*

Mariana Amatullo
*International Initiatives & Designmatters*
*Art Center College of Design*

This panel discussion, centered on MMVR16's focus on collaboration, will take as a principal case study the Mpala Project where Art Center College of Design is collaborating with another discipline and university (Princeton Institute of Science and Technology), a community-based mobile health clinic in Kenya (the Mpala Community Trust, MCT) and a series of experts from solar technology and public health education.

The premise of the Mpala Project is to improve upon the healthcare delivery system and social innovations established by MCT, which has been piloting camel convoys and the training of local community leaders as counselors to reach the highly isolated and nomadic populations in the region. The project's significance to both design research and application has earned it recognition as a finalist in the May 2007 World Bank Development Marketplace Competition. The innovative contributions to the project include: a breakthrough mobility system that improves the efficiency of the loads carried by the camel convoys; the design and engineering of unique solar powered refrigeration units which allow the clinic to deliver crucial vaccines and medicines that are currently inaccessible to the community; and a culturally relevant, visually-based health education campaign for the non-literate population of the area.

The panel will illustrate fundamental design principles for medicine and will share prototype outcomes of the project, methodologies and lessons learned.

---

FRIDAY MORNING, FEBRUARY 1

**PANEL**

**Cognitive Skills in Surgery**

*Organizers:*

Mark Smith
*Simulation & Training Ctr*
*Banner Good Samaritan Med Ctr*

Richard M. Satava
*Surgery, Univ Washington*

Many advances in the learning/acquisition/evaluation of psychomotor skills in surgery have occurred in recent years, both in the literature as well as in the design of surgical simulators and surgical curricula. However, every experienced surgeon will confirm that the easy part is teaching a novice the manual skills; the more difficult challenge is to teach and evaluate the intra-operative decision-making processes that are crucial for proficiency in a surgeon. This panel will attempt to explore those aspects of a surgeon's skills, both from the acquisition as well as the assessment of them.

---

FRIDAY MORNING, FEBRUARY 1

**PANEL**

**Overcoming Leonardo's Constraint: When Does Stereoscopy Contribute to Medical Visualization?**

*Organizers:*

Michael D'Ambra
*Brigham & Women's Hosp; D'Ambra Technologies*

Steven Senger
*Comp Sci, Univ Wisconsin - La Crosse*

Leonardo da Vinci, through his interest in revealing nature's laws and perfecting the art of painting, noted that with two eyes it is possible to see more of near objects, and the background that they obscure, than is possible with either eye alone since objects obscured from view for one eye may be visible to the other eye. This constraint implied that no matter how perfect, a painting on canvas would never represent what the painter saw. Stereoscopic visualization technology provides a way to escape the limits of the canvas and defeat Leonardo's constraint. This panel will examine the uses of stereoscopy in medical visualization and try to answer the question "When does stereoscopy contribute to medical visualization?". The panel will also address the related question of whether the impediments to wider use of stereoscopic visualization are technical or because there are relatively few situations in medical visualization where stereoscopic vision contributes critical value.

---

FRIDAY MORNING, FEBRUARY 1

**TUTORIAL & PANEL**

**Towards Digital Surgery in the New Millennium**
Featuring the Center for Advanced Surgical Technology (CAST), University of Nebraska

*Organizer:*

Dmitry Oleynikov
*Center for Advanced Surgical Technology*
*University of Nebraska Medical Center*

The purpose of the tutorial and panel discussion is to acquaint listeners and describe new computer aided technologies in surgical practices including training, guidance, tools, and techniques. This topic plays strongly into the mission of the Center for Advanced Surgical Technology (CAST). CAST's mission is to develop innovative surgical technologies and procedures through creative interdisciplinary biomedical research which will decrease complica-

tions, reduce hospitalization, improve health, and enhance quality of life. The Center for Advanced Surgical Technology (CAST) is a multi-disciplinary, multi-department, multi-campus collaborative effort at the University of Nebraska. The affiliation provides an appropriate research, training, and clinical practice infrastructure that facilitate interaction and collaborative research among surgeons, physicians, life scientists, engineers, and computer scientists who are specifically interested in contributing to work on biomedical issues.

## PRESENTATIONS

### In Vivo Robotics for Natural Orifice Transgastric Peritoneoscopy

Miniature in vivo robots are a potentially disruptive approach to Natural Orifice Transluminal Endoscopic Surgery (NOTES). NOTES gains access to the peritoneal cavity transgastrically through a natural orifice and has several potential advantages including eliminating the need for external incisions, reducing pain, improving cosmetics, speeding recovery, and reducing adhesions and ileus. While NOTES is very appealing from the patient's perspective, it is surgically challenging. Since access is limited to the size of the natural orifice it is difficult to have multiple instruments simultaneously passing through these orifices and the instruments must be flexible throughout their entirety to traverse the natural lumen. Current endoscopes' tools are inadequate in both their ability to visualize the surgical environment and their ability to manipulate tissue. Our work focuses on creating a family of remotely controlled image-guided mini-robots that can be placed entirely into the peritoneal cavity through the mouth to perform abdominal surgery.

### Ergonomic Usability Testing of OR devices

Ergonomic usability testing methodology and standardized metrics for OR medical devices, especially laparoscopic systems will be discussed. By identifying the type, scope and impact of medical errors and promoting interventions for reducing or eliminating these errors via design standards, increased efficiency and positive surgical outcomes achieved by the thorough observation of process specific interactions among workers (nurses and physicians), patients, technology and organizational parameters. The major aspect influencing the intuitive and error free operation of devices is the design of the devices.

### Modeling Surgical Tool Selection Patterns as a "Traveling Salesman Problem" for Optimizing a Modular Surgical Tool System

We have previously designed and reported on a modular, multifunction surgical tool which delivers function tool tips from a cartridge system. In this paper, we present a modeling approach for optimization of the tool arrangement in the cartridge with the goal of minimizing tool-change time. This approach is based on a graph representation of tool-change patterns as found by analyzing surgical video. The optimal solution is found by solving the "Traveling Salesman Problem" on the weighted graph. Simulation results using this method are compared and contrasted to our previously reported efforts to solve this problem using a fuzzy inference system.

### Validating Advanced Robot-Assisted Laparoscopic Training Task in Virtual Reality

The purpose of this study was to validate a complex surgical task, mesh alignment task in virtual reality. Nine subjects unrolled and aligned a mesh onto an inanimate template for the mesh alignment task in both an actual (the Da Vinci surgical robot) and a virtual environment. Data analysis included time to task completion, distance traveled, and speed of the surgical instrument, as well as electromyography of the extensors and flexors of the dominant arm of the subject. Paired t-tests were used to compare the dependent variables between the actual and virtual environments. The virtual mesh alignment task was statistically similar for all variables except the flexor activity as compared to the actual task. In conclusion, virtual reality could be used as an effective environment to train the next generation of robot-assisted laparoscopic surgeons.

### Towards An In Vivo Wireless Mobile Robot for Surgical Assistance

The use of miniature in vivo robots that fit entirely inside the peritoneal cavity represents a novel approach to laparoscopic surgery. Previous work has demonstrated that mobile and fixed-base in vivo robots can be used to improve visualization of the surgical field, and perform surgical tasks such as collecting biopsy tissue samples. All of these robots used tethers to provide for power and data transmission. This paper describes recent work focused on developing wireless in vivo robotic sensor and manipulator platforms. One vision for these types of self-contained in vivo robotic devices is that they could be easily carried and deployed by non-medical personnel at the site of an injury. Such wireless in vivo robots are much more transportable and lower cost than current robotic surgical assistants, and could ultimately allow a surgeon to become a remote first responder irrespective of the location of the patient.

MMVR16

# SESSION A

## TUESDAY AFTERNOON, JANUARY 29

---

**Daphna Weinshall**

***The Distortion of Reality Perception in Schizophrenia Patients, as Measured in Virtual Reality***

Background: Virtual Reality is an interactive three-dimensional computer generated environment. By providing a complex and multi-modal environment, VR can be particularly useful in the study of complex cognitive functions and brain disorders. Here we used a VR world to measure the distortion in reality perception in schizophrenia patients. Methods: 43 schizophrenia patients and 29 healthy controls navigated in a VR environment and were asked to detect incoherencies, such as a cat barking or a tree with red leaves. Results: Whereas the healthy participants reliably detected incoherencies in the virtual experience, 88% of the patients failed in this task. The patients group had specific difficulty in the detection of audio-visual incoherencies; this was significantly correlated with the hallucinations score of the PANSS. Conclusions: By measuring the distortion in reality perception in schizophrenia patients, we demonstrated that Virtual Reality can serve as a powerful experimental tool to study complex cognitive processes.

---

**Thomas Parsons**

***A Virtual Environment for Assessment of Neurocognitive Functioning: Virtual Reality Cognitive Performance Assessment Test***

While traditional neuropsychological measures have adequate predictive value, their ecological validity may diminish predictions about real world functioning. Our project involves two phases: Phase 1 established the construct validity of the Virtual Reality Cognitive Performance Assessment Test (VRCPAT) Memory Module. In Phase 2 we are establishing the VRCPAT Attention Module's construct validity. 40 health subjects (ages 21-36, 50 % male; equivalent ethnic distribution) completed the VRCPAT (20 minute) and a neuropsychological assessment (1.5 hour). No subjects had history of psychiatric or neurologic conditions. Results supported both convergent and discriminant validity. VRCPAT correlated significantly with traditional neuropsychological Learning ($r = 0.69$, $p < 0.001$, 48% of variance) and Memory ($r = 0.67$, $p < 0.001$, 45% of variance) composites. No correlations existed between VRCPAT and confounding composites. We conclude that the VRCPAT has sufficient construct validity and provides opportunity to study neurocognitive function within an ecologically valid environment.

---

**Giuseppe Riva**

***Why Do You Drink? Virtual Reality as an Experiential Medium for the Assessment of Alcohol-Dependent Individuals***

The aim of this study is to assess social, personality and behaviors of alcoholics using VR. Specifically, we defined a VR protocol to investigate the following factors: Intrapersonal factor (Emotional Management and Self Esteem) and Environmental factor (Relational Competences and Social Pressure). In this preliminary study we evaluated the difference between assessment methods by comparing VR assessment with traditional self-report questionnaires in a sample of 20 alcohol-dependent individuals (10 experimental group + 10 control group) entering a non-pharmacological outpatient treatment. The obtained data confirm the possibility of using the VR protocol in the assessment of alcoholic patients: The therapist obtains more critical data about behaviors and attitudes in less time. Further, the questionnaires' scores suggest the possible role of the VR experience in improving both self-esteem and motivation for change. A wider sample and a multicentric trial are now needed to confirm these results.

---

**Don Stredney**

***Evaluating Elicited Anxiety in a Simulated Environment***

We report on an exploratory study to determine the efficacy of a simulated environment to elicit anxiety. The purpose of this study is to quantify the ability of a simulated environment to emulate dangerous situations that can lead to injury producing events. We will present the problem situation of an agricultural environment, including national rates and statistics of injuries. We will present our methods to emulate the environment synthetically, and our study design and methods to sample the physiological affects of the simulation environment on the subject. Finally, we will present the statistical results of this study, our conclusions, and directions for further extensions of the simulation environment.

---

**Melba Stetz**

***The Usefulness of Virtual Reality Stress Inoculation Training with Coping Strategies on Military First Responder Students***

Virtual Reality Stress Inoculation Training (VR-SIT) is a technique to inoculate deploying warfighters against job/deployment-related stress. To investigate the overall dynamics inherent in this approach, we examined the stress levels of fifty-eight military medical personnel. Specifically, we compared the stress incurred by participants who were trained on more traditional combat stress reduction techniques (Coping Training (CT)) with those who navigated through Virtual Reality (VR) scenarios. Our preliminary results provide a greater understanding of the dynamics behind how VR-SIT may inoculate warfighters against combat stress injuries. That is, post-treatment hostility levels were higher in the group exposed to virtual reality condition when compared with participants who were in the CT group. Along those lines, post-treatment positive affect and sensation seeking were higher among participants who were exposed to both VR-SIT and CT. This preliminary data will be discussed in more depth at the MMVR conference.

---

**Skip Rizzo**

***Virtual Iraq: Initial Results from a VR Exposure Therapy Application for OIF/OEF Combat-Related Post Traumatic Stress Disorder***

Post Traumatic Stress Disorder (PTSD) is reported to be caused by traumatic events that are outside the range of usual human experience including military combat, violent personal assault, being kidnapped or taken hostage and terrorist attacks. Reports indicate that at least 1 out of 6 Iraq War veterans are exhibiting symptoms of depression, anxiety and PTSD. Virtual Reality exposure therapy has been previously used for PTSD with reports of positive outcomes. This paper will present a brief description of the USC/ICT Virtual Iraq PTSD therapy application and present clinical outcome data from all patients treated as of Jan. 2008. Clinical trials are currently underway at the NMCSD, Camp Pendleton, Emory University, WRAMC and Fort Lewis along with 10 other clinical test sites. Initial outcomes from the first eight patients treated at the time of this writing indicate that 6 no longer meet diagnostic criteria for PTSD at post treatment.

---

**Dennis Wood**

***Combat Related Post Traumatic Stress Disorder: A Multiple Case Report Using Virtual Reality Exposure Therapy with Physiological Monitoring***

Posttraumatic stress disorder (PTSD) is one of the most disabling psychological conditions affecting the veteran population. The percentage of Army and Marine Corps personnel, who participated in combat during Operation Iraqi Freedom or Operation Enduring Freedom, who met screening criteria for major depression, generalized anxiety disorder or PTSD, ranged from 11.2% to 17.1%. An increased incidence of mental health problems have been experienced by warriors following their having been deployed to subsequent combat tours.

Research has suggested that virtual reality exposure (VRE) therapy as a new medium of exposure therapy for treating Vietnam veterans with PTSD. Virtual Reality Medical Center of San Diego is participating in a research study at the Naval Medical Center San Diego investigating the therapeutic effects of VRE therapy with warriors diagnosed with PTSD; this research study has been funded by the Office of Naval Research (ONR). VRMC has just completed the treatment on the first twelve patients who were members of this research program's pilot study. Our paper will review not only the VR treatment protocol to treat combat-related PTSD, but also we will review the treatment outcome results for our first twelve patients in our pilot group.

---

**José Luis Mosso**

***Laparoscopic Cholecistectomies and Inguinal Hernia Repairs under Regional Anesthesia and Cybertherapy***

Objective. Demonstrate Virtual Reality VR scenarios are a complementary therapy to reduce anxiety, discomfort and pain during common laparoscopic procedures under regional anesthesia. Methodology. 5 laparoscopic cholecistectomies and 5 laparoscopic inguinal hernia repairs were performed under regional anesthesia using virtual scenarios displayed on the HMD. Results. VR reduced considerably anxiety and pain during procedures. No opiod medications were used except in low doses in 4 patients. Conclusions. VR is an option to reduce anxiety and pain during laparoscopic procedures specifically: cholecystectomy and inguinal hernia repairs under regional anesthesia.

---

**Kate Miller**

***Preparation & Distraction Using a Multi-Modal Device to Reduce Anxiety & Distress in Children Undergoing Burns Procedures***

A Multi-Modal Distraction Device was developed, from a virtual reality model of sensory distraction (without the head piece), to meet the developmental challenges of the younger population (3-10 years) we treat with burn injuries. A randomised control trial of 120 children is currently being undertaken to assess the efficacy of this clinically specific distraction device, in reducing levels of pain and anxiety, when compared to (1)standard distraction, used in our paediatric outpatient burn injury clinic, and (2)distraction from an off the shelf hand held game console. Initial data is indicating significant pain score reductions, including child self report, caregiver report and nursing observation, when the multi-modal device is being used compared to both standard distraction and off the shelf games. The inclusion of psychosocial procedural preparation, via the multi-modal device, to reduce pre-procedural anxiety and to enhance procedural coping is also being recognised as an effective instrument that will enhance the outpatient service we deliver.

# PLENARY SESSION

**WEDNESDAY MORNING, JANUARY 30**

---

**Sir Alfred Cuschieri**

***Emerging Technologies for Cellular Surgery***

Cellular surgery is based on creation of transient defects in the bi-lipid cell membrane, which then seal within a few ms. Micro-manipulation of the intracellular environment and cell organelles is possible by photonic forces (e.g. optical tweezing/ cutting) and ingress of molecules (DNA, drugs) is significantly enhanced (x 102- 103) during the permeabilisation period. The applications for cellular surgery are several and include: stem cell therapy and tissue engineering, gene transfection, high-dose targeted cancer chemotherapy, and regenerative medicine. The technologies for cell poration include: controlled sonoporation (sonopores created by cavitating micro-bubbles energised by low power ultrasound [1], photoporation with femto-s pulsed lasers, and electroporation (EP) - the application of controlled electric fields to facilitate cell permeabilization. This is the oldest technique first reported by Neumann el [2]. The main limitation of clinical EP is related to the existing technology for its application as this involves transmission of the high voltage electric fields from external generators to the target tissue by multiple needle or flat plate electrodes. A new system for cell electropermeabilization based on the use of carbon nanotubes (CNTs) which enables in-vitro electropermeabilization of mammalian cells with low voltage electrical fields (< 50 V/cm) and with an efficiency exceeding 80% has been developed in Pisa [3].

1. Prentice P, Cuschieri A, Dholakia K, Prausnitz M, Campbell P. Membrane disruption by optically controlled micro-bubble cavitation. Nature-Physics, 2005 1: 107.
2. Neumann, E.; Schaefer-Ridder, M.; Wang, Y.; Hofschneider, P. H. EMBO J 1982, 1, 841-845.
3. Raffa V, Pensabene V, Ciofani G, Vittorio O, Cuschieri A, Kostarelos K. Carbon nanotube-enhanced cell permeabilization (in press)

# SESSION A

## WEDNESDAY AFTERNOON, JANUARY 30

---

**Marjorie McShane**

***Revealing the Conceptual Substrate of Biomedical Cognitive Models to the Wider Community***

The Maryland Virtual Patient (MVP) Project is based upon ontologically encoded cognitive models of diseases that reflect the mental models of practicing physicians. Models are inspectable in encapsulated form in the interface and able to be modified to author instances. Authors are permitted to change certain property values within a set range to allow for a broad range of patient behaviors. Ranges are set by the developers of the model to ensure that the disease plays out in a way that reflects clinical findings as reported in the literature. An author can create a virtual patient instance in minutes, making development of whole populations of virtual patients simple. Knowledge can also be modified to accomodate additional expert opinions, new biological or clinical evidence, or new applications that require enhancement of the basic models. These capabilities will allow a broader community to collaborate in this project.

---

**W. LeRoy Heinrichs**

***Design and Implementation of Rule-Based Medical Models***

A Virtual Emergency Department, as a learning environment, requires the representation of patients who deteriorate if appropriate interventions are not applied in time. We have simulated patients who have been exposed to bomb explosions or to the release of nerve toxins, and whose condition deteriorates rapidly, requiring efficient and accurate diagnosis and treatment in the emergency department. Simulation of such patients requires an appropriate representation of their physiology and of their response to interventions. We have developed, and present here, a systematic approach to the creation of patient cases with temporal evolution of physiology.

---

**Adeline Deladisma**

***Medical Student Satisfaction Using a Virtual Patient System to Learn History-Taking and Communication Skills***

Virtual patients (VPs) have the potential to enhance the efforts of health professions students in learning history-taking and communication skills by providing a means for standardized, repetitive practice in a safe environment. The purpose of this study was to examine learner perceptions of the virtual patient experience and their relationship to satisfaction with and potential future use of this system. Each student completed an interview with Edna, a 55 year old VP with a breast mass. Subjects were asked to rate the authenticity of the VP and the examination room and the educational value of the experience. Despite some of the limitations in this developing technology, students are generally receptive to its use as an educational tool. VPs could serve as an adjunct to existing medical school curricula providing students another venue to practice their history-taking skills.

---

**Roger Phillips**

***Virtual Reality Training for Radiotherapy Becomes a Reality***

A national crisis in England for training staff and students for the radiotherapy treatment of cancer was reported in 2007. Providing clinical-based training for students and staff in radiotherapy treatment rooms is problematic for a number of reasons. VERT is an immersive virtual environment (VE) of a radiotherapy treatment room that addresses this crisis. In 2007 immersive VERT systems for radiotherapy training were established at training centres in Europe. The papers presents the rationale for VE training in radiotherapy. It reports on the functionality provided by VERT and describes how the University Aarhus Hospital in Denmark are using VERT for training nurses and doctors and it reports on their results and insights into VE training of radiotherapy. A national scheme is underway to provide VE training for radiotherapy at all training centres in England.

---

**Greg Ruthenbeck**

***A Virtual Reality Throat Examination Simulation***

Clinical skills education is enhanced by deconstructing the skills and teaching them in parts. Patient simulators are useful learning aids and part task trainers are widely used for teaching a range of procedures. We have developed a throat examination simulator (with haptics) using open source technology that incorporates knowledge and skill learning elements for a core diagnostic clinical skill in a flexible platform that can be applied to many other skills. We also share some insights into our experiences with different approaches and different technologies applied to haptics and visco-elastic modelling.

---

**Naoto Kume**

***Asynchronous Teaching of Psychomotor Skills through VR Annotations: Evaluation in Digital Rectal Examination***

Many VR technology based systems have been created with the aim of asynchronous (i.e. record and replay) training. Such systems use expert's motion data as the training aid, but would not provide any short-cut to teaching medical skills that do not depend on exact motions but relative performance according to every patient's unique anatomy. Earlier we presented Annotated Simulation Records (ASRs), which can be used to encapsulate experts' insight on psychomotor skills. The underlying VR annotations based on behavioural parameters in training simulators enable asynchronous teaching instead of just motion training. We evaluated ASRs for asynchronous teaching of Digital Rectal

Examination (DRE) with 3 urologists and 8 medical students. The ASRs were found more effective for teaching than motion-based training with verbal feedback.

---

**Thomas Parsons**

***Objective Structured Clinical Interview Training Using a Virtual Human Patient***

Effective interview skills are a core competency for psychiatry residents and developing psychotherapists. Although schools commonly make use of standardized patients to teach interview skills, the diversity of the scenarios standardized patients can characterize is limited. Virtual Human technology has evolved to a point where researchers may begin developing mental health applications. The work presented here allows novice mental health clinicians to conduct an interview with a virtual patient (VP) that emulates an adolescent male with conduct disorder. Initial outcomes have been favorable. We have collected (and continue to collect) quantitative and qualitative results. The VP fit well into usability testing. Clinicians in training had positive response to the VP and behaved as they normally would during a clinical encounter. This study illustrates the ways in which a variety of core research components developed at the University of Southern California facilitates the rapid development of mental health applications.

---

**Jennifer Pierce**

***Comparative Usability Studies of Full vs. Partial Immersive Virtual Reality Simulation for Medical Education and Training***

Virtual reality (VR) simulation provides a means of making experiential learning reproducible and reusable. This study was designed to determine the efficiency and satisfaction components of usability. Previously, it was found that first year medical students using a VR simulation for medical education demonstrated effectiveness in learning as measured by knowledge structure improvements both with and without a head mounted display (HMD) but students using a HMD showed statistically greater improvement in knowledge structures compared to those not using a HMD. However, in this current analysis of other components of usability, there were no overall significance differences in efficiency (ease of use), nor in satisfaction, within this same group of randomized subjects comparing students using a HMD to those not using a HMD. These types of analyses may be important in determining the most appropriate, cost effective VR simulation technology needed to achieve specific learning goals and objectives.

---

**Valeriy Kozmenko**

***Initial Implementation of Mixed Reality Simulation Targeting Teamwork and Patient Safety***

The most pressing challenge that the health care system is experiencing now is patient safety. A unique multidisciplinary group of physicians and medical educators at the Louisiana State University Health Sciences Center has developed and implemented a variety of mixed environment training strategies and models in recent years. In 2006, the LSUHSC-based research team received funding from the Agency for Healthcare Research and Quality (AHRQ) to evaluate the effectiveness of a truly interdisciplinary team training program that included mixed environment features. This presentation reports on initial implementation of the STEPS program (System for Teamwork Effectiveness and Patient Safety) in which a mobile mock operating room (MMOR) configuration is used to train truly interdisciplinary general surgical teams in teamwork and patient safety competencies within their own operating room environment.

---

**Bryan Bergeron**

***Learning & Retention in Adaptive Serious Games***

Serious games are being actively explored as supplements to and, in some cases, replacement for traditional didactic lectures and computer based instruction in medicine and in the military. As part of an intelligent tutoring system (ITS) for nuclear event first responders, we designed and evaluated two serious games that were integrated with conventional multimedia content. Results reveal that there was no decay in score, which would have been expected with traditional training. This study suggests that adaptive serious games may help integrate didactic content presented though conventional means.

---

**Patricia Youngblood**

***Evaluation of Virtual World Mass Casualty Simulation Exercises for Training and Assessing Hospital Staff***

In this presentation the researchers will present their findings from the evaluation of a new method for training and assessing hospital staff, using Virtual Words technologies. We used the Online Interactive Virtual Environment (OLIVE) gaming platform from Forterra Systems, Inc. to re-create Stanford Hospital's Emergency Department, including areas designated as the Triage Area, the Immediate Treatment Area, and the Delayed Treatment Area. In the evaluation, experienced hospital physicians and nurses enacted the roles of doctors and nurses in the Virtual World to practice their skills in responding to a mass casualty event resulting from a Chemical, Biological, Radiological, Nuclear, or Explosive (CBRNE) terrorist attack in the community. The Treatment Teams were responsible for assessment and management of ten patient cases for each of two scenarios-exposure to Sarin and injuries sustained from a "dirty bomb" explosion.

---

**Johan Creutzfeldt**

***Effects of Repeated CPR Training in Virtual Worlds on Medical Students' Performance***

There are several reports in the literature of the ineffectiveness of current CPR training. Non-technical skills together with insuffi-

cient vigour are mentioned as sources of weakness. Serious games have in later years been developed to promote learning and training. This study was a 6 month follow up study evaluating affective outcomes, performance and retention for 12 medical students which in groups of 3 were engaged in MMOS (Massively, Multi-player, Online Simulation) using a serious game. In the second training session the mean time that elapsed between witnessed collapse and the beginning of chest compressions decreased by 35 % between the first and fourth training scenarios and the mean number of violations of the CPR protocol decreased by 68 %. In addition the previously reported increase in Flow experience during the training process was reproduced as was the increase in Self Efficacy.

---

**Benjamin Ward**

***An Evaluation of Prototype VR Medical Training Environment: Applied Surgical Anatomy Training for Malignant Breast Disease***

This paper presents an enquiry into the suitability of Virtual Reality (VR) technology as the principal training method of anatomy and surgical rehearsal. To this end we have developed a VR interface that forms the conduit of information to the trainee surgeon. To evaluate the aforementioned system we developed a 3D human model of the axilla and breast area as primary teaching material for junior surgical trainees. In turn we have conducted a comparative study of Problem Based Tutorials using either the VR interface or traditional resources. Twelve trainees participated in this study. Initial results indicate the benefits of the proposed VR application and highlight potential issues for future development. Finally, we entertain the possibility of expanding the Human Computer Interface (HCI) components for additional functionality and identify a tentative plan of future work, which expands on the scope and variety of the VR tutorials and VR evaluation methods.

---

**Kapil Bajaj**

***Repeated Palpatory Training of Medical Students on the Virtual Haptic Back***

The Virtual Haptic Back (VHB) is a simulator for training medical students in palpatory diagnosis based on virtual reality and haptics. The users feel a simulated back using two PHANToM 3.0 (SensAble Technologies, Woburn, MA) haptic interfaces while viewing a graphic model (developed using OpenGL) on a computer screen. This system is capable of simulating different types of backs: male/female, young/old, and with different body-mass indices. The feel of the VHB is based on stiffness measurements from real human backs. The VHB has been included in the 1st year curriculum of Ohio University College of Osteopathic Medicine in conjunction with the Osteopathic Manipulative Medicine (OMM) lab. This study looks at the retention of skills attained from training on the VHB over time and the outcome of repeated training.

# SESSION B

## WEDNESDAY AFTERNOON, JANUARY 30

---

**Yoshito Otake**

***Hip Motion Analysis Using Multi Phase (Virtual and Physical) Simulation of the Patient-specific Hip Joint Dynamics***

In total hip arthroplasty (THA), the patient-specific bone geometry or the characteristics of the skeletal movement should be considered during treatment in order to prevent complications. In this paper, we propose a novel approach for the analysis of joints which combines the patient-specific virtual and physical simulation. The patient-specific anatomical structure and hip motion was obtained from CT and optical motion capture. The virtual simulation was conducted by integrating these data using virtual reality technique. The physical simulation was achieved by using plaster models of the patient's pelvis and femur and robotic manipulator. The plaster models were driven by two robotic manipulators to reproduce the hip motion. The accuracy of the robot movement was 0.245mm over the working area according to the validation by an optical tracking system. By combining this system with linear actuators that reproduce the muscle functions, patient-specific muscle function can be simulated, thereby helping clinicians to diagnose and make a treatment plan.

---

**Shiva Mohan**

***Computer Integrated System for Minimally Invasive Lung Brachytherapy***

In this paper, a novel approach for the treatment of lung cancer is described. The method consists of accessing the lung through small incisions in a minimally invasive manner in order to insert radioactive seeds directly into the tumour using a computer integrated system. An experimental test-bed that incorporates robotic assistance, electromagnetic tracking and ultrasound imaging has been developed and used to place dummy seeds at target locations. The results show a considerable improvement in performance when using this system for minimally invasive brachytherapy when compared to an open surgery procedure, while reducing the invasiveness of the procedure, improving ergonomic conditions for the clinician and reducing radiation exposure.

---

**Kirby Vosburgh**

***Image Registration Assists Novice Operators in Ultrasound Assessment of Abdominal Trauma***

Transcutaneous ultrasound imaging may be used to detect abdominal hemorrhage in the field setting. The Focused Assessment with Sonography for Trauma (FAST) examination was developed to characterize blunt abdominal trauma and has been shown to be effective for assessing penetrating trauma as well. However, it is unlikely that a minimally trained operator

could perform a diagnostic examination. In our system, the operator is be supported by real-time 3D volume displays. The operator is directed through the examination by prompts from a computer system or outside expert, potentially with knowledge of the anatomy of the injured patient. The key elements of the teleoperated FAST exam capability have been demonstrated; the exam is performed with real-time guidance from anatomic images registered to the body. It appears likely that Image Registration will assist hemorrhage detection at the point of injury or in the initial evaluation by a trauma response team.

---

**Namjung Kim**

***Verifying the Effectiveness of a Computer-Aided Navigation System for Arthroscopic Hip Surgery***

Computer-aided technology can decrease the difficulty associated with arthroscopic surgery. Unlike a larger incision that exposes the whole joint, a small arthroscopic incision limits the surgeon's view to only the arthroscope. Our developed computer-aided system for hip arthroscopy addresses this loss of joint visibility by (1) tracking tool position with a linkage of encoders, and (2) indicating tool position relative to the patient anatomy. This paper presents a study of user performance to verify the effectiveness of this computer-aided system for hip arthroscopy. A user study was completed to determine if the system can reduce task completion time and tool path length. Ten participants completed a simple navigation task with and without the assistance of the computer-aided system. A time reduction of 38% and a 72% tool path-length decrease was achieved with the computer-aided system, confirming its effectiveness. The survey information also suggests improvement areas for our continued research.

---

**Karsten Noe**

***GPU Accelerated Viscous-Fluid Registration of Radiotherapy Images***

In cancer treatment with radiotherapy dose planning and delivery relies on an accurate knowledge of the morphology of tumor- and normal tissue. For series of radiotherapy sessions deformable registration of images provides valuable information about organ deformation required to calculate the accumulated dose distributions. The viscous-fluid algorithm is one method for such registration. It has not previously been clinically applicable however due to extensive computation times In this talk it is presented how modern graphics hardware (GPUs) can be used to accelerate the computations required in the viscous-fluid method by the use of finite difference approximations and Jacobi iteration. Such discretization makes the method suited for exploiting the parallelized architecture of the GPU for computation rather than rendering. With our GPU implementation of the viscous-fluid registration method it can be completed in less than 10 minutes (40-fold acceleration) and it is now feasible for use in the dose planning process.

---

**Johannes Vockeroth**

***Handiwork Documentation Using a Wearable Gaze-Driven Camera***

In medical teaching, telemedicine, or documentation it is useful to provide a video of important hand movements and operations. In images of common scene oriented cameras, the interesting part is often covered by the operators hand or body. Head-mounted cameras have a conflict between a wide-angle camera with low spatial resolution, or a tighter angle with loss of the overall scene context. We present the combination of a wide-angle head-mounted camera to maintain an overall context and a tight gaze-driven camera to provide an in-focus high resolution image of the considered detail. The gazed area is automatically focused using the vergence position of the eyes. The overall system is mobile and could be remotely controlled over the internet.

---

**Henry Fuchs**

***Choosing a Head-Tracked Stereo Display to Guide Hepatic Tumor Ablation***

Radio frequency ablation (RFA) is a minimally invasive intervention that introduces-under 2D ultrasound guidance and via a needle-like probe- high-frequency electrical current into non-resectable hepatic tumors. Such tumors recur mostly on the periphery, indicating errors in probe placement. We hypothesize that a contextually correct 3D display will aid accurate targeting and decrease recurrence rates. We have developed a prototype guidance system based on a head-tracked 3D display and motion-tracked instruments. In this presentation, we describe our reasoning and our experience in selecting components for, designing and constructing the 3D display. The initial candidates were an augmented reality see-through head-mounted display and a virtual reality "fish tank" type system. We describe the system requirements and explain how we arrived at the final decision. We show the completed, operational RFA guidance system in use on phantoms and animals.

---

**Peter Kazanzides**

***A Cooperatively-Controlled Image Guided Robot System for Skull Base Surgery***

We describe a cooperatively-controlled, image-guided robot system for skull base drilling. The system integrates a surgical robot (modified Neuromate), a navigation system (Medtronic Stealthstation with Stealthlink research interface), and the 3D Slicer planning/visualization package. The surgeon uses 3D Slicer to segment the region of the skull that can be safely drilled. This defines a virtual fixture, which is transformed to robot coordinates. The robot is placed in a cooperative control mode, where applied forces are converted to tool velocities subject to the virtual fixture constraints. Simultaneously, the robot positions are transformed to image coordinates, thereby allowing intraoperative visualization of the cutter with respect to the virtu-

al fixture and the actual bone. The system has been tested with a skull phantom and with cadaver heads. The results suggest an average error of about 1 mm, with maximum errors on the order of 2.5 mm. Some areas for improvement are noted.

---

**Peter Allen**

***in vivo Pan/Tilt Endoscope with Integrated Light Source, Zoom and Auto-focusing***

We have developed an insertable Pan/Tilt endoscope with integrated LED light source. This device is 10mm in diameter, and contains fully controllable pan and tilt axes. The device can pan 120 degrees and tilt 90 degrees. It is controlled by a simple joystick interface that is intuitively easy to control. The integrated light source consists of a ring of LED's that are attached to the end of the camera/lens assembly. We have tested the device in a porcine animal model, and performed simulated appendectomies with it. Our animal tests showed the need for both zoom and auto-focus capabilities with this device. We have designed a zoom mechanism that uses a rack and pinion mechanism to translate the rotational motion to linear motion. We also designed a compact autofocusing lens based on new liquid lens technology. We are currently using this device in animal trials.

---

**Ming Li**

***A Robotic System to Assist Real-Time MRI Guided Aortic Valve Replacement on the Beating Heart***

We have been developing a robotic system for real-time MRI guided transapical aortic valve replacement. Our system integrated real-time MRI system, a MRI compatible robot and interface for surgeon to plan the procedure and manipulate the robot. The use of real-time MR imaging allows continuous evaluation of the delivery of the prosthesis, excellent views of valvular and annular anatomy, and can be performed on the beating heart without requiring ventricular unloading. A fatigueless MRI compatible robotic arm replaces human assistant to hold a 60cm deliver device in desired position and orientation steadily. The combination of MRI and the robotic provides a novel approach to the transapical valve replacement procedure. This system not only allows direct access to the aortic valve, and also provides a direct channel for deploying surgical tools inside heart for more complicated MRI guided beating-heart, off-pump surgery, such as mitral valve repair.

---

**Pablo Valdivia y Alvarado**

***Tele-Operated Robotic HIFU Manipulator***

This presentation will survey the progress on the tele-operated robotic HIFU manipulator system being developed by Energid Technologies in collaboration with researchers from the Universities of Toronto and Washington. The challenges and objectives of the project will be described and results regarding position and force control, hemorrhage detection, and HIFU experimental treatment achieved with funding from the U.S. Office of the Secretary of Defense through the Telemedicine and Advanced Technology Research Center (TATRC) will be presented. We will also discuss how the tele-operated robotic HIFU system can be integrated and operated in emergency and remote environments. Finally, the major challenges remaining and a discussion of system improvements will also be presented.

---

**Bruce Cameron**

***Patient Specific Physical Anatomy Models***

The advent of desk-side stereo-lithographic printers and the ready availability of segmentation and surface modeling software provide a unique opportunity to create patient-specific physical models of anatomy, allowing the researcher to validate image guided intervention applications against phantoms that exhibit naturally occurring anatomic variation. Because these models can incorporate all structures relevant to a procedure, this allows validation to occur under realistic conditions using the same or similar techniques as would be used in a clinical application. This in turn reduces the number of trials and time spent performing in-vivo validation experiments. In this paper, we describe our general approach for the creation of both non-tissue and tissue-mimicking patient-specific models as part of a general-purpose patient emulation system used to validate for image guided intervention applications.

---

**Mark Vranicar**

***The Use of Stereolithographic Hand Held Models for Evaluation of Congenital Anomalies of the Great Arteries***

Imaging anomalies of the great vessels has traditionally been accomplished using conventional biplane modalities as well as three-dimensional (3D) video displays. Our aim was to review the use of stereolithography to create 3D models to assess coarctation of the aorta and vascular rings. In twelve patients with anomalies of the great arteries digital dicom data from high-resolution CT scans were converted by a commercially available software package into 3D digital images. Then a 3D stereolighographic printer created 3D models, which were then compared to CT scan reports and catheterization and surgical findings. All models accurately displayed the pathology investigated. Stereolithography can create realistic 3D models that accurately display aortic pathology and add important additional information, which may have implications regarding surgical and transcatheter intervention.

---

**Tomoko Ikawa**

***Evaluation of the Simulation Robot for Mandibular Movements with the Patient-Specific 3D Plaster Model and Mandibular Movement Data—Clinical Application of the Physical Simulation Robot***

We developed a multi-phase simulation system for patients with jaw deformity and dysfunction as a collaborate study between our departments. The intended application of the physical simulation robot was to evaluate its function based on well it quantitatively measured the movement of the individual patient. This physical simulation robot consists of a 6-degree-of-freedom robotic manipulator and a plaster model of patient-specific bone geometry. Each plaster model was mounted on the serial-articulated robotic manipulator. To establish the accuracy of the robot movement, the programmed movement of the robotic arm was validated using an optical tracking device. The results of the physical simulation robot corresponded with the data from the 4D analysis system. We could construct interactive relations between the 4D analysis system that was presented by virtual reality and the simulation robot which was constructed from physical simulation.

# SESSION A

## THURSDAY MORNING, JANUARY 31

---

**Peter Cosman**

***Simulated Surgical Training: What is the Denominator?***

In many jurisdictions, surgical simulation is struggling to negotiate its role in the skills curriculum. This paper explores the reasons for this and suggests novel strategies for gaining broader acceptance of this valuable educational resource.

---

**F. Jacob Seagull**

***Integration of Virtual Reality and Conventional Skills Trainers: A Mixed Resource Model***

Through its fifteen year existence, MMVR has heralded the adoption of virtual reality in the medical domain for both medical practice and medical training. However, relatively few training institutions have adopted a purely VR-based training paradigm. Most have a variety of training equipment, ranging from purely physical to purely virtual. These resources are commonly viewed as separate and independent training equipment, and curricula rarely integrate both VR and bench station/box trainers within a single training paradigm. The authors propose to measure the effectiveness of using the VR system periodically throughout box-training exercises to track performance, and identify basic skills that need further practice. This use of VR integrated into box training exercises could be a valuable complement to traditional training approaches. Implementing a mixed model of VR and box trainers could increase training capacity, improve training efficiency, and hasten the adoption of VR training into existing curricula.

---

**Brent Gillespie**

***The Instrumented Instrument: Characterization and Training of Manual Skill in Open Suturing***

We report on the use of microelectromechanical accelerometers and rate gyros mounted on a needle driver for tracking the motions generated by a surgeon while suturing. We simultaneously record certain interaction forces and digital video for subsequent synchronization, parsing, and analysis with the motion tracking signals. Preliminary results indicate that certain procedures have very distinctive signal profiles yet individuals display characteristic variations within those templates. We envision providing process and performance feedback during practice to speed learning of suturing.

---

**Adam Dubrowski**

***Effects of Expertise, Practice and Contextual Interference on Adaptations to Visuo-Motor Misalignment***

The cognitive demands of laparoscopic surgery may be amplified when rotation of the camera causes discrepancies between the displayed surgical field, intended and actual movements. While Visuo-Motor Misalignment (VMM) impairs surgical technical performance, motor learning literature suggests that adaptations to VMM happen with practice. Two experiments investigated VMM adaptations within a laparoscopic context. The first examined the effects of practice and angle of visual rotation (0, 30, 60 and 90 degrees) while the second investigated if, and how, the Contextual Interference effect facilitates VMM adaptations. Laparoscopic performance was less affected with smaller angles of camera rotations then larger angles ($p<.001$). With practice these effects dissipated for all angels except for 90 degrees. Performance was not affected by schedule of practice. In order to facilitate VMM adaptation acquisition, it is recommended that future simulated trainers incorporate the capacity for practice under visual rotation with flexibility in practice schedule.

---

**Carol Reiley**

***Automatic Recognition of Surgical Motions Using Statistical Modeling for Capturing Variability***

The ability to accurately recognize elementary surgical gestures is a stepping stone to automated surgical assessment and surgical training. However, as the pool of subjects increases, variation in surgical techniques and unanticipated motion increases the challenge of creating robust statistical models of gestures. This paper examines the applicability of advanced modeling techniques from automated speech recognition to the problem of increasing variability in surgical motions. In particular, we demonstrate the effectiveness of automatically bootstrapped user-adaptive models on diverse data acquired from the da Vinci surgical robot.

---

**Ben Boedeker**

***A Comparison of Direct Versus Indirect Laryngoscopic Visualization in Endotracheal Intubation***

Expertise in endotracheal intubation and airway management is vital in the provision of quality health care in both the in-hospital and out-of-hospital settings. Our previous work demonstrated using the videolaryngoscope (VL) in mannequin-based training improved airway visualization in even the most difficult airway modes, facilitated the learning process, and allowed the trainee to achieve successful intubation. Based upon these favorable results, after ethical review, we performed this human study to compare the use of both direct standard view (DV) and indirect view (VL) laryngoscopy techniques during intubation by trainees. Results showed use of the video laryngoscope significantly improved visualization of the vocal cords in both normal and expected difficult airways (high Mallampati scores) as com-

pared to the use of standard laryngoscopy (DV). Based on these results, we believe that videolaryngoscopy should become a standard method used in providing hands-on airway management training for medical personnel.

---

**Marcus Schlickum**

***Transfer of Systematic Computer Game Training in Surgical Novices on Performance in Virtual Reality Image Guided Surgical Simulators***

The aim of this prospective randomized study is to investigate transfer of systematic computer game training of different content and context to advanced simulators in relation to previous video game experience, visual-spatial ability and visual working memory in surgical novices. We report on working memory, high level visual-spatial ability and transfer of systematic computer game training on performance in image guided surgical simulators. There was a positive correlation between training with a FPS-shooter video game and performance in the GI-Mentor simulator. Participants training with the FPS computer games also subjectively describe that they experience a positive effect of game training on their simulator-skills. Further, an inverse relation was observed between the positive effect of training with FPS video games and previous video game experience before entering the study.

---

**Lars Enochsson**

***Visuospatial Ability Affects the Performance of Simulated Gynecological Procedures***

Objectives: To asses the correlation between visuospatial ability and performance in the LapSimGyn(r) VR simulator. Study Design: Nine obstetrics and gynecology consultants were visuospatially tested by using the mental rotation test (MRT-A). They then performed three consecutive virtual tubal occlusions followed by three virtual salpingectomies. The correlation between MRT-A and the simulator performance was established by linear regression. The proficiency curve in the simulator was also determined. Results: Visuospatial ability correlated well with higher total score (r2=0.68; P=0.006), shorter operating time (r2=0.65; P= 0.009), less blood loss (r2=0.66; P=0.008), and less ovarial diathermia damage (r2=0.52; P=0.029) during virtual salpingectomy. A steep proficiency curve was registered among all the participating subjects. Conclusions: Visuospatial ability is important for successful performance of advanced gynecological procedures in the LapSimGyn VR simulator with a steep proficiency curve. We thus believe that training in the simulator is well invested time before attending the OR.

---

**Jacob Rosen**

***Objective Laparoscopic Skills Assesments of Surgical Residents - Five Years Longitudinal Study***

Laparoscopic surgical skill evaluation of surgical residents is usually a subjective process, carried out in the operating room by senior surgeons. The aim of the study is to develop and assess an objective laparoscopic surgical skill scale using Markov Models (MM) and to evaluate an objective laparoscopic surgical learning-curve of surgical residents through their entire residency program utilizing a longitudinal study. As part of the longitudinal study five surgical residents performed two Laparoscopic tasks once a year over a period of five years on animal models. The Blue DRAGON system was used for acquiring the kinematics and the dynamics of two endoscopic tools along with the visual view of the surgical scene. The methodology of decomposing the surgical task is based on a fully connected, finite-states (32 states) Markov Model (MM). The objective laparoscopic surgical skill learning-curve showed significant differences between residents at different levels of their training. The MM proved to be a powerful and compact mathematical model for decomposing a complex task such as MIS with applications in surgical robots or medical simulators. Using this information in real-time during the course of learning as feedback to the novice surgeons may improve the learning curve, reduce soft tissue injury and increase performance efficiency in MIS.

---

**Mark Smith**

***Collaborative Surgical Proficiency Rating Initiative***

We present a web based gaming paradigm (www.ratethesurgeons.com) that allows the surgical community of practice to collaborate on anonymous video recording of common surgical procedures performed on simulators and rate their subjective level of proficiency which can then be employed to correlate with objective measures of captured data. This paradigm was inspired by Google's image labeling initiative. Our underlying algorithms conduct statistical analysis of the provided ratings to generate the most consistent ratings for each of the recorded procedures. The consistent subjective ratings along with objective data capture will be made available for the entire surgical informatics community to develop novel algorithms for objective proficiency. The presentation discusses the initial results, and establishes validity of the presented approach. It will also discuss methods through which simulation training facilities throughout the country can use the website to obtain efficient community driven ratings for procedures performed in their facilities.

---

**Mark Bowyer**

***Far Forward Feasibility: Testing a Cricothyoidotomy Simulator in Iraq***

A haptic enabled simulator developed for teaching cricothyroidotomy was deployed to Iraq and used to augment the training of 65

combat medics over a six month period. Participants found the simulator to be highly realistic with moderate ease of use. Self perceived comfort level with this life saving procedure increased significantly (P < 5.6 x 10-17) over baseline after practice on the simulator. Nearly 80% of the participants related that they felt confident that this training would enable them to perform a cricothyroidotomy in the correct fashion. This study demonstrates the feasibility of deploying part task trainers and simulators for teaching and maintaining vital skills in the war zone. Allowing such just in time and refresher training for high-risk low frequency procedures may improve outcomes and deploying simulation assets forward will aid in necessary outcome studies.

---

**Phil Blyth**

***Virtual Screw Fixation of Slipped Capital Femoral Epiphysis by Advanced Orthopaedic Trainees***

Cannulated screw fixation is used to treat patients with Slipped Capital Femoral Epiphyses (SCFE). A SCFE module of the Bonedoc simulator was used to test the ability of advanced trainees in this procedure, and the practicality of using the simulator within the orthopaedic training curriculum. The SCFE model was created from CT images, using 3DView and Blender to morph a generic femur. All New Zealand advanced orthopaedic surgical trainees operated on the same virtual SCFE. The number of x-rays taken did not correlate with accuracy of screw placement. The number of misplaced drillholes was correlated both with number of x-rays taken ($p<0.01$) and operative time ($p<0.01$) but not with final accuracy of the screw. There was no correlation between the trainees' self assessment with any measured variable. The Bonedoc simulator allows standardised assessment of trainees on technical aspects of a surgical procedure, providing objective results which mimic real world outcomes.

---

# SESSION B

## THURSDAY MORNING, JANUARY 31

---

**Gerald Moses**

***Barriers to Wider Adoption of Mobile Telerobotic Surgery: Engineering, Clinical and Business Challenges***

The past decade has witnessed the growth of both interest in and capability of telesurgery systems. These developments were supported by demonstrations, experiments and strategy planning that enabled the technologies of engineering, computer science, robotics, telecommunications, medical informatics, and surgery to identify and to some extent ameliorate the physical barriers of latency, visual discrepancy, round-trip delay, jitter and limited bandwidth that are indicators of transmission quality of service. There are non-technical challenges that impede the implementation of a mobile telesurgery system. Industry and political arena representatives need to establish a nation-wide communications network capable of supporting telesurgery. Agents for licensure, medical privacy and reimbursement must cooperate to enable wider adoption and effective use of telecollaboration. The authors propose two distinct research projects that address overcoming technical issues related to robotic movements and quality of service; and non-technical challenges such as management of intellectual property, engagement with FDA, inclusion of CMS, and funding.

---

**Eran Schenker**

***MedUAV: Medical Resupply & Casualty Evacuation Vertical Take Off & Landing Unpiloted Aerial Vehicle***

The MedUAV, is a medical resupply and Casualty Evacuation (CASEVAC) Vertical Take Off and Landing (VTOL) Unpiloted Aerial Vehicle (UAV). It is a collaboration of technologies from research and universities groups with the leading UAV industries partners which will enable to resupply medical logistic to combat medics and facilitate them to provide the best treatment, stabilization and subsequent evacuation of combat casualties from hostile situations onboard the MedUAV autonomously. Integrated with the Telemedicine Ground Control Station (TGCS) console, where the medical doctor can not only monitor from remote but actively control the medical device and treat the causalities during the MedEvac short flight, and the Medics Portable Control console (MPC), which able the medical crew at the scene to take control of the landing site and time of arrival, will bring in the future to the medical EMS evacuation market a new platform which may smoothly deployed in various civilian urban locations.

---

**Robert Tan**

***Development of an Implantable, Wireless Vital Signs Sensor Suite***

We present here the fabrication and initial testing of a wireless, implantable, and continuous vital signs monitor capable of sensing pressure, body temperature, dissolved oxygen, and heart rate. This device consists of three parts: a sensor suite, a central processing unit and transmitter, and an external PDA to receive the data. Currently, we have implemented the piezoresistive pressure sensor. In vitro data shows that it is capable of sensing pressure within the physiologically relevant renal pressure range of 0-1 psi (0-5.2 mmHg) with a resolution of 0.2 psi (1 mmHg). Initial in vivo testing has shown that the sensor can transmit data up to 20 feet away while implanted in a pig model. We will report on the progress of the in vivo pressure data as well as the implementation of a thermistor for temperature sensing, platinum electrode for oxygen sensing, and electrodes for EKG and heart rate sensing.

---

**Shih-Ching Yeh**

***VR-Based Interactive System for Stroke Rehabilitation on Wrist-Forearm Synchronized Movement***

A VR-based motor training task, the Spatial Rotation, one of a

series developed for post-stroke upper extremity rehabilitation was tested with five patients over 12 two-hour sessions. In the virtual environment, the patient has to superpose the controlled block with the target block accompanied with adequate spatial translation and rotation of wrist-forearm. Positional and rotational differences are quantitatively set between controlled block and target block that various difficulty levels can be defined, as well as block complexity. Performance measures, movement efficiency and performance time, are derived from continuous capture of the patients' 3D hand positions. Torque about forearm-axis, exerting by wrist, can be extracted via angular acceleration and moment inertia of physical adaptor. Methodology is proposed to visualize patient's current status and progress. The correlation between movement efficiency and moving speed, and the correlation between torque and wrist's pose (orientation), are investigated.

---

**Oshri Even Zohar**

***Muscle Force Visualization for Virtual Reality Assisted Rehabilitation***

Identification, assessment and modification of neuromuscular control are common goals in rehabilitation for musculoskeletal or neurological disorders. However, only indirect information about neuromuscular control is available to the therapist and the patient. Neuromuscular control is typically inferred from observed body movements, but this has significant limitations. Successful clinical interpretation of movement depends on the experience of the therapist, and is at best qualitative. A worst case scenario is when the patient alters muscle coordination in a way that does not affect movement, thus remaining invisible to the therapist. Even if the therapist's interpretation is accurate, this can only result in indirect verbal feedback to the patient.

---

**Richard Fan**

***A Prototype Haptic Feedback System for Lower-Limb Prostheses and Sensory Neuropathy***

Lower-limb sensory loss as a result of peripheral neuropathy or amputation results in sub-optimal movement and an increased incidence of injury. While the adoption of lower-limb prostheses and therapeutic footwear can reduce tissue injury and support movement, the fundamental problem of sensory loss continues to exist. A prototype haptic feedback system has been developed to aid in the recovery lower-limb sensation due to these causes. Thin-film force sensors placed at the critical points for gait and balance functions collect essential force data, which is delivered to the user via pneumatically controlled balloon inflation. It is postulated that the use of this system will increase the tactile awareness of a patient's lower-limb or prosthesis, and when used in concert with modern rehabilitation techniques will create a method that will reduce the duration and improve the quality of lower-limb rehabilitation, especially in gait and balance functions.

---

**Alexander Koenig**

***Virtual Gait Training for Children with Cerebral Palsy Using the Lokomat Gait Orthosis***

This work describes the implementation of virtual training scenarios in the context of robot-assisted lower limb rehabilitation of children with Cerebral Palsy (CP). For children with CP, motivation and extended training intensity present a problem due to their short attention spans. We hypothesize that the success of movement training of the lower limbs can increase significantly in children with CP by coupling treadmill training on the Lokomat gait orthosis with exercising virtual Activities of Daily Living (ADL's) in a virtual world. We developed a scenario in which the children are able to exercise ADL's like a street traffic situations or stepping over obstacles in a save and supportive environment. In future experiments, we will investigate our hypothesis by using indices such as the 10 meter walking test and the 6 minutes walking test.

---

# PLENNARY SESSION
## THURSDAY AFTERNOON, JANUARY 31

---

**Randall Shumaker**

***Virtual Reality and Mixed Reality for Accessibility***

Virtual worlds such as Second Life are beginning to be considered for serious applications in addition to purely social uses. In particular, virtual worlds are receiving research attention and even commercial interest as a way for individuals to maintain rich social interactions, conduct business, receive education, and travel despite some physical, cognitive, or emotional limitations. These successes are especially notable given the fairly basic human interfaces currently used. Mixed reality systems with sophisticated interface and performance capability have demonstrated great potential in many training and therapeutic applications, but current costs and equipment availability will limit availability for personal use.

Sophisticated interfaces for user interface with virtual worlds that do not require learning special skills or knowledge to access, that provide multiple complementary modalities, and that are operated in a natural manner would enable many new applications. Where the goal is therapeutic or assistive, and for enabling people with personal limitations to function more effectively, this capability is critical. Among the things I'll be discussing in my talk are: the computing, communication and interface capability that might be required to fully engage human senses in a virtual environment; prospects and issues in creating high performance cognitive avatars in virtual environments; and when, if ever, we might expect to be able to buy a personal virtual environment that could provide the kind of high level capability currently limited to research facilities.

---

**Paul Barach**

***Strategies to Reduce Patient Harm: Understanding the Role of Design and the Built Environment***

There is growing recognition that risks and hazards of health care associated injury and harm are a result of systemic design problems rather than poor performance by providers. The evidence is overwhelming that current hospital designs are not sufficient to prevent medical errors, rates of infection and injuries from falls, and even contribute to the slow patient recovery and high nurse turnover. The world is in the middle of the biggest hospital construction boom in a half-century, a development expected to increase the use of high-tech medicine and add fuel to rising health care costs. The presentation will review the clinical and business evidence around patient safety and the built environment, and describe initiatives now underway to understand how the designed or architectural environment of hospitals affects the causes of patient injury. A key challenge remains how to incorporate technology into the care environment and culture in ways that optimize its implementation and use, and maximize the benefits for learning and patient care.

---

# SESSION A

## FRIDAY MORNING, FEBRUARY 1

---

**Ganesh Sankaranarayanan**

***VBLaST: A Virtual Basic Laparoscopic Skill Trainer***

With increasing popularity of minimally invasive surgery in treating both malignant and benign diseases, surgical skill training becomes more and more important. In this paper, we develop for the first time, a stereoscopic visio-haptic Virtual Basic Laparoscopic Skill Trainer (VBLaST)which allows the users to perform, on the computer, the skill training tasks distributed as part of the Foundations of Laparoscopic Surgery(FLS) Trainer Box introduced by the Society of American Gastrointestinal Endoscopic Surgeons (SAGES). The tasks that can be performed using VBLaST include peg transfer, pattern cutting, ligating a loop and suturing.

---

**Laura Doyle**

***The Role of Haptic Feedback in Cataract Surgery Training***

Cataract surgery is a common surgical procedure, but surgical residents receive limited manual training before their first operation. Capsulorhexis, the segment of cataract surgery in which a circular hole is torn in the lens capsule, has been simulated in a virtual environment. To evaluate the effectiveness of haptic training in a procedure that nominally provides little haptic feedback, we will conduct an experiment contrasting the performance of three groups of medical students: the first group will receive no simulation training, the second will train on the simulator without haptics, and the third will train on the simulator with haptics. After training, capsulorhexis performance of each subject on a real pig eye will be evaluated according to time to complete the exercise, size and circularity of the hole created, and number of times the tissue is re-grasped with the forceps. We expect that haptic simulator training will produce superior surgical performance.

---

**Howard Schwid**

***Open-Source Shared Simulation Case Library***

An open-source, shared simulation library was made freely available on the internet as an experiment to test the utility of sharing simulation cases between authors and institutions. There was no charge for downloading cases and downloading was made available to anyone. Initially the case library consisted of 72 cases in four medical content areas. Almost 12,000 case downloads occurred in the first four months after posting the library. The case library encouraged the development of 23 additional cases by 16 new contributing authors in 13 institutions. The large number of cases downloaded indicates strong demand for a shared case library by instructors. However, the true test of success of the library will be the willingness of instructors to upload new cases into the library. The initial development of 23 new cases to upload is encouraging. Four additional content areas will be added to the library in the next few months with at least 68 cases developed by 23 content experts at 16 institutions.

---

**Yaroslav Tenzer**

***Investigation into the Effectiveness of Vibrotactile Feedback to Improve the Haptic Realism of an Arthroscopy Training Simulator***

In recent published work, it was found that high frequency vibrations which occur when two objects come into contact (e.g. during tapping, stroking or puncturing) can be discriminated by the human tactile system. It was found that the operator's response to the high frequency vibrations, generated by a custom haptic device, drastically improved the operator's ability to identify the nature of the material being simulated. Previously, a virtual environment simulator with a custom developed haptic device named OrthoForce was developed at Imperial College for knee arthroscopy training. In this study, a special purpose vibrotactile extension for the OrthoForce System was developed and the subjective response of a number of orthopaedic surgeons to different virtual scenarios, implemented with and without vibrotactile feedback, was recorded. The presentation will describe the study results in detail as well as providing particulars of the custom developed haptic knee arthroscopy training system and vibrotactile feedback mechanism implemented.

---

**David Hellier**

***A Modular Simulation Framework for Colonoscopy Using a New Haptic Device***

Colonoscopy involves the intubation of a flexible endoscope through the colon to the cecum. High forces are normally present during the procedure and sedation is often used over anaesthetic. Loop formation is painful and inevitable and can lead to colon wall rupture if excess force is used. To address the need for more fidelity and higher complexity in a colonoscopy simulator we integrated our software framework for colonoscopy with a prototype haptic device. We determined the required maximum forces in colonoscopy intervention from prior work and used this to custom build the prototype. The modular multi-threaded software framework we developed is based on OpenGL with a real-time interface to the colonoscopy haptic device. To develop a realistic visualisation of the colon we meshed an automatically segmented colon from CT colonography data and applied textures from real colonoscopy videos and realistic lighting. The modular design allows efficient integration of new research.

---

**Yi-Je Lim**

***MR Fluid Haptic System for Regional Anesthesia Training Simulation***

Magneto-Rheological (MR) fluid is a type of controllable smart material whose rheological properties may be rapidly varied by the application of a magnetic field. In this paper we focus on an pair of MR fluid based haptic systems for providing accurate force feedback for simulated needle insertion and needle injection procedures. We use the essential characteristic of MR fluid, a controllable yield strength (changeable in milliseconds under a magnetic field), to impose simulated forces on a nerve block needle used in regional anesthesia procedures. By controlling the magnetic field strength, the viscosity of the MR fluid can be changed in such a way that the needle insertion and injection force generated mimic the actual tissue viscosity of the human body and a real syringe injection in the magnetic valve. Based on the experimental data we will determine the nominal system specifications for the two MR haptic feedback systems.

---

**Chris Enedah**

***Dealing with Network Delay in Touch-Enabled Teledermatology***

A new approach to dealing with network delays and jitter in telerobotic operations is presented. This method is particularly suited to teledermatology but may work with other telerobotic operations. A virtual, local model of the skin being palpated is generated and updated over time with information from a remote tactile sensor. This breaks the closed-loop between the master and slave sites reducing the system's dependency on network parameters. By exploiting typical palpation techniques, a predictor is built to estimate the motion of the master device. Finally a constant, artificial time-delay is imposed on all transmissions to rid the system of jitter.

---

# SESSION B

## FRIDAY MORNING, FEBRUARY 1

---

**Fernando Bello**

***Interactive Finite Element Simulation of the Beating Heart for Image-Guided Robotic Cardiac Surgery***

An interactive finite element simulation of the beating heart is described in which the intrinsic motion is implied from preoperative 4D scan data. The equations of motion are reversed, such that given changes in node displacements, the node forces that produce those changes are recovered. Subsequently, these forces are resolved from the global coordinate system into systems local to each mesh element. Therefore, at each simulation time step, the collection of node forces can be expressed as simple weighted sums of current node positions. Importantly, this facilitates the combination of extrinsic forces such as those due to tool-tissue interactions, changes in the relative direction of gravity, and effects due to insufflation of the thoracic cavity and left lung deflation. Through the development of an image-guided coronary artery bypass application of the da Vinci tele-manipulator system, the method has been applied initially to volumetric images of a pneumatically-operated beating heart phantom.

---

**Mario Cheng**

***Towards Anatomical Modelling of Multiple Organs Interaction Using Real Time GPU Based Nonlinear Elasticity***

Finite element methods (FEM) have been used extensively within the field of surgical simulation to model bio-mechanical properties of various organs. Within the surgical simulation field, researchers have always needed to balance computational costs against physically accurate modelling to maintain real-time haptic and rendering rates. In previous work, we have developed an accurate high speed nonlinear FEM formulation (NLFEM) computed on a graphics processing unit (GPU) at real time rates. In this work we present three novel extensions implemented on the GPU which extend the existing FEM to efficiently model multiple organs which are anchored by springs to mimic connectivity tissue. Within the surgical simulation framework the new FEM formulation can solve for 18000 tetrahedral elements (three 10x10x10 cubes) proccessed concurrently with collision detection and haptic interaction.

---

**Megumi Nakao**

***Interactive Volume Manipulation for Supporting Preoperative Planning***

This paper presents a new volume manipulation framework by which surgeons can interactively manipulate soft models like through surgical tools. We propose surface-constraint-based manipulation that robustly simulates common surgical manipulations such as grasping, holding, cutting and retraction. We simulate cutting based on FEM formulation by replacing vertices and eliminating elements, without subdividing elements or adding new vertices. The size of stiffness matrix is constant. This prevents increase of calculation time and enables pre-computation of most parts of terms in matrix update formula. We also present real-time volume shading methods for deformable modeling. Our approach does not update voxels, and achieves fast volume shading by per-vertex gradient and color estimation with interpolation on GPUs. We applied our techniques to various CT volume dataset on general purpose PC. Our algorithms achieved interactive response in volume manipulation. Several surgical approaches and procedures were rehearsed and used for preoperative discussion.

---

**Ganesh Sankaranarayanan**

***An Efficient Dynamic Point Algorithm for Line-based Collision Detection in Real Time Virtual Environments Involving Haptics***

In this paper we present the dynamic point algorithm as the most efficient algorithm for line-based collision detection and response in multimodal virtual environments involving haptics. It can handle very large deformable triangle meshes involving tenths of thousands of triangles at haptic frame rates of more than 10 kHz for both rigid and deformable objects. The algorithm captures the advantages of both point- and ray-based haptic rendering for collision detection and response with a mesh. It uses a single point constrained to lie on the line representing the haptic probe at a location which is instantaneously the closest to the mesh. We have implemented and evaluated the dynamic point within a complete graphics-haptics-physics-based framework. In this paper we also present a case-study on virtual laparoscopic surgery to illustrate the use of the algorithm in a practical interactive application.

---

**Venkat Devarajan**

***Parameter Optimization for 3D MSD Models***

The mass-spring-damper (MSD) model has been widely used in compute graphics and surgical simulation community. Typically material properties are used as a qualitative guidance to tune the parameters of the model on a trial-and-error basis, which is tedious and sub-optimal. Although methods have been proposed to systematically calculate the parameters based on the material properties, none of them has completely resolved the coupling between shearing and stretching and thus is inaccurate. In this paper we propose a new method to unify the modeling of shearing and stretching, which results in a set of constraints on the parameters. Based on these constraints, the parameters of the unstructured model can be solved by the least square optimization and those of the structured model can be even obtained in an explicit form. The efficacy of the method is verified by deformation comparisons between the model and the real object.

---

**Taehyun Rhee**

***Creating an Animatable 3D Volume Hand Model from in vivo MRI***

Volume data obtained from medical scans (e.g. MRI or CT) can represent the bones, muscles, tendons, skin, and other anatomical structures that are important in various fields as well as medical application. Transparent volume rendering can successively visualize inner organs without loosing the overall context of the subject. Volume animation of a vertebrate body region has additional requirements that are not met by general deformation techniques: articulated volume animation must simultaneously produce rigid deformation of the hard tissue regions, smooth deformation of the skin surface, and continuous, shear-free deformation of the soft-tissue interior. This study presents an approach to rapidly creating an animatable 3D volume of an in vivo human hand MRI. The result is a fully articulated hand volume that respects rigid deformation of the bone structures and produce smooth deformations of both the skin surface and the interior soft tissue region.

---

**Christos Constantinou**

***Visualization of Biomechnical Properties of Female Pelvic Floor Function Using Video Motion Tracking of Ultrasound Imaging***

Real time ultrasound imaging is one of the many ways to clinically evaluate the anatomical and functional condition of female pelvic floor in patients with urinary incontinence. Reflex arc testing of the displacement of uro-gynecological structures during imaging, provides a non-invasive way of visualizing their motility. The response from such tests invariably contains a very large amount of visual information, which is not readily captured and assimilated by the observer because it occurs so fast. For this reason only a portion of available information is retained, typically the beginning end ending frame of the image is preserved. The pattern and pathways of the intervening response is extrapolated in by the examiner. Using video motion tracking, parameters were identified to define important biomechanical and temporal relationships. We conclude that new and clinically significant amount of original information about the female pelvic floor can be obtained through the proposed analysis of visualizations.

---

**Jannick Rolland**

***Collaborative Engineering: 3-D Optical Imaging and Gas Exchange Simulation of In-Vitro Alveolar Constructs***

Tissue engineering is driven in large part by the potential for creating functional tissues and organs for much-needed transplants. Also, tissue engineering of immunological constructs can provide alternatives to animal studies in the development of preventive or healing drugs. We describe a research effort that focuses on developing methods for engineering in-vitro alveolar tissue constructs. A hypothesis of this collaborative research is that to dissect the mechanisms of immunity, bio-imaging and computational science are necessary to visualize, monitor, model and characterize adequately the architecture of the engineered tissue. This abstract reports on the simulation and modeling of the in vitro alveolar construct system that is comprised of human alveolar endothelial and epithelial cells, and methods for high-resolution 3D optical imaging of the 3D construct.

---

**Nigel John**

***MedX3D: Standards Enabled Desktop Medical 3D***

The new ISO standard for using 3D graphics over the internet is X3D and the Web3D Consortium has formed a Medical Working

Group with a remit to develop an extension to X3D, called MedX3D, which will support the required functionality and interoperability needed for any medical visualization application. This paper reports on the results of recently completed projects funded by the US Army's Telemedicine and Advanced Technology Research Center(TATRC) to specify and implement the first version of MedX3D.

---

**Andrei Turinsky**

***Integration of Genomic and Medical Data into a 3D Atlas of Human Anatomy***

We have created an atlas-based visual system called CAVEman for the integration, cross-referencing and exploration of heterogeneous biomedical data. The main component of the system is an ontology-based 3D digital atlas of the human anatomy. The structure of the atlas follows Terminologia Anatomica, which is currently the international standard for anatomical nomenclature. The underlying data-indexing mechanism ensures that the atlas can be cross-referenced with other biomedical ontologies. The notable advantage of this system is the possibility of merging the model with other data types, such as molecular biology and medical imaging data. The atlas then can serve as a common context for visual correlation and queries of the bioinformatics and medical data. The use of Java 3D software makes the atlas-based system portable and platform independent. It also allows the incorporation of existing Java tools for biomedical data analysis and data mining into the system.

---

**Jonathan Silverstein**

***Multi-Parallel Open Technology to Enable Collaborative Volume Visualization: How to Create Global Immersive Virtual Anatomy Classrooms***

We have combined multi-location, multi-directional, multi-stream sharing of video, audio, desktop applications, and parallel stereo volume rendering, to converge on an open, globally scalable, and inexpensive collaborative architecture and implementation method for anatomic teaching using radiological volumes. We have focused our efforts on bringing this all together for several years and have offered several prior presentations on our early attempts. We have also most recently presented the feasibility of using the base technologies, without multi-site collaboration, for a formal anatomy course and for surgical treatment planning. The new contribution here is that we've completed development, implemented, tested, and made use of the complete system to teach in multiple simultaneous locations. We outline here the technology we're making available to the open source community and a system implementation suggestion for how to create global immersive virtual anatomy classrooms.

---

**Benny Bürger**

***Simulation of Dynamic Ultrasound Based on CT Models for Medical Education***

Besides X-ray image acquisition, ultrasound (US) is second frequently used image acquisition technique. However, interpretation of this modality demands detailed experience and hence qualified training is required. This paper presents the underlying technology of our medical ultrasound simulator. It relies on a flexible environment simulating the US images at a real-time frame rate. Based on CT-data as underlying model, acoustic properties to regions are assigned by interactive segmentation. The simulation uses Rayleigh integration combined with Ray Tracing, and acceleration techniques like early ray termination and space leaping. By this technique we are able to simulate e.g. acoustic shadows, mirror artefacts and posterior enhancement. Deformations are being realized by free-form deformation (FFD). The final system will consist of a haptic device that is used for the probe, and a commodity PC for synthesis of the results, running the simulation engine, and displaying the images.

# POSTER PRESENTATION SESSION

## WEDNESDAY MORNING, JANUARY 30

---

**Ravinder Reddy**

***Virtual Reality-Assisted Cognitive Therapy for Schizophrenia (VRACTS) - A Proposal***

Patients with schizophrenia, in spite of optimal treatment, can have persistent paranoia leading to difficulties in keeping clinic appointments and filing prescriptions, associated with treatment nonadherence and long-term poor outcome. Cognitive behavior therapy (CBT) is a promising tool, but of little use when patients are unable to attend clinic due to paranoia! We propose that combining virtual reality (VR) technology, currently being utilized in the treatment of anxiety disorders, with CBT is a novel and feasible approach to overcoming these limitations. VR uniquely offers portability, interactivity, repeatability, flexibility and safety, obviating the need for traveling to a fear locus. Multiple sessions can provide exposures to the anxiety provoking environments (e.g., public spaces), thereby increasing treatment density. The flexibility of VR software allows tailoring the virtual environment to specific treatment needs. Finally, VR can be instantly "switched off" providing a degree of safety that cannot be duplicated by other exposure-based therapies.

---

**Giuseppe Riva**

***Why You Really Eat? Virtual Reality in the Treatment of Obese Emotional Eaters***

The aim of this study is to assess the efficacy of a specific relaxation protocol based on immersive Virtual Reality (VR) to be used as integration in the clinical treatment of obesity. Forty (40) participants, all female, were recruited for the study at San Giuseppe Hospital of Istituto Auxologico Italiano at Piancavallo, Italy. Participants were chosen among obese patients with high level of anxiety; they all fulfilled the inclusion criteria of scoring higher than 0.5 in Anxiety symptoms, as measured through SCL-90 (Symptom Check list) questionnaire. The sample was randomly distributed in the three conditions as follows: (a) An immersive virtual reality environment with therapeutic narrative; (b) A DVD with therapeutic narrative; (c) no treatment (CTRL condition). Data show that the VR condition produced a significantly higher reduction in anxiety, as compared both to DVD and to CTRL groups. More, we found a significant correlation between changes in the emotional state and the level of presence: the more present the users felt, the higher the reduction in anxiety.

---

**David Stefan**

***Virtual Reality and the Bariatric Surgery Patient: Confrontation and Collaboration***

Discussion of virtual reality techniques to educate pre-operative bariatric patients of the actual physical shape, techniques to compare pre- and post-op weight loss in virtual reality, techiques to build forecasted models of post-op body given weight loss trends, psychological aspects and collaboration between surgeons, post-oeprative caregivers an patient, results of study

---

**Robert Sweet**

***Development of a Virtual Saint Paul for Adult Immersion***

We report our development leading towards building a virtual Saint Paul that is intended to provide immersion for adult patients. We think that adults are drawn more towards real-world scenes and activities that they can easily relate to in real life. Our development capitalizes on the recent advancement on laser scanning technology for high-speed and long-range outdoor scanning. Specifically we introduce our complete pipeline for processing outdoor scan data, from registration to segmentation and ultimately constructing full polygon models. Our intent is to use virtual St. Paul for clinical applications and specifically for pain management.

---

**Jan Cannon-Bowers**

***Pulse!! Usability and Playability: Preliminary Findings***

Pulse!! The Virtual Clinical Learning Lab(c) is a federally-funded research project designed to transfer and further develop state-of-the-art game design and technology to create subject matter for clinical medical learning in virtual reality. Pulse!! problem-based case scenarios are being designed for degree-based education and post-degree certification, as well as continuing education and training for health-care professionals that is pedagogically structured for deep and rapid experience-based learning. An important feature of the Pulse!! development strategy has been to incorporate evaluation issues early in the design cycle. This iterative approach begins with usability analyses and proceeds to incorporate learner reactions, cognitive change, behavior and transfer. To this end, Pulse!! field research has begun with beta testing of the learning platform in institutions of medical education to establish the system's functionality, playability and usability. Preliminary results indicate that the Pulse!! platform appears to be a viable environment in which to embed instruction.

---

**Vassilios Hurmusiadis**

***Cardiac Simulation for Training and Education***

The technical feasibility of computer-based interactive simulation of the human heart was investigated by the author. The project has now entered the development phase, which is aimed towards a pre-production prototype of the virtual heart organ. The prototype will be customized for general cardiology education. Further, the prototype will also be customized for clinical skills training in interventional cardiology and cardiac electrophysiology. A real-time interactive 3D application has served as proof of concept for the simulation and data visualization models. The simulation module incorporates the electro-mechanical

model based on the conduction tree, ventricle tissue sample and fiber orientation set. The visualization module is used for importing and visualizing pre-calculated data and patient imaging data such as MRI. Further development will include a haptic user interface for handling catheter insertion for ablation and pacing procedures. The project is partly funded by a R&D Grant from the London Development Agency, UK.

---

**James Kinross**

***Second Health: Health Care Strategy in the Virtual World***

The rapid growth of on line virtual worlds has provided a novel medium for health education. Within the UK, the health service is currently being redesigned around efficient and patient orientated care pathways. Development tools are thus required for concept visualisation and clear communication with all stakeholders. Imperial College, London has utilised Second LifeTM to create a fully interactive vision of a future 'local' hospital. This functional building demonstrates how healthcare could be provided. A thirty two acre site was constructed, based on six key treatment pathways. Three movies were also made using 'actors' within second life. User feedback was gained through questionnaires. We believe that this is the first time such technology has been used to assist in the development of future models of health care delivery. This work suggests that online virtual worlds are an effective and robust tool for the description of complex health care systems.

---

**Greg Ruthenbeck**

***A Virtual Reality 3D Jigsaw for Teaching Anatomy***

Comprehension of complex anatomical structures and their biomechanical behaviour is difficult from traditional media (books & 2D graphics). Our software provides substitute for hands-on learning of anatomy via accurate 3D models in a virtual reality application where the user can manipulate parts of a human skull. A new interface was used which successfully addresses some of the difficulties typically associated with providing an easy to learn and intuitive interface for manipulating and positioning objects within a virtual scene. We will also discuss how the software has been made extensible (using XML etc).

---

**Mark Scerbo**

***Monitoring Simulated Maternal-Fetal Heart Rate Signals***

The present study examined how individuals can detect subtle, but critical signals in simulated maternal-fetal heart rate tracings over an extended period of watch. Participants monitored simulated MFHR tracings for signals (late decelerations) over 3 contiguous, 16-min periods under one of three schedules: only in the first period, only in the last period, or continuous (in all three periods). Detection accuracy was high across all conditions; however, mean RTs did become slower in the continuous schedule and participants made a lot of false alarms. Our results show that allowing observers to look for signals in MFHR tracings under ideal monitoring conditions can result in good levels of detection accuracy, but with significant false alarms. Future research is aimed at studying performance under more ecologically valid viewing conditions.

---

**Hilary Stathes**

***Virtual Standardized Patients for Training Health Professionals on Alcohol Screening and Brief Intervention***

Although alcohol use disorders are common, some health care professionals have limited skills in conducting alcohol screenings and brief interventions. SIMmersion LLC and the University of Wisconsin are producing an interactive, immersive computer-based simulation that will address this need. This training simulation, funded by NIH-NIAAA, will allow learners to interact with a video-recorded simulated patient. Learners will build skills by holding detailed, unpredictable conversations with this character that can last for up to an hour and are never the same. The simulated character will react emotionally to trainees' questions, creating a highly realistic experience. The simulation will be supplemented with an e-learning component. The University of Wisconsin will facilitate a research study to test the simulation's validity in which 100 clinicians will be randomly divided into two groups. Their skills and knowledge will be evaluated and compared before and after the experimental group uses the training simulation.

---

**John Stone, Jr.**

***Virtual Medical Trainer for Peripheral Nerve Blocks***

The Virtual Medical Trainer (VMT) web-based simulation is designed to train Air Force anesthesia practitioners to perform peripheral nerve blocks for clinical anesthesia and pain management. This training was required to be widely distributed through a learning management system. The simulation is presented in a game-like interface that engages the user in realistic learning activities. It is driven by an improved state engine and framework that manages variables about the learner's performance and the patient's condition. The new engine is able to accommodate additional blocks with each nerve block as its own separate unit or SCO. The VMT simulation is an example of how innovative solutions to modeling challenges can produce a level of interactive realism seldom seen or "felt" in on-line, web-based training. The VMT simulation will provide training that will help improve pain management, and survivability rates of warfighters who suffer combat injuries that involve the extremities.

---

**John Stone, Jr.**

***Forensic Dental Identification (FDI)***

The Forensic Dental Identification (FDI) web-based training is designed to teach Air Force dental personnel to systematically apply forensic dental identification procedures. This project will also investigate if 3D virtual models of mandibles and maxillae can lead to the same level of accuracy for dental charting as having an actual specimen. Air Force dentists play a key role on the identification teams at the Dover Air Force Base mortuary and on deployed identification teams worldwide. The FDI simulation presents several innovative solutions to the complex challenges imposed by the subject matter and delivery platform. During a performance-based virtual lab, learners will be given information related to a (fictional) mass fatality, including a Missing Persons List. He or she will be challenged to determine the identities of seven individuals by comparing antemortem dental records to virtual remains (upper and lower jaws), postmortem dental records, and in some cases, personal effects.

---

**Bo Sun**

***Medical Student Evaluation Using Virtual Pathology Echocardiography (VPE) for Augmented Standardized Patients***

Standardized patients (SPs), individuals who realistically portray patients, are widely used in medical schools for training and assessment. One limitation is that these SPs are healthy individuals and they cannot portray abnormities upon physical examination with typical medical equipment. With the increasing role of ultrasound in clinical diagnostics, ultrasound training and assessment in medical education has been becoming more and more important. The clinical routine, which is for ultrasound to be trained on real patients, limits monitored and guided examinations for medical students. SPs could solve this time constraint if they could be augmented with the ability to portray physical abnormalities. Our research has developed a real-time ultrasound simulation technology to augment SPs with simulated sonography. We present this methodology and its use in simulating echocardiography. Medical students are able to use this ultrasound simulator to access SPs with pathologies as well as enhance their ultrasound knowledge.

---

**Jaydev P. Desai**

***Soft-Tissue Characterization During Monopolar Electrocautery Procedures***

Advances in electrosurgical technology have promoted the use of electrocautery in many surgical procedures. Precise modeling of soft tissue deformation during electrocautery with electrosurgical generators can be a valuable tool in training simulators for surgical procedures. Coupling the visualization of electrocautery with the force feedback during an electrocautery process (to maintain optimal current) without causing necrosis is an important learning tool. Realistic simulation will provide surgeon trainees a method to practice electrocautery techniques prior to experimenting on live tissue as well as allow surgeons to gain a feel for electrocautery procedures.

---

**Kanav Kahol**

***Physics Based Hybrid Deformation Model for Configurable Haptic Training for Virtual Surgery***

Realistic simulation of soft tissue is one of the most desired aspects of a VR medical simulator which can be characterized by features such as accuracy, speed and configurability. Lack of information about material characterization of soft tissue makes this problem of look and feel real more challenging. We present here a novel hybrid modeling approach that facilitates configurable visual and haptic interactions for surgeons in real time. We render the behavior of organs and tissues by optimal integration of the classic mass spring and finite element method, in a manner that induces configurability into the system. Regions of interest which we define as subsystems where interactions are more frequent are simulated with mass spring deformations and consequently superimposed onto the rest of the system exhibiting an FEM behavior. We describe the applicability of our algorithm to simulate a polyp extraction process and its extensibility to other interactive domains in haptics.

---

**Yoshihiro Kuroda**

***Haptic Rate for Surgical Manipulations with Fingers and Instruments***

Even now, 1000Hz of haptic update rate is a severe requirement, because endless demand for more accurate and realistic simulation increases computational cost. Psychophysical study has investigated requirements of haptic rate, basically assuming one finger interaction with an object. On the other hand, in surgery, many kinds of manipulations are conducted using multiple fingers and instruments. The aim of this study is to investigate required haptic rate for multi-finger manipulation and instrumental manipulation. This paper investigated required haptic rate for multi-finger and instrumental haptic interaction with haptic device and soft tissue deformation. Results of experiment clarified the fact that there is difference of threshold of haptic rate between the number of manipulation fingers. The result of this study allows assigning excess computational resource to other functions in surgical simulation.

---

**Erik Lövquist**

***Utilizing Existing Toolkits for Development of Realistic and Stable Force Feedback at Needle Tip with 3 DOF Haptic Devices***

This project has investigated the possibility of using existing toolkits to create realistic simulations of human tissue for needle insertion using a 3 DOF haptic device. The model for needle inser-

tion was developed through a collaborative design process with medical doctors, interaction designers and a psychologist. To test the validity and consistency of the model, a landscape study was designed and tested with 24 skilled anaesthetists. The results showed that the human tissue model has great potential as a needle insertion simulation. A huge benefit from previous models is that through utilizing the existing toolkits the model offers not just realism but also rapid prototyping, high performance and stability.

---

**Sugeng Rianto**

***Haptic Feedback for the Multilayer Cutting***

This paper describe our approach in developing an effective force feedback for a tactile haptic based on a multi-proxy rendering for 3D surface cuttings, and our current progress. We derived force models by approximation of composite forces based on dAlemberts principle in mechanic case of spring-damper-stiffness interaction of the surfaces. We introduce a cutting strategy by a combination between refinement and adaptive re-meshing . We present results of the haptic force feedback for cutting several layers with difference material properties. Skin, muscle, and fat in a single cut can create sensations as a resultant of forces of three independent quantities of a system having three degrees of freedom. The proposed strategy is effective enough to simulate a scalpel with multi-interaction paths on multilayer surfaces. The scalpel model provides physical interactions in the form force feedbacks and visual representation of cutting paths.

---

**Sugeng Rianto**

***Force Model for Volume Rendering in Immersed Virtual Environment***

This paper describes our approach in generating force models for volume haptic. Scalar values and force interactions are approximated by a combination of boundary detection thresholds and opacity peelings. While force vector field solvers between boundaries are estimated using numerical cubic interpolated propagation, our current volume visualizations are utilizing parallel streaming processors of inexpensive commodity graphics hardware. Beside the presentation of transparent supports and color information for non-orthogonal constraints and boundaries, we demonstrated inertial force and inertial torque feedbacks of the haptic device when entering a volume object. The current testing used normal CT and MRI visible human female datasets for head anatomy. Our implementation of collision and force computations rely on field offset boundary surfaces rather than implicit surfaces to provide consistent contact sensation in both visual presentations and tactile haptic.

---

**Venkat Devarajan**

***Design and Simulation of a Visual and Haptic Assisted Biopsy (ViHAB) System***

Core needle biopsy is a non-invasive technique for confirming breast cancer. Over the years, several image guided systems have been developed to guide the needle to the target lesion/tumor. Frequently used methods are those employing x-ray, ultrasound, MRI or x-ray fluoroscopy to guide the needle during biopsy. However, these methods suffer from the disadvantages that they are non-real time or the imaging technique is 2D or ionizing. Our broad objective is to develop a visually guided, haptic assisted breast biopsy system (ViHAB) using real time 3D ultrasound imaging. The system will help the radiologist in identifying target micro-calcifications and provide real time guidance for core needle biopsy. The ViHAB simulator, developed at the Virtual Environment Laboratory can read and display 3D ultrasound images, keep track of micro-calcifications in near real time in a sequence of images and also provide haptic guidance to a virtual needle via a force feedback joystick.

---

**Thomas Di Sessa**

***The Use of 3-D and Virtual Reality Technology to Project Images of Aortic Arch Anomalies***

Background/ Problem: Aortic arch anomalies such as coarctation of the aorta and vascular rings comprise a group of vascular structures that have complex three dimensional shapes. Tortuosity of the arch as well as hypoplasia or atresia of segments of the arch or pulmonary artery makes conventional two dimensional imaging difficult. Thus, three dimensional reconstructions of these anomalies provide may more precise anatomical detail. We demonstrate that 3-D reconstruction and virtual reality projection of these complex structures allows for multidimensional views which provide additional valuable information helpful in the therapeutic decision making process or teaching arena.

---

**Jürgen Fornaro**

***Interactive Visuo-Haptic Surgical Planning Tool for Pelvic and Acetabular Fractures***

Treatment of pelvic and acetabular fractures still poses a major challenge to trauma surgeons. We present a tool for intervention planning for such injuries using patient-specific models built from Computed Tomography data, providing additional information to surgeons. The presented tool has three main parts: (1) the virtual reduction of the bone fragments, (2) the virtual adaptation of the osteosynthesis implants and (3) Finite Element Analysis (FEA) of the resulting intervention plan. Our tool provides an intuitive visuo-hapic interface designed to be used by trauma surgeons. The type and size of the osteosynthesis material can be determined and measurements like distances and angles relative to landmarks can be taken. Osteosynthesis plates can be roughly prebent manually, thus reducing time for the procedure in the

operating room where only fine tuning of the plates' shape is necessary. And finally, the mechanical behaviour of the intervention plan can be tested using FEA.

---

**Mathias Hofer**

***First Clinical Evaluation of the Navigated Controlled Drill at the Lateral Skull Base***

Surgery on the lateral skull base puts delicate risk structures such as the facial nerve or the carotid artery at risk. The intervention is usually performed with a powered drill. To support the surgeon in identifying and protecting the risk structures the principle of navigated control (NC) can be used. A drill is regularly controlled by the surgeon. In addition, it is controlled according to the position of the instrument relatively to a deliberated position known from a preoperatively segmented work space (within CT-Data) excluding risk structures. An optical navigation system is connected to the navigated control unit. There was no risk structure damage with NC. For all patients there was an automatic shutoff on the work space borders. Navigated Control seems to have a great potential for safe risk structure protection, a morbidity reduction, a reduction in intervention time and also in a relief of strain for the surgeon.

---

**Ashraf Ibrahim**

***A New Ultrasound Phased Array Applicator to Treat Prostate Cancer Using Hyperthermia***

The effect of array geometry on the steering performance of ultrasound phased arrays is examined theoretically, in order to maximize array performance under the given anatomical constraints. This paper evaluates the performance of arrays with spherical and cylindrical geometry, determined by using computer simulations of the pressure fields produced at various extremes of steering. The spherical segment arrays were truncated for insertion into the rectum, and contained either annular or linear elements. The cylindrical arrays were either flat or had a variable curvature applied along their length. Fields were computed by dividing the array elements into many point sources. The effectiveness of an array configuration when steered to a particular focal location was assessed by defining a parameter, G, as the ratio of the intensity at the desired focus to the maximum intensity of any unwanted lobes. The performance of truncated spherical arrays with annular elements was evaluated for focal steering along the array axis (in depth, in the z direction).

---

**Shuhei Kubo**

***CT Image Applications for Pre-Surgical Assessment and Surgical Pre-Planning in Pediatric Dentistry***

In this present study we focused on dental diseases peculiar to children and investigated how 3D-surgical planning and simulation could be applied to each case.__This study included 4 patients (3 female and 1 male, from 8 to 12 years, with an average age of 11 ± 0 years). The CT imaging was performed via a SOMATOM Plus4. From the resulting data, an image of the tooth and bone was rendered using image analysis software Amira 3.1 which was then used to reconstruct three-dimensional images. The reconstructed 3D images were imported to 3D modeling software, which provided the basis for the surgical simulations. From these results, we were able to gain some rather important insights that helped shape the planning of the surgical operation. Furthermore we consider that these findings would be useful for the patient when taking them through the process of obtaining informed consent.

---

**Andreas Melzer**

***MRI and CT Guided Robotic System for Image Guided Interventions - Principles and First Clinical Application***

A fully MR-compatible assistance system INNOMOTION (Innomedic, Herxheim & FZK Karlsruhe Germany) was developed in collaboration with University of Applied Sciences Gelsenkirchen, to provide precise and reproducible instrument positioning inside high field closed bore magnets with 1-3 Tesla. The goal was to achieve a telemanipulated robotic systems for MRI guided interventions and surgery as inaugurated for endoscopic surgery in 1993. Percutaneous interventions such as MRI guided insertion of cannulaes and probes for biopsy, drainage, drug delivery and energetic tumor destruction are further application with the same system. The INNOMOTION system has received CE mark in 2005 is currently in clinical use for MRI guided sciatic pain and facet joint treatments, biopsies, drainages, and CT guided osteosynthesis. The objective of the fist clinical trial was to determine targeting precision during MRI guided percutaneous interventions in a clinical trail for bilateral facet joint injection of steroids at spine segment L5 S1.

---

**Andreas Melzer**

***Inductively Coupled MR Visualization of Minimal Invasive Implantable Stent Based Aortic Heart Valve for MRI Guided Implantation***

The purpose of this project was to improve visualization of a self expanding percutaneously implantable heart valve under MRI. A fresh porcine heart valve that was sutured into a 24 mm Nitinol stent. A resonant circuitry tuned to the MR Larmor frequency of the 1 1.5 Tesla MRI was applied around the valve to minimizing the negative shielding effect of the stent structure. This enables improved imaging and delivery of the stent based heart valve with MRI. The aortic valve could be approached with the delivery system and the expansion of the heart valve could be visualized with real-time MRI. There was a two-fold increase in signal of the resonant part of the stent. The RF shielding of the Nitinol stent could be overcome so that the substrate could be visualized using a flip angle of 20°. The signal increase facilitated MRI guided positioning via a trans apical approach

**Robert Oberreuter**

***Optimizing Joint Placement and Motion Schedule for 2 DOF Computer-Assisted Distraction Osteogenesis***

A novel 2 DOF fixator device for the correction of bone deformities with distraction osteogenesis is presented. The device is a hyper-redundant kinematic chain containing a single rotational and prismatic joint. It operates on the principle that arbitrary positioning can be reduced to a single rotation and single translation with carefully chosen axes. A robotic arm can drive the fixator chains into the proper configuration to set the device for installation. This research is part of a project to create a computer-integrated surgery system for distraction osteogenesis. The proposed system will create a 3-D image of the bone based on two orthogonal radiographs and will then automatically determine the deformity parameters. In this paper, the modeling processes used to locate the configuration of the fixator joints and to plan an alignment schedule are described. The device was found to be viable for a range of deformity types and alignment trajectories.

---

**Yuko Shigeta**

***Changes in Three Dimensional Simulation Models of the Airway which are Due to Increases in Age or Body Mass Index***

The aim of this study was to investigate the significance of the changes that occur with increasing age and weight in the soft and hard tissue around the upper airway, and to visually gauge them through the use of 3D simulation models. We created two standard 3-dimensional models, with one set to represent a healthy subject model and the other serving as an OSA model. The results of the regression models in our anatomical variables were attached to each 3D model. We compared our data with the data of previous studies to recognize the validity of our regression model. In both models the pharyngeal length increased as age increased. We observed an increase in the fat tissue, soft palate length, and a thickening of the soft palate as BMI increased. As age and BMI increased, the narrowing of airway appeared more severe in the OSA model

---

**Gunther Sudra**

***Augmented Reality Assistance for Realization of Incision Planning and Model-based Analysis of the Modified Surface Model***

Augmented Reality (AR) techniques directly visualize virtual objects in the surgical site, virtual data is often based on preoperatively acquired CT / MRI data. During the intervention, the modification of anatomical structures due to the surgeon's activity (e.g. cutting) impede that this preoperatively acquired data basis becomes obsolete. To overcome this problem, the use of intraoperative gained sensor data is proposed. This data could be used for a model-based analysis and provide helpful information for recognition of the actual state of an anatomical structure. In this paper an application for incision planning, AR visualization and a method for model-based analysis of the modified surface model after realization of the planning is presented. The model-based algorithm detects characteristic edges and creates a parameterized description of the wound. Objective is to use this information for context-aware augmented reality systems.

---

**Yasushi Yamazaki**

***Dental Fiberscope with Navigation System for Endodontic Treatments***

We developed a dental fiberscope with navigation system. The aim of this study is to navigate the position of tip of endoscope fiber in the root canal with our navigation system. The characteristic of our system is that it could apply to the narrow space such as a root canal in the endodontic treatment. We were subsequently able to precisely indicate the relation of the position between the device and the teeth on the 3D model in the monitor. We inspected our navigation system using the phantom and the reconstructed 3D model. We could understand the relation of position between teeth and the device, and aim at the lesion precisely. If we were grasp the correct position of the endoscope, we can safety and accurate laser irradiation to the lesion. Consequently, the application of endoscopic navigation system could increase the success rate for root canal treatments with recalcitrant lesion.

---

**Xiaolong Zhang**

***Stereoscopic Visualization and Haptic Virtual Exploration of Gastrointestinal Endoscopic Images for Improved Diagnosis***

Endoscopy has become an established procedure for the diagnosis and therapy of various gastrointestinal ailments. However, endoscopic images are not useful in accurately discerning subtle pathology like mucosal inflammation, superficial early cancer or precancerous lesions. Early diagnosis of these lesions is very important. We propose a novel methodology that enables convenient (glasses-free) stereoscopic visualization plus virtual exploration of the monocular endoscopic images through haptic visualization, so that the subtle alterations of the tissue surface texture due to the presence of pathology can be diagnosed/detected by a physician during endoscopy in a faster, less intrusive, less costly, and potentially more accurate fashion, compared with current practices. The proposed approach has the potential of expanding to related areas such as endoscopic surgery and simulation-based training.

---

**Linping Zhao**

***Experiences in Virtual Craniomaxillofacial Surgery: Planning, Transferring to OR, and Validation***

While virtual craniomaxillofacial surgery (VCMS) has been gaining attention from cliniciansfor decades, it has not been used

routinely for planning craniomaxillofacial surgery. Closer interaction between the virtual world and reality is needed in, at least, three temporal phases: input and processing medical images, transferring presurgical plan to operating room, and validation of the simulated surgical outcomes and predictions with clinical outcomes. We will discuss our ongoing study and demonstrate our experiences in applying virtual craniomaxillofacial surgery in four unique clinic cases: (1) cranial vault reconstruction using a custom implant, (2) neonatal mandible distraction, (3) orthognathic surgery using virtual intermediate splint design, and (4) zygoma reconstruction through a real time collaborating between biomedical engineer and surgeons in operating room.

---

**Miguel Franco**

***A Mountable Pneumatic Haptic Feedback Actuator Array for the da Vinci“ Surgical Robotic System***

While robotic surgical systems offer many benefits, they suffer from a total loss of haptic feedback, requiring surgeons to rely solely on visual cues during surgery. A pneumatically driven balloon-based actuator array has been developed for mounting against the fingers on the surgical robotic master controls of the da Vinci(r) Surgical Robotic System. Three tests were performed to evaluate the viability of the mounted actuators with the first stimulating the thumb vs the forefinger, the second stimulating the index finger from left to right, and the third stimulating the index finger from front to back. Five subjects were able to successfully determine thumb vs forefinger location with 100% accuracy, medial/lateral position with 98% accuracy, and anterior/posterior position with 95% accuracy. The results indicate that the mounted system is a viable means to provide tactile feedback to the fingers.

---

**Fuji Lai**

***Robotic Telepresence for Collaborative Clinical Outreach***

The American Stroke Association has advocated the development of stroke systems and networks to coordinate activities and resources to ensure timely treatment of stroke victims. Remote Presence is in a unique position to facilitate the communication and collaboration needed to deliver effective stroke care. Remote Presence is a transformational technology which harnesses the power of robotics, wireless, and the internet to enable hospitals and physicians to deliver an unprecedented quality and level of healthcare-bringing the right care to the right patient at the right time. Remote Presence has been successfully implemented in a hub and spoke model allowing stroke neurologists at a stroke center of excellence to provide the spoke hospital staff with patient consultation and training services. The results are improved geographical reach of stroke specialist care throughout the region with significant impact on patient outcomes as well as improved alignment with established care standards and best practices.

---

**Mitchell Lum**

***Objective Assessment of Tele Surgical Robot Systems: Telerobotic FLS***

In the late 1990's SAGES formed a committee to develop curriculum for teaching the Fundamentals of Laparoscopic Surgery (FLS). The FLS skills tasks have been used to quantitatively assess the skill of thousands of surgeons ranging from novice to expert and are considered by many the "gold standard" in surgical skill assessment. In the area of surgical robotics, researchers typically devise their own scheme for system evaluation based on their needs. We present results using three of the skills tasks for performance evaluation of the University of Washington RAVEN surgical robot in local and teleoperation modes, as well as a performance comparison to the ISI da Vinci. The teleoperation experiments presented were part of the NASA Extreme Environments Mission Objective (NEEMO XII). The use of FLS tasks for telesurgical robotic system evaluation will allow researchers across the World to share common results.

---

**Shigeyuki Suzuki**

***Telecontrol Function of an Endoscopic Surgical Robot with Two Hands for Tele-NOTES Surgery***

We have been developing a surgical robot system with navigation function for abdominal surgery since 2001. Clinical feasibility of the robot has been evaluated by animal experiments. Endoscopic mucosal resection (EMR) and other surgical procedures for Natural Orifice Transluminal Endoscopic Surgery (NOTES) were performed by the combined use of the robot manipulators. In this study, we developed a telecontrol system for the robot to perform an endoscopic abdominal robotic surgery using a robotic telesurgery method. By using a developed system, a telesurgery experiment was conducted between laboratories through LAN. As a result, high-speed data transmission from the master device to the slave robot could be performed. We also confirmed the implementation of a telecontrol function for the surgical robot. In the near future, we will perform surgeries such as EMR and NOTES with the optimal telecontrol function.

---

**Takumi Ogawa**

***Application of a Craniofacial Surgical Multiphase (Virtual and Physical) Simulation System for Jaw Deformities***

The goal of craniofacial surgery is to lessen dysfunction and aesthetic impairment in patients with jaw deformities. Thus far, roentgenographic cephalogram and set-up models have been the main modes available to analyze, diagnose and simulate the surgical procedures. However, the information produced by these methods was often insufficient. The purpose of this study was to develop a new surgical simulation system and to apply it to a clinical case. Three-dimensional craniofacial images were reconstructed through CT data and mandibular movements were recorded by a tracking device with Optical System. The craniofa-

cial images were then combined with the mandibular movements. A simulation model of the craniofacial region was reconstructed through rapid prototyping and applied for surgical correction on the model. A new craniofacial surgical simulation system was developed through 4-dimensional images and a simulation model was reconstructed from CT data. The model was found to be useful for simulation surgery.

---

**Joerg Wulf**

***Pectus Excavatum: Silicone Implant Construction Using Computed Tomography and CAD Technology Versus Conventional Plaster Molding***

Pectus excavatum is the most common type of congenital chest wall deformity. The reconstruction may be supported by the use of a custom made silicone implant. A case of a 17 year old patient is presented. A direct molding on skin surface area of the deformed chest wall was performed. The resulting template was scanned using an optical 3D digitizing surface scanner. Furthermore a computed tomography of the thorax was performed. A 3D model was generated using a commercial image processing and segmentation software. By means of a haptic device (SensAble Technologies Inc.) a virtual implant was created using "digital clay". The geometry of digitized template and virtual implant were compared. A significant measured difference was documented. Finally the decision was made, to use the virtual implant to create a rapid prototyping model as a template for the silicone implant.

---

**Christoph Aschwanden**

***Performance Measures for Dominant and Non-Dominant Hand Training in a Virtual Reality Motor-Skills Simulator***

Current research shows differences in the error rate and first time accuracy between the dominant and non-dominant hand. Lack of synchronized movement of the non-dominant hand has been described as among one of the crucial limitations for live operative performance of trainees in Laparoscopic Radical Prostatectomy. We conducted a virtual reality manual skills experiment to investigate performance differences in dominant and non-dominant hand training. Performance measures were among (i) accuracy, (ii) efficiency of motion and (iii) errors. Findings indicate that training on our virtual reality motor-skills simulator (VRMSS) results in equal skills acquisition for both dominant and non-dominant hand regarding (ii) efficiency of motion and (iii) errors committed.

---

**Nathan Delson**

***Anatomically Configurable Mannequin Designed for Laryngoscopy Training and Assessment***

Variation in anatomy between different patients can be a source of difficulty in many medical procedures. When procedures can be studied with complete virtual simulation, the software model can develop a range of patients anatomies. However, where existing technology does not permit virtual simulation, the available training tools are largely static mannequins that represent a single anatomical configuration. To address these limitations for the laryngoscopy procedure, a new mannequin has been developed with widely adjustable features that can model a range of patient anatomy. The capabilities of this mannequin will be further extended through use of instrumentation and correlation with in vivo measurements to provide guided training and assessment. The mannequin developed has enabled a parametric study of the effect of changes in specific anatomy, and opens the door to mannequin training that is quantifiably connected to in vivo procedures.

---

**Adam Dubrowski**

***Trocar Insertion: The Neglected Child of VR Simulation***

The effects of practice on trocar insertion skills are not understood. We hypothesized that simulation based practice will results in skill improvement. Novices, junior trainees and practicing surgeons inserted a trocar into a simulated human abdomen. The depth of penetration into the abdominal space (plunge) was the similar for novice and junior trainees ($p=.98$), and exceeded that observed for practicing surgeons ($p<.05$). Novices used less turns to insert the trocar than juniors ($p<.001$) and surgeons ($p<.01$). The amount of plunge was not related to the technique applied, but to the amount of hands-on exposure. Thus trocar insertion may be an important variable to consider for surgical skill training. To date, no virtual reality (VR) trainers allow for practice of this skill. We will present a prototype of a VR trainer designed for this purpose which allows optional visualization of abdominal tissue penetration.

---

**Nigel John**

***Physics-Based Virtual Environment for Training Core Skills in Vascular Interventional Radiological Procedures***

The Collaborators in Radiological Intervention in Virtual Environments (CRaIVE) are developing a high fidelity virtual environment (VE) that provides a validated alternative to the traditional apprenticeship model used for teaching core skills in interventional radiology such as the Seldinger technique. This paper describes the current version of the CRaIVE simulator.

---

**Kanav Kahol**

***Surgeons on Wii: Applying Nintendo Wii to Improve Surgical Skills***

Nintendo Wii(r) games include a novel combination of both psychomotor and cognitive skill which has led to its widespread popularity. Modern day surgery involves both cognitive and psychomotor resources. It is possible to exploit the inherent skill base required to master Nintendo Wii games to train and hone

certain surgical skills. This presentation will cover results of an experiment where surgical residents practiced with the Nintendo Wii to improve surgical skills. Their performance is discussed and contrasted with a control group of residents who did not practice with the Wii. Initial Results show a marked improvement in surgical dexterity following practice with the Wii. The poster will also include taxonomy of Wii games that can be employed for improving surgical skills.

---

**F. Jacob Seagull**

***Perfect Partners: Surgical Ergonomics and Minimally Invasive Training***

Protocols and guidelines used for laparoscopic trainee evaluation far too often are subjective. The capability to monitor the physical movements of trainees so that they achieve effective, safe instrument maneuvering and task performance must develop beyond instructors' visual analysis and past experience. Our latest research has continued to characterize surgeons' movements, specifically upper body joint movement and postural balance control, and training environments, particularly station table height, and we detailed the methodologies informing the surgical ergonomics field in a literature review. All of our recent work contributes convincing evidence that the most promising area for the practical application of the scientific, evidence-based discipline of surgical ergonomics is surgical training.

---

**Dennis Sessanna**

***Simulation of Punch Biopsies: A Case Study***

We report on the development of a low-cost interactive simulation environment for training in the technique of a punch skin biopsy. The purpose of this effort is to promote the optimal acquisition of tissue for the determination of malignancy. The system exploits the graphical processing unit (GPU) to provide realtime computation of skin deformation. We present the use of the system for use by departments of Continuing Medical Education in the State of Ohio.

---

**Cyle Sprick**

***Simulation Debriefing and Quantitative Analysis Using Video Analysis Software***

Video analysis has been shown to be a valuable tool for debriefing after simulations. However, these debriefings can take longer than the simulation itself, and are heavily reliant on the skill of the facilitator for their effectiveness. It is also very challenging to extract quantitative data from a video recording. We have been using a commercially available software tool called StudioCode, which makes such video analysis easy. There is a time burden on facilitators to gather this data in real-time. However, the ability to provide consistent, standardised feedback to students, with easily accessed video clips of debriefing points is well worth the extra effort. We are currently investigating how this enhanced feedback can be used to assess student progress over time. StudioCode promotes organization of video clips by keywords, with cross referencing through its database, and makes gathering of statistical data trivial by tracking number and duration of tagged events.

---

**Don Stredney**

***Translating Human Simulation Technologies to Veterinary Surgical Practice: Accelerating Adoption***

We report on a project funded by the Alternatives Research & Development Foundation to translate developments in human simulation to the field of veterinary surgical simulation. The development includes software to intuitively import standard computed tomography and magnetic resonance and visually register them for use in teaching and surgical simulation. Additional software provides segmentation and viewing of regional anatomy, as well as the surgical simulation environments. We present on several limiting factors that impede the validation and adoption of simulation technologies for use by the veterinarian surgical community.

---

**Robert Sweet**

***Integration of MMVR Research Laboratories into Simulation Training Centers***

We introduce the University of Minnesota's Center for Research in Education and Simulation Technologies (CREST) as a new VR development laboratory focused on medical applications whose infrastructure promotes facile collaborations between VR developers and their medical collaborators. Our primary development laboratory is offsite, with two satellites situated in the 5000 square foot Academic Health Center Simulation Center, and our 3000 square foot Medical School's SimPORTAL (Simulation PeriOperative Resource for Training and Learning) to promote daily cross-collaboration with trainees and trainers. SimPORTAL is the central videoconferencing hub for the simulation program, and bi-directional conferencing occurs between the operating theaters at two campuses, the simulation training centers, our 1500 square foot live animal experimental surgery center and CREST. The Simulation Program at the University of Minnesota's infrastructure stimulates daily cross-collaborations between medical personnel and engineers leading to a productive environment for the applications of Medicine meeting Virtual Reality.

---

**Xun Zhou**

***An Interoperable Platform for Evaluating Resident Performance on Virtual Simulators***

Despite the ACS mandate that all residency programs incorporate simulation training by 2008, there is currently no nationally-recognized curriculum for surgical simulators. One of the difficulties in developing such a standard is that most of today's simulators are focused on allowing users to practice their skills, deemphasizing tools designed to assess their performance. We

propose a software platform that will streamline and enhance the ability to access assessment-related data from surgical simulators. Our Resident Assessment Uploader (RAU) will be able to integrate in a wide range of simulators and generate customizable grade reports. These reports can then be viewed locally or uploaded to online residency management suites, such as New Innovations or Residency Partner. The RAU is currently in development, and is intended to be an intuitive platform that is accessible to administrators, curriculum managers, and students.

---

**Syed Ali**

***Eye Gaze Tracking for Endoscopic Camera Positioning: An Application of a Hardware/Software Interface Developed to Automate Aesop***

Some of the weaknesses of Aesop are fixed step size, poor voice recognition and limited control (hand controller/voice command). We have developed an interface to automate Aesop3000 and an application of this interface, that is, camera positioning with eye gaze tracking is discussed. This setup allows us to successfully track a subject's eye movement and then translate the gaze point into coordinates correlating to location on monitor. Joint angles are calculated and sent to Aesop to move the endoscopic camera such that gaze point is now at the center of the video image. Integration of eye tracking with Aesop is the first step towards a broader application of this research. Our future goal is to make greater use of this interface by integrating it with our image guided system and various types of biosensors, as well as to simulate our system in Webots, allowing us to preplan Aesop's movement.

---

**T. "Kesh" Kesavadas**

***Augmented Reality for MRI-Guided Needle Biopsy of the Spine***

In MRI-guided needle biopsy for detecting lesions in the spine, certain factors, such as the presence of critical organs near the spine, and the strict directional restrictions the surrounding bone structure places on the biopsy route, make the targeting of lesions difficult. The biopsy needle must be advanced very slowly and its position checked frequently under MRI to ensure that vital organs are not damaged and that the approach is accurate. In this project, we have developed an Augmented Reality software that uses a static single-camera tracking mechanism to locate the biopsy needle in the patient space and which then augments the patient space view with virtual data to provide real-time guidance to the surgeon for insertion of the biopsy needle. The lack of requirement of elaborate infrared tracking systems needing high computing power makes this system very cost effective without loss of accuracy.

---

**C. Donald Combs**

***Visualizing the Medical Modeling and Simulation Database: A Comprehensive Analysis of Trends in the Research Literature***

The published literature in the field of medical modeling and simulation has increased substantially since 2000. This research paper analyzes the development of medical modeling and simulation by reviewing the articles presented at the past eight MMVR Conferences and the 100,000+ articles in the Medical Modeling and Simulation Database (MMSD) published from 2000 until 2007. A meta-analysis was conducted such that research emphases were classified into eight categories: simulation, procedural simulation, modeling, diagnosis, therapy, education, validation, and telemedicine. Trends observed in the MMVR Conference articles were then compared with the trends noted in the broader MMSD database. Among the trends is an expansion in the application of simulation technologies, a larger percentage of MMVR articles addressing procedural simulation, and an increase in validation studies in the MMSD. This analysis represents a comprehensive portrayal of the state and trends of medical modeling and simulation research.

---

**Rebeccah Marsh**

***Designing a "Virtual Liver" for the Prediction of Drug Transport and Metabolism***

As the main organ responsible for the transformation and metabolism of drugs, the liver plays a significant role in determining the amount of beneficial and harmful substances that enter the bloodstream. However, due to the complexity of the liver and variability between individuals, it can be difficult to predict how a particular patient will process a drug. We have made significant progress in the development of a virtual liver that can be used to simulate the body's reaction to different drugs. The virtual liver takes into account as many anatomical and physiological characteristics of a real patient as possible and can be used as a platform for performing dynamic simulations of real-time drug transport and enzymatic reactions. As an alternative or complement to laboratory experiments and clinical trials, these virtual reality simulations can be used to estimate patient response and ultimately help determine the optimum therapy for an individual patient.

---

**Panaiotis**

***Transforming an Educational Virtual Reality Simulation into a Work of Fine Art***

Internet sites abound with works by photographers and digital artists who create beautiful artwork from biological phenomena. Inherent differences of purpose require dissimilar approaches to artistic and scientific/educational treatments of the same subject. Is there a value in considering the context of one while working on the other? Collaborators between the state Universities of Hawaii and of New Mexico developed a reified model of the nephron into which important physiologic functions are integrated and rendered into a 3-D virtual environment. Attracted by the use of music, curators at the New Mexico Museum of Art in Santa Fe requested that a version of the simulation be included as part of a three-month exhibit. Preparation for its new context exposed the sharp contrast (sometimes conflict) between them. This paper discusses the transformation from educational tool to fine arts work, and the design considerations this experience has to offer the development community.

# POSTER PRESENTATION SESSION

## THURSDAY MORNING, JANUARY 31

---

**Martin Culjat**

***A Flexible, Conformable Ultrasound Array for Medical Imaging***

Current medical ultrasound techniques require scanning with rigid multi-element arrays to obtain images over curved surfaces of the body. An ultrasound imaging system that does not require mechanical scanning may expand the use of ultrasound to medical personnel with limited ultrasound training, including point of care physicians and those in remote or emergency settings. A flexible, conformable ultrasound transducer array and imaging system is currently being developed that will remove the need for mechanical scanning. The device is intended for use both in a partially wrapped configuration (i.e., around the abdomen), or fully wrapped around an object (i.e., around an extremity). This paper describes the development of a flexible, conformable transducer prototype and accompanying imaging system, and reports preliminary results on the ability of the prototype transducer to image internal objects within a soft tissue phantom.

---

**Ramona Grzeschik**

***An Adaptive Virtual Reality Environment for Real-Time fMRI***

Virtual reality in fMRI, i.e. navigation studies, is mostly used in conjunction with conventional control devices like MR - compatible buttons or joysticks. On the other hand, human brain interfaces in fMRI in general use simple 2D visualizations for representing the brain activation to the subjects.
The approach represented here is considered as a further development towards three-dimensional adaptive virtual worlds.
Several experiments were successfully conducted: our system was able to differentiate between 3 activation patterns of the subjects (finger-tapping: right/left hand, mental calculation) depending on the spatial expansion and strength of the activation. With those results the volunteers could move through the 3D maze in three directions (left, right, forward).
With this application we succeeded to design an adaptive 3D-virtual world for real-time fMRI. This combines human brain interfaces with virtual reality.

---

**Rahul Singh**

***Towards THz Medical Imaging: Reflective Imaging of Animal Tissues***

The high dielectric constant of water at THz frequencies lends itself well to the detection of slight variations in water content of biological materials. Variations in dielectric constant have been reported among different tissue types. These advantages coupled with the non-ionizing THz photon energy (1-12 meV) and the ability to penetrate through clothing / synthetics make THz an ideal tool for in-vivo imaging of skin abnormalities. We report on using a single pixel, whiskbroom scanning, THz reflection imaging system to image common deli meats. The system has a spatial resolution of 1 mm and a post-detection SNR of 40 dB using a 16 ms integration time constant. The system operates at a center frequency of 600 GHz and a 3 dB bandwidth of 200 GHz. Imaging of deli meats is a first step towards to ultimately imaging skin and skin features, including burns, wounds, and other surface abnormalities.

---

**Mario Strauss**

***Model for Nerve Visualization in Preoperative Image Data Based on Intraoperatively Gained EMG Signals***

The excision of the mastoid is a common and complex intervention in the field of ENT surgery. While removing bone tissue, the facial nerve is at risk of being injured. A neuro monitor can support the surgeons during this task. It is used to 'hear' the nerve. In this presentation a model for nerve visualization in preoperative image data based on intraoperatively gained electromyogram signals is presented. During nerve excitation in order to locate it, the position of the stimulator is measured by assistance system. The location of appearance of the stimulation and strength are stored and lead to an assumed position of the nerve. The proposed model can be used to assist the surgeon during intervention passively and actively. Passively while visualizing the assumed nerve course and actively by using these information to control the power of active instruments.

---

**Mario Strauss**

***Virtual Endoscopy on a Portable Navigation System for ENT Surgery***

Virtual endoscopy can help surgeons and radiologists visualize the complex anatomy of their patients, which can be a difficult task, particularly if anatomical structures have been pathologically modified in previous operations. An extension to a miniaturized navigation system, based on a portable Tablet-PC is presented. This extension provides real-time virtual endoscopy including collision. If the quality of the polygonal mesh is not sufficient for diagnosis purposes, a region of interest can be specified to generate a high-quality mesh. The virtual endoscope can be used during planning and navigated intervention as well.

---

**Viet Quang Huy Huynh**

***On the Problem of Determination of Spring Stiffness Parameters for Spring-Mesh Models***

Surgical simulators have been developed to create environments to help train physicians in learning skills of surgical operations at many research centers. In Surgical simulators, the real-time inter-

active models of behaviors of deformable objects play important roles. Two important requirement of simulations are high preciseness and real-time. Spring meshes are useful for soft tissue modeling in surgical simulation due to their real-time behavior. A spring mesh is a system of vertices and edges, in which each vertex is a mass, each edge is a linear spring, and linear springs are connected at the vertices. Given elastic material properties, however, the precise simulation the behavior of the material by spring mesh is impossible. The objective of our research is to improve the preciseness of the spring mesh method by way of introducing torsional spring into the conventional mass-spring model.

---

**Nigel John**

***Efficient Soft Tissue Deformation Using Charged Particles***

The motivation for our work is to provide a viable alternative to fixed anatomy models in training interventional radiology procedures, using high fidelity virtual environments. We aim to produce a simulation that is both visually and haptically realistic. The purpose of this paper is to describe a novel approach to soft tissue modelling and deformation using charged particles. Each particle in our system is modelled as having an electrical charge which will determine how it interacts with other particles according to the rules of electromagnetic interaction. This means collisions between the soft tissue and the haptic interface point (HIP) never actually occur, which makes the whole process more efficient to implement. We demonstrate the creation and deformation of anatomical shapes, in real time on a standard desktop PC.

---

**Sergei Kurenov**

***Fatty Tissue in a Haptic Illustration Environment***

The presentation will center around a demonstration of the TIPS (Toolkit for Illustration of Procedures in Surgery) environment with focus on deposition and cutting of fatty tissue and peritoneum. The presentation will include a comparison with alternative approaches and discuss progress in sharing TIPS as a communication tool within the community.

---

**Nobuhiko Mukai**

***Real-Time Blood Vessel Deformation with Bleeding Based on Particle Method***

We have investigated the performance of blood vessel deformation with bleeding. Blood vessel can be deformed by using mass spring model for the faster deformation than FEM (Finite Element Method); however it is not stable when three consecutive masses are on the same line. Therefore, our method adds two extra masses and springs for the stable deformation. Bleeding method is based on MPS (Moving Particle Semi-implicit) in order to represent splash; however it takes huge time to solve Poisson equation. Then, our method modifies each particle position directly so that it can render bleeding very fast. As a result, blood vessel deformation with two bleedings can be rendered in real-time (30Hz) for the model, which has 20 masses and springs excluding extra ones for blood vessel and 500 particles for bleeding.

---

**Karl Reinig**

***Realist Anatomic Models for Virtual Environments***

With the continuing evolution of virtual environments for training medical procedures, comes the increasing need for hi-fidelity anatomic models. These models are generally used for both haptic and graphic display and often come from volumetric clinical data such as Magnetic Resonance Imaging and Computed Tomography or possibly the Visible Human Dataset. Regardless of the source, a great deal of work must be done to transform the raw data into useful models. This presentation focuses on steps and lessons learned in the process of making hi-fidelity anatomic models for use in virtual environments. From segmentation through Finite Element Modeling of deformable tissues, the presentation details some of the different paths we have tried as well as how we have arrived at our current solutions.

---

**Alessandro De Mauro**

***Neurosurgical Training System Based on an Operating Microscope***

The aim of this project is the development of a virtual reality training system for neurosurgical interventions. The realism of the simulation has to be provided by an accurate human tissue modeling, by the use of a force feedback device and, for the visual feedback, rendering the virtual scene directly on the oculars of the operative microscope In neurosurgery, microscopes but, in the state of art, the are only few examples of virtual reality neurosurgical simulators which use force feedback and for all of them the architecture use only displays or HMD and not a real surgical microscope. In our institute, a prototype of a stereoscopic Augmented Reality microscope for neurosurgical interventions has been realized. We are modifying the AR-platform, providing a neurosurgical training system based on a virtual environment based on real patients' images. This will be the first example of neurosurgical training system using a real operating microscope.

---

**Matthias Faerber**

***Training and Evaluation of Lumbar Punctures in a VR Environment Using a 6DOF Haptic Device***

A virtual reality lumbar puncture trainer has been developed to reduce trouble for the patient and to provide the trainees with a possibility to prepare for their first lumbar puncture. A haptic device with six degrees of freedom is used to steer the virtual needle. It enables the restriction of needle rotation and transver-

sal movement inside the virtual body. An extended proxy-based haptic volume rendering technique combines information from label- and CT-data to give haptic feedback from segmented and unsegmented fine structures. Besides the 3D visualization of the virtual scene a manifold of assisting 2D and 3D visualizations can be generated to give new insights into the human anatomy and the individual optimal path of the needle. An evaluation system rates the performance of the trainee and gives feedback about failures. The system is now being used in medical education where the first evaluations show a high user-acceptance.

---

**Dhruv Garg**

***A Surgical Simulator for Intra-Corporeal Suturing Utilizing the SPRING Platform***

Intra-corporeal suturing, which is one of the most difficult videoendoscopic manipulations, is not routinely learned by surgical students. The suturing modules in today's commercial simulators often neglect to provide dynamic feedback, consistent scoring metrics, or sufficient realism. Our suturing trainer is built on SPRING, an open-source, cross platform surgical simulator with haptic compatibility. It provides advanced visco-elastic tissue properties, realistic instrument models, real-time object interactions, and useful feedback options, such as audio prompts and workflow diagrams, to facilitate user learning. In addition, personal proficiency evaluations gathered from user actions can be easily analyzed and compared over time with those of experienced surgeons. A unique feature of the trainer is the acquisition of demographic data to support subsequent analysis. The trainer's dynamic feedback and detailed metrics confer potential as a valuable learning and self-assessment tool also useful for surgical training program directors.

---

**Jason Line**

***Mediseus Epidural: Innovative Full Procedure Simulator***

Surgical and medical simulators are being developed for technical skills training and analysis of data for objective evaluation of these skills. While most emphasis is placed on the technology driving simulators, the full potential of simulators as stand-alone trainers is not being used. Users not only need to be able to practice a skill and learn from this experience but they also need to see that skill in the broader context of the full procedure and the patient. Mediseus Epidural, a full-procedure simulator for epidurals, demonstrates how educational theory can be integrated with simulation technology to provide a complete learning experience. It provides users with a multi-faceted learning experience including watching a procedure, learning through text, examples, expert statements, case studies, extension activities, interactive menus, 3D haptic simulation, real-time feedback, performance metrics, summative feedback, formative feedback and suggestions for further learning.

---

**Karsten Noe**

***The Visible Ear Surgery Simulator***

This talk presents a real-time computer simulation of surgical procedures in which a surgeon drills into the temporal bone to gain access to the middle or inner ear. The purpose of this simulator is to support training of drilling skills as well as anatomical insight for both medical students and experienced otologists. The visualization is based on the unique "The Visible Ear" data-set, containing a volume depicting the inner ear in natural colours. We utilize GPU ray casting, allowing high quality and flexible volume rendering using modern graphics card. A range of methods for optimizing the GPU ray casting is presented, along with a method for combining polygon based graphics with volume rendering. In addition, different light models are presented that contribute to a realistic rendering of the different parts of the inner ear. To achieve a physically plausible drilling experience, a Phantom Omni force feedback device is utilized.

---

**Cyle Sprick**

***SimTools - A New Paradigm in High Fidelity Simulation***

Medical simulation typically uses either expensive high fidelity manikins or Standardized Patients. Both have inherent limitations. SimTools bridges the gap between these two extremes by bringing the smarts out of the manikin, and putting them in the tools of the trade. SimTools provides a set of diagnostic tools that can be used on SPs or static manikins and still provide all of the simulated information to the clinician as it is normally gathered. The basic set of SimTools devices includes: Stethoscope - BP Cuff - Glucometer - Thermometer - Pulse Oximeter - ECG Monitor/Defibrillator - Pulse bands - Coaching intercom/Vocal speaker SimTools provides the framework to simulate any sort of clinical device with outputs including sound, video, numerical values, colours etc. The augmented reality arising from use of SimTools combines the high fidelity of expensive manikins with the patient interaction and non-verbal cues realised using standardized patients at much lower cost.

---

**Cyle Sprick**

***Virtual Patient Monitors for New User Familiarization***

Medical staff are faced with a huge variety of equipment - often with complex user interfaces. When people move between locations, or are new to the job, they are expected to know how to use all of the equipment with little formal training. ECG Monitor/Defibrillators can overwhelm new users with their numerous buttons and dials - particularly in an emergency situation. We have developed a web-delivered training package that provides users with a simulated device that they can explore and use as if it were the real device. A tutorial is provided for initial familiarization. This is followed up by a guide to provide hints at different levels. The simulator communicates with a database to provide individualized device selection and tracking of student

progress. This simulator is being trialled at the Flinders University School of Medicine, where students complete their last two years of education at a wide variety of worksites.

---

**Thomas Lendvay**

***VR Robotic Surgery: A Randomized Blinded Pilot Study of the dV-Trainer Robotic Simulator***

This research represents a randomized blinded pilot study to evaluate the acceptability and validity of a da Vinci robotic virtual reality simulator platform tested during a pediatric robotic surgery post-graduate course during the annual American Urological Association meeting in June 2007. Course enrollees performed robotic skills tasks on the da Vinci robot and on an offline dV-Trainer and course participant demographic and performance data were analyzed. The majority of learners believed that VR simulation is useful for teaching robotic skills, they believed that the offline trainer can teach robotic skills comparable to a dry lab robotics skills station, and the offline trainer was able to discriminate between experts and novices of robotic surgery, thereby meeting criteria for face, content, and construct validities. This is the first reported acceptability study of a VR robotic surgery simulator as compared to the da Vinci robot system.

---

**Vasile Nistor**

***Construct Validity for the UCLA Laparoscopic Training System (LTS)***

This is the first study to establish the construct validity of the new Laparoscopic Training Simulator (LTS) developed at UCLA. UCLA-LTS is a modular system consisting of a traditional laparoscopic training box combined with state of the art DC electromagnetic motion tracking system, with the sensors directly integrated into the instruments. These sensors provide real-time tracking of the spatial positions of the instruments, visually represented in a 3-D animated space using computer graphics. A desktop PC collects all the motion sensing data, and provides the visual feedback. We converge on the measured differences for the kinematic performance metrics: time to completion, path length, and acceleration, at the instrument tip, between experienced surgeons and novice trainees, while they perform a set of three different training tasks, previously validated in other studies, “peg transfer”, “rope pass”, “needle cap”. Statistical analysis of the measured data clearly differentiates between the experts and the novice.

---

**Chandrashekhar Sathaye**

***Haptic Guided Laparoscopy Simulation Improves Learning Curve***

Haptic fidelity has been increasingly emphasized in MIS simulators and the real benefits of the simulated environments are mostly under-exploited for MIS Simulation and Training. We discuss the use of augmented forces such as haptic guidance in our laparoscopic simulator for improving learning curve. A simple virtual environment has been designed to simulate advanced MIS tasks such as cutting. A simple haptic guidance system has been implemented to provide a guiding force pulling a novice trainee along the ideal motion path for manipulating the laparoscopic tools. An experiment has been designed to compare the time taken by two groups of participants with and without guidance for the cutting procedure. The results indicate that the haptic guidance has assisted participants in learning of motor skills in its cognitive and associative stage of learning. The participants were all novices and the effect of different modes of haptic guidance is not verified in this experiment. The effect of haptic guidance on experts surgeons is the future scope of this study.

---

**Ravikiran Singapogu**

***Comparative Study of Haptic Training versus Visual Training for Kinesthetic Navigation Tasks***

Kinesthetic motion appears in tasks ranging from minimally invasive surgical procedures to patient rehabilitation. Previous researchers have used different paradigms in comparing the two cognitive modalities. In this work, a comparative study is performed using unique “virtual fixture” based training paradigms for kinesthetic tasks. Subjects are trained to learn a complex 3D path through either the haptic method or the visual method. After the learning period, subjects trace the learned 3D path without any feedback. Performance is evaluated primarily based on deviation and time. Results indicate that haptically trained users have significantly higher performance than visually trained users. Other relevant results are also presented that can have a significant effect in the design of haptics-based interaction systems.

---

**Hyun Soo Woo**

***Improvement of Colonoscopy Skills through Simulation-Based Training***

The objective of this study is to determine whether targeted colonoscopy skills are acquired through simulation-based training using the KAIST-Ewha Colonoscopy Simulator II, and the acquired skills can be transferred to colonoscopy to actual patients. Twelve subjects consisting of six fellows and six residents participated in the study. The fellows and residents were divided into two groups, simulation-trained group and control group. Simulation-based training included practicing the targeted skills of colonoscopy using two training scenarios with different colon flexures and degrees of difficulty. The trainees were requested to practice until they reach all the established training goals. The both groups were evaluated during their colonoscopies to actual patients, which were performed under close supervision of colonoscopy experts. The results of this study show that the developed colonoscopy simulator is effective in teaching the targeted colonoscopy skills, and transferring those skills to actual colonoscopy.

---

**Eric Acosta**

***Collaborative Voxel-Based Surgical Virtual Environments***

Virtual Reality-based surgical simulators are valuable training tools. Although many existing simulators focus on training individuals, supporting collaborative interactions can help establish team-oriented training environments. Collaborative Virtual Environments (C-VEs) enable multiple users to interact within a shared virtual world. To support real-time interactions, many C-VEs replicate the VE on each computer and utilize a method to synchronize all local copies when a change occurs. However, this approach does not work well when modifying voxel-based C-VEs since frequent and large volumetric updates make synchronization difficult. This presentation describes a hybrid depth-buffered image and geometry-based rendering method created to simulate visual interactions between local virtual bone cutting tools and remotely maintained volumetric bone material for a craniotomy simulator being developed. Additionally, methods are described to combat network bandwidth/latency to remotely simulate haptic and bone drilling interactions between tools and the volumetric VE. Our approach provides an improved performance over replicated VEs using 3D model-based updates.

---

**Ehsan Basafa**

***A Prototype Laparoscopic Surgery Simulator Based on Real Soft Tissue Behavior***

In this paper, we propose an extension of the mass-spring models of soft tissues that can show more realistic deformations, while maintaining the real-time response. The model parameters are tuned based on soft tissue experimental results, a process which has received little attention in the literature. A practical method for graphics rendering is used that reduces the amount of effort and code writing with conventional methods. The results have shown to be promising in developing a laparoscopic surgery simulator for educational purposes.

---

**Kup-Sze Choi**

***An Adaptive Transmission Protocol for Managing Dynamic Shared State in Collaborative Surgical Simulation***

Maintaining dynamic shared state is one of the hardest challenges in the collaborative virtual environment (CVE) developers. This requirement is more demanding in collaborative surgical simulator where every event occurred during the procedure should be distributed timely and accurately. In this paper, we present an adaptive transmission protocol to meet this challenge. A hybrid derivative polynomials prediction algorithm is proposed in force prediction to reduce network latencies. Meanwhile, state regeneration is used to correct the estimated prediction. In addition, some auxiliary primitives such as view synchronization and coupling control are provided in this protocol to ensure the system consistency. We implemented this protocol using multi-thread technique and integrated it into a cluster-based network architecture. Experimental results demonstrate this protocol is helpful in maintaining a high level of system consistency for collaborative surgical simulation.

---

**Thomas Lendvay**

***The Biomechanics of Percutaneous Needle Insertion***

Emphasis has been placed on improving patient outcomes in healthcare management. Significant patient morbidity and mortality exists from inappropriate procedural technique and percutaneous catheter needle insertion procedures have been linked to medical complications. Healthcare trainees learn these procedures through trial and error and most existing simulators are synthetic tissue based and lack in-vivo force feedback. We seek to utilize the Blue DRAGON instrument positioning system coupled with a force sensor to determine true forces experienced by a needle as it is passed through animal and human tissues in an effort to design a percutaneous needle insertion simulator that affords the learner with the experience of the true force feedback. Acquiring force displacement measurements of needle insertion is the first step towards development of a computational model of the phenomena. The computational model may be further incorporated into a medical haptic simulator that provides physically based force feedback to the user.

---

**Wen Pei Liu**

***Representing Fluid with Smoothed Particle Hydrodynamics in a Cranial Base Simulator***

We describe the implementation of irrigation and blood simulation using Smoothed Particle Hydrodynamics (SPH) in a cranial base surgical simulator. Graphical accuracy of virtual surgery is a significant goal for improving the realism and immersive experience of computerized training environments. For temporal bone micro-surgery fluids contribute not only to the visual integrity of the surgical field but provide relevant anatomic cues as well. We have successfully integrated an initial SPH system into our virtual surgical environment. Our ongoing efforts include fine-tuning SPH parameters, and adding surface reconstruction for improved efficiency and greater visual realism. Based on this experience, we intend to explore the potential of SPH to represent deformable objects in surgical simulation.

---

**Sarthak Misra**

***Physically Valid Surgical Simulators: Linear Versus Nonlinear Tissue Models***

The development of high-fidelity surgical simulators involves many modeling decisions that contribute to or detract from the physical validity of tool-tissue interactions. This work applies a proposed framework for examining the effect of tool-tissue interaction modeling techniques on human perception of surgical simulators with haptic feedback. Using continuum mechanics theory and experiments, linear and nonlinear elasticity-based models are

quantitatively compared via the palpation of bovine myocardial tissue and Sylgard 527 gel samples. Depending on the tissue, the well-known nonlinear Poynting effect developed during palpation can result in normal forces not seen in a linear elastic model. For myocardial tissue, the difference in force magnitude for linear and nonlinear models is significantly larger than a human's absolute force discrimination threshold.

---

**Ganesh Sankaranarayanan**

***Physics-Based Real Time Laparoscopic Electrosurgery Simulation***

While physics-based modeling of electrosurgical procedures is essential for most laparoscopic simulation systems, we present such a system for the first time in this paper. Electrosurgery cutting, unlike scalpel cutting, actually removes mass of the tissue by vaporization. The amount of tissue to be removed depends on the rate of heat generation and may have different effects on membranous or massive tissues. The contact of the electrode with the tissue results in a rise in temperature in its vicinity. This is a transient process and the rate of temperature rise is dictated by the thermal conductivity of the soft tissue and the coefficient of thermal diffusivity. We have implemented a physics-based model of electrosurgery to control the temperature distribution on the tissue as a function of time. Then, we evaluate the algorithm within a complete graphics-haptics-physics-based system. Excellent performance is achieved allowing force-feedback rendering at a frequency of several kHz.

---

**Ganesh Sankaranarayanan**

***CUDA-Based Real Time Surgery Simulation***

In this paper we present a general software platform that enables real time surgery simulation on the newly available compute unified device architecture (CUDA)from NVIDIA. CUDA-enabled GPUs harness the power of 128 processors which allow data parallel computations. Compared to the previous GPGPU, it is significantly more flexible with a C language interface. We report implementation of both collision detection and consequent deformation computation algorithms. Our test results indicate that the CUDA enables a twenty times speedup for collision detection and about fifteen times speedup for deformation computation on an Intel(R) Core 2 Quad 2.66GHz machine with GeForce 8800 GTX.

---

**Ganesh Sankaranarayanan**

***Novel Virtual Lap-Band" Simulator Could Promote Patient Safety***

This paper presents, for the first time, a physics-based modeling technique for the Lap-band(r) (Inamed Health) used in laparoscopic gastric banding (LAGB) operations for treating the morbidly obese. A virtual LAGB simulator can help train medical students as well as surgeons who embark at learning this relatively new operation. The Lap-band(r) has different thickness and curvature along the centerline, and therefore leads to different deformation behaviors. A hybrid modeling strategy is therefore adopted to successfully replicate its dynamics. A mass-spring model, used to model the less stiff part, is coupled to a quasi-static articulated link model for the more stiff and inextensible part. The virtual Lap-band(r) model has been implemented into a complete graphics-haptics-physics-based system with two PHANToM Omni devices (from Sensible Technologies) being used for real-time bimanual interaction with force feedback.

---

**Mark Scerbo**

***Can Principles of User Interface Design Improve the Next Generation of Medical Simulators?***

Usability engineering is an interface design method used to meet behavioral specifications. "Usability" is decomposed into multiple attributes that can be operationally defined, measured, and incorporated into system design specifications. The usability engineering approach provides a means for development teams to establish and verify measures for the success of an entire system, including user performance. This technique offers several advantages for medical simulators beyond the obvious improvement in simulator system operation. Applying usability concepts to training would require instructors and designers to consider performance criteria in the initial stages of development. Further, emphasis in simulation-based training would shift from "how long does it take trainees to reach performance goals" to "how long should it take them". Moreover, focusing on specific training and performance goals would stimulate developers to consider alternative solutions and new technologies to meet those goals and ultimately, increase their commercial success.

**Yunhe Shen**

***Realistic Soft Tissue Deformation Strategies for Real Time Surgery Simulation***

For the purposes of virtual reality (VR) based surgical training, we are building a virtual abdominal cavity with a hybrid modeling technique that includes using mass-spring structures. Although mass spring modeling has been a popular real-time deformation algorithm, a classic mass-spring model ignores continuum volume or area effects. This compromises the realistic quality of deformation. Among the work in adding volume constraint to mass-spring structure, this paper presents an equilibrium/convergence condition that inspects if such an approach converges at equilibrium state. Accordingly, our volume or area constraint vectors are determined by a circumcenter alignment method for each subdivided element inside the model. Additionally, we have implemented a balloon model for fast simulation of virtual objects containing elastic volume or area. These deformable models simulate not only soft cloth but also stiffer layer objects or elastic volume of human tissues up to force-feedback rendering rates.

---

**Kumar Tamma**

***Challenges and the Path Forward for the Next Generation of Bio-Physical Based Real Time Surgery Simulations with Attention to Laparoscopic Nephrectomy***

Patient information specific bio-physical based real time surgery simulations for residents/students and surgeon's education and training practices before surgery not only have immense learning benefits but also have practical value. This effort focuses attention on challenges and the path forward towards the development of bio-physical based real time surgery simulations with particular attention to laparoscopic nephrectomy. To achieve realism with real time computations poses significant technical challenges to include careful considerations as related to geometric modeling and mesh generation, numerical selection and treatment of the space discretization process, design of time integrators with adaptive time step features to enable real time computations of the dynamic equations of motion, accurate material modeling of human soft tissues and organs and the like, realism of surgical procedures associated with surgical instruments with tissues and organs and modeling of damage with contact detection, collision and response, and integration with graphic visualization.

---

**Xiangmin Zhou**

***The Family of Optimal Time Integration Algorithms for Real Time Virtual Surgery Simulations with Application to Virtual Nephrectomy***

The bottle neck in the development of the real time virtual surgery simulations is the battle between preserving high physical accuracy and lowering the computational effort with respect to the mathematical discrete model fidelity together with the complexity of the material models and boundary conditions. Computationally, for a well-posed dynamic problem with given spatial discretization, the accuracy of the real time results are proportional to the amount of computational effort primarily due to the time integration algorithms for the dynamic equations of motion. The existing state-of-the-art time integration algorithms for computational mechanics are not ideally suitable for applications in real time virtual surgery simulation which requires direct self-starting and time step adaptive features. The objectives of present study are to design a next generation, practical and optimal family of numerical time integration algorithms for real time virtual surgery simulations, and demonstrate the application of the developments for virtual nephrectomy simulations.

---

**Eran Schenker**

***Mobile Life Support for Trauma and Transport (MLSTAT)***

The Mobile Life Support for Trauma and Transport (MLSTAT) system designed to incorporating the latest innovated telemedicine technologies, newly wireless medical sensors, RFID capabilities and "lessons learned" from the most recent military action at the second Lebanon war in 2006. The MLSTAT is in a way the next generation of the Life Support for Trauma and Transport (LSTAT) and the DARPA Trauma Pod. With the collaboration of technologies from research and universities groups with the leading medical device industries partners the autonomously Mobile Medical Monitoring system integrates a telemonitoring and intervention capabilities. The wireless miniature near filed communication (NFC) system embedded in a small band package with the ability to transmit location, vital sign information such as body temperature, heart rate and respiratory rate, as well as other critical data immediately and effortlessly to medics unit and directly to the physician "on-call" seating at a remote consul. In the future the MSTAT Mobility Platform - May give the MLSTAT self autonomously moving capabilities.

---

**Rob Aspin**

***Interactive 3D Volumetric Visualisation of Soft Tissue Injuries***

This presentation will present the background domain for the research; describing the problem of understanding and communicating the 3D nature of Superior Labrum Anterior to Posterior (SLAP) tears within the shoulder joint. In particular this will describe the issues of segmenting and surfacing soft tissue imagery captured by MRI Shoulder Arthrogram. The middle stage of the presentation will describe the technical domain activities, both as a research narrative, from the initial aim of producing 3D physical printouts of to the realisation that 3D interactive visualisation would be more appropriate and effective, and as a scientific challenge describing the creation of appropriate volume modelling and visualisation techniques and determination of the appropriate display platform. The final stages of our presentation will discuss the evaluation of the prototype system, by practicing medical practitioners, and explore the future directions of the work.

---

**Collin Brack**

***Evaluating the Clinical Utility of Stereoscopic Images Acquired During Clinical Examinations***

Affordable, high-quality digital SLRs (dSLRs) have given physicians a broad range of choices for examination room imaging. The advantage of the dSLRs is that they allow for interchangeable lenses. Determining which scenarios call for a specialty lens should be a mix of both qualitative and quantitative analysis as well as the case's potential educational benefit for academic settings. Our results will help determine if stereoscopic image acquisition deserves to be included in the dSLR lens selection process. We have removed many of the barriers that prevent clinics from incorporating three-dimensional viewing in their practices which include a lack of EMR support, steep learning curve, expensive hardware, and the ability to view 3D images from an unsupported software system. We assess and compare the preferences and impression of the clinical utility of these two different image lenses among 12 physicians in varying specialties.

---

**Alessandro De Mauro**

***Improvement of the Concept for an Augmented Reality Neurosurgical Microscope***

In neurosurgical operating theater actually almost all interventions are carried out using a microscope. All the best commercial systems provide the surgeon with only a real twodimensional, overlay of the region of interest (ex. tumor) inside the oculars of the operating microscope related on the preoperative processed patients image data. The threedimensional environment reconstruction from 2D is another difficult and critical mental work for the surgeon. In this paper we describe how we are improving a prototype of an augmented reality stereoscopic microscope for neurosurgical interventions developed in our institute optimizing and completing the information set visible for the surgeons needs. The goal is to enhance the surgeon ability for a better intraoperative orientation by giving him the threedimensional view, and other information he needs for a safe navigation inside the patients.

---

**Jung Leng Foo**

***A Framework for Interactive Examination of Automatic Segmented Tumors in a Virtual Environment***

This paper presents the development of an immersive virtual environment for viewing and interacting with three-dimensional volumes of medical image data. Real time interaction is established using joystick movements and button presses on a wireless gamepad. Several open-source platforms have been utilized, such as DCMTK for processing of DICOM formatted data, Coin3D for scenegraph management, SimVoleon for volume rendering, and VRJuggler to handle the immersive visualization. The application allows the user to manipulate representation with features such as fast pseudo-coloring using Color Look-Up Tables to highlight details of the patient data, windowing to select a range of tissue densities for display, and multiple clipping planes to allow the user to slice into the patient data to view a selected region of interest. Using an automatic segmentation method developed by the authors, a segmented object (e.g., tumor or organ) can also be viewed in the context of the original patient data.

---

**C. William Hanson**

***Neurofuzzy Derived Topographies of Cardiac Performance***

Intensive care patient data is typically transcribed by nurses from bedside physiologic monitors into a paper record using a variety of unit-specific, non-standard formats. Electronic medical records have recently become available. Lab and physiologic information is transcribed automatically into these records, freeing clinicians from this laborious process. While these systems clearly represent an advance of some sort, they do little to enhance the analytic performance of clinicians, who are forced to take the tabular data and construct a mental model or visualization of the data to understand temporal trends and relevant interrelationships among the data. Data visualization is used in other rapidly changing, data-rich environments such as flight traffic control and stock-market analysis, and takes the form of 3D representations, visual metaphors, charts, graphs, dashboards etc to present complicated data "at a glance." We present a neurofuzzy-derived topographic visualization of cardiac performance.

---

**Karsten Noe**

***A Framework for Shape Matching in Deformable Image Registration***

Many current deformable image registration methods have difficulty in correctly describing rotation and bending of shapes. In this talk we present a particle based framework for shape registration that supports multiple interacting bodies to be registered simultaneously using one of multiple motion models for each body. The registration is driven by minimization of a novel similarity metric based on Euclidian distance fields. The presentation of our framework is followed by examples of the results attainable by combining our driving force model with a deformable body motion model.

---