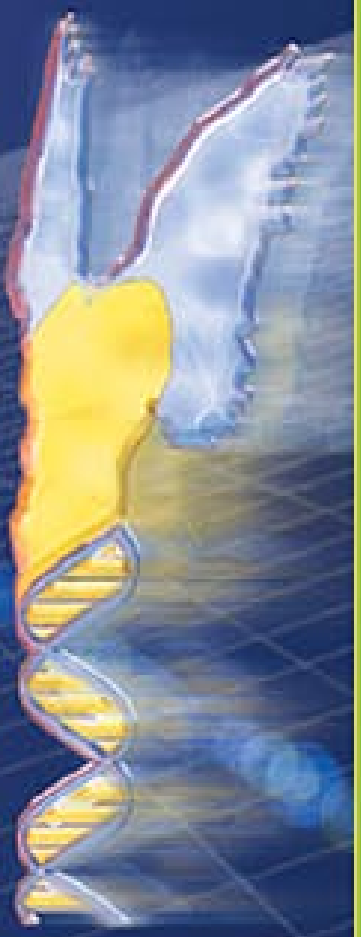
MMVR14

MEDICINE MEETS VIRTUAL REALITY 14

Accelerating Change in Healthcare: Next Medical Toolkit



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DARPA www.darpa.mil/dso

METI www.meti.com

ASF www.accelerating.org

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Organizer

Aligned Management Associates, Inc.
www.amainc.com

www.nextmed.com/mmvr_virtual_reality.html
MMVR14 @ NextMed.com

MMVR turns vision into policy.™

JANUARY 24 – 27, 2006

THE HYATT REGENCY LONG BEACH
LONG BEACH, CALIFORNIA

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The Virtual Reality Medical Center

*** Abstract Review Committee member**

Conference Information

WELCOME

Welcome to the **14th Annual Medicine Meets Virtual Reality** conference. This year's program, with approximately 275 presentations, represents incalculable hours of creativity and hard work by presenters and their colleagues. We are pleased to bring all this discovery and experience together, from around the world, for four days of lectures, posters, panels, exhibits, and discussion.

Accelerating Change in Healthcare: Next Medical Toolkit. With this year's theme, we encourage awareness of increasing technological change and its effect on medicine. While futurists may predict, following Moore's Law, a complete integration of the human life with data-centered technologies, the future of medical care and education is far from clear. However, you here — participants in a global medical economy of scientific discovery, business and academic competition, and socio-political pressures— have the opportunity to shape medicine's future according to your own vision.

Thank you for being part of MMVR.

COURSE DESCRIPTION & OBJECTIVES

MMVR14 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 general sessions, seven half-day parallel sessions, two poster sessions, nine specially organized workshop/panel activities, exhibits and exhibitor reception, and one adjunct full-day program.

Presentations are chosen with the objective of educating participants on:

- State-of-the-art for biomedical simulation and its enabling technologies, modeling and haptics
- Emerging tools for clinical diagnosis and therapy—imaging tools, data visualization and fusion techniques, and robotics
- Intelligence networks for medical decision-making and patient care

TARGET AUDIENCE

MMVR14 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 gathering, 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 want to understand where medicine is headed

ACKNOWLEDGMENTS

The conference organizers wish to thank our colleagues at TATRC/USAMRC for their ongoing participation in this conference. MMVR participants benefit from TATRC's interest, enthusiasm, and support for innovation in advanced biomedical technology.

Similarly, we thank our DARPA colleagues for contributing leading-edge research to the MMVR educational curriculum.

We thank Medical Education Technologies, Inc. (METI) for another year of generously sponsoring the Satava Award.

We are grateful to the Organizing Committee for its continuing encouragement and guidance. We especially thank committee members who review abstracts and thus contribute an extra portion of energy and critical judgment to MMVR. We give additional thanks to the Proceedings editors for giving us their time and expertise.

Finally, we sincerely thank all the researchers who present their work here. They make MMVR possible.

EVALUATION

We welcome the input of all conference participants. Please complete your conference evaluation before you leave. We carefully take note of your criticism and suggestions when we create next year's program. Please take a few minutes to write down your reactions, negative and positive, to this year's conference.

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 assume responsibility for any decision made or action taken as a result of the information provided through this activity.

ORGANIZER CONTACT INFO

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THE SATAVA AWARD

The 12th annual Satava Award will be presented at MMVR14. 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:

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)

Medical Education Technologies, Inc. (www.meti.com) is sponsoring the 12th annual Satava Award with a prize of $2500.

Presentation Schedule

Tuesday, January 24, 2006

ALL DAY

TATRC'S 6TH ANNUAL ADVANCED MEDICAL TECHNOLOGY REVIEW

"Enabling Technologies for Simulation: Impact and Influence on Medical Training and Education"

Organized by the Telemedicine & Advanced Technology Research Center (TATRC), US Army Medical Research & Materiel Command.

[Please see the separate TATRC agenda for presentation details.]

TUESDAY AFTERNOON

DARPA SEEDLINGS / SBIRs

Organizer:
Richard M. Satava MD FACS and the DARPA Defense Sciences Office

[Please see Special Activity Summaries for session overview.]

1:00 Richard M. Satava MD FACS
Surgery, Univ of Washington; DARPA; TATRC/USAMRMC [US]
Welcome & Introduction

1:20 Jodie L. Conyers PhD
Univ of Texas Health Science Center at Houston [US]
FRAMR

1:40 Lilianne R. Mujica-Parodi PhD
SUNY Stony Brook [US]
Alarm Pheremone

2:00 John S. Maier PhD MD
Biomedical Application Science, ChemImage Corp [US]
Digitizing Biology

2:20 Jeffrey J. Berkley PhD
Mimic Technologies, Inc. [US]
Robot Suturing

2:40 Break

3:00 Gary Friedman PhD
Electrical & Computer Engineering, Drexel Univ [US]
Plasma Discharge

3:20 Thomas L. Ferrell PhD
Physics, Univ of Tennessee [US] &
François G. Pin PhD
Oak Ridge National Laboratory [US]
IntelliCath

3:40 Jack Scully MBA
Ascension Technology Corporation [US]
Miniaturized 6D Position Locator for Medical Imaging

4:00 Naresh Menon PhD
Physical Optics Corporation [US]
Smart Hyperspectral Imaging Laser Scalpel

4:20 Ross W. Bird BSEE
QorTek [US]
Computer Integrated Dynamic Scalpel

4:40 Wrap-Up

5:00 Adjourn

Wednesday, January 25

WEDNESDAY MORNING

GENERAL SESSION

Moderator:
Richard M. Satava MD FACS

8:00 James D. Westwood & Karen S. Morgan
Conference Organizers, Aligned Management Associates, Inc.
Welcome & Introduction

8:05 *Featured Speaker:*
Anthony Atala MD
The W. Boyce Professor and Director, Wake Forest Inst for Regenerative Medicine, Wake Forest Univ School of Medicine [US]
Regenerative Medicine: New Approaches to Health Care

8:35 George Berci MD FACS FRCS Ed (Hon.)
Surgery, Cedars-Sinai Medical Ctr [US]
The Impact of Video Technique in Anesthesia

8:50 Gabor Fichtinger PhD
Computer Science, Mechanical Engineering & Radiology, Johns Hopkins Univ [US]
Image Overlay Guidance for MRI Arthrography Needle Insertion

9:05 Nigel W. John PhD
Sch of Informatics, Univ of Wales, Bangor [UK]
A Flexible Infrastructure for Delivering Augmented Reality Enabled Transcranial Magnetic Stimulation

9:20 Lawrence Kulinsky PhD
BioMEMs Research Group, Univ of California, Irvine [US]
Catheter-Guided Drug Delivery System - A New Generation of Biomedical Micro-Devices

9:35 James A. Bacon MS
Energid Technologies [US]
The Surgical Simulation and Training Markup Language (SSTML): An XML-Based Language for Medical Simulation

9:50 Minho Kim MS
CISE, Univ of Florida [US]
Exploiting Graphics Hardware for Haptic Authoring

10:05 Mark Bowyer MD FACS
National Capital Area Medical Simulation Ctr, Uniformed Services Univ [US]
AIMS Update on Simulation Funding

10:20 Break [Extended]

GENERAL SESSION *continued*

THE INNOVATION CENTER COMPUTER ASSISTED SURGERY (ICCAS)
Leipzig, Germany

Session Chairs:
Juergen Meixensberger MD & Andreas Dietz MD

[Please see Special Activity Summaries for session overview.]

11:00 Jürgen Meixensberger MD
ICCAS/Neurosurgery, Univ of Leipzig [DE] &
Heinz U. Lemke PhD
Inst for Technical Informatics, Technical Univ Berlin [DE]
ICCAS - A New Interdisciplinary Research Setting for CAS

11:15 Oliver Burgert PhD
ICCAS, Univ of Leipzig [DE]
Surgical Workflow Modeling

11:30 Werner Korb PhD
ICCAS, Univ of Leipzig [DE]
Surgical PACS for the Digital Operating Room

11:45 Discussion

12:00 Adjourn

WEDNESDAY AFTERNOON

SESSION A

EDUCATION & SIMULATION

Moderator:
Helene M. Hoffman PhD

1:25 Moderator's Welcome

1:30 Jonathan C. Silverstein MD
Surgery, Univ of Chicago [US]
Web-Based Viewer for Systematic Combination of Anatomy and Nomenclature

1:45 Brittany S. Hampton MD & John Qualter
Obstetrics & Gynecology, Div of Reconstructive Pelvic Surgery & Urogynecology, New York Univ Hospital [US]
Construction of a Web-Based Virtual Pelvis Trainer

2:00 Mark Bowyer MD FACS
National Capital Area Medical Simulation Ctr, Uniformed Services Univ [US]
Combining High Fidelity Patient Simulation with a Standardized Family Member: A Novel Mixed Reality Approach to Teaching Breaking Bad News

2:15 Matt Kaufman MS
Forterra Systems, Inc. [US]
Team Training of Medical First Responders for CBRNE Events Using Multiplayer Game Technology

2:30 N. Ty Smith MD
Anesthesia, Univ California, San Diego (Retired) [US]
Worst-Case Scenario:
Battlefield Injury/Can't Intubate

2:45 Victor M. Vergara MS
Electrical & Computer Engineering, Univ of New Mexico [US]
Flatland Sound Services Design Supports Virtual Medical Training Simulations

3:00 Panaiotis PhD
Electrical & Computer Engineering / Music, Univ of New Mexico [US]
Using Algorithmically Generated Music to Enhance VR Nephron Simulation

3:15 Break

Moderator:
Ajit K. Sachdeva MD FRCSC FACS

3:30 Robert F. Dickerson BS
Computer & Information Science/Engineering, Univ of Florida [US]
Virtual Patients: Assessment of Synthesized Versus Pre-Recorded Speech

3:45 Frederic D. McKenzie PhD
Electrical & Computer Engineering, Old Dominion Univ [US]
Medical Student Evaluation Using Augmented Standardized Patients: Preliminary Results

4:00 Charisse Corsbie-Massay MA
Critical Studies, USC Sch of Cinema Television [US]
Surgical Multimedia Academic, Research and Training (S.M.A.R.T.) Tool: A Comparative Analysis of Cognitive Efficiency for Two Multimedia Learning Interfaces

4:15 Dale C. Alverson MD
Ctr for Telehealth & Cybermedicine Research, Univ of New Mexico [US]
Reification of Abstract Concepts to Improve Comprehension Using Interactive Virtual Environments and a Knowledge-Based Design: A Renal Physiology Model

4:30 Karl D. Reinig PhD
Ctr for Human Simulation, Univ of Colorado [US]
Creating and Displaying Virtual Trauma in Models Derived from the Visible Human

4:45 Pheng-Ann Heng PhD
Computer Science & Engineering, Chinese Univ of Hong Kong [HK]
Virtual Acupuncture Human Based on Chinese Visible Human Dataset

5:00 Discussion

5:15 Adjourn

WEDNESDAY AFTERNOON

SESSION B

MODELING

Moderator:
Michael J. Ackerman PhD

1:25 Moderator's Welcome

1:30 Roy Kerckhoffs PhD
Bioengineering, Univ of California, San Diego [US]
From Myocyte to Torso: Spatially and Temporally Multi-Scale Simulation of Cardiac Injury

1:45 Martin Berzins PhD
SCI Inst, Univ of Utah [US]
Ballistic Injury Simulation Using the Material Point Method

2:00 Michel A. Audette PhD
Surgical Assist Group, AIST [JP]
A Topologically Faithful, Tissue-Guided, Spatially Varying Meshing Strategy for the Computation of Patient-Specific Head Models for Endoscopic Pituitary Surgery Simulation

2:15 Timothy P. Kelliher
Imaging Technologies, GE Global Research [US]
Computer-Aided Forensics: Facial Reconstruction

2:30 Xunlei Wu PhD
Simulation Group, Massachusetts General Hospital [US]
Smooth Vasculature Reconstruction from Patient Volume Data

2:45 Denis Laroche MASc
National Research Council Canada [CA]
Computer Prediction of Balloon Angioplasty from Artery Imaging

3:00 Balakrishna Haridas PhD
Biomedical Engineering, Colleges of Medicine & Engineering, Univ of Cincinnati [US]
PelvicSim - A Computational-Experimental System for Biomechanical Evaluation of Female Pelvic Floor Organ Disorders and Associated Minimally Invasive Interventions

3:15 Break

Moderator:
Steven Senger PhD

3:30 Doo Yong Lee PhD
Mechanical Engineering, Korea Advanced Inst of Science & Technology [KR]
Centerline-Based Parametric Model of Colon for Colonoscopy Simulator

3:45 Bruce M. Cameron MS
Biomedical Imaging Resource, Mayo Clinic College of Medicine [US]
Tissue Engineering Templates Using Minimal Surfaces

4:00 Ron Alterovitz PhD (Cand)
Industrial Engineering and Operations Research, Univ of California Berkeley [US]
Geometric Nonlinearity: Is it Important for Real-Time FEM Surgical Simulation?

4:15 Venkat Devarajan PhD
Electrical Engineering /Bio-Med, Univ of Texas at Arlington [US]
Selective Tessellation Algorithm for Modeling Interactions Between Surgical Instruments and Tissues / Physically Accurate Mesh Simulation in a Laparoscopic Hernia Surgery Simulator

4:30 Yogendra Bhasin MSEE
National Capital Area Medical Simulation Ctr, Uniformed Services Univ [US]
Bounds for Damping that Guarantee Stability in Mass-Spring Systems

4:45 Bryan C. Lee PhD (Cand)
BioMedIA Lab, CSIRO ICT Ctr [AU]
Efficient Topology Modification and Deformation for Finite Element Models Using Condensation

5:00 Discussion

5:15 Adjourn

WEDNESDAY AFTERNOON

SESSION C

Workshop:

PATIENT SAFETY AND MEDICAL SIMULATION: ISSUES, CHALLENGES AND OPPORTUNITIES

Organizers:
Alan Liu PhD and Mark Bowyer MD FACS
National Capital Area Medical Simulation Center

[Please see Special Activity Summaries for session overview.]

1:25 Alan Liu PhD
National Capital Area Medical Simulation Ctr, Uniformed Services Univ [US]
Introduction

1:35 Heidi King MS
Dept of Defense Patient Safety Program, TRICARE Management Activity [US]
A Patient Safety Primer

1:55 Mark Bowyer MD FACS
National Capital Area Medical Simulation Ctr, Uniformed Services Univ [US]
A Clinician's Perspective

2:15 Mark W. Scerbo PhD
Psychology, Old Dominion Univ [US]
Human Factors Issues in Patient Safety

2:55 Heidi King MS
Dept of Defense Patient Safety Program, TRICARE Management Activity [US]
DoD Patient Safety Initiatives

3:15 Break

3:30 Mark Bowyer MD FACS
National Capital Area Medical Simulation Ctr, Uniformed Services Univ [US]
SimCen Initiative: Fundamentals of Laparoscopic Surgery

3:50 Alan Liu PhD
National Capital Area Medical Simulation Ctr, Uniformed Services Univ [US]
SimCen Initiative: The Wide Area Virtual Environment

4:10 Conclusion & Open Forum

5:00 Adjourn

WEDNESDAY EVENING

POSTER SESSION – GROUP 1

5:15 – 6:15 PM

EDUCATION

Corinne E. Collier BSc
Creative Technologies, Univ of Portsmouth [UK]
The Effect of Virtual Immersive Scenarios in High Human Cost Task Based Learning

Judith E. Grunwald PhD
Speech Communication Studies, Iona College [US]
The Application of Virtual Reality in the Healthcare Communication Interaction

Claudia L. Johnston PhD
Special Projects, Texas A&M Univ - Corpus Christi [US]
Pulse!! - A Virtual Learning Space Project

Eric Savitsky MD
Emergency Medicine, Univ of California, Los Angeles Medical Ctr [US]
Natural Progression: Multimodal Education and Procedural Training

Tom Szeless
SIMmersion LLC [US]
Interactive Simulation Training: Computer Simulated Standardized Patients for Medical Diagnosis

MENTAL HEALTH

Cheryl A. Bolstad PhD
SA Technologies [US]
Medical Cognitive Readiness: From Theory to Practice

José Luis Mosso MD
Surgical/Endoscopy Depts, National Medical Ctr la Raza IMSS; Clínica-Hospital A. Pisanty ISSSTE [MX]
Pain Reduction with Entertainment Game in Upper Gastrointestinal Endoscopies, Extensive Injuries Treatments in Infected Soft Tissues, and Cervical Conization with Diathermy Loop

Giuseppe Riva PhD
Applied Technology for Neuro-Psychology Lab, Istituto Auxologico Italiano [IT]
Stress Treatment Using UMTS Cellular Phones: A Controlled Trial

Morris Steffin MD
VRNEUROTECH [US]
Avionics-Compatible Video Facial Cognizer for Detection of Pilot Incapacitation

Robert M. Sweet MD
Urologic Surgery, Univ of Minnesota [US]
Virtual Reality as an Adjunctive Pain Control During Transurethral Microwave Thermotherapy

MODELING

Fernando Bello PhD
Surgical Oncology & Technology, Imperial College London [UK]
Simulating Tele-Manipulator Controlled Tool-Tissue Interactions Using a Nonlinear FEM Deformable Model

Pei Chen PhD
Electrical & Computer Engineering, Univ of Delaware [DE]
A Mass-Spring Deformable Surface Model for Soft Tissue Simulation with Haptic Feedback

Clément Forest PhD
IRCAD [FR]
Breath Modeling, Application to Ultrasound Simulation

Balakrishna Haridas PhD
Biomedical Engineering, Colleges of Medicine & Engineering, Univ of Cincinnati [US]
A New Experimental Methodology for In Vivo Measurement of Elastic and Viscoelastic Properties of Pelvic Floor Organs/Tissues

Don Hilbelink PhD
College of Medicine, Dept Anatomy, Univ of South Florida [US]
Wavelet Analysis of Heart Geometry for Morphological Modeling

T. "Kesh" Kesavadas PhD
Mechanical & Aerospace Engineering, State Univ of New York at Buffalo [US]
Parametric Patient Specific Modeling and Simulation of Trocar Insertion Using Reduced Basis Method

Sebastian König Dipl-Inf
Inst for Computational Medicine, Univ of Mannheim/ Univ Heidelberg [DE]
3D Live-Wires on Mosaic Volumes

Alex J. Lindblad MSCE
Human Interface Technology Lab, Univ of Washington [US]
Real-Time Finite Element Based Virtual Tissue Cutting

Qiang Liu PhD (Cand)
Sch of Computer Engineering, Nanyang Technological Univ, Singapore [SG]
Flat Maps: A Multi-Layer Parameterization for Surgery Simulation

Maud Marchal PhD (Cand)
TIMC-GMCAO Lab [FR]
A Discrete Soft Tissue Model for Simulating Complex Anatomical Environments

Maxwell L. Neal BS
Bioengineering, Univ of Washington [US]
Hemodynamics of Hemorrhage Simulated with an Open-Loop Cardiopulmonary Model

Rajni Patel PhD
Electrical & Computer Engineering, Univ of Western Ontario [CA]
Rendering of Virtual Fixture for MIS Using Generalized Sigmoid Functions

Yingge Qu PhD (Cand)
Computer Science & Engineering, Chinese Univ of Hong Kong [HK]
Semi-Automatic Segmentation and Marking of CVH Data

Sascha Seifert Dipl-Inform
Inst of Computer Science & Engineering, Univ Karlsruhe (TH) [DE]
Soft Tissue Modeling Forum

Yuzhong Shen PhD
Virginia Modeling, Analysis, & Simulation Ctr, Old Dominion Univ [US]
Realistic Irrigation Visualization in a Surgical Wound Debridement Simulator

Ofek Shilon MSc
Simbionix Ltd [IL]
Simulating Bending Behaviour of Suturing Thread and Needle

Michael Stoettinger Dipl-Ing
Medical Informatics, Upper Austrian Research [AT]
An Approach for Anthropometrically Correct 3D Adaptation of Human Body Models

SURGICAL SIMULATION

Christoph Aschwanden PhD (Cand)
John A. Burns Sch of Medicine, Univ of Hawaii at Manoa, Telehealth Research Inst [US]
A Surgical and Fine-Motor Skills Trainer for Everyone? Touch and Force-Feedback in a Virtual Reality Environment for Surgical Training

Ifesegun D. Ayodeji MD
General Surgery, Maxima Medical Ctr [NL]
Determination of Face Validity for the Simbionix Lap Mentor Virtual Reality Training Module

Lee A. Belfore II PhD
Electrical & Computer Engineering, Old Dominion Univ [US]
A Software Framework for Surgical Simulation Virtual Environments

Allen Burnett PhD
Learning Technologies, MountainTop Technologies, Inc. [US]
Virtual Medical Simulation Training for Nerve Block Anesthesiology

M. Cenk Cavusoglu PhD
Electrical Engineering & Computer Science, Case Western Reserve Univ [US]
Evaluation Methods of a Middleware for Networked Surgical Simulations

M. Cenk Cavusoglu PhD
Electrical Engineering & Computer Science, Case Western Reserve Univ [US]
Virtual Environment-Based Training Simulator for Endoscopic Third Ventriculostomy

George Chami MD
Computer Science, Univ of Hull [UK]
Factors Affecting Targeting Using the Computer Assisted Orthopaedic Surgery System (CAOSS)

Chee-Kong Chui PhD
Mechanical Engineering, National Univ of Singapore [SG]
Integrative Haptic and Visual Interaction for Simulation of PMMA Injection During Vertebroplasty

Raymond Glassenberg MD
Anesthesiology, Northwestern Univ, Feinberg Sch of Medicine [US]
Virtual Epidural

Reidar Källström MD
Biomedicine & Surgery, Univ of Linköping [SE]
Development and Evaluation of a Novel Real-Time Simulation Model with Haptic Feedback for Training Transurethral Prostatic Surgery

José Luis Mosso MD
Surgical/Endoscopy Depts, National Medical Ctr la Raza IMSS; Clínica-Hospital A. Pisanty ISSSTE [MX]
Towards a Simulator of the Upper Gastrointestinal System

Rajni Patel PhD
Electrical & Computer Engineering, Univ of Western Ontario [CA]
A Haptics Based Simulator for Laparoscopic Pyeloplasty

Daniel C. Shang BASc
Kinesiology, Univ of Waterloo [CA]
Modeling of a Laparoscopic Needle Driver: Implication for the Design of Virtual Reality Simulators

Mark Smith MD PhD
Medical Informatics & Advanced Laparoscopy, Banner Good Samaritan Medical Ctr, Phoenix [US]
Gesture Based Hand Movement Analysis and Haptic Feedback for Surgical Training

6:15 – 7:30 PM
EXHIBITOR RECEPTION

Thursday, January 26

THURSDAY MORNING

SESSION A

SURGICAL SIMULATION: DEVELOPMENT TOOLS – DESIGN ISSUES

Moderator:
Randy S. Haluck MD FACS

7:55 Moderator's Welcome

8:00 Alan Liu PhD
National Capital Area Medical Simulation Ctr, Uniformed Services Univ [US]
The Design and Implementation of a Pulmonary Artery Catheterization Simulator

8:15 Kevin N. Montgomery PhD
National Biocomputation Ctr, Stanford Univ
Project Hydra - A New Paradigm of Internet-Based Surgical Simulation

8:30 Johanna Pettersson PhD (Cand)
Biomedical Engingeering, Univ Linköping [SE]
A Hip Surgery Simulator Based on Patient Specific Models Generated by Automatic Segmentation

8:45 John Hu PhD
Medical Robots & Systems, Energid Technologies [US]
Effectiveness of Haptic Feedback in Open Surgery Simulation and Training System

9:00 George Chami MD
Computer Science, Univ of Hull [UK]
Smart Tool for Force Measurements During Knee Arthroscopy: In Vivo Human Study

9:15 Julien Lenoir PhD
Simulation Group, CIMIT [US]
Interactive Physically-Based Simulation of Catheter and Guidewire

9:30 Oliver Tonet PhD
CRIM Lab, Scuola Superiore Sant'Anna [IT]
Tracking Endoscopic Instruments without Localizers: Image Analysis-Based Approach

9:45 Discussion

10:00 Break

Moderator:
Kevin N. Montgomery PhD

10:15 Magnus G. Eriksson PhD (Cand)
Mechatronics Lab/Machine Design, Royal Inst of Technology [SE]
A Virtual Reality and Haptic Milling Surgery Simulator - Use High-Resolution Volume Data

10:30 Daniel Bachofen
Inst for Applied Information Technology, ZHW [CH]
Enhancing the Visual Realism of Hysteroscopy Simulation

10:45 Pablo Lamata MSc
Bioingeniería y Telemedicina, Polytechnic Univ of Madrid [ES]
Virtual Reality Thread Simulation for Laparoscopic Suturing Training

11:00 Pablo Lamata MSc
Bioingeniería y Telemedicina, Polytechnic Univ of Madrid [ES]
Study of Laparoscopic Forces Perception for Defining Simulation Fidelity

11:15 Fernando Bello PhD
Surgical Oncology & Technology, Imperial College London [UK]
The Use of a GripForce System to Map Force Distribution Patterns of Laparoscopic Instruments

11:30 Anton J.B. Sanders MSc
Kunst & van Leerdam Medical Technology bv [NL]
Validation of Open-Surgery VR Trainer

11:45 Discussion

12:00 Adjourn

THURSDAY MORNING

SESSION B

INFORMATION-GUIDED THERAPIES

Moderator:
Richard A. Robb PhD

7:55 Moderator's Welcome

8:00 Kirby G. Vosburgh PhD
CIMIT; Brigham & Women's Hospital; Harvard Medical Sch [US]
Tracking Instruments and Probes in the Body: Current and Future Opportunities

8:15 Mathias Hofer MD
Innovation Ctr Computer Assisted Surgery (ICCAS), Univ of Leipzig [DE]
Establishing Navigated Control in Head Surgery

8:30 Maryam E. Rettmann PhD
Biomedical Imaging Resource, Mayo Clinic College of Medicine [US]
An Integrated System for Real-Time Image Guided Cardiac Catheter Ablation

8:45 Michael N. D'Ambra MD
Div of Cardiac Anesthesiology, Brigham & Women's Hospital [US]
Image Guided Cannulation of Central Veins Using Real-Time Machine-Vision Analysis and Live Image Fusion - A Precursor to Fully Automated Motion Control

9:00 Simon P. DiMaio PhD
Surgical Planning Lab, Dept Radiology, Brigham & Women's Hospital, Harvard Medical Sch [US]
Needle Artifact Localization in 3T MR Images

9:15 Yoshito Otake MS
Inst for High Dimensional Medical Imaging, Jikei Univ Sch of Medicine [JP]
Evaluation of Soft Tissue-Generated Forces by Intraoperative Contact Pressure Measurement of the Hip Joint-Supportive Structures During Total Hip Arthroplasty

9:30 Kevin F. Fitzpatrick MD
Orthopaedics & Rehabilitation, Walter Reed Army Medical Ctr [US]
The Use of CT-based 3D Model Construction to Aid in Resection of Heterotopic Ossification after Traumatic Transfemoral Amputation: A Case Series

9:45 Emily M. Monahan MS
Mechanical Engineering, Carnegie Mellon Univ [US]
Computer-Aided Navigation for Arthroscopic Hip Surgery Using Encoder Linkages for Position Tracking

10:00 Break

ROBOTICS

Moderator:
Steve Charles MD

10:15 Henry C. Lin PhD (Cand)
Computer Science, Johns Hopkins Univ [US]
Vision-Assisted Automatic Detection and Segmentation of Robot-Assisted Surgical Motions

10:30 Mitchell J.H. Lum MSEE
Electrical Engineering, Univ of Washington [US]
Dynamic Analysis of a Spherical Mechanism for a Minimally Invasive Surgical (MIS) Robot - Design Concepts for Multiple Optimizations

10:45 Lars Matthaeus Dipl. Math. techn.
Inst for Robotics & Conitive Systems, Univ of Luebeck [DE]
Planning and Analyzing Robotized TMS Using Virtual Reality

11:00 Christopher C. Enedah PhD (Cand)
Mechanical Engineering, Stanford Univ [US]
Robotic Perception of Mechanical Properties of the Human Skin: A Validation Study

11:15 Simon P. DiMaio PhD
Surgical Planning Lab, Dept Radiology, Brigham & Women's Hospital, Harvard Medical Sch [US]
Robot-Assisted Needle Placement in Open-MRI: System Architecture, Integration and Validation

11:30 Mark E. Rentschler MS
Mechanical Engineering, Univ of Nebraska [US]
Mobile In Vivo Biopsy and Camera Robot

11:45 Discussion

12:00 Adjourn

THURSDAY MORNING

SESSION C

Workshop/Panel
ADVANCES IN MEDICAL TECHNOLOGIES: ROBOTICS & SIMULATION

Organizer:
Gerald R. Moses PhD
TATRC/USAMRMC

[Please see Special Activity Summaries for session overview.]

8:00 Gerald R. Moses PhD
TATRC/USAMRMC [US]
Moderator's Welcome

ADVANCES IN ROBOTICS

8:10 Timothy J. Broderick MD
Univ of Cincinnati [US]
Robotic Surgery: A Surgeon's View

8:30 Blake Hannaford PhD
Bio Robotics Lab, University of Washington [US]
Robotic Surgery: An Engineer's View

8:50 Mehran Anvari MBBS PhD
McMaster Univ [CA]
Telesurgery

9:10 Charles P. Steiner MS
Cleveland Clinic Foundation [US]
Image Guided Surgery

ADVANCES IN ENABLING TECHNOLOGIES FOR SURGERY

9:30 Adrian Park MD
Univ of Maryland [US]
Innovations in Surgery

9:50 Mark Meyer MD MPH
Massachusetts General Hospital [US]
The OR of the Future

10:10 Break

10:25 Jeffrey J. Berkley PhD
Mimic Technologies, Inc. [US]
Affordable Haptics

ADVANCES IN SIMULATION TRAINING SYSTEMS

10:45 Randy S. Haluck MD FACS
Surgery, Penn State College of Medicine
EndoTower/Rapid Fire System

11:05 Haakon Gundersen
The Mobile Media Company AS [NO]
Multi-Level VR Simulation

11:25 Howard R. Champion MD
SimQuest Intl LLC [US]
Exsanguination Treatment

11:45 Discussion

12:00 Adjourn

THURSDAY AFTERNOON

GENERAL SESSION

REHABILITATION

Moderator:
Kirby G. Vosburgh PhD

1:25 Moderator's Welcome

1:30 He Huang PhD (Cand)
Harrington Dept Bioengineering, Arizona State Univ [US]
Design of Interactive Multimodal Biofeedback for Stroke Rehabilitation

1:45 Emma L. Patchick BSc
Sch of Psychological Sciences, Univ of Manchester [UK]
Can Immersive Virtual Reality Reduce Phantom Limb Pain?

2:00 Albert "Skip" Rizzo PhD
Inst for Creative Technologies & Sch of Gerontology, Univ of Southern California [US]
User-Centered Design Driven Development of a VR Therapy Application for Iraq War Combat-Related Post Traumatic Stress Disorder: From Training to Toy to Treatment

2:15 *Featured Speaker:*
John Smart
President, Acceleration Studies Foundation [US]
Accelerating Change: Developing Tomorrow's Medical Toolkit

2:45 **Presentation of the 12th Annual Satava Award**

3:00 Break

GENERAL SESSION *continued*

INTELLIGENT TUTORING TECHNOLOGY: ACCELERATING CHANGE IN MEDICAL INSTRUCTION

Organizer:
Susann Luperfoy PhD
Principal Scientist,
Tilted Axis Corporation

[Please see Special Activity Summaries for session overview.]

3:15 Susann Luperfoy PhD
Tilted Axis Corporation [US]
Intelligent Tutors for Medical Simulations

3:45 Kirstie L. Bellman PhD
Aerospace Integration Science Center (AISC)
The Aerospace Corporation
Transforming Medical Tutoring Programs

4:15 Sowmya Ramachandran PhD
Stottler-Henke Associates, Inc. [US]
Authoring Tools for Simulation-Based Intelligent Tutoring Systems

4:45 Panel Discussion on Outstanding Issues

5:15 Adjourn

THURSDAY EVENING

POSTER SESSION – GROUP 2

5:15 – 6:15 PM

DISPLAY TECHNOLOGY

Yoshifumi Kitamura PhD
Human Interface Engineering Lab, Osaka Univ [JP]
An Interactive Stereoscopic Display for Cooperative Work – Volume Visualization and Manipulation Environment with Multiple Users

Fuji Lai MS
Medical Systems, Aptima, Inc. [US]
Gestalt Operating Room Display Design for Perioperative Team Situation Awareness

Warren S. Sandberg MD PhD
Anesthesia & Critical Care, Massachusetts General Hospital [US]
Integration of All Operating Room Digital Data on a Single, Large-Format Display

Gunther Sudra Dipl Wi-Ing
Inst of Computer Science & Engineering, Univ Karlsruhe (TH) [DE]
Augmented Reality with Fiber Optics

GENERAL ISSUES

Bryan P. Bergeron MD
HST Div, Harvard Medical Sch & MIT [US]
Augmented Assessment as a Means to Augmented Reality

C. Donald Combs PhD
NCCMMS/Planning & Program Dev, Eastern Virginia Medical Sch [US]
Simulating the Domain of Medical Modeling and Simulation: The Medical Modeling and Simulation Database

Sarah D. Miyahira PhD
Pacific Telehealth & Technology Hui, VA Pacific Islands Health Care System [US]
A Meta-Analysis and Review of Virtual Reality in Training, Treatment, and Rehabilitation

Hisham M.F. Sherif MD
[US]
Is Practicing Medicine Virtually Impossible?

HAPTICS

Laurent Barbé PhD (Cand)
AVR Team, LSIIT, UMR 7005 CNRS-ULP [FR]
Online Robust Model Estimation During In Vivo Needle Insertions

Robert Riener Dr-Ing
Automatic Control Lab, ETH Zurich [CH]
Haptic Device for a Ventricular Shunt Insertion Simulator

INFORMATION-GUIDED THERAPIES

Xiao Dong PhD (Cand)
MEM Research Ctr, Univ of Bern [CH]
Zero-Dose Fluoroscopy-Based Close Reduction and Osteosynthesis of Diaphyseal Fracture of Femur

Randy Ellis PhD
Harvard Medical Sch [US]
Fast Assessment of Acetabular Coverage Using Stereoscopic Volume Rendering

Gregory D. Hager PhD
Computer Science, Johns Hopkins Univ [US]
Vision-Based Human-Machine Collaborative System for Ophthalmic Micro-Surgery

Timothy P. Kelliher
Imaging Technologies, GE Global Research [US]
Computer-Aided Forensics: Metal Object Detection

Uwe Kirschstein Dipl-Inf
Computing Science, Div of Automation & Measurement Technologies, KISUM, Univ of Oldenburg [DE]
Navigated Imaging for 3D Planning of Excisions and Register-Free Milling in Spine Surgery

Ching-Yao Lin PhD
IT & Visualization Div, National Ctr for High-Performance Computing [TW]
A VR Surgery Planning System for Craniosynostosis

John S. Maier PhD MD
Biomedical Application Science, ChemImage Corp [US]
Raman Molecular Imaging in Application to Bladder Cancer Diagnosis

Ulrich Mueller
Inst for Computational Medicine, Univ of Mannheim [DE]
Fast Rigid Registration in Radiation Therapy

Seza Orcun PhD
Discovery Park, Purdue Univ [US]
Lifecycle Planning and Management for IMRT Treatment

David B. Stefan MSEE
Novaptus Systems, Inc. [US]
3D Scanner: An Aid for Planning Breast Augmentation Surgery

Daigo Tanaka PhD (Cand)
Biomedical Engineering, Carnegie Mellon Univ [US]
Computerized Planning of Prostate Cryosurgery

NETWORKING

David Balch MA
DCB Consulting, LLC [US]
Virtual Presence in Disaster Response

Ruth A. Bush PhD
Field Medical Technologies, Naval Health Research Ctr [US]
Naval Medical Knowledge Management System: Providing In-Theater Visibility across the Entire Evacuation Chain

Martin J. Dudziak PhD
R & D, TETRAD Technologies Group, Inc. [US]
Flat, Flexible Postage-Stamp-Sized Sensor Modules and Networks for Invasive and Non-Invasive Monitoring During Surgical Procedures

Martin J. Dudziak PhD
R & D, TETRAD Technologies Group, Inc. [US]
A Mechanism for Detecting Trigger Points and Irreversibility Thresholds in Shock and Trauma for Critical Large-Population Catastrophic Events

Paul N. Kizakevich MS PE
Digital Solutions, RTI International [US]
Technologies for Measuring Human Exposure-Related Behavior

Damini Kumar PhD (Cand)
Sch of Physiotherapy, Medicine, Univ College Dublin [IE]
Wearable Kinematic and Physiological Biofeedback System for Movement Based Relaxation

Lori Maiolo
Telemedicine, Driscoll Children's Hospital [US]
Telecommuting to Virtually Manage a Telemedicine Program in South Texas and Portions of Mexico Using Advanced Communications

Azhar Rafiq MD MBA
Surgery, Virginia Commonwealth Univ [US]
Development of Triage and Casualty Informatics Tool for Mass Casualty Incidents

Azhar Rafiq MD MBA
Surgery, Virginia Commonwealth Univ [US]
Coherent Event Capture in the Operating Room: A Tool for Patient Safety

Sarmad Sadeghi MD
Sch of Health Information Sciences, Univ of Texas Health Science Ctr at Houston [US]
Point-of-Care Decision Support System on Pocket PC Using Bayesian Inference

Warren S. Sandberg MD PhD
Anesthesia & Critical Care, Massachusetts General Hospital [US]
Automatic Detection and Annunciation of Geographic Location Errors in a Hospital

ROBOTICS

Kenneth J. Fodero II BS
Electrical Engineering, Univ of Washington [US]
Control System Architecture for a Minimally Invasive Surgical Robot

Fuji Lai MS
Medical Systems, Aptima, Inc. [US]
Integrating Surgical Robots into the Next Medical Toolkit

VISUALIZATION

WeeKee Chia BSE
R & D, Volume Interactions Pte Ltd [SG]
Contouring in 2D while Viewing Stereoscopic 3D Volumes

Chee-Kong Chui PhD
Mechanical Engineering, National Univ of Singapore [SG]
Flow Visualization for Interactive Simulation of Drugs Injection During Chemoembolization

Octavian Ciobanu PhD
Medical Bioengineering, "Gr.T.Popa" Univ of Medicine & Pharmacy, Iasi [RO]
The Use of a Computer Aided Design (CAD) Environment in 3D Reconstruction of Anatomic Surfaces

Celina Imielinska PhD
Biomedical Informatics, Columbia Univ [US]
Structure-Function Relationships in the Human Visual System Using DTI, fMRI and Visual Field Testing: Pre- and Post-Operative Assessments in Patients with Anterior Visual Pathway Compression

Edmond A. Jonckheere PhD
Electrical Engineering, Univ of Southern California [US]
Visualization of a Stationary CPG-Revealing Spinal Wave

Dmitry V. Romanov
Central Child Polyclinic, M.I.A. [RU]
Virtual Medical Ultrasound Simulator

Ilana A. Souza
Lab de Sistemas Integráveis, Dept Sistemas Eletrónicos, Univ de São Paulo [BR]
Direct Volumetric Rendering Based on Point Primitives in OpenGL

Gunther Sudra Dipl Wi-Ing
Inst of Computer Science & Engineering, Univ Karlsruhe (TH) [DE]
Marker Detection with Minolta Vi-900 Laser Scanner

Bharti H. Temkin PhD
Computer Science / Surgery, Texas Tech Univ [US]
Segmenting the Visible Human Female

Bharti H. Temkin PhD
Computer Science / Surgery, Texas Tech Univ [US]
Registration and Segmentation for the High Resolution Visible Human Male Images

R. John Winder PhD
Health & Rehabilitation Sciences Research Inst, Univ of Ulster [UK]
3D Surface Accuracy of CAD Generated Skull Defect Contour

Gianluigi Zanetti PhD
Visual Computing Group, CRS4 [IT]
A Holographic Collaborative Medical Visualization System

Friday, January 27

FRIDAY MORNING

SESSION A

SURGICAL SIMULATION: DIDACTICS/METRICS – SKILLS ASSESSMENT

Moderator:
David M. Hananel

7:55 Moderator's Welcome

8:00 Adam Dubrowski PhD
Surgery, Univ of Toronto [CA]
Quantification of Process Measures in Laparoscopic Suturing

8:15 Bin Zheng MD PhD
Minimally Invasive Surgery, Legacy Health System [US]
Effects of Assembling Virtual Fixtures on a Virtual Navigation Task

8:30 Kent R. Van Sickle MD
Surgery, Univ of Texas Health Science Ctr at San Antonio [US]
The Pre-Trained Novice: Bringing Simulation-Based Training to Improve Learning in the Operating Room

8:45 Li Felländer-Tsai MD PhD
Clinical Science, Intervention & Technology, Karolinska Inst [SE]
Working Memory and Virtual Image Guided Surgical Simulation

9:00 Thomas R. Mackel MSEE
Biorobotics Lab, Electrical Engineering, Univ of Washington [US]
Data Mining of the E-Pelvis Simulator Database - A Quest for a Generalized Algorithm Capable of Objectively Assessing Medical Skill

9:15 Jan-Maarten Luursema PhD (Cand)
Behavioral Sciences, Univ of Twente [NL]
Stereopsis and User-Interaction in Anatomical Learning

9:30 Sayra M. Cristancho PhD (Cand)
Univ of British Columbia [CA]; Univ Pontificia Bolivariana, Bucaramanga [CO]
Assessing Cognitive & Motor Performance in Minimally Invasive Surgery (MIS) for Training & Tool Design

9:45 Discussion

10:00 Break

10:15 Linh N. Tran
Bioengineering & Mathematics, Univ of Washington [US]
Face, Content and Construct Validation Study of SimPraxis™: A Novel Prototype Cognitive Simulator for Standard Teaching and Assessment

10:30 Sheena J. Johnson MSc
Organisational Psychology, Univ of Liverpool NHS Trust [UK]
Metrics for an Interventional Radiology Curriculum: A Case for Standardisation?

10:45 Oliver Tonet PhD
CRIM Lab, Scuola Superiore Sant'Anna [IT]
Biomechanical Analysis of Surgeon's Gesture for Evaluating Skills in Virtual Laparoscopy

11:00 James R. Korndorffer, Jr MD FACS
Surgery, Tulane Health Sciences Ctr [US]
Haptic Interfaces: Do They Matter?

11:15 Erich Schneider PhD
Neurology, Hospital of the Univ of Munich [DE]
Documentation and Teaching of Surgery with an Eye Movement Driven Head-Mounted Camera: See What the Surgeon Sees and Does

11:30 Discussion

12:00 Adjourn

FRIDAY MORNING

SESSION B

HAPTICS

Moderator:
Roger Phillips PhD CEng FBCS CIPT

7:55 Moderator's Welcome

8:00 Thomas Sangild Sørensen PhD
Ctr for Advanced Visualisation & Interaction, Univ of Aarhus [DK]
Haptic Feedback for the GPU-Based Surgical Simulator

8:15 Adrianus J. Houtsma PhD
Aircrew Protection Div, US Army Aeromedical Research Lab [US]
Can Augmented Virtual Force Feedback Facilitate Virtual Target Acquisition Tasks?

8:30 Zhuming Ai PhD
Biomedical & Health Information Sciences, Univ of Illinois at Chicago [US]
New Tools for Sculpting Cranial Implants in a Shared Haptic Augmented Reality Environment

8:45 Dejan Ilic PhD
IPR-LSRO, EPFL [CH]
A Haptic Device for Guide Wire in Interventional Radiology Procedures

9:00 Dhanannjay S. Deo
Mechanical, Aeronautical & Nuclear Eng, Rensselaer Polytechnic Inst [US]
Measurement of the Mechanical Response of Intra-Abdominal Organs of Fresh Human Cadavers for Use in Surgical Simulation

VISUALIZATION

9:15 Gabor Fichtinger PhD
Computer Science, Mechanical Engineering & Radiology, Johns Hopkins Univ [US]
Bootstrapped Ultrasound Calibration

9:30 Toshikuni Saito
Graduate Sch of Science & Engineering, Waseda Univ [JP]
Estimation of Skeletal Movement of Human Locomotion from Body Surface Shapes Using Dynamic Spatial Video Camera (DSVC) and 4D Human Model

9:45 Yi Su PhD
Physiology & Biomedical Engineering, Mayo Clinic College of Medicine [US]
TRUS-Fluoroscopy Fusion for Intraoperative Prostate Brachytherapy Dosimetry

10:00 Break

Moderator:
Jannick P. Rolland PhD

10:15 Peter Kazanzides PhD
Computer Science, Johns Hopkins Univ [US]
System Architecture and Toolkits for Image-Guided Intervention Systems

10:30 Scott A. Gregory BS
Human Interface Technology Lab, Univ of Washington [US]
Patient-Specific Creation of a Global Static Model of the Bladder Urothelium Using AutoStitch: A Potential Enhanced Clinical Application for the Patient Record

10:45 Hakim Atmani PhD (Cand)
Le2i UMR CNRS 5158, ENSAM [FR]
Towards a Computer-Aided Surgery System for Shoulder Prosthesis Placement

11:00 Anand P. Santhanam MS
Sch of Computer Science, Univ of Central Florida [US]
Medical Simulation and Visualization of Pneumothorax Influenced 3D Lung Dynamics

11:15 R. John Winder PhD
Health & Rehabilitation Sciences Research Inst, Univ of Ulster [UK]
'Virtual Unwrapping' of a Mummified Hand

11:30 Eric Herbranson DDS
National Biocomputation Ctr, Stanford Univ [US]
A 2000 Year Old View into the Future of Medical Imaging

11:45 Discussion

12:00 Adjourn

FRIDAY MORNING

SESSION C

Panel/Workshop:

INTEROPERABILITY STANDARDS FOR MEDICAL MODELING AND SIMULATION: REVIEW OF PROGRESS AND FUTURE PLANS

Organizer & Chair:
Kenneth C. Curley MD
Chief Scientist, TATRC, U.S. Army Medical Research & Materiel Command;
Assistant Professor, Military and Emergency Medicine and Biomedical Informatics,
Uniformed Services Univ of the Health Sciences

Co-Chair:
J. Harvey Magee
Portfolio Manager-Medical Modeling and Simulation, Clinical Applications Division,
TATRC, US Army Medical Research & Materiel Command

[Please see Special Activity Summaries for session overview.]

8:00 Kenneth C. Curley MD
TATRC, US Army Medical Research & Materiel Command; Uniformed Services Univ of the Health Sciences
Welcome & Overview

8:15 J. Harvey Magee
TATRC, US Army Medical Research & Materiel Command
Overview, Part 2

Panelists

8:30 Mike Aratow MD FACEP
Member, Web3D Consortium;
Assistant Director, Dept of Emergency Medicine, San Mateo Medical Ctr
Extending X3D: Progress of the Medical Working Group of the Web 3D Consortium

8:55 Kevin Montgomery PhD
Technical Director, National Biocomputation Ctr, Stanford Univ
[Presentation title TBA]

9:20 Stephane Cotin PhD
Research Lead, Medical Simulation Projects, The Simulation Group at CIMIT
SOFA: Simulation Open Framework Architecture - Current Status and Future Directions

9:45 M. Cenk Cavusoglu PhD
Assistant Professor, Dept of Electrical Engineering and Computer Sciences, Case Western Reserve Univ
GiPSi: An Evolving Open Source/Open Architecture Framework for Surgical Simulation - Current State and the Future Direction

10:10 Break

10:20 Karl Reinig PhD
Director of Engineering, Touch of Life Technologies, Aurora, CO
A Developer's Perspective

10:45 Frank Tendick PhD
Assistant Adjunct Professor and Director, UCSF Surgical Skills Ctr;
Dept of Surgery, Univ of California, San Francisco
Challenges in Shared Development of Tissue Modeling and Haptics Software

11:10 Rick Severinghaus
Medical Systems Product Manager, Dynamic Animation Systems;
Medical Simulation Liaison, Executive Committee, Simulation Interoperability Standards Organization
Simulation Standards - Now and in Your Future, at a Clinic Near You

11:35 Neil Tardella
Chief Operation Officer, Energid Technologies
The Surgical Simulation and Training Markup Language (SSTML): An Overview of Energid's XML-Based Language for Medical Simulation and Training

12:00 Adjourn

FRIDAY MORNING

SESSION D

Symposium:

ADVANCED TECHNOLOGIES AND BEHAVIORAL HEALTHCARE: WHAT'S NEW?

Organizer & Chair:
Brenda K. Wiederhold PhD MBA
President, Interactive Media Institute
Executive Director, The Virtual Reality Medical Center
bwiederhold@vrphobia.com
http://www.vrphobia.com
http://www.interactivemediainstitute.com

[Please see Special Activity Summaries for session overview.]

Presenters

8:00 Brenda K. Wiederhold PhD MBA
The Virtual Reality Medical Center [US]
Welcome & Introduction

8:15 Stanley M. Saiki MD
Pacific Telehealth & Technology Hui [US]
Virtual Reality in Behavioral Health - Hawaii Initiatives

8:45 Wm. LeRoy Heinrichs MD PhD
SUMMIT, Stanford University [US]
Educational Technologies Improve Behavioral Healthcare - The View from SUMMIT

9:15 Giuseppe Riva PhD
Istituto Auxologico Italiano [IT]
Virtual Reality Treatment for Eating Disorders and Obesity: From Body Image to Anxiety Treatment

9:45 Walter J. Greenleaf PhD
Greenleaf Medical Systems [US]
Next Generation Technology for Physical and Cognitive Rehabilitation

10:15 Break

10:30 Alex H. Bullinger MD MBA
COAT-Basel [CH]
COAT-Basel: Center of Applied Technologies in Neuroscience

11:00 Mark D. Wiederhold MD PhD FACP
The Virtual Reality Medical Center [US]
A Review of VRMC Projects: Past, Present, and Future

11:30 Discussion

Adjourn

FRIDAY AFTERNOON

SESSION A

SURGICAL SIMULATION: VALIDATION – FUTURE ISSUES

Moderator:
Patrick C. Cregan FRACS

1:25 Moderator's Welcome

1:30 Matthias Harders PhD
Virtual Reality in Medicine Group, ETH Zurich [CH]
A Web-Based Repository of Surgical Simulator Projects

1:45 Jonathan Marmurek
Imaging Research Labs, Robarts Research Inst [CA]
Image-Guided Laser Projection for Port Placement in Minimally Invasive Surgery

2:00 Eelco E. Kunst PhD
Kunst & van Leerdam Medical Technology bv [NL]
Open Surgery in VR: Inguinal Hernia Repair According to Lichtenstein

2:15 Eelco E. Kunst PhD
Kunst & van Leerdam Medical Technology bv [NL]
Towards a VR Trainer for EVAR Treatment

2:30 Timothy N. Judkins PhD (Cand)
HPER Biomechanics Lab, Univ of Nebraska at Omaha [US]
Real-Time Augmented Feedback Benefits Robotic Laparoscopic Training

2:45 Christopher M. Sewell MS
Computer Science, Stanford Univ [US]
Achieving Proper Exposure in Surgical Simulation

3:00 Break

Moderator:
Robert M. Sweet MD

3:15 M. Cenk Cavusoglu PhD
Electrical Engineering & Computer Science, Case Western Reserve Univ [US]
GiPSiNet: An Open Source/Open Architecture Network Middleware for Surgical Simulations

3:30 Dhanannjay S. Deo
Mechanical, Aeronautical & Nuclear Eng, Rensselaer Polytechnic Inst [US]
Use of Surgical Videos for Realistic Simulation of Surgical Procedures

3:45 Matthias Harders PhD
Virtual Reality in Medicine Group, ETH Zurich [CH]
Highly-Realistic, Immersive Training Environment for Hysteroscopy

4:00 Cristian J. Luciano MS
Computer Science, Univ of Illinois at Chicago [US]
Second Generation Haptic Ventriculostomy Simulator Using the ImmersiveTouch™ System

4:15 Mark W. Scerbo PhD
Psychology, Old Dominion Univ [US]
A Simulation-Based Training System for Surgical Wound Debridement

4:30 William E. Lewandowski MS
[US]
A Return on Investment (ROI) Model to Measure and Evaluate Medical Simulation Using a Systematic, Results-Based Approach

4:45 Discussion

5:00 Adjourn

FRIDAY AFTERNOON

SESSION B

1:25 – 3:15PM

Workshop:

DEVELOPING SERIOUS GAMES IN MEDICINE

Organizer:
Bryan Bergeron MD
Massachusetts General Hospital & Harvard Medical School

[Please see Special Activity Summaries for session overview.]

FRIDAY AFTERNOON

SESSION C

1:25 – 5:00PM

Workshop:

VIRTUAL PATIENT: RESEARCH ROADMAP FOR INTEGRATION OF NEW LEARNING TECHNOLOGIES INTO MEDICAL SIMULATION

Organizer:
Gerry Higgins PhD
Federation of American Scientists; Laerdal Medical Corp.

[Please see Special Activity Summaries for session overview.]

PRESENTATIONS

Henry Kelly PhD & Kay Howell
Federation of American Scientists - The Learning Federation [US]
Introduction and Objectives - What is the Research Roadmap?

Gerry Higgins PhD
Laerdal Medical Corporation [US]
Computerized Patient Simulation for Learning Cognitive and Psychomotor Skills

Sowmya Ramachandran PhD
Stottler-Henke Associates [US]
Intelligent Tutoring Systems and Medical Simulation

Jan Cannon-Bowers PhD
Inst for Simulation and Training, Univ of Central Florida [US]
Simulation Tools to Support Knowledge Acquisition and Integration

Christoph Kaufmann MD MPH FACS
Associate Medical Director, Trauma Services, Legacy Emanuel Hospital, Portland; Chair, Committee on Advanced Trauma Life Support (ATLS), American College of Surgeons; Former Director, Surgical Simulation Lab, USUHS National Capital Area Simulation Ctr.; Professor of Surgery, Uniformed Services Univ and Clinical Associate Professor of Surgery, Oregon Health Sciences Center [US]
Patient Simulation: A Clinician's Perspective

Ron Walls MD
Harvard Medical Sch [US]
STRATUS Center for Medical Simulation: Vision for the Next 10 years

FRIDAY AFTERNOON

SESSION D

1:25 – 5:00PM

Panel/Workshop:

INTEGRATION OF BIODEFENSE WITH PUBLIC HEALTH AND PREVENTIVE MEDICINE: HOW THE FUNCTIONS AND TECHNOLOGIES CAN COLLABORATE AND SUPPORT EACH OTHER

Organizer:
Martin Dudziak PhD
TETRAD Technologies Group, Inc.

[Please see Special Activity Summaries for session overview.]

PRESENTATIONS & PANELISTS

Dorothy Small PhD [Co-Chair]
Chief Scientist, Shaw Environmental and Infrastructure The Shaw Group [US]
What Does the Result "10 CFUs of Bacillus anthracis" Really Mean and What is Your Potential Risk as an ER Doctor During Treatment?

Kristin M. Omberg PhD [Co-Chair]
Group Leader, Systems Engineering & Integration Group Decision Applications Division [US] Los Alamos National Laboratory [US]
BioWatch and Coordination of Military Methods and Measures to Public Health Applications, Based upon Work in the San Diego Community

Martin Dudziak PhD [Co-Chair]
TETRAD [US]
Application of Intelligence Community and Military Tools for Knowledge Discovery, Analyst Coordination, and Novel Intelligence from Massive Data being Applied to Both the Counterterrorist and Natural Biodefense Applications in Conjunction with Sensor Data and Public Health Clinic and Hospital Information Sources

Brent Pulsipher PhD
Statistical and Mathematical Sciences Pacific Northwest National Laboratory [US]
Visual Sample Plan Software and Statistical Sampling Methods and Approaches Related to Chemical/Biological/Radiation Contamination from Potential Terrorist Events

Gary Resnick PhD
Associate Director for Chemical and Biological Threat Reduction Center for Homeland Security Los Alamos National Laboratory [US]

Gary S. Brown PhD
Sandia National Labs [US]

Barbara Beckman PhD
Tulane Univ Sch of Public Health [US]

Devra Davis PhD MPH
Univ of Pittsburgh Sch of Public Health [US]

Teresa Lustig PhD
Acting Director, Interim Interagency Modeling and Atmospheric Assessment Center (IMAAC), Biological Countermeasures Office, Science and Technology Directorate Dept of Homeland Security [US]

Harry Quebbeman PhD [Invited]
Director, BioWatch Program Office [US]

Special Activity Summaries

DARPA SEEDLINGS / SBIRS

Organizer:
Richard M. Satava MD FACS and
The DARPA Defense Sciences Office

The Defence Sciences Office (DSO) of the Defence Advanced Research Projects Agency (DARPA) seeks to establish a new capability that will revolutionize care to support the soldier. While this care will be used both on and off the battlefield, the main focus is on upgrading the far-forward medical combat casualty care while keeping pace with the military transformation which reduces the number of personnel and logistics required on the battlefield. This program is comprised of four areas including; Diagnostics, Therapeutics, Simulation and Training, and and Supporting Technologies. The portfolio consists of several major programs, as well as ten quick turnaround, proof of principle efforts known as Seedlings and SBIRs. This session will highlight a wide spectrum of science and technology being developed under the Seedling and SBIR efforts.

THE INNOVATION CENTER COMPUTER ASSISTED SURGERY (ICCAS), LEIPZIG, GERMANY

Organizer:
Heinz U. Lemke PhD
Institute for Technical Informatics, Technical University Berlin

ICCAS (Innovation Center Computer Assisted Surgery) is an interdisciplinary center attached to the medical faculty of the University of Leipzig, Germany. Experts from surgery, computer science and medical engineering are working in close cooperation in ICCAS to advance the field of computer assisted surgery. The creation of the center in March 2005 is based on an initiative of the Ministry for Education and Research (BMBF) of Germany to build centers of competence in specific areas, where innovative R&D will be of benefit to the economy and society.

In addition to a number of specific projects in computer assisted surgery, the focus of the center is on surgical workflow, modelling and analysis as well as on surgical PACS. A strong emphasis of ICCAS towards the development of IT standards in the OR, resulted in its active participation in the international working group WG24 on "DICOM in Surgery" as well as in a number of focussed projects in Germany.

PATIENT SAFETY AND MEDICAL SIMULATION: ISSUES, CHALLENGES AND OPPORTUNITIES

Organizers:
Alan Liu PhD and **Mark Bowyer MD FACS**
National Capital Area Medical Simulation Center

Patient Safety has been succinctly defined as “freedom from accidental injury”. In the Institute of Medicine report, To Err is Human: Building a Safer Health System (Washington, DC: National Academy Press, 1999), the documented human cost of medical errors is immense. The majority of medical errors originate from basic flaws in the current health system. Since then, a considerable amount of effort has been devoted to addressing patient safety concerns.

This workshop aims to heighten awareness of patient safety issues within the MMVR community. The fundamental issues related to patient safety are highlighted. Human factors affecting patient safety are discussed, and the clinician’s perspective is highlighted. Initiatives undertaken within the Department of Defenses Patient Safety program are described. The innovative use of simulation technology to improve patient safety will also be highlighted. This workshop concludes with a forum to discuss the issues raised.

For additional information and updates, please refer to this workshop’s website at http://simcen.org/mmvr2006

ADVANCES IN MEDICAL TECHNOLOGIES: ROBOTICS & SIMULATION

Organizer:
Gerald R. Moses PhD
TATRC/USAMRMC

Leaders in research and clinical medicine will present the state of technology development in focused areas. Ongoing studies in robotic surgery will be discussed, with emphasis placed upon innovative methodologies. Application of enabling technologies to the fields of telesurgery and image-guided surgery will be discussed. Similarly, advances in enabling technologies will be applied to operating room systems and to simulation training.

INTELLIGENT TUTORING TECHNOLOGY: ACCELERATING CHANGE IN MEDICAL INSTRUCTION

Organizer:
Susann Luperfoy PhD
Principal Scientist
Tilted Axis Corporation

This plenary session has been designed to provide MMVR participants with a practical overview of the field of Intelligent Tutoring System (ITS) technology. A primary aim is to identify methods, tools, and software components that result from work in Artificial Intelligence (AI) and ITS, many of which are available for direct application to medical training in virtual reality environments today. The forum will also provide opportunity for AI practitioners to learn from the audience, more about the expectations and requirements

of the medical training community. This session includes three brief presentations and an interactive panel discussion with ample time allotted for audience questions and bidirectional inquiry.

The first talk, will be an overview of the field. A brief history of CBT (Computer Based Training) and intelligent tutoring will be followed by a sketch of those subdisciplines that hold particular relevance to medical training. Topics of interest will include student modeling, adaptive coaching, remediation, automated skills assessment, and spoken dialog interaction. The second talk will delve into expert modeling as a key technology for developing intelligent tutors. We will review recent work that involves automating some aspects of human perception leading to focused presentation of an innovative technique involving saliency algorithms. We will discuss how saliency, combined with Virtual Worlds may improve our ability to identify what the expert notices and does so that the tutor can convey it to novices. Our third talk presents authoring technology as a key enabler to the mushrooming popularity of multi-media CBTs and Intelligent Tutors. Authoring tools shift the task of course production and even look-and-feel properties from software engineers to content experts and instructional designers thereby increasing production efficiency. Some of these authoring tools are tutor specific in that they allow the development of content for a specific tutor. Some are specific to certain types of domains. Some focus to content authoring for a fixed style of instruction, while a few allow the instructional style to be customized along various dimensions. This talk will give an overview of the current state-of-the-art in ITS authoring technology and suggest ideas for application to the healthcare domain.

We will close the session with an interactive panel discussion in which members of the audience engage speakers in review and clarification of presentation content as well as identification of perceived problems that challenge ITS researchers and application developers to adapt our current methods and assumptions.

INTEROPERABILITY STANDARDS FOR MEDICAL MODELING AND SIMULATION: REVIEW OF PROGRESS AND FUTURE PLANS

Organizer & Chair:
Kenneth C. Curley MD
Chief Scientist, TATRC, U.S. Army Medical Research & Materiel Command;
Assistant Professor, Military and Emergency Medicine and Biomedical Informatics,
Uniformed Services Univ of the Health Sciences

Co-Chair:
J. Harvey Magee
Portfolio Manager-Medical Modeling and Simulation,
Clinical Applications Division,
TATRC, US Army Medical Research & Materiel Command

Medical Modeling and Simulation (MM&S), including modeling and simulation of biological processes across scales from molecular to whole-organism, and simulation for education and training, has arisen in a geographically dispersed and multi-disciplinary manner that has generally been separate from the older and more organized defense and aerospace simulation community. As indicated by multiple experts speaking at previous MMVR and other meetings, MM&S has reached a point where the issue of interoperability standards must be addressed, lest the community face a stagnation of development that will in turn lessen the impact of these technologies upon the biomedical sciences. At the 2005 MMVR we had a very successful panel entitled "Interoperability Standards for Medical Modeling and Simulation: The Need, Challenges and Opportunities" where our panelists described what they each felt was needed in order to realize the development of standards in the arena.

Over the past year many of the panelists and many panel audience members were motivated to begin or to expand developing aspects of potential standards. This year, our goal is to review the work accomplished and to develop plans for the next steps of the various efforts. This panel will engage the audience to offer their experience and insights and will challenge the community to come together even more than it has in the past year to realize the goal of medical modeling and simulation interoperability standards.
http://www.craive.org.uk

ADVANCED TECHNOLOGIES AND BEHAVIORAL HEALTHCARE: WHAT'S NEW?

Organizer & Chair:
Brenda K. Wiederhold PhD MBA
President, Interactive Media Institute
Executive Director, The Virtual Reality Medical Center
bwiederhold@vrphobia.com
http://www.vrphobia.com
http://www.interactivemediainstitute.com

Groups from around the world have proven the value of adding advanced technologies as an adjunct to traditional cognitive-behavioral protocols in treating a multitude of disorders. Originally most virtual reality applications were developed on silicon graphics work stations and cost millions of dollars. As the power of technology has increased and costs have decreased, groups have continued to push the envelope and look at how various simulations may be ported to a variety of platforms. This will allow these technologies to become more widespread and accessible, easier to disseminate to the population at large. In addition, groups have continued to expand the list of disorders that may be treated with these technologies.

This specialized symposium will include world leaders who will present new and exciting work their research teams are doing to bring the latest in cutting edge technologies to the behavioral healthcare world.

DEVELOPING SERIOUS GAMES IN MEDICINE

Organizer:
Bryan Bergeron MD
Massachusetts General Hospital & Harvard Medical School

This session provides an overview of the technologies, tools, and best practices of medical serious games development, with an emphasis on hardware-enabled augmented reality games. Topics discussed include:

- Historical Perspective—The contribution of the industrial-military complex to medical serious games development and the evolution of computing platforms and toolsets.
- Working Context—Defining the medical serious games space and the value proposition associated with products developed thus far.
- Technology Trends—An overview of the latest hardware platforms, middleware, and tools for managing the complexity of development, including the latest development technologies.
- Standards—The standards applicable to medical serious games, including platform standards, game standards, game design notation standards (e.g., UML), asset standards, and communications standards. The evolution of the SCORM standard as it applies to games will be discussed as well.
- Best Practices—The best practices in user interface design, programming, asset development and management, level design, archiving, and reporting.
- Tools—An overview of the tools available for medical serious games development, data acquisition, and deployment. This section will emphasize the repurposing of controllers and other off-the-shelf hardware, as well as the BASIC STAMP microcontroller.
- Serious Game Design—An introduction to the serious games design document, including the Requirements Specification, Technical Architecture, Game Design, Programming, Asset Acquisition & Development, Testing & Debugging, Deployment, Maintenance & Troubleshooting, Project Management, and Legal issues.
- Examples—3D Game Design using off-the-shelf tools, Embedded Microcontroller Game Design using the BASIC Stamp, Alternative interfaces using repurposed game controllers.
- Resources—Resources applicable to medical serious games design will be reviewed, from game engines, multimedia sources, standards organizations, to hardware vendors.

Actual development projects will be discussed and demonstrated, including an augmented reality vest for simulated patients and a virtual Geiger counter simulation-based game integrated with a disaster support learning environment.

After attending the session, attendees will be able to:
- List the software and hardware tools and resources available to medical serious games developers.
- Evaluate the applicability of specific hardware and software tools to their serious games development project.
- Evaluate the applicability of repurposed controllers and other peripherals to specific development projects.
- Explain the various components of the serious games design document and incorporate these into a grant application or active project.

VIRTUAL PATIENT: RESEARCH ROADMAP FOR INTEGRATION OF NEW LEARNING TECHNOLOGIES INTO MEDICAL SIMULATION

Organizer:
Gerry Higgins PhD
Federation of American Scientists; Laerdal Medical Corp.

The focus of this venue will be the Research Roadmap to be presented to the National Institutes of Health to begin a new program called 'The Virtual Patient.' This roadmap draws from a workshop sponsored by The Learning Federation meeting that was held in 2005, involving both medical simulation, game developers, learning scientists, and focusing on three specific domains:
- Automated Generation of Patient Case Scenarios
- Intelligent Tutoring
- Debriefing and Assessment

This will focus on the next generation of dynamic, computer-generated patient cases based on performance modeling and past execution status of the learner. A central question in designing simulation-based practice environments involves the design of scenarios and cases that can be generated on-the-fly to optimize the learning objectives required by the specific learner, serving as the benchmark for medical instruction. An important topic will be the drive to standardize patient case scenarios in computer-based medical education, as has recently been advocated by several professional medical organizations.

INTEGRATION OF BIODEFENSE WITH PUBLIC HEALTH AND PREVENTIVE MEDICINE: HOW THE FUNCTIONS AND TECHNOLOGIES CAN COLLABORATE AND SUPPORT EACH OTHER

Organizer:
Martin Dudziak PhD
TETRAD Technologies Group, Inc.

Co-Chairs:
Dorothy Small PhD
Chief Scientist, Shaw Environmental and Infrastructure
The Shaw Group

Kristin M. Omberg PhD
Group Leader, Systems Engineering & Integration Group
Decision Applications Division
Los Alamos National Laboratory

This session will address the issue of how to create synergy and symbiosis in two areas of critical need for rapid and accurate information gathering, collection, and analysis: biodefense from the standpoint of intentional military and terrorist threats, and public health protection against epidemics and pandemics of natural or accidental origin.

Participants will examine how prior technologies, systems and projects in both the military and civilian realms, including large-scale simulations and tests such as virtual-reality scenarios, have migrated from one sector to another successfully—or not so successfully—and where there are possibilities for fruitful collaboration, re-use and transformation.

Participants will discuss concrete historical examples and also consider what may work in the future as threats, needs, and technologies dynamically change in both sectors.

Exhibitor Information

Exhibit Hours

WEDNESDAY, JANUARY 25

10:20-11:00AM	Exhibits Open. Break in Exhibit Ballroom [Exhibits closed during lunch break.]
3:15-3:30PM	Break in Exhibit Ballroom
5:15PM	Exhibits Close for Poster Session
6:15-7:30PM	Reception in Exhibit Ballroom

THURSDAY, JANUARY 26

10:00-10:15AM	Exhibits Open. Break in Exhibit Ballroom [Exhibits closed during lunch break.]
3:00-3:15PM	Break in Exhibit Ballroom
4:00PM	Exhibits Close and dismantle

Exhibitors

Acceleration Studies Foundation
San Pedro, CA
www.Accelerating.org

John Smart
Mail@Accelerating.org

ASF is an educational 501(c)(3) nonprofit organization, engaged in building awareness, education, research, and selective advocacy of communities and technologies of accelerating change. Its mission is: 1) to promote a multidisciplinary and critical understanding of the present and expected future of accelerating processes of technological change, in service to greater professional competency and better economic, political, social and personal development; 2) to improve the way individuals and organizations predict, manage, and create the future by advancing the fields of Acceleration Studies, Development Studies, Futures Studies, Technology Roadmapping, and Forecasting; and 3) to help individuals, communities, business, and society to realize a future of 'exponential promise'.

ASF explores our increasingly technological and computational world via four key services: 1) advancing the dialogue by improving public Awareness; 2) high school, undergraduate and graduate initiatives for Education; 3) roadmapping, forecasting, scenarios and other data-driven Research; and 4) selected technological, economic, political and social Advocacy.

Advanced Simulation Corporation
Point Roberts, WA
www.bodysim.com

Kenton Starko
Kenton@advsim.com

BODY Simulation is a mathematical model of human physiology and pharmacology that is based on the work of N. Ty Smith MD. Circulation, respiration, autonomic nervous system, and other physiologic systems are mathematically implemented in a 70-compartment model. The result is an accurate response to physiologic stress, drugs, and agents. The BODY model is packaged as a DLL that may be linked with and harnessed by Windows software applications. BODY thus acts as a "patient" for any simulation, testing or human-factors purpose, for example. Development can proceed much faster, when using the BODY DLL. BODY Simulation for Anesthesia is an exciting PC-based, interactive, multimedia simulation that uses the BODY Simulation DLL. It is used as a teaching and training tool worldwide. Users may converse with the patient, perform clinical maneuvers, choose and use monitors, IVs, agents, anesthesia machine settings, etc. A wide range of patient types may be selected, and normal, scientific, or critical incident cases may be experienced and explored. Many plotting and graphing features complement the diverse, clinically oriented interface windows. New features include terror agents, aged patients and basic and advanced life support, including realistic chest compression and arrhythmias, with 12-lead ECGs, as well as their conversion.

CFD Research Corporation
Huntsville AL
www.cfdrc.com

Dr. Andrzej Przekwas
ajp@cfdrc.com

Computational Medicine and Biology (CMB) Div. of CFD Research Corporation (CFDRC) is developing Leonardo—an anatomy/physiology-based multi-scale model of a virtual human. Leonardo integrates 3D distributed models of cardiopulmonary circulation, lung respiration, oxygen/glucose metabolism, neural regulation, and other systemic components. Leonardo is built of spatially distributed 3D arterial-venous vascular system perfusing several organs. The organs, in the multi-scale 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 multi-scale modeling capability spans from systemic, organ, tissue, cellular, to sub-cellular pathway models. Our goal is to simulate Leonardo's virtual life with "faster than life" speed using novel multi-scale modeling and parallel computing. The GUI "Monitoring Window" will allow programming of his daily life including circadian clock, rate of metabolic processes (e.g. rest, exercise), and life events (e.g. hemorrhagic injury, living on Mt. Everest, or experiencing fast accelerations in maneuvering military jets). At present, Leonardo is being prepared for "military life" to test his responses to traumatic injuries resulting from trauma injuries, explosion blasts, or novel resuscitation, reperfusion, and pharmacological treatment ideas. In the future, Leonardo will host several other physiological and pathological functions such as lymphatic circulation, gastro-intestinal processes (digestion, absorption, secretion, and clearance), immune system, endocrinal, neurochemistry, and several others. Leonardo is freely available for academic scientific research.

Claron Technology
Toronto, Ontario
www.ClaronTech.com

Claudio Gatti
Claudio@ClaronTech.com

Claron Technology Inc. designs and manufactures innovative products that use computer vision technology to remotely measure and track objects in space. Our first product line is MicronTracker, a family of real-time sub-millimeter video-based pose tracking products specialized for medical applications. At MMVR14 Claron will present a demonstration of an advanced image guided radiation therapy system, developed by the Image Guided Therapy Group at Princess Margaret Hospital - UHN, which takes full advantage of the unique features of the MicronTracker.

Computer Vision Lab, ETH Zurich
Zurich, Switzerland
www.hystsim.ethz.ch/

Matthias Harders
mharders@vision.ee.ethz.ch

The driving application of our work is the development of a generic surgical training simulator for hysteroscopy. A key target is to go beyond rehearsal of basic manipulative skills,and enable training of procedural skills like decision making and problem solving. The prototype has been created using several modules, which for instance provide simulation of soft tissue deformation, collision detection and response, cutting, as well as a hysteroscopy tool as input device to the simulator. In addition, a CFD module has been integrated for blood flow simulation. Moreover, we replicated an OR in our lab and provide standard hysteroscopic tools for interaction. In this setting, the training starts as soon as the trainee enters the OR, and it ends, when she leaves the room. A reduced version of this simulation system is demonstrated at the conference.

D'Ambra Technologies, LLC
Portland, ME
www.dambratec.com

David Kaplan MD FRCS
davegdi@dambratec.com

D'Ambra Technologies is dedicated to providing the benefits of elite 3-D 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 display. The process affords precise control of every pixel in time and space. The result is a convincing 3-D image rendered in real-time that passes the rigors imposed by clinical medicine.

Forterra Systems, Inc.
San Mateo, CA
www.forterrainc.com

David "Bart" Bartlett, VP Marketing
dbartlett@forterrainc.com

Forterra Systems builds distributed virtual world technology and turnkey applications for defense, homeland security, medical, corporate training, and entertainment industries. Using the OLIVE (On-Line Interactive Virtual Environment) Technology Platform customers can rapidly generate realistic three-dimensional virtual environments that easily scale from single user applications to large scale simulated environments supporting many thousands of concurrent users. Forterra's technology and services enable organizations to train, plan, rehearse, and collaborate in ways previously considered impossible or impractical. The OLIVE Platform provides an integrated medical training solution to support the unique and growing requirements of the medical community. Realistic virtual emergency departments, operating rooms, reception areas, and even entire health-care facilities can be built to support a wide range of training applications. Extending interdisciplinary emergency and operating room teamwork skills, EMCRM (Emergency Medicine Crisis Resource Management) training, developing patient interactions skills, and preparing for mass-casualty incidents can all be accomplished using OLIVE. Today, Forterra is conducting sponsored research into applying multiplayer game technology to medical first responder training. This work will lead to a wide range of training applications in a variety of industries including the military where combat medics may be called on to extend emergency medical care to the civilian population

Innovative Sports Training, Inc.
Chicago, IL
www.InnSport.com

Lee Johnson
Admin@InnSport.com

The MotionMonitor, SensAble Technologies and SenseGraphics AB have partnered to develop the latest in virtual reality immersive systems. Now for the first time, stereoscopic visualization displays are available as an integrated turnkey system with haptic feedback, kinematic data, eye tracking data, and EMG data collected in real-time and automatically synchronized. Easy setup processes allow for co-location of the immersive display, kinematic sensors, eye trackers and haptic devices. Integrated head trackers provide head compensation to the immersive display for unrestricted head motion during viewing resulting in a more realistic experience. Driven with intuitive drop-down menus, The MotionMonitor presentation and analysis software requires no programming skills. Using the system's biofeedback module, present subjects with a wide range of 3D "targets", objects, and mesh files; control their position and movements; define chase cursors with any raw, processed or user-defined variables; and accurately monitor the subject's kinematic, physiological, and 3D eye gaze vectors in response to

the virtual world. This unique configuration is an ideal product for motor control research, neurological studies and assistive rehabilitation.

Karl Storz Endoscopy-America, Inc.
Culver City, CA
www.KarlStorz.com

June Marchigiani, Marketing Manager, Anesthesia
JMarchigiani@KSEA.com

Karl Storz offers an array of products to simplify tracheal intubation—including unexpectedly difficult intubations in the ED. Our crisp, clear optics enhance visualization of the airway, which in turn can simplify and speed intubation with reduced patient trauma. Fiber-optic intubation scopes, such as the Bonfils Retromolar Fiberscope, Digital Video Laryngoscopes, and flexible intubation fiberscopes provide distinct advantages in all difficult airways. All intubation instruments are available in a range of sizes, and may be operated with battery-powered light sources as a lightweight, portable alternative. Other products include ergonomically optimized carts, laryngoscope blades and instruments, and bronchoscopes.

Lippincott Williams & Wilkins
Philadelphia, PA
www.lww.com

Robert O'Malley
bomalley@lww.com

Lippincott Williams & Wilkins is a leading international publisher of medical journals, books, and electronic media. Visit our booth to learn about Simulation in Healthcare: The Journal of the Society for Medical Simulation. This new journal will publish the leading research and clinical data from this fast-growing field.

Mimic Technologies, Inc.
Seattle, WA
www.mimic.ws

Jan Ostman
jan@mimic.ws

Mimic Technologies provides tension-based force feedback devices and real-time Finite Element (FE) modeling capabilities that enable rapid development of advanced haptic applications and accurate simulation of soft tissue and deformable objects. Mimic's proprietary technology facilitates customized touch-enabled applications that are very realistic, yet low-cost and scalable—
tension-based haptic systems can be built smaller than a shoebox or as large as a room. Mimic's state-of-the-art FE modeling engine makes it possible to interact with anatomical structures characterized by continuum mechanic-based material properties. Our software capabilities also include advanced skeleton-based collision detection and patient specific model generation tools. Mimic has also developed a platform for embedding simulation training into robotic surgical systems. This platform includes complete dynamic modeling for the robot system, deformable patient specific models (created from DICOM images), real-time display capabilities for rendering tool force and tissue strain, complex tool/organ interaction with high order collision detection (multiple and deformable body collision analysis), needle insertion and simple thread modeling for suturing, and an array of robotic task trainers with target-based metrics. Mimic's objective is to provide a more realistic and useful medical simulation experience through innovative software and hardware.

The National Capital Area Medical Simulation Center
Uniformed Services University
Bethesda, MD
www.simcen.usuhs.mil

Alan Liu
alan@simcen.org

The mission of the National Capital Area Medical Simulation Center (SimCen) is to develop and deliver leading edge advances in medical simulation education, research, and readiness. Both computer- and non computer-based simulators are employed. The SimCen is part of the Uniformed Services University (USU). Since April 1999, the SimCen has trained more than 1300 USU medical students, residents, and physicians in over 27,000 training encounters. The SimCen conducted the nationís first fully simulation-based Advanced Trauma Life Support course. The SimCen has developed, or has in its possession, many first-in-kind computer-based surgical simulators. They include simulators for vascular anastomosis, pericardiocentesis, diagnostic peritoneal lavage, and cricothyroidotomy. Simulators for pulmonary artery catheterization, and the management of intracranial hematoma are under development. We will be demonstrating our cricothyroidotomy simulator with 3D graphics and haptic feedback. We will also be testing new navigational paradigms for Project TOUCH virtual environment. Project TOUCH is a collaboration between the University of New Mexico, the University of Hawaii, the Pacific Telehealth and Technology Hui, and the SimCen.

National Institute of Biomedical Imaging and Bioengineering (NIBIB)
National Institutes of Health
Bethesda, MD
www.nibib.nih.gov

Cheryl Fee
info@nibib.nih.gov

The National Institute of Biomedical Imaging and Bioengineering leads the development and accelerates the application of emerging and breakthrough biomedical technologies in order to improve human health. The Institute is

committed to integrating the engineering and physical sciences with the life sciences to advance basic research and medical care. The NIBIB is one of the 27 Institutes and Centers that comprise the National Institutes of Health, an agency of the U.S. Department of Health and Human Services.

Pacific Telehealth & Technology Hui
Honolulu, HI
www.pacifichui.org

Nancy Downes
Nancy.Downes@pacifichui.org

The Pacific Telehealth & Technology Hui ('Hui') is a joint venture of the Department of Defense and Department of Veterans Affairs formed in 1999 with the support and encouragement of U.S. Senator Daniel K. Inouye. A subsidiary of the Telemedicine and Advanced Technology Research Center (TATRC) under the U.S. Army Medical Research and Materiel Command, the Hui facilitates interdisciplinary research partnerships with government, academia and industry to advance the development of emerging technologies and improve health care for beneficiaries in the Pacific region. At this year's MMVR, the Hui exhibit booth will feature three of its collaborative projects with the University of Hawaii Telemedicine Research Institute and the University of New Mexico Medical School. These virtual reality (VR) initiatives, developed for use in medical education, include simulations of the nephron function and a head trauma medical rescue, as well as a haptics/VR surgical and fine-motor skills training application. The Hui booth will also showcase two applications developed for its VR Behavioral Health Program - one is used in the treatment of post traumatic stress disorder in war fighters returning from Iraq and Afghanistan; the other was developed for use in smoking cessation intervention therapy.

Princeton Autism Technology
Princeton, NJ
www.AutismTechnology.org

Sharon Oberleitner
SharonOber@aol.com

PAT will demonstrate technologies that facilitate treatment, research and understanding of autism. These include: 1) CareLog image capture system as an imaging modality for behaviors, 2) TalkAutism distance learning, web services, and 3) CNow telehealth solutions via interactive video.

SAGES / SLS Project
Los Angeles, CA
www.FLSProgram.org

Lisa Jukelevics, Project Manager
FLS@SAGES.org

The Fundamentals of Laparoscopic Surgery (FLS) is a new educational program designed to teach the physiology, fundamental knowledge and technical skills required in basic laparoscopic surgery and offers a means to measure and document those skills. FLS includes two multi-media CD-ROM-based study guides, and a laparoscopic trainer box and accessory kit designed to develop psychomotor skills and dexterity incorporating tasks developed and validated through the MISTELS Program at McGill University. It also includes a validated, two-part proctored examination that assesses cognitive knowledge, clinical judgment and technical skills. FLS is the first program to provide a standardized, comprehensive curriculum and validated assessment tool in basic laparoscopic surgery. FLS gives surgical residents, fellows and practicing surgeons the opportunity to study and practice laparoscopic surgical procedures and techniques in a safe environment on their own time and at their own pace. The overarching goal of the FLS program is improved patient care and the advancement of minimally invasive surgery. FLS was developed and validated by SAGES and launched through a partnership with the American College of Surgeonsí Division of Education. For more information or to request a brochure please call 310.437.0544 ext 115, e-mail fls@sages.org or visit www.flsprogram.org.

SensAble Technologies, Inc.
Woburn, MA
www.sensable.com

Mark Tatkow, Sales Director, The Americas
mtatkow@sensable.com

SensAble Technologies, Inc. is a leading provider of 3D touch-enabled digital solutions for commercial software development, academic and commercial research, product design, and digital content creation. At the core of SensAble products is the PHANTOM line of haptic devices, which makes it possible for users to touch and manipulate virtual objects. Developers use SensAble haptic devices and toolkits in a broad range of applications including maxillofacial and cranial reconstruction, medical simulation, virtual training, molecular modeling, nano-manipulation, robotics, and teleoperations. Selected customers include Boeing, 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 sales offices in Europe, Japan, and China. SensAble products are available through direct and reseller channels.

SenseGraphics AB
Kista, Sweden
www.sensegraphics.com
www.H3D.org

Tommy Forsell
tommy.forsell@sensegraphics.com

SenseGraphics combines haptics (sense of touch) and graphics in a range of hardware and software products. Our flagship product, H3D API, is an open-source, open standards, C++ API for development of hapto-visual VR applications.

VHTK, developed in conjunction with Linkoping University, offers researchers a powerful and easy-to-use platform for haptic exploration of medical volume data. Our hardware platform, a 3D stereoscopic hand-immersive workbench, provides a natural 3D interface for haptics. SenseGraphics will also demonstrate a range of rehabilitation applications aimed initially at stroke rehabilitation—using our hardware and software expertise to make rehabilitation stimulating and rewarding, as well as offering rehabilitation metrics for research into stroke.

Telemedicine & Advanced Technology Research Center (TATRC)
Ft. Detrick, MD
www.tatrc.org

Lori DeBernardis
debernardis@tatrc.org

For this year's 2006 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 expand 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 around 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.

Virginia Economic Development Partnership
Richmond, VA
www.YesVirginia.org

Dave Enghauser, Marketing Manager
denghauser@YesVirginia.org

Virginia provides modeling and simulation companies an unrivaled combination of assets needed for success, including a pro-business environment, the Virginia Modeling and Simulation Center, numerous federal research and development facilities, abundant military installations, and acclaimed universities. We invite you to contact the Virginia Economic Development Partnership.

Presenter Abstracts

MMVR 14

MEDICINE MEETS VIRTUAL REALITY

PRESENTATION OVERVIEWS

New Tools for Sculpting Cranial Implants in a Shared Haptic Augmented Reality Environment

Presenter: Zhuming Ai PhD

New volumetric tools were developed for the design and fabrication of high quality cranial implants from patient CT data. These virtual tools replace time consuming physical sculpting, mold making and casting steps. The implant is designed by medical professionals in tele-immersive collaboration. Virtual clay is added in the virtual defect area on the CT data using the adding tool. With force feedback the modeler can feel the edge of the defect and fill only the space where no bone is present. A carving tool and a smoothing tool are then used to sculpt and refine the implant. To make a physical evaluation, the skull with simulated defect and the implant are fabricated via stereolithography to allow neurosurgeons to evaluate the quality of the implant. Initial tests demonstrate a very high quality fit. These new haptic volumetric sculpting tools are a critical component of a comprehensive tele-immersive system.

Geometric Nonlinearity: Is it Important for Real-Time FEM Surgical Simulation?

Presenter: Ron Alterovitz PhD (Cand)

The Finite Element Method (FEM) is often used in real-time surgery simulation and planning to simulate small and large deformation of human tissue. Past work often relies on linear FEM, which assumes that tissues exhibit linear elastic material behavior and geometric linearity (relatively small deformations). We compare linear versus nonlinear geometry assumptions for a case study in the deformation of the prostate. In magnetic resonance spectroscopy imaging (MRSI), an endorectal probe is inserted, causing significant deformation of the prostate and surrounding tissues. We simulate the tissue deformations caused by probe insertion using the commercially available software ABAQUS. As a percent of the overall prostate diameter (4.58 cm), results indicate only a 3.7% average difference with a 6.7% maximum difference in simulated tissue deformations. In this case, the difference is small but nonlinear geometric modeling is helpful in avoiding overlapping degenerate elements caused when assuming linearity in high distortion areas.

Reification of Abstract Concepts to Improve Comprehension Using Interactive Virtual Environments and a Knowledge-Based Design: A Renal Physiology Model

Presenter: Dale C. Alverson MD

Reification is the process of making abstract concepts, beyond the realm of direct human experience, concrete and accessible to teachers and learners. Using a knowledge-based design process and appropriate subject matter experts, knowledge structure methods are applied in order to prioritize and characterize important relationships, creating a concept map that can be integrated into the reified models being developed. Applying these principles, we have been developing a reified model of the nephron into which important physiologic functions can be integrated and rendered in a virtual environment. The nephron model can be driven dynamically by a rules-based artificial intelligence engine with which the learner interacts. In the future, the nephron model can be used to demonstrate a number of physiologic principles or a variety of pathological processes that may be difficult to teach and understand. In addition, this approach can be applied to other physiologic and pathological concepts in other systems.

A Surgical and Fine-Motor Skills Trainer for Everyone? Touch and Force-Feedback in a Virtual Reality Environment for Surgical Training

Presenter: Christoph Aschwanden PhD (Cand)

Surgical and fine-motor skills are traditionally taught in laboratory environments where an expert instructor interacts with students. However, access to laboratories is limited by resources, while lab training is not currently possible for distance learning. We propose a solution which enables hands-on, interactive, objectively scored and appropriately mentored learning in a widely accessible environment. A virtual-reality motor-skills trainer is prototyped using Spring and Flatland as the underlying development tools. The trainer is specifically designed to teach baseline fine-motor skills used in surgery. Bead-like objects of various sizes are manipulated in 3D virtual space. Haptics is utilized for touch and force-feedback to provide more human-computer interaction and realism then previously possible for personal-computer applications. Our presentation will conclude with a short demonstration of the prototype implemented.

Towards a Computer-Aided Surgery System for Shoulder Prosthesis Placement

Presenter: Hakim Atmani PhD (Cand)

The substitution of the articulations of the knee and the hip by prostheses is a procedure which succeeds well. However, the case of the shoulder is much less obvious. The main cause of the failure of the positioning of the prosthesis is related to the anatomy of the shoulder. The visual field of the surgeon is very limited during the operation because a small incision is carried out on the patient to limit the damage to surrounding tissues. Consequently, only the sleeve of the scapula and the humeral head are exposed. The goal of this work is the development of a virtual reality system in order to ease the preoperative and peroperative work for surgeons when substituting the shoulder articulation by prosthesis. The

paper will address these different steps have been identified: modeling the bones of human shoulder from medical images of the patient; simulation of the operation from this model (preoperative virtual surgery); designing of a real-time augmented reality system for peroperative work.

A Topologically Faithful, Tissue-Guided, Spatially Varying Meshing Strategy for the Computation of Patient-Specific Head Models for Endoscopic Pituitary Surgery Simulation

Presenter: Michel A. Audette PhD

This paper presents a method for tessellating tissue boundaries and their interiors, given as input a tissue map consisting of relevant classes of the head, in order to produce anatomical models for finite element-based simulation of endoscopic pituitary surgery. Our surface meshing method is based on the simplex model, which is initialized by duality from the topologically accurate results of the Marching Cubes algorithm, and which features explicit control over mesh scale, while using tissue information to adhere to relevant boundaries. Our mesh scale strategy is spatially varying, based on the distance to a central point or linearized surgical path. The tetrahedralization stage also features a spatially varying mesh scale, consistent with that of the surface mesh.

Determination of Face Validity for the Simbionix Lap Mentor Virtual Reality Training Module

Presenter: Ifesegun D. Ayodeji MD

The first full-procedural virtual reality trainer has emerged: LAP-Mentor by Simbionix. Its application in the surgical curriculum requires validation. Face validation is the first step: determining experts and referents opinions on the basis of simple inspection.

After a hands-on introduction to LAP-Mentor all 49 participants filled out a standardized questionnaire. They were classified ´experts´ and `referents´. No significant difference was found between the answers from both groups on content questions.

All respondents value procedural training. 88% expect LAP-Mentor to increase the trainees' capability, 84% predict a reduction of the laparoscopic cholecystectomy learning curve, 59%feels the surgical curriculum is incomplete without VR-training, and 96% experiences training on the simulator as 'fun'.

As training on this simulator is perceived both effective and entertaining, enthusiasm among future trainers and trainees is to be expected. Further validation of the system

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Enhancing the Visual Realism of Hysteroscopy Simulation

Presenter: Daniel Bachofen

The target of our current research is the development of a highly realistic simulator for hysteroscopic interventions. Our goal is to go beyond training of basic manipulative skills, but enable procedural training. Therefore, the comprehensive and realistic display of the surgical site is a key element. We developed a graphics framework, which handles a vast number of visual cues, for instance bleeding, tissue fiber movement, or bubbles. Furthermore it simulates lens distortion and provides extended surface visualization to achieve highly realistic rendering. All these effects are interactive and adapted in real-time according to user input. The graphics engine is stand-alone and can easily be adapted to a different surgical application area.

The Surgical Simulation and Training Markup Language (SSTML): An XML-Based Language for Medical Simulation

Presenter: James A. Bacon MS

Energid Technologies is developing an XML based language for representing all aspects of surgical simulation and training called the Surgical Simulation and Training Markup Language (SSTML). The language can be used to describe everything from organ models to detailed surgical scenarios.

We will present an overview of the language and discuss how a common data representation can be used to support distributed simulationsósimilar to those used by the DoD for battlefield training. We will present a sample XML schema of SSTML and show a surgery scenario being developed by Energid in consultation with surgeons at Massachusetts General Hospital. We will also discuss how SSTML integrates into our larger untethered surgical simulation and training system.

Virtual Presence in Disaster Response

Presenter: David Balch MA

Surge capacity issues are a major challenge in preparing for the threat of Biological and Chemical attacks as articulated by terrorist factions against the United States or by force of nature (i.e. earthquakes, avian influenza). Surge capacity is the ability of hospitals and medical responders to handle a large surge in the influx of patients. With potential complicating factors such as bad weather, full hospitals, limited ambulances, staff shortages, and the possibility that biological agents will not respect borders but could impact broad reaches of our country, these challenges become even more daunting. This has created a need for healthcare providers to learn about and deploy advanced communication technologies (including virtual presence) in disaster response. DCB LLC

has explored, demonstrated, and (in some cases) developed best of breed advance communication technologies (hardware and software) which optimize situational awareness and clinical response in disasters. This presentation at MMVR will provide an opportunity to share results from a statewide bioterrorism exercise recently conducted in Montana.

Online Robust Model Estimation During In Vivo Needle Insertions

Presenter: Laurent Barbé PhD (Cand)

Soft tissue modeling is of key importance in medical robotics. In the case of percutaneous interventions, a precise haptic perception of layers transitions and target tissues is determining. It allows to convey realist haptic feelings in the case of teleoperation or to control the interactions of a robotic system with organic tissues. Unfortunately, it is established that the nature and the variety of the tissues involved in a needle insertion is such that the interaction modeling is extremely complex. Whereas some biomechanical viscoelastic models can be identified online to take into account the patient's specificities, the methodologies proposed in the case of needle insertion are based on specific tests that are uncompatible with real operations conditions. To offer a solution to this problem, we online estimate a model with varying parameters that is suitable to recontruct needle insertion interactions. The robustness and the precision of the model estimation is illustrated by in vivo experiments in standard operating conditions. The analysis of the model parameters evolution throws a new light on the modelling of needle insertions.

A Software Framework for Surgical Simulation Virtual Environments

Presenter: Lee A. Belfore II PhD

Development of surgical simulators presents various challenges that affect the performance, maintenance, and usability of the simulator. High performance physics based simulations are required to provide realistic tissue modeling. Rendering and visual simulation provide the appearance. Haptics models the sensation of touch in the form of force feedback rendering. Advanced functions include geometry remeshing and collision detection. All fundamentally share a common link in the form of the basic geometry which each of these act upon and update. In this presentation, we introduce a framework for surgical simulation virtual environments that links all of the major components just described through the geometry and more specifically the coordinates (or displacements) of the geometry vertices. A multithreaded class structure allows each to operate autonomously with synchronization enforced when the shared geometry is updated. An example implementation is presented to demonstrate the framework.

The Use of a GripForce System to Map Force Distribution Patterns of Laparoscopic Instruments

Presenter: Fernando Bello PhD

Since the advent of laparoscopic surgery, surgeons have complained about uncomfortable instruments and stressful working positions. Not only are the instruments uncomfortable, but it is well documented that many actually cause neuropraxia and pain. It is acknowledged that the forces required to manipulate the instruments are important and that compressive forces can be concentrated at certain points on the hand in some instrument designs. Using a previously developed GripForce system we compared the force distribution of varying instruments. Instruments acknowledged as being more comfortable and having ergonomic designs had different force distribution patterns. Poor ergonomically designed instruments showed concentration of large forces on small areas of the hand whilst ergonomic instruments allowed for a greater spread of force. Analysis of force distribution patterns of laparoscopic instruments can help towards improving instrument design as well as providing useful feedback to trainees and surgeons.

Simulating Tele-Manipulator Controlled Tool-Tissue Interactions Using a Nonlinear FEM Deformable Model

Presenter: Fernando Bello PhD

Providing augmented reality facilities for robotically assisted minimally invasive surgery enables the surgeon to view information from pre-operative scans overlaid onto the intra-operative video. This information may be used for guidance or navigation during a procedure. The Da VinciTM system is currently used for surgery in which the environment is highly dynamic. In order to ensure that the data overlaid onto the video stream is accurate, the tool-tissue interactions that occur must be accounted for in the 3D reconstructions before it is merged with the video and displayed. A methodology to produce a non-linear finite element model that reacts to inputs computed from the forward kinetics of the Da VinciTM's instruments is described. This allows the tetrahedral model to be updated and the overlay refreshed to give an accurate representation of the scene.

The Impact of Video Technique in Anesthesia

Presenter: George Berci MD FACS FRCS Ed(Hon.)

Using a standard laryngoscope, a small TV camera was inserted into the handle creating a panoramic enlarged view of the larynx instead of a narrow, key-hole vision of the naked eye. The magnified image provides faster perception and easier manipulations with fewer attempts. Television display is the method of choice in teaching. We have successfully employed it in several hundred cases. If assistance is

required, (i.e. cricoid pressure), the movements are well coordinated because both parties can observe the image simultaneously. It is particularly important in the difficult airway situations, (obesity, emergencies, etc...). One of the major reasons why Minimally Invasive Surgery has become so well disseminated is the ability for the entire surgical team to observe the magnified view of the enlarged anatomy as is shown on the monitor.

Augmented Assessment as a Means to Augmented Reality

Presenter: Bryan P. Bergeron MD

The rate of technological change has accelerated continually for the past century. However, proper assessment, which is based on the scientific method, is either performed or glossed over because of time or monetary issues. Neither approach is acceptable in a time of accelerating change. A better assessment methodology is required - one that provides developers with a toolset that bypasses the limitations of traditional assessment. Candidates include the practice of rapid prototyping from the software industry, in-silico methods of performing assessment based on bioinformatics work, and encapsulation methods borrowed from Object Oriented programming. There is also a need for standards and methods of communicating assessment findings among similar systems. Innovation should be focused on improving assessment technologies before we either give up on assessment or give in to the lengthy and expensive process that was devised before the first electrical computer circuit was constructed.

Ballistic Injury Simulation Using the Material Point Method

Presenter: Martin Berzins PhD

Modeling the mechanical failure of soft tissue can help to predict the type and extent of spatial damage, providing information that is necessary to predict physiology and outcome. The objective of the present research was to apply a previously developed soft tissue failure model to study ballistic wounds to the heart with the Material Point Method (MPM). An accurate model of a porcine heart discretized into material points. The myocardium particles contained data about the local collagen fiber direction and the extrafibrillar matrix. A cylindrical projectile was modeled using an elastic-plastic material with neo-hookean elastic material properties. The results showed a realistic wound tract that reflects the geometry of wound tracts observed in experimental studies on cadaveric and animal tissue. The main advantages of the present framework are the easiness to discretize complicated geometries, the ability to implement arbitrary constitutive models and to accommodate large computations with excellent parallel scaling.

Bounds for Damping that Guarantee Stability in Mass-Spring Systems

Presenter: Yogendra Bhasin MSEE

Mass-spring systems are often used to model anatomical structures in medical simulation. They can produce plausible deformations in soft tissue, and are computationally efficient. Determining damping values for a stable mass-spring system can be difficult. Previously stable models can become unstable with topology changes, such as during cutting.

In this presentation, we show how bounds can be derived for the damping coefficient in a mass-spring system. Our formulation can be used to evaluate the stability for user specified damping values, or to compute values that are unconditionally stable. We will also present the class of optimally damped systems that reach a steady state in the shortest time after an initial perturbation. These models have the visually pleasing property that the object does not oscillate before coming to rest, an important property when simulating many anatomical structures.

Medical Cognitive Readiness: From Theory to Practice

Presenter: Cheryl A. Bolstad PhD

Medical teams benefit from enhanced Cognitive Readiness when deploying to Iraq, Afghanistan and elsewhere. We have been developing a Decision Support System (DSS) called Medical Cognitive Readiness Statusing Techniques (M-CREST) for use by military medical personnel. The M-CREST system is designed to identify cognitive readiness needs of the individual and provide prescriptions that are tailored for each recipient while at the same time protecting their confidentiality. M-CREST was created from factors identified as highly important to the maintenance and formation of cognitive readiness including: Behavioral Style, Cognitive Resources, Communication, Decision Making, Leadership, Problem Solving, Team Social Factors, and Training/Education. M-CREST is comprised of various modules that measure these factors. The factors were determined based on ratings from medical personnel deployed in the US, Afghanistan and Iraq. We will be presenting our early prototype of this system, which will be tested in the field in early 2006.

Combining High Fidelity Patient Simulation with a Standardized Family Member: A Novel Mixed Reality Approach to Teaching Breaking Bad News

Presenter: Mark Bowyer MD FACS

Breaking Bad News (BBN) is a skill that is often neglected in medical school curricula. We have developed a novel approach using mixed reality in which a Human Patient

Simulator with a gun shot wound dies under the care of a student who must then inform the wife played by a standardized actress of the news. Seventy-six students were divided into two groups: no training for BBN (n=39) or a didactic lecture and a one hour practice on BBN (n=37). Both groups showed marked improvement over baseline skills. Those who received pre-training were rated significantly higher on several communication skills by the standardized wives (who were blinded to group). The results of this pilot study will serve as a template for future curricular development.

Surgical Workflow Modeling

Presenter: Oliver Burgert PhD

Without a clear understanding of the surgical workflow, the impacts of technology or changes in surgical strategies are hard to evaluate. Most assumptions about computer assisted surgery are very subjective, depending on the surgeon, used technique and the other OR-affecting workflows in the hospital. To obtain a reliable basis for carrying out research on optimizing methods and techniques for surgical interventions, it is important to find a way to describe and analyze what actually happens during the surgical intervention. One of the research focus of the Innovation Center Computer Assisted Surgery (ICCAS) in Leipzig, Germany addresses the above problems and leads to the development of tools for surgical workflow modeling and presentation.

Virtual Medical Simulation Training for Nerve Block Anesthesiology

Presenter: Allen Burnett PhD

This Virtual Medical Trainer (VMT) will utilize virtual simulation to train military anesthesiologists to perform nerve block regional anesthesiology for pain management. While simulation training can be delivered in dedicated simulation training centers, it also can be adapted for delivery “over the Internet,” utilizing High Level Architecture (HLA) virtual modeling and simulation technologies. The VMT will also use advanced distributed learning (ADL) methodologies for this Internet delivery. Appropriate metrics will be developed to assess medical skill proficiency. The project will also address joint mission readiness training solutions of medical/surgical significance to provide care for the war fighter from in-theater to stateside. The primary interaction during the virtual simulation will be controlling the movement of the needle while seeing a subjective view “from the eye of the needle.”

Naval Medical Knowledge Management System: Providing In-Theater Visibility across the Entire Evacuation Chain

Presenter: Ruth A. Bush PhD

Medical operations management requires patient encounter information available throughout the echelons of care, data for logistical planning, and comprehensive, longitudinal records for research.

The Naval Medical Knowledge Management System (NMKMS), built on an n-tier architecture, uses an underlying data repository with star schema design to store raw data gathered by existing tools, such as CHCS II T and CTR. Once standardized, the multi-service data commingle and are easily analyzed.

The NMKMS is in spiral development. When fully developed, this server-based system will feed the Department of Defense Clinical Data Repository, with in-theater visibility across the entire evacuation chain (including other services.)

The NMKMS architecture will serve as a prototype for the TMIP-J Program Office, enhance command and control by providing a user-friendly interface to sophisticated data sources, such as TRAC2ES, CHCS, CHCS II T, CTR, and BMIST, and provide the foundation for a truly common operational picture for naval medicine.

Tissue Engineering Templates Using Minimal Surfaces

Presenter: Bruce M. Cameron MS

Preformed scaffolds used in tissue engineering are biomimetic "trellis-like" structures which, on implantation and integration, act as tissue surrogates. Such scaffolds are generically fabricated using tessellations of unit cells derived from Boolean intersections of geometric primitives like spheres and cylinders. While such constructs can be modeled easily using existing CAD tools, these lattice constructs do not provide an efficient environment in which the cells can cling, crawl and proliferate. The geometry that would best mimic the required structural configuration would be one that is continuous through all space, divided into two sub-spaces by a non-intersecting two-sided surface. Minimal surfaces are ideal to describe such a space. While natural examples of minimal surfaces exist in the form of soap films, practical applications of minimal surfaces are rare. This paper presents one of the very first practical applications of minimal surfaces for the construction of efficient unit cell based tissue engineering scaffolds.

GiPSiNet: An Open Source/Open Architecture Network Middleware for Surgical Simulations

Presenter: M. Cenk Cavusoglu PhD

Among the various simulation methods for surgical education, virtual environments are a promising new medium. The accessibility of surgical virtual environments can be substantially extended by network communications. The resulting networked simulations will enable continuing education and advanced training over wide geographical areas. Our objective is to build a general networked surgical simulation framework by adding a network extension to our previous GiPSi (General Interactive Physical Simulation Interface) prototype. GiPSi is our open source/open architecture framework for developing surgical simulations and works on individual workstations. Network extension of GiPSi involves a middleware module (GiPSiNet) to remediate for the lack of network QoS and to enhance the user-perceived quality of a networked simulation. In this presentation, we show the architectural design of the GiPSiNet middleware. Meanwhile, we provide an overview of the techniques to ensure timely data delivery over the network.

Evaluation Methods of a Middleware for Networked Surgical Simulations

Presenter: M. Cenk Cavusoglu PhD

Distributed surgical simulations are desirable since they substantially extend the accessibility of surgical resources by network communication. However, network conditions critically affect the quality of a networked surgical simulation. A solution to this problem is to build a middleware to remediate for the lack of network QoS. To comprehensively test the effectiveness of such a middleware, we propose several evaluation methods in this presentation.

The first step of the evaluation is to develop a framework for the semi-automatic evaluation of surgical simulation. We give criteria on how to choose a benchmark task, and show some examples and corresponding performance metrics. Then, we introduce methods to measure the overhead (time, throughput) and the computational requirement imposed by a middleware. At last, we give some guidelines of the usability test and list the issues related to the network influences on user experiences.

Virtual Environment-Based Training Simulator for Endoscopic Third Ventriculostomy

Presenter: M. Cenk Cavusoglu PhD

A virtual neuroendoscopy simulation for third ventriculostomy is being developed by constructing patient specific models of the ventricular geometry for use in the GiPSi open source/open architecture framework for surgical simulation. This is being accomplished by starting from magnetic resonance images (MRI) of the patients, creating a visually and dynamically realistic virtual environment using these models, and constructing a training simulator using this virtual environment to teach the steps of the endoscopic third ventriculostomy. Realistic visualization of the surgical scene is achieved by using advanced shading models implemented in the OpenGL Shading Language. Interaction with the user is implemented by modification of the PHANTOM® Omni™ Haptic Device. Finally, realistic physical behavior of model is simulated to provide a life-like representation by using mass-spring-damper method and finite element method.

Smart Tool for Force Measurements During Knee Arthroscopy: In Vivo Human Study

Presenter: George Chami MD

We present a smart tool for measuring the forces that is applied on an arthroscopic probe during surgery. An in vivo human study of knee arthroscopy was conducted for different grades of surgeons; the result quantified the variation on forces in each compartment of the knee and in standard arthroscopic tasks. An understanding of arthroscope probe forces is important in developing an effective virtual arthroscopic training system with haptic feedback. The pattern of forces produced by the study was analysed with the aim of providing objective parameters of surgeon's performance, and as an aid in diagnosis of pathologies.

Factors Affecting Targeting Using the Computer Assisted Orthopaedic Surgery System (CAOSS)

Presenter: George Chami MD

We present a study of six factors that affects the difficulty of targeting in 3D space for computer assisted orthopaedic surgery systems. The study quantifies the effect of each element on the procedure time and the learning curve. Evaluation of the results of the current CAOS system has led to the development of a new design for a jig for trajectory targeting for the dynamic hip screw operation.

A Mass-Spring Deformable Surface Model for Soft Tissue Simulation with Haptic Feedback

Presenter: Pei Chen PhD

This paper proposes a mass-spring deformable model for soft tissue modeling for virtual surgery simulations. The proposed method simulates the deformations of soft tissues utilizing triangular surface meshes modeled by mass-spring nets. Deformations at the surface contact point are computed by solving a dynamic differential equation. Propagation of defor-

mations to the rest of the surface nodes is modeled by traversing a deformed node index table (DNIT). Compare to previous deformable models that utilize volumetric data, the proposed method greatly reduces computational cost, since only surface data are involved in the deformation computations. As a result, real-time simulations are easily to generate using high-resolution object model. The proposed method has been implemented in a virtual surgery simulator. Simulation results show that, coupled with PHANTOM haptic device, the simulator is able to provide a user with real-time visual and haptic feedbacks.

Contouring in 2D while Viewing Stereoscopic 3D Volumes

Presenter: WeeKee Chia BSE

In segmentation, the ability to manually contour structures allows precise control over the process; frequently, automatic segmentation is not applicable to structures with unclear boundaries; and in some fields, like radiation therapy, the contours require user-definition. Lack of 3D context while contouring is a main difficulty: it requires constant shifting between 2D views (where contours are drawn) and 3D views (where context is appreciated)). We present an contour editing tool that integrates the views of contours and their corresponding volumetric data to assist in defining the contours. This tool is immersed within a virtual environment for surgical planning and diagnostics, the Dextroscope. This stereoscopic two-handed interaction volumetric system provides the user with fast hand-eye coordination and clear visualization of the volumetric data and contours hence providing greater control and flexibility in the volume segmentation workflow. The tool is used in clinical routine for the segmentation of brain tumors, etc.

Integrative Haptic and Visual Interaction for Simulation of PMMA Injection During Vertebroplasty

Presenter: Chee-Kong Chui PhD

In vertebroplasty, physician relies on both sight and feel to properly place the bone needle through various tissue types and densities, and to help monitor the injection of PMMA or cement into the vertebra. Incorrect injecting and reflux of the PMMA into areas where it should not go can result in detrimental clinical complication. This paper focuses on the human-computer interaction for simulating PMMA injection in our virtual spine workstation. Fluoroscopic images are generated from the CT patient volume data and simulated volumetric flow using a time varying 4D volume rendering algorithm. The user's finger movement is captured by a data glove. Immersion CyberGrasp is used to provide the variable resistance felt during injection by constrainting the user's thumb. Based on our preliminary experiments with our interfacing system comprising simulated fluoroscopic imaging and haptic interaction, we found that the former has a larger impact on the user's control during injection.

Flow Visualization for Interactive Simulation of Drugs Injection During Chemoembolization

Presenter: Chee-Kong Chui PhD

Chemoembolization is an important therapeutic procedure. A catheter was navigated to the artery that feeds the tumor, and chemotherapy drugs and embolus are injected directly into the tumor. There is a risk that embolus may lodge incorrectly and deprive normal tissue of its blood supply. This paper focuses on visualization of the flow particles in simulation of chemotherapy drugs injection. We assume that the flow follows a defined path in the hepatic vascular system from the catheter tip. The vascular model is constructed using sweeping and blending operations. Quadrilaterals which are aligned to face the viewer are drawn for the trail of each particle. The quadrilateral in the trail is determined using bilinear interpolation. On simulated fluoroscopic image, the flow is rendered as overlaying and semi-transparent quadrilaterals representing the particles' trails. This visualization model achieves a good visual approximation of the flow of particles inside the vessels under fluoroscopic imaging.

The Use of a Computer Aided Design (CAD) Environment in 3D Reconstruction of Anatomic Surfaces

Presenter: Octavian Ciobanu PhD

CAD is now being used extensively in biomedical engineering in applications ranging from clinical medicine and customized medical implant design, to tissue engineering, with many novel and important medical applications. In this paper we have evaluated and compared the following two different types of software for generating a CAD model from medical imaging data: first, a Mimics interface approach, by Materialise and second an engineering CAD (AutoCAD and Solid Works) interface approach. The outline of the comparison and comments of these two methods for a case study of an anatomic surface are presented in some tables and figures. An important limitation of using 3D reconstruction specialized software and engineering CAD software is the difficulty in capturing anatomical surfaces with complicated geometry. Effective methods for the conversion of CT or MRI data into CAD solid models still need to be developed.

The Effect of Virtual Immersive Scenarios in High Human Cost Task Based Learning

Presenter: Corinne E. Collier BSc

Task based learning has moved rapidly from use of text, multimedia, virtual reality and more recently immersive scenario technologies as didactic tools to an ever widening audience of users. This paper discusses research into the use of 3D stereoscopic film, within a Cave - like environment to produce an immersive scenario to train and test participants in

high human cost, task based learning. The choice of computer manipulated 3D stereoscopic film rather than computer generated animation is driven by the correlation in 3D computer generated environments of poor "extended presence" (engagement) when the medium is unrealistic and ìlack of real world consequence" when the medium resembles a games console environment.

Simulating the Domain of Medical Modeling and Simulation: The Medical Modeling and Simulation Database

Presenter: C. Donald Combs PhD

The National Center for Medical Modeling and Simulation (NCCMMS) has expanded its Medical Modeling and Simulation Database (MMSD) to include new sections to evaluate simulators in a "Consumer Reports" style and a new message board for those organizations wishing to get into contact with fellow researchers. The simulator evaluation will be conducted in accordance with set a criterion that varies by simulator type to remove any bias. Similarly the message boards will be used strictly for research purposes and not for a company's self-promotion. The database itself has been expanded to include 130,000 entries with 200 new companies and conferences. We anticipate that the expanded versions of the NCCMMS site and MMSD will foster further collaboration between like-minded researchers. It is the hope of the NCCMMS that our website will help develop the medical modeling and simulation field by establishing limiting criteria and providing a centralized location for discussion.

Surgical Multimedia Academic, Research and Training (S.M.A.R.T.) Tool: A Comparative Analysis of Cognitive Efficiency for Two Multimedia Learning Interfaces

Presenter: Charisse Corsbie-Massay MA

Our presentation will begin with a brief overview of research regarding the efficiency of multimedia learning tools (MMLs). Our findings show that although MMLs are employed at many levels of medical education, there is little quantitative evidence for successful techniques. We will present a series of guidelines extracted from existing and new research that can be used to create a cognitively efficient MMLs. The design of the interfaces used in our randomized study will be explained thoroughly. We will present our results and outline how to use these guidelines to create a more cognitively efficient learning tool. A large portion of our presentation will be dedicated to describing guidelines for MML development and ideas for future research. Our literature review, entitled "Guidelines for Cognitively Efficient Multimedia Learning Tools: A review of literature relating to educational strategies, cognitive load and interface design," is currently in publication with Academic Medicine.

Assessing Cognitive & Motor Performance in Minimally Invasive Surgery (MIS) for Training & Tool Design

Presenter: Sayra M. Cristancho PhD (Cand)

The current surgical training process will be explored to highlight the reported problems related to assessing surgical performance. This will provide the appropriate background to introduce our proposed structured evaluation system, which is composed of two phases: event sequence analysis and in-context analysis of surgeon motor performance. In this presentation, we will focus on results from the first phase by describing the processes we implemented to map surgical procedures using task sequence decomposition and to integrate motor performance into our proposed MCMD - motor and cognitive modelling diagram. Although our first application and test case was laparoscopic cholecystectomy, we will also present results for laparoscopic colorectal procedures to demonstrate its general applicability. Finally we will provide a concise description of potential applications of our proposed modelling technique.

Image Guided Cannulation of Central Veins Using Real-Time Machine-Vision Analysis and Live Image Fusion - A Precursor to Fully Automated Motion Control

Presenter: Michael N. D'Ambra MD

Intravenous access is a critical component of trauma resuscitation. After control of the airway and the arrest of hemorrhage, venous access is the most important intervention. We programmed an algorithm for ultrasound vessel identification and target recognition using Halcon machine vision software. Halcon operators detect vein and artery edges, identify the vein center, measure distance from origin to vein center and fuse this derived data on the ultrasound image in near real time (<70msecs). When the target is aligned, the needle is advanced the distance to target center. When the needle is visualized in the lumen of the vessel, the wire is inserted and then the catheter is threaded. A handheld version may be used in civilian medical practice when cannulation by routine approaches fails. The automated version could be applied in remote location trauma treatment such as in space, the "trauma pod", or other hostile environments.

Measurement of the Mechanical Response of Intra-Abdominal Organs of Fresh Human Cadavers for Use in Surgical Simulation

Presenter: Dhanannjay S. Deo

Determination of soft tissue properties is essential for the realism of the virtual scenarios. However, the major challenge in this field is that soft tissues exhibit complicated mechanical properties including viscoelastic, nonlinear, inhomogeneous, and rate dependent behaviors. For surgical simulation, ideally it is necessary to measure, and then model the

in vivo mechanistic response of the soft tissues operated on. However, the current efforts are either aimed at obtaining ex vivo properties, which are grossly different from in vivo conditions, or utilizing animals such as the porcine tissues which have fundamental differences in anatomy and tissue consistency compared to human tissue. In this work, we develop a set of experiments to obtain biomechanical properties of intra-abdominal organs and perform physical experiments on fresh human cadavers whose results are used to develop constitutive models of soft tissues. Typical results of experiments will be presented at the conference.

Use of Surgical Videos for Realistic Simulation of Surgical Procedures

Presenter: Dhanannjay S. Deo

One of the major challenges in the development of virtual environments for medical simulations is photorealistic rendering, permitting high fidelity visual effects and user interaction. Digitized video recorded from the laparoscopic camera are a rich source of information about surgical scenarios. How to fully utilize the information is important for improving the realism of the simulated scenarios. In reality, the camera viewpoint changes frequently and even for the same viewpoint, the scene is dynamic due to rhythmic heartbeat. Hence, the results of classical texture mapping are usually visually unappealing as they fail to capture the pulsatile effect, as well as other global illumination properties of the scene. In this paper we present a hybrid technique to improve the photorealistic rendering of the virtual surgery scenarios by spatio-temporally utilizing videos recorded during actual surgical procedures.

Selective Tessellation Algorithm for Modeling Interactions Between Surgical Instruments and Tissues

Presenter: Venkat Devarajan PhD

We present a selective spatial tessellation algorithm that is specifically optimized for instrument-to-tissue and instrument-to-instrument collision detection cases, which are the essential part of interaction modeling in surgery simulation with haptic feedback. Virtual surgeries demand haptic rate collision solutions only when instrument objects are involved in collisions; thus tissue-to-tissue collision cases can be processed at slower rates, or merely ignored in some scenarios. This selective tessellation algorithm is capable of differentiating various collision cases and accordingly, assigning different priorities to their processing. Without making a coherence assumption for a scenario, selective tessellation derives clipping volume as collision detection regions, in which objects of interest are exactly located. This algorithm has been implemented in a haptic surgery simulation.

Physically Accurate Mesh Simulation in a Laparoscopic Hernia Surgery Simulator

Presenter: Venkat Devarajan PhD

In a VR based laparoscopic hernia surgery simulator, simulation of the mesh placement procedure is very crucial. During this procedure, a plastic mesh is rolled into a cylinder, and inserted into the abdominal area where it unrolls itself. The surgeon uses other instruments to place and fix the mesh at the proper position to cover the defective area of the patient's abdominal wall. It is therefore necessary to properly simulate the mesh behavior. However, the traditional mass-spring-damper (MSD) model cannot provide correct resistance against bending and the mesh flattens out very slowly.

In this paper we propose a new method to systematically derive and optimize an angular spring based MSD model for accurate simulation of the plastic mesh. We implement this model with optimized parameters and the simulation shows that the resulted mesh is much more realistic.

Virtual Patients: Assessment of Synthesized Versus Pre-Recorded Speech

Presenter: Robert F. Dickerson BS

Virtual Patients have great potential for training patient-doctor communication skills. This research explores which type of speech output should be chosen for virtual patient applications. This study provides insight into the pros and cons of using synthesized speech and evaluates the necessary vocal fidelity for communication skills training. Our approach is to run a user study with medical students that compares synthesized speech and recorded speech conditions in a virtual patient scenario. This will help determine if current speech synthesis technology is capable of preserving simulation accuracy. This pilot study is the first of an ongoing interdisciplinary effort to improve virtual patient technologies by examining not only speech output, but graphics, immersion, and speech understanding and its impact towards the overall simulation.

Needle Artifact Localization in 3T MR Images

Presenter: Simon P. DiMaio PhD

This work explores an image-based approach for localizing needles during MRI-guided interventions, for the purpose of tracking and navigation. Susceptibility artifacts for several needles of varying thickness were imaged, in phantoms, using a 3 tesla MRI system, under a variety of conditions. The relationship between the true needle positions and the locations of artifacts within the images, determined both by manual and automatic segmentation methods, have been quantified and will be presented.

Robot-Assisted Needle Placement in Open-MRI: System Architecture, Integration and Validation

Presenter: Simon P. DiMaio PhD

This work describes an integrated system for planning and performing percutaneous procedures--such as prostate biopsy--with robotic assistance under MRI-guidance. The physician interacts with a planning interface in order to specify a set of desired needle trajectories, based on anatomical structures and lesions observed in the patient's MR images. All image-space coordinates are automatically computed, and used to position a needle guide by means of an MRI-compatible robotic manipulator, thus avoiding the limitations of the traditional fixed needle template. Direct control of intra-operative imaging aids visualization of the needle as it is manually inserted through the guide. Results from in-scanner phantom experiments and details of an imminent clinical trial will be presented.

Zero-Dose Fluoroscopy-Based Close Reduction and Osteosynthesis of Diaphyseal Fracture of Femur

Presenter: Xiao Dong PhD (Cand)

Fluoroscopy is the most common tool for the intraoperative control of long bone fracture reduction. Limitations of this technology include high radiation exposure to the patient and the surgical team, limited visual field, distorted images, and cumbersome verification of image updating. Fluoroscopy based navigation systems partially address these limitations by allowing fluoroscopic images to be used for real-time surgical localization and instrument tracking. Existing fluoroscopy-based navigation systems are still limited as far as the virtual representation of true surgical reality is concerned. This paper for the first time presents a reality enhanced virtual fluoroscopy with zero-dose updates of in situ surgical fluoroscopic images to control diaphyseal fracture reduction and osteosynthesis. Algorithms and methods to achieve this goal will be presented together with the experimental results.

Quantification of Process Measures in Laparoscopic Suturing

Presenter: Adam Dubrowski PhD

Process measures describing generation of movement are useful for evaluation, and performance feedback purposes. This study aimed to identify process measures that differ between novice and advanced laparoscopists while completing a suturing skill.

Ten novice and six senior residents placed 10 laparoscopic sutures in a synthetic model. Process measures were quantified using an opto-electric motion/force sensor assembly recording: wrist rotation, forces, timing, and difference between force application and wrist rotation. Senior residents showed increased wrist rotation, increased force, and faster performance compared to novices (all $p<.01$). However, over trials, only novices showed adaptations for wrist rotation and total time (interactions at $p<.01$) with no adaptation for the force application. The difference between the moments of force application and wrist rotation was not sensitive to participant training.

Movement process measures can enhance our understanding of early adaptation processes and how such factors might be used as feedback to facilitate skill acquisition.

Flat, Flexible Postage-Stamp-Sized Sensor Modules and Networks for Invasive and Non-Invasive Monitoring During Surgical Procedures

Presenter: Martin J. Dudziak PhD

We have developed an instrumentation technology based upon LBL (layer-by-layer) polymer film composition for application to both external and internal sensing and measurement of biomedical parameters. The resulting architecture can be adapted to virtually any phase of surgical or non-surgical treatments including potentially also MRI procedures. This technology is based upon a common architecture employing PET (polyethelene terephthalate) film substrates in which particular sensor elements are embedded and interfaced through a common wireless protocol for communication to data acquisition systems that are external to the patient or in some cases the immediate clinical environment. Circuitry logic is printed into the PET film and does not entail silicon or metallic logic elements. The architecture has been designed to serve multiple modalities of sensing including optical, electromagnetic, and chemical measurements through the ability to physically accommodate different sensor elements in a common medium.

A Mechanism for Detecting Trigger Points and Irreversibility Thresholds in Shock and Trauma for Critical Large-Population Catastrophic Events

Presenter: Martin J. Dudziak PhD

Findings from the field of anomaly and intrusion detection, classically a domain of network engineering and information security, and from the discipline of fluid dynamics and turbulence, both seemingly distant from trauma medicine, may contribute to improvements in response to mass trauma. We address the situation where hundreds or thousands of persons may be subject, within a relatively short period of time, to a very wide and disparate range of symptoms based upon exposure to or ingestion of toxic biological agents, chemicals, radiation, or alternatively injury due to impact trauma from natural effects of storms, earthquakes, or from conventional explosives. We have developed predictive behavior modeling

for identifying likely upcoming moments of anomaly recurrence, an effective component of critical care response both on the battlefield and in the emergency medical response setting.

Fast Assessment of Acetabular Coverage Using Stereoscopic Volume Rendering

Presenter: Randy Ellis PhD

Previous CT-based methods of measuring acetabular coverage of the femoral head have either been labor-intensive or have required extensive pre-processing of the data prior to visualization. We propose a method of measuring acetabular coverage using stereoscopic digitally reconstructed radiographs that required very little labor or image preprocessing time. Taking a craniocaudal view of the pelvis, we measured both preoperative and postoperative CTs of 5 patients treated with transtrochanteric periacetabular osteotomy. The measurements were made in both monocular and stereoscopic rendering modes by two independent subjects. Our method is fast, easy, and provides an intuitive means of visualizing an orthopedic parameter that is important in the progression of early hip arthritis.

Robotic Perception of Mechanical Properties of the Human Skin: A Validation Study

Presenter: Christopher C. Enedah PhD (Cand)

Skin surfaces representing various mechanical properties and skin pathologies are scanned by a texture and stiffness sensing device. The acquired data is analyzed and used to generate a digital representation of the skin surface. Palpation of the same skin surface is carried out by a dermatologist and the results are compared with the digital representation generated earlier. Preliminary clinical data from this validation study will be presented.

A Virtual Reality and Haptic Milling Surgery Simulator - Use High-Resolution Volume Data

Presenter: Magnus G. Eriksson PhD (Cand)

The work presented here describes the use of a surgical training simulator for the milling process developed by the authors. The system will be used to educate and train surgeons for milling operations, i.e. complicated temporal bone operations, such as removal of brain tumors. In our simulator we use high-resolution data sets, which give us very realistic 3D visualization of the milling process. We apply a voxel-based haptic rendering method, which uses voxel density values for force modeling and haptic rendering. This gives a realistic force feedback to mimic the milling process. An energy-based approach is used for modeling of material removed during the milling process. A proxy-based method is used to maintain a tip position on the surface and to avoid fall-through problems. This simulator can also be used in other areas such as dental simulation, simulation of craniofacial surgery and freeform design/sculpting of high-resolution volumetric data sets.

Working Memory and Virtual Image Guided Surgical Simulation

Presenter: Li Felländer-Tsai MD PhD

Advanced simulators for intervention are increasingly used in training of physicians in order to improve patient safety. Several studies show correlatotion between innate visual spatial and surgical performamce in novices. Research in the field of cognition has indicated that Working Memory (WM) seems to be a limited capacity system that temporarily stores and processes information. WM can be viewed as a four component model with a central executive coordinating attention activities and governing responses. 32 medical students participated in the study. Performance from the GI Mentor II and MIST were compared with WM data. In another group of 13 students, the corresponding simulator data were compared with scores from a computer program, RoboMemo. Significant correlations were found between WM scores and the simulator performance scores . The possibility to specific computerized WM training opens up new possibilities for adjuvant practice and optimizing of advanced image guided intervention.

Bootstrapped Ultrasound Calibration

Presenter: Gabor Fichtinger PhD

This paper introduces an enhanced (bootstrapped) method for tracked ultrasound probe calibration. Prior to calibration, a position sensor is used to track an ultrasound probe in 3D space, while the US image is used to determine calibration target locations within the image. From this information, an estimate of the transformation matrix (translation, rotation, and scaling) of the scan plane with respect to the position sensor is computed. While all prior calibration methods terminate at this phase, we use this initial calibration estimate to bootstrap an additional optimization of the transformation matrix on independent data to yield the minimum reconstruction error on calibration targets. The bootstrapped workflow makes use of a closed-form calibration solver and associated sensitivity analysis, allowing for rapid and robust convergence to an optimal calibration matrix. Bootstrapping demonstrates superior reconstruction accuracy, compared to standard techniques.

Image Overlay Guidance for MRI Arthrography Needle Insertion

Presenter: Gabor Fichtinger PhD

Conventional MRI has unmatched potential for guiding and monitoring therapy and MR arthrography is the imaging gold standard to assess small ligament and fibrocartilage injury in joints. Direct MRA consists of two sessions: 1) gadolinium contrast is injected into the joint space under fluoroscopy or CT guidance and 2) within one hour, diagnostic MRI is used to visualize the distribution of contrast and evaluate the joint condition. Our approach to direct MRA is to eliminate the separate radiologically guided needle insertion by performing those tasks on conventional high-field closed MRI scanners. We propose a 2D augmented reality image overlay device to guide needle insertion procedures. The MR overlay displays axial images and virtual needle guides in the appropriate pose in the patient as seen through a semitransparent mirror. This approach makes diagnostic high-field magnets available for interventions without a complex and expensive engineering entourage.

The Use of CT-based 3D Model Construction to Aid in Resection of Heterotopic Ossification after Traumatic Transfemoral Amputation: A Case Series

Presenter: Kevin F. Fitzpatrick MD

We present a case series of five patients with traumatic transfemoral amputations whose courses of rehabilitation were halted by the presence of heterotopic ossification at residual limbs, resulting in difficulty with prosthesis fitting, pain, and skin breakdown. Each patient elected to have surgical resection of heterotopic ossification performed after failure of conservative treatment approaches. In each case, a CT-based 3-D model of the patient's limb was constructed, modeling heterotopic ossification and its relationship to native structures. These models aided in the surgical approach to each patient by providing the surgical team with a three dimensional representation of ectopic bone and its relationship to native muscles, soft tissue, nerves, and blood vessels. The use of the models served to prevent potential surgical complications and improve patient outcomes. We feel that this application will be useful in the future treatment of amputees whose rehabilitation is hindered by heterotopic ossification.

Control System Architecture for a Minimally Invasive Surgical Robot

Presenter: Kenneth J. Fodero II BS

Surgical robotics is a field that is revolutionizing the way in which clinicians deliver health care to their patients. A key consideration of all medical systems, especially those that interact directly with the patient, is safety.

In this paper we describe a system developed to achieve safe and reliable operation of a surgical robot. To achieve safe and reliable operation, our control system consists of a small number of well defined states. For additional safety, the state of the system, as well as a heartbeat signal, is monitored by a Programmable Logic Controller (PLC). Furthermore the surgical manipulator will be enabled and disabled by a surgeon-side foot pedal.

The control system architecture described in this paper is a crucial element in the overall surgical robot system under development at the University of Washington BioRobotics Lab.

Breath Modeling, Application to Ultrasound Simulation

Presenter: Clément Forest PhD

We present here a preliminary model for breath simulation designed to be used in a real-time patient-based US simulator, but applicable to other problems. Starting from a 3D image (CT or IRM) of the patient, the result of our method is a deformation field that will modify in real time the view field of the simulated US probe. Although the study still lake for experimental validation, we presents very good results allowing us to already provide a first example of US simulator with breath simulation.

Virtual Epidural

Presenter: Raymond Glassenberg MD

Currently only artistic drawings, CT scans, and plastic models are available to help visualize the anatomy of the spine and epidural space. A Virtual Reality simulator was created to simulate the interaction of a needle in lumbar tissue. The simulator uses the Sensable Phantom Desktop, a 3D force-feedback "pen" interface with 6 degrees of freedom (DOF) input and 3 DOF haptic output. This simulation allows the user to experience all the potential difficulties associated with placing an epidural, without exposing a patient to the complication of a dural puncture.

Patient-Specific Creation of a Global Static Model of the Bladder Urothelium Using AutoStitch: A Potential Enhanced Clinical Application for the Patient Record

Presenter: Scott A. Gregory BS

Combining digital cystoscopic video and current image stitching software, we designed a program to create a global model of a patient's entire bladder urothelium. Such an image, when attached to the patient record could serve as an effective communication tool regarding a patient's pathology.

The Application of Virtual Reality in the Healthcare Communication Interaction

Presenter: Judith E. Grunwald PhD

In this age of high technology, a critical healthcare component can be jeopardized; that is, the patient/physician relationship. Because it has been determined that this relationship has a direct effect on positive outcomes for the patient, it must not be lost. Therefore, through the use of the aforementioned technology, the communication skills of both physician and patient can be developed and enhanced in a virtual environment atmosphere. With systematic programming, medical students, practicing physicians and patients may practice their verbal and nonverbal skills, receive feedback and proceed to the next level of difficulty in a realistic, but non-threatening situation. Research benefits are available as well, for maximizing communication skills training.

Vision-Based Human-Machine Collaborative System for Ophthalmic Micro-Surgery

Presenter: Gregory D. Hager PhD

Retinal disorders, such as age-related macular degeneration and branch and central retinal vein occlusion are among the leading causes of blindness in the country. Current treatments are risky and unreliable. One reason for the problem is the micro-scale of the environment. We present our research on systems that promotes dexterous motion at micro-scale. Our methodology contains four components: guidance virtual fixtures, JH (surface and tool tracker)U Steady Hand robot, vision-based stereo system, and surgical field modeling. We explain our experiment setup and validation study. Finally we present our results and future developments.

Construction of a Web-Based Virtual Pelvis Trainer

Presenter: Brittany S. Hampton MD

An accessible interactive pelvic anatomy model to enhance the medical training of students, residents and fellows is needed. The Division of Urogynecology and Reconstructive Pelvic Surgery, with Advanced Educational Systems at New York University School of Medicine, is building a web-based "Virtual Pelvis Trainer" (VPT): a 3D anatomy trainer that achieves a real-time interactive element for the user. The VPT harnesses the power of 3D volumetric renderings by delivering to the user a dataset resurfaced for not only dimensional medical visualization, but dynamic manipulation. The application interface was designed for the user to navigate the virtual space of the VPT in an exploratory fashion. As educational software, the VPT has user controlled point-of-views, transparency texturing, voiceover, and embedded animation. The significance of this web-based trainer is its technical achievements and its application as a useful learning module, teaching aid, and demonstration tool.

Highly-Realistic, Immersive Training Environment for Hysteroscopy

Presenter: Matthias Harders PhD

The primary driving application of our current research is the development of a generic surgical training simulator for hysteroscopy. A key target is to go beyond rehearsal of basic manipulative skills, and enable training of procedural skills like decision making and problem solving. In this respect, the sense of presence plays an important role in the training effect, which can be achieved. To enable user immersion into the training environment, the surrounding and interaction metaphors should be the same as during the real intervention. To this end, we replicated an OR in our lab, provided standard hysteroscopic tools for interaction, and generate a new virtual scene for every session. In this setting, the training starts, when the trainee enters the OR, and it ends, when she leaves the room.

A Web-Based Repository of Surgical Simulator Projects

Presenter: Matthias Harders PhD

The idea of using computer-based surgical simulators for training of prospective surgeons has been a topic of research for more than a decade. Several academic projects have been carried out, and a growing number of commercial products are available on the market. Keeping track of all these endeavors for established groups as well as for newly started projects can be quite arduous. Gathering information on existing methods, already traveled research paths, and problems encountered is a time consuming task. To alleviate this situation, we established a modifiable online repository of existing projects. It contains detailed information of a large number of simulator projects gathered from web pages, papers and personal communication. The database is modifiable (with password protected sections) and allows for a simple statistical analysis of the collected data. Currently, all research groups are contacted to verify the stored data. Further information can be found at www.virtualsurgery.vision.ee.ethz.ch.

PelvicSim - A Computational-Experimental System for Biomechanical Evaluation of Female Pelvic Floor Organ Disorders and Associated Minimally Invasive Interventions

Presenter: Balakrishna Haridas PhD

Urinary Incontinence and pelvic floor disorders represent a significant and growing problem in women's health in the United States, and unfortunately is also one of the least researched. This is largely due to the under-reporting of these dysfunctions, as well as the inherent complexity in the natural history & biomechanical origins of these disorders. To better understand the complexity of the three dimensional biome-

chanical interactions among the pelvic floor organs, our group is developing "PelvicSim", a realistic nonlinear finite element modeling environment to simulate the pelvic floor organ system based on imaging and material property data collected in vivo. This simulation system will be used to (a) understand and quantify the in vivo biomechanical origins/mechanisms of UI & POP, and (b) conduct functional evaluations of in vivo biomechanics of new novel devices and therapies designed to treat pelvic floor dysfunction related pathologies in women.

A New Experimental Methodology for In Vivo Measurement of Elastic and Viscoelastic Properties of Pelvic Floor Organs/Tissues

Presenter: Balakrishna Haridas PhD

This study is a part of a larger project aimed at developing in-depth understanding of female pelvic floor disorders including urinary incontinence and organ prolapse that occur in a large percentage of women in the United States. Our aim is to develop a comprehensive nonlinear computational modeling system, PelvicSim to simulate the biomechanical interactions among the pelvic organs, the levator ani muscle and connective tissue support system. A key input into this modeling system is the in vivo nonlinear and viscoelastic constitutive properties of the soft tissues (vaginal, bladder, cervix, levator ani, and fascia). The objective of this study was to measure the local in-vivo biomechanical properties of vaginal wall tissues. This includes the tissues in the suburethral region, the vesico-vaginal, recto-vaginal, and cervical regions. The new non-invasive technique appears to be a promising approach to in vivo characterization of the hyperviscoelastic constitutive properties of pelvic organs and tissues

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Educational Technologies Improve Behavioral Healthcare - The View from SUMMIT

Presenter: Wm. LeRoy Heinrichs MD PhD

SUMMIT's mission is translating medical and life-sciences education into useful information and practices through the innovative use of information technology. Its perspective on behavioral healthcare is very broad; as it focuses on both individuals and groups as beneficiaries, some directly, and others, indirectly. Part of our portfolio of activities, always including educational goals and outcomes, includes online interventions on topics of eating disorders, depression related to breast cancer, and strengthening global immunization management programs for Hepatitis B and Japanese encephalitis, both chronic diseases with high mortality. An online course for empowering medical students to assist in end-of-life issues reduces anxiety and depression via lessons learned about effective communication. Formative research has demonstrated that med students and intern teams practicing in virtual worlds are able to save the virtual lives of trauma patients brought to the virt-Emergency Department. Also, a community of Indian infertility specialists updates knowledge about the physical, technical, and emotional aspects of infertility diagnosis and management, based upon a project developed jointly with SUMMIT. Finally, innovation in emerging technologies for learning healthcare topics has been a recent focus in a series of workshops conducted by SUMMIT on simulation and games in medicine.

Future scheduled online developments are expansion into tele-education and telemedicine practices via MedNet, a new, country-wide. dedicated network in India. Another new venture using multi-player, game technology will develop online opportunities for practicing and confidence-building among high school students about responding effectively to medical emergencies. We plan to extend this program to develop online training of primary care associates working as apprentices in rural areas of California and Pennsylvania. A prototype program with healthful interventions via mobile communications will be directed to pregnant teenagers and new moms, seeking to improve reproductive outcomes, enhance self-esteem and self-sufficiency, reduce the frequency and severity of postpartum depression, and improve mother-child interactions.

Virtual Acupuncture Human Based on Chinese Visible Human Dataset

Presenter: Pheng-Ann Heng PhD

We have developed advanced information technologies for computer-assisted Chinese acupuncture training and research. Optimally integrated the virtual reality, visualization and imaging techniques, we construct a detailed virtual acupuncture digital human model based on ultra-high resolution Chinese Visible Human dataset. The system integrates many innovative features such as the meridian system positioning, multi-layer dissection, needle puncturing simulation and training, as well as the common diseases-therapy information. In addition to providing multi-modality and multi-lingual support, we are developing an open and comprehensive information-enhanced digital platform to support modern research in Chinese medicine. Our work can be widely applied to acupuncture education, clinical applications, as well as biomedical and digital human research.

A 2000 Year Old View into the Future of Medical Imaging

Presenter: Eric Herbranson DDS

This lecture would be a review of a project to scan a 2000 year old child mummy from San Jose's Rosicrucian Egyptian Museum and Planetarium and discuss the technology used. The resulting data from this project was the highest resolution ever achieved in a mummy scan. The data represented a pixel size of about 200 microns, this is compared to the recent scans from Egypt of King Tut, which were about 600

microns. The quality of the images produced from this project are spectacular and interesting from both a technical and esthetic standpoint. Imaging was done at Stanford University Radiology with a Seimens AXIOM C- arm scanner, the processing was done on a Silicone Graphics Prism visualization platform using Germany's Volume Graphic GmbH software. This combination was able to do near real-time rendering of the whole 3D data set and very accurate segmentation of the structures. A virtual autopsy became possible and with the input from many experts in medicine, forensics and archeology a number of facts were determined. It was determined the child was a girl about 4 Ω years old, suffered no chronic diseases and was apparently healthy and active until she died suddenly. Her parents were very wealthy, indicated by the quality of the mummification. A number of fused deposition models were made. One of the skull, was used as the base for a facial reconstruction. Besides being an interesting and compelling story this project is a window on the future of medical imaging.

Wavelet Analysis of Heart Geometry for Morphological Modeling

Presenter: Don Hilbelink PhD

The goal of the study was to define the geometry of the human heart in a manner conducive to large cross-subject studies of imaging data. The technique introduced is a variation of a procedure previously reserved for brain morphology. The method includes segmenting heart geometry from ultrasound data into two-dimensional contours performing wavelet analysis. Wavelet transformation provided descriptors that served as parameters for describing and comparing heart geometry. Several wavelet basis functions were fitted and compared and a cross-subject comparison was also performed. The optimal wavelet transformation provided newly computed contours storing less than 1% of the original data required to represent the geometry and only 10% data loss. The descriptors are introduced as parameters of heart condition and the method is now being performed on a study of over 500 pediatric patients undergoing evaluation for congenital heart malformations.

Establishing Navigated Control in Head Surgery

Presenter: Mathias Hofer MD

Navigated Control (NC) describes an additional control of a tracked instrument which is only powered within a preoperatively segmented work space. The guiding principle is to integrate the navigation data directly into a power driven instrument and increase the implementation time of the navigation system. In head surgery we implemented NC in a first study where the system's feasibility for functional endoscopic sinus surgery (FESS) was shown. After technical modifications a second investigation was conducted. Recently we evaluated the feasibility of NC for a mastoidectomy. We believe NC could reduce the risk of an injury. A planned cavity can be realized with sufficient accuracy and high comfort. The change of the technical setup for NC in the operation room would be minimal. With NC the usability and comfort of a navigation system would be increased. Navigated Control promises a high potential particularly for endoscopic procedures at the skull base.

Can Augmented Virtual Force Feedback Facilitate Virtual Target Acquisition Tasks?

Presenter: Adrianus J. Houtsma PhD

This presentation reviews a study that investigated facilitation of a manual target acquisition task by the application of appropriate force feedback through the control device (e.g., mouse, joystick, trackball). Typical manual movements with these devices were measured, and models of such movements were used to predict an intended target location from an initial portion of a trace. Preferred forms and sizes for feedback force functions to be applied were empirically determined by collecting preference ratings and measuring task completion times. The general experimental task used is typical for an office situation, but appears generalizable to some medical and surgical situations (e.g. laparoscopy, catheterization) where a certain target has to be reached whose precise location is either known or unknown.

Effectiveness of Haptic Feedback in Open Surgery Simulation and Training System

Presenter: John Hu PhD

This paper presents progress in the development of an untethered haptic feedback system for an open surgery simulation and training system. A key challenge for implementing open surgery simulation is an untetherd haptic feedback method. The haptic system has to work well in a large surgery working space, provide natural tool-tissue interaction, and generate high fidelity force feedback. This article will describe our approach to an effective haptic feedback system design, the successes and challenges we have found in integrating it with surgery tool tracking, tissue deformation modeling and visualization. We will present our analysis on effectiveness of haptic feedback (tethered v.s. untethered) in open surgery simulation, and the system control bandwidth considerations in tissue deformation model implementation, tool tracking and haptic feedback close-loop control

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Design of Interactive Multimodal Biofeedback for Stroke Rehabilitation

Presenter: He Huang PhD (Cand)

Neuroplasticity and recovery of function following stroke depend on task practice, repetition, and intensity. The purpose of this project is to demonstrate the feasibility of designing an interactive, multimodal environment (IME) based biofeedback system that allows patients to practice goal-directed reaching intensely and repetitively. The design utilizes multimedia composed of 3D computer graphics and music to create an interactive environment. The central controller evaluates the task performance based on multisensing data and provides augmented feedbacks. Through successful processing of multimodal feedback, the patient receives a real-time feedback that may be useful for modification of current or future performances. We also evaluated the reaching performance of stroke patients when using IME biofeedback system. Results showed the patients improved arm coordination, accuracy and smoothness of endpoint trajectory, and constrained compensatory motion. Therefore, an IME biofeedback system is feasible to offer patients an opportunity to repetitively train on task with augmented performance.

A Haptic Device for Guide Wire in Interventional Radiology Procedures

Presenter: Dejan Ilic PhD

Interventional Radiology (IR) is a MIS in which small tubular instruments, catheters and guidewires, are steered in the vascular system. In order to offer a realistic and adapted training to the radiologists, a computer-assisted training system with haptic feedback is proposed. Since the instruments are inserted one over the over, the tracking of the inner instruments is challenging. To solve this issue, haptic interfaces for IR are composed of separated devices for each instrument that are spaced by the desired stroke. This method introduces an unrealistic insertion length of the inner instruments. This contribution focuses on an original haptic device for a guidewire that solves the insertion length issue. The guidewire is gripped at the entrance of the simulator by a micro-gripper that transmits applied forces and movements along a rod to the carriage of a linear stage. Hence, a guidewire can be tracked even inside a catheter.

Structure-Function Relationships in the Human Visual System Using DTI, fMRI and Visual Field Testing: Pre- and Post-Operative Assessments in Patients with Anterior Visual Pathway Compression

Presenter: Celina Imielinska PhD

The recently developed magnetic resonance technique of diffusion tensor imaging (DTI), is used clinically to trace the structure of white fiber tracts in the human brainThe focus of this paper is to improve our understanding of the relationships between brain structure and function, using pre- and post-operative assessment in patients with anterior visual pathway compression. Pituitary tumors often compress the anterior visual pathways producing significant visual loss. Surgical resection of these lesions decompresses the optic chiasm and may lead to visual recovery. To test these theories, we investigate changes in the visual system of patients with large, compressive, pituitary tumors by applying DTI, functional MRI (fMRI), and automated visualfield (VF) testing before and after trans-sphenoidal tumor resection. We used DTI, an MRI technology to visualize nerve fiber connections in the brain. We have developed in-house software to process DTI images to visualize the nerve bundles, via extraction of Principle Component.

A Flexible Infrastructure for Delivering Augmented Reality Enabled Transcranial Magnetic Stimulation

Presenter: Nigel W. John PhD

Transcranial Magnetic Stimulation is the process in which electrical activity in the brain is influenced by a pulsed magnetic field. The electromagnetic coil can be tracked, enabling points of interest to be targeted and displayed on a local workstation. In this presentation we explore the hypothesis that using an Augmented Reality interface will improve the efficiency of carrying out this procedure. With the use of a “see-through” Head Mounted Display it is possible to render the patient's MRI data in 3D and overlay it onto the operator’s view and in practice this will allow the operator to "see" the brain surface within the patient's head and not only make the targeting process more natural but also allow the operator to “see” the brainwave activity as it occurs in real time. We also aim to provide a flexible infrastructure that can seamlessly deploy remote high performance computing resources as required.

Metrics for an Interventional Radiology Curriculum: A Case for Standardisation?

Presenter: Sheena J. Johnson MSc

In medical practice, clinical governance demands well regulated post graduate training with clearly defined endpoints and objective evidence of competence at completion of training. This has been addressed in a framework document, accepted by the Canadian Royal Colleges. In the UK, the time available for specialty training has been reduced by the European Working Time Directive, increasing the importance of clear standards of competence, particularly where novel training techniques such as using virtual environments, are increasingly used by doctors from differing specialties. Interventional radiology in the UK, and elsewhere, lacks a specific curriculum, yet this is becoming essential to define

the knowledge, skills and attitudes for performing imaging guided intervention and detailing progression through training. In order for training to be quality assured this must be combined with standards for valid, transparent and objective assessment of interventional radiology skills. This paper outlines how this might be achieved.

Pulse!! - A Virtual Learning Space Project

Presenter: Claudia L. Johnston PhD

Pulse!! is a reusable, high-fidelity, persistent, first-person, total immersion learning platform for first-responders, students and practicing health care providers. Maintaining critical skill sets anytime, anywhere facilitates accelerated diagnosis and treatment of wounds, diseases and other conditions that result from rapid change and development in health care. Using interactive game-based technologies, Pulse!! provides quick response learning through rapid scenario production using a robust authoring system that mirrors in real-time almost any medical environment. This intelligent authoring system rapidly provideshealth care practitioners with effective training scenario production for competency based training. The project's design employs or modifies cutting-edge game-based technologies and techniques such as performance feedback and on-line guidance. Military and civilian medical providers will use the virtual learning platform to "see one, practice many, do one, teach one" (Boyer 2004). It will reduce the intensity of injuries, save lives and limbs and provide substantial reductions in errors and risk inducing events.

Visualization of a Stationary CPG-Revealing Spinal Wave

Presenter: Edmond A. Jonckheere PhD

Network Spinal Analysis (NSA) is a technique through which the practitioner applies light pressure at the dural attachment areas in the cervical and sacral regions of the spine, until the cervical and sacral oscillators are synchronized and the spine is in a stationary wave pattern. The neural pathways are hypothesized to remain in the spine without higher cerebral function involvement, as demonstrated on a quadriplegic subject who was able to sustain the wave despite the cord nearly severed at C5. The absence of external stimuli, the pathways localized in the spine, and a rhythmic motion in a stationary wave pattern, are among the features of a Central Pattern Generator (CPG). The main point of this presentation is the video confirmation of the wave pattern along with its nodes, which was originally revealed through the spatio-temporal correlation analysis of the signals generated by an array of sEMG electrodes along the spine.

Real-Time Augmented Feedback Benefits Robotic Laparoscopic Training

Presenter: Timothy N. Judkins PhD (Cand)

Robotic laparoscopic surgery has been shown to decrease task completion time, reduce errors, and decrease training time when compared to manual laparoscopic surgery. However, real-time augmented feedback has not been investigated as a means of improving surgical proficiency. We sought to determine if providing real-time visual feedback improves training. Thirty right-handed medical students were trained in three tasks with dVSS while providing speed, grip force, or relative phase feedback as well as expert video. Subjects were tested before and after training for changes in performance. Time to task completion, distance traveled, and standard deviation of phase were found to improve depending on the feedback given. These findings stress the importance of using different types of feedback during training to improve various aspects of robotic surgical proficiency.

Development and Evaluation of a Novel Real-Time Simulation Model with Haptic Feedback for Training Transurethral Prostatic Surgery

Presenter: Reidar Källström MD

In Sweden 6.000 transurethral resection of the prostate (TUR-P) were performed in 2003. The resident's learning curve, the economical impact and patient safety issues will be discussed. Based on these facts the need of a training opportunity outside the operation theatre will be stressed. To be able to train the TUR-P procedure we have developed a simulation model. The model enables training in: anatomical orientation, control of instruments (optics, rinse solution valve, foot pedals), resecting prostatic adenoma, control of bleedings (including visual impairment) and perforations. The model supplies information about the performance regarding time (total, cutting cutting with impaired vision etc), resection volumes, blood loss, rinse solution volumes and uptake, and parameters regarding effectiveness (movements, blood loss per resection volume etc). The simulator has been evaluated regarding face, content and construct validity. We will present data about learning curve and comparison between inexperienced students and experienced urologists performance in the simulator.

Team Training of Medical First Responders for CBRNE Events Using Multiplayer Game Technology

Presenter: Matt Kaufman MS

Forterra Systems and SUMMIT (Stanford University Medical Medial and Information Technologies Center) collaborated on research to explore the application of multiplayer game technology to team based training of medical first responders. Focusing on medical first response to CBRNE (Chemical,

Biological, Radiological Nuclear, and High Explosive) events, we developed sample training curricula for pre-hospital and in-hospital first responders, developed a virtual training environment, performed a formative assessment of the training with professional first responders, and developed a technical roadmap for supporting interchangeable 3rd party medical models within a multiplayer game platform. This presentation will summarize our research to-date and describe our plans for future development.

System Architecture and Toolkits for Image-Guided Intervention Systems

Presenter: Peter Kazanzides PhD

This presentation will describe three open source software toolkits, 3D Slicer, IGSTK and MRC-II, and a vision for a unified architecture and middleware that enables their integration into image-guided intervention systems. Formal software development processes and tools have been adopted to enable the creation of well documented and tested software that should facilitate clinical certification. Collectively, these toolkits (and the toolkits they utilize) address requirements for application control, visualization, registration, segmentation, tracking system interfaces and robot control. 3D Slicer has been available for several years and has a broad user base. IGSTK and MRC-II are in active development and have been used for a few prototype systems. The presentation will include example applications that use these toolkits. Results from our evaluation of different middleware will also be presented.

Computer-Aided Forensics: Metal Object Detection

Presenter: Timothy P. Kelliher

Recently, forensic investigators1 have started using diagnostic radiology devices to acquire image data from cadavers. Called virtual autopsy, this has the potential to provide an alternative or supplement to conventional autopsies. We describe one technique in the emerging field of Computer-Aided Forensics (CAF) that uses image analysis techniques to locate and analyze metal fragment location, size and distribution. We have created a regional atlas of the human body, dividing the body into head, neck, thorax, abdomen and upper/lower extremities. We adapt the atlas to each individual using global deformable registration2. Each metal object is associated with these regions. This work is the first in a series of investigations into the usefulness of automatic, objective analysis of virtual autopsy data. Additional information from the extracted metal objects may also be possible. Depth of penetration and determination of the metal distribution is possible and may help find ballistic trajectories.

Computer-Aided Forensics: Facial Reconstruction

Presenter: Timothy P. Kelliher

The forensic identification of human remains is often aided by the three-dimensional reconstruction of a face model from an unknown or questioned skull. In many cases subtle traces of resemblance to the questioned face can be enough to trigger recognition in someone familiar with the deceased. A comprehensive Computed Tomography (CT) head-scan database is currently being collected which will enable a new approach to forensic facial reconstruction. Using this unique resource, we show how a face space can be tailored to a specific unknown skull. The face space is a direct approximation of correlated soft tissue variance indicative of the population. Criteria such as race, age, weight and sex must be defined so that a face space can be generated using appropriate samples from the database. A tailored face space only provides a basis for possible reconstructions. In order to home in on a reconstruction, a priori knowledge is required.

From Myocyte to Torso: Spatially and Temporally Multi-Scale Simulation of Cardiac Injury

Presenter: Roy Kerckhoffs PhD

An introduction will be given on the necessity of multi-scale numerical modeling. Next, an overview will be given of the multi-scale model, composed of a finite element model of cardiac electromechanics (active and passive mechanics, cellular ionic model), circulatory/respiratory model, and thoracic potentials model and their interrelations. Every sub-model will be shortly discussed, as well as the novel method enabling simulating many cardiac beats by using a combination of precomputations and interpolation. Then the application of the multi-scale model to a penetrating wound in the left ventricular free wall will be shown. We will show a ~20 s movie containing the transition from a healthy beating heart (with myofiber strains and transmembrane potentials) to the injured state. Results will be discussed as well as future improvements to the multi-scale model.

Parametric Patient Specific Modeling and Simulation of Trocar Insertion Using Reduced Basis Method

Presenter: T. “Kesh” Kesavadas PhD

Trocar insertion, the first step to most micro surgery procedures is difficult to perform as it is done almost entirely without any visual feedback of the organs underlying the tissue being punctured. The tissue modeling for this problem is difficult due to lack of patient specific physiological data. While it would be helpful to have a patient model for pre-operative training, it is difficult to perform deformation in real time using regular FEA methods. We discuss a procedure developed to address this problem. The procedure uses a ARX

algorithm to fit a parametric model from porcine datasets and then using the identified parameters a FEM formulation is done. The initial FEM formulation is used to build a library for the Reduced Basis formulation, which can be used to perform accurate real time simulations. The entire procedure is integrated with a haptic set up.

Exploiting Graphics Hardware for Haptic Authoring

Presenter: Minho Kim MS

The presentation starts with a succinct overview over the generic Haptic Authorkit developed at the University of Florida, its haptic and visual rendering options in particular. Next, we summarize the user studies to establish the importance of synchronization of haptic and visual rendering for interaction with elastic tissue, even in an environment that does not require the full fidelity of surgery simulation.

The two nonlinear surface representations, PN Triangles and Loop Subdivision, are briefly introduced. It will be pointed out by example, how PN Triangles fail to give synchronized feedback for elastic tissue. The remainder of the presentation will focus on how recent GPU-based implementations of Subdivision Surfaces can be used in a feedback cycle for haptic rendering and to show how this benefits the plausibility of exercises generated by the Haptic Authorkit.

Navigated Imaging for 3D Planning of Excisions and Register-Free Milling in Spine Surgery

Presenter: Uwe Kirschstein Dipl-Inf

In this lecture a new system for navigated imaging for 3-d planning of excisions and register-free milling in spine surgery will be presented. Results of reconstruction from navigated images will be shown as well as the results from experiments on geometrical correctness of the image slices. The two methods of navigated imaging and “Navigated Control” for milling were combined and the results on milling in a spine phantom will be presented. The planning process for milling with “Navigated Control” based on the slices which were reconstructed from the navigated images.

An Interactive Stereoscopic Display for Cooperative Work - Volume Visualization and Manipulation Environment with Multiple Users

Presenter: Yoshifumi Kitamura PhD

We propose a unique interactive stereoscopic display that allows multiple observers to simultaneously observe a stereoscopic image from their own viewpoints. The system is named IllusionHole. With a simple configuration, it provides intelligible 3D stereoscopic images free of flicker and distortion. Based on the idea of IllusionHole, an interactive volume data visualization and manipulation system is developed. IllusionHole displays stereoscopic images such that all users observe the 3D image at exactly the same position, therefore, it is useful for applications in which several people work together to perform tasks with a multiplier effect. By using IllusionHole, several medical doctors can simultaneously observe the patient’s symptoms from their own viewpoints and exchange their opinions. Consequently, it can be a powerful tool for making quick and accurate diagnoses, surgery simulation and training, and so on.

Technologies for Measuring Human Exposure-Related Behavior

Presenter: Paul N. Kizakevich MS PE

Methods and technologies under development for collecting longitudinal data on human exposure-related activities for EPA research. The purpose is to develop and evaluate methods that can be readily adapted for use by other longitudinal studies of human exposure-related behavior. The challenge is to collect a broad range of survey, physical, and physiological data, maximize accuracy and completeness, and minimize participant burden. A prototype system was developed integrating forms-based diaries and questionnaires with a collection of wireless peripheral devices for monitoring physical and physiological data. Diary information is acquired for activity, dietary, product use, microenvironment, geographical location, work effort, and environmental conditions and exposures. Heart rate, ECG, impedance cardiography, microenvironment proximity, KeyFOB-activated product-use events, GPS, and other data are collected via a set of devices linked via Bluetooth wireless. Voice diaries are taken via Bluetooth headsets. Results from a 40-home pilot test will be presented.

3D Live-Wires on Mosaic Volumes

Presenter: Sebastian König Dipl-Inf

In this paper a 3D Live-Wire technique is discussed and evaluated which includes the real 3D information and operates on a pre-processed mosaic volume. Using automated over-segmentation by histogram spreading and region growing a mosaic volume is generated. Surfaces between two neighboring homogeneous mosaic regions are assigned to a graph node structure on which 3D Live-Wires is applied. Each triple of user-defined points defines a surface patch by first connecting the points by a cost-optimal path defining a framework of the patch. Additional paths are created between one of the user-defined points and the opposite path filling the initial frame. Remaining gaps are closed by region growing. A mean deviation from the correct object boundary extracted from available model data of about 0.16 pixel is

observed on an MRI data set when separating white and grey matter, the surface of the brain, and the surface of the skin.

Surgical PACS for the Digital Operating Room

Presenter: Werner Korb PhD

In today's surgical theatres the usage of devices for computer assisted surgery (CAS) is increasing. Different to the business and automation industry, there exists no communication platform within the operating theatre that allows unified data exchange between imaging systems and other surgical assistant systems (SAS) such as navigation or mechatronic devices [1,2]. Many SASs have good functionality as standalone facilities, however they lack plug-and-play features. SASs are required for surgical interventions and should be integrated to allow interoperability, e.g. smooth communication of data such as images and signals as well as the visualization of data according to the users needs. So far these requirements have not been addressed in a systematic way. One of the research focuses of the "Innovation Center Computer Assisted Surgery" (ICCAS) in Leipzig, Germany addresses the above problems and leads to the development of a "Surgical Acquisition and Communication System" (S-PACS). Other research topics of ICCAS include surgical workflow and systematic clinical evaluation of SAS. The development of an S-PACS, presented in this paper, includes mainly the following aspects (i) communication architecture, (ii) workflow management, (iii) usability and human-machine interface.

Haptic Interfaces: Do They Matter?

Presenter: James R. Korndorffer, Jr MD FACS

Virtual reality simulators are commonly used for training in minimally invasive surgery and have been shown to improve performance in the OR. However, videotrainer type simulators are more prevalent in training programs and are often preferred by trainees because of the increased realism. To increase the realism (face validity) of virtual reality simulators, haptic interfaces are now being utilized. The purpose of this study was to determine the effect of a haptic interface on perceived realism and user performance. 51 volunteer surgeons were randomized to a Lap Mentor with or without haptics and performed a laparoscopic cholecystectomy task. Subjects were blinded regarding the haptics status and completed a post-procedure questionnaire. Automated performance measures were recorded. Data suggest that a haptic interface imparts improved force feedback face validity for a virtual reality simulator and may have a beneficial impact on performance.

Catheter-Guided Drug Delivery System - A New Generation of Biomedical Micro-Devices

Presenter: Lawrence Kulinsky PhD

Present study is looking at the problem of integrating catheter (guiding system), drug delivery microcapsule and a bio-sensor into a biomedical system. A wide range of medical practices from cancer therapy to gastroenterological treatments can benefit from such novel bio-system. Machining of the system is performed using the standard Si-based microfabrication techniques. Polypyrrole (PPy) conducting conjugated polymer is used extensively in the microcapsule construction, both as an actuator element and as a part of the biosensor.

Wearable Kinematic and Physiological Biofeedback System for Movement Based Relaxation

Presenter: Damini Kumar PhD (Cand)

Movement based therapies, such as Yoga, have been shown to have significant beneficial effects on the cardiovascular, respiratory, musculoskeletal systems and therapeutic benefits in rehabilitation.

Learning and enjoyment of these therapies can be facilitated by means of developing an interactive video game in which the players' movement can be guided using feedback and their performance is determined by their ability to master one of these therapies to bring about a state of physical and mental relaxation.

We are developing a garment based physiological and kinematic measurement system which will provide real time measurement of posture, rate of movement, physiological indicators and communicate with the video game. To measure the human body motion we have designed and implemented a Universal Serial Bus (USB) based inexpensive unobtrusive kinematic transducer capable of scalable deployment with minimum instrumentation.

This system could be used by patients suffering from many conditions including hypertension and chronic pain.

Towards a VR Trainer for EVAR Treatment

Presenter: Eelco E. Kunst PhD

Endovascular repair (EVAR) of aortic abdominal aneurysms (AAA) is more and more becoming part of clinical practice. Literature indicates that the reliability of the performance of such a highly specialized procedure requires a learning curve of approximately 30 cases. The current study aims to generate a VR trainer to speed up the training process of experienced vascular surgeons to become experienced EVAR (endovascular AAA repair) surgeons by introducing a

VR environment. The VR trainer is being build on the VREST Platform for Virtual Medical Training.

Open Surgery in VR: Inguinal Hernia Repair According to Lichtenstein

Presenter: Eelco E. Kunst PhD

The demand for proper health care is a hot issue. With time the expectation of the quality and capacity of medical treatments rises. The number of surgeons has to grow and for the quality issue, new innovative techniques and instruments arise. This results in a situation in which more surgeons need to be certified in lesser time. Besides they have to be able to cope with techniques with a fast growing complexity. Patients expect to be treated by an experienced physician, who is trained with the last insights. The development of an effective education system for surgeons is inevitable to meet these demands. VREST (Virtual Reality Educational Surgical Tools) is developing a universal and autonomous workstation which can be used for training and assessment of medical students and for continuing education of physicians. Unlike existing virtual trainers, our workstation is capable to load different operations of varying types. In order to validate the system the trainer is filled with an inguinal hernia repair operation according to the Lichtenstein Procedure.

Gestalt Operating Room Display Design for Perioperative Team Situation Awareness

Presenter: Fuji Lai MS

The perioperative environment is a complex, high risk environment that requires real-time coordination by all perioperative team members and accurate, up-to-date information for situation assessment and decision-making. There is the need for a "Gestalt" holistic awareness of the perioperative environment to enable synthesis and contextualization of the salient information such as: patient information, case and procedure information, staff information, operative site view, physiological data, resource availability. One potential approach is to augment the medical toolkit with a large screen wall display that integrates and makes accessible information that currently resides in different data systems and care providers. The objectives are to promote safe workflows, team coordination and communication, and to enable diagnosis, anticipation of events, and information flow from upstream to downstream care providers. We used the human factors engineering design process to design and develop a display that provides a common operational picture for shared virtual perioperative team situation awareness to enhance patient safety.

Integrating Surgical Robots into the Next Medical Toolkit

Presenter: Fuji Lai MS

Surgical robots hold much promise for revolutionizing the field of surgery and improving surgical care. However, despite the potential advantages they offer, there are multiple barriers to adoption and integration into practice that may prevent these systems from realizing their full potential benefit. This study elucidated some of the most salient considerations that need to be addressed for integration of new technologies such as robotic systems into the operating room of the future as it evolves into a complex system of systems. We conducted in-depth interviews with operating room team members and other stakeholders to identify potential barriers in areas of workflow, teamwork, training, clinical acceptance, and human-system interaction. The findings of this study will inform an approach for the design and integration of robotics and related computer-assisted technologies into the next medical toolkit for "computer-enhanced surgery" to improve patient safety and healthcare quality.

Study of Laparoscopic Forces Perception for Defining Simulation Fidelity

Presenter: Pablo Lamata MSc

One of the most controversial dilemmas in laparoscopic virtual simulation design is the incorporation of force feedback. Determination of the required degree of haptic fidelity is sought by studying how surgeons perceive pulling forces in the laparoscopic theatre. A conventional grasper is equipped with a force sensor and is used to characterise the interaction with four different organs of the porcine abdominal cavity. Acquired pulling forces are then related to the subjective assessment of the consistency of these four organs. Surgeons were able to distinguish between the four organs despite the fact that interaction forces of soft organs were hidden by friction forces. These results indicates that simulators require force feedback capability if tissue consistency information has to be delivered. Moreover, interaction forces with four different organs have been characterized, which constitute a basis for the design of a force feedback algorithm.

Virtual Reality Thread Simulation for Laparoscopic Suturing Training

Presenter: Pablo Lamata MSc

The grade of realism in virtual reality trainers might not be proportional to its didactic value. As an example three exercises to train suturing skills are proposed in this article. They use a thread discrete model with a simple but good enough behaviour, and constitute a training means for three laparoscopic skills: (1) Accurate grasping, which trains grasping a precise point in the thread. (2) Coordinated Pulling, which

trains tightening the thread co-ordinately and in different space orientations; and (3) Knotting, which allow the surgeon to practice this manoeuvre. These three exercises, found interesting among experts in surgical training, are now being validated in MIS workshops at the Minimally Invasive Surgery Centre of C·ceres (Spain).

Computer Prediction of Balloon Angioplasty from Artery Imaging

Presenter: Denis Laroche MASc

A numerical model for rapidly predicting patient specific angioplasty is presented. The goal of this numerical tool is to assist clinicians in the selection of appropriate intervention strategy for a specific patient by using IVUS imaging data to simulate the intervention. In an effort to render the tool clinically useful, two often competing requirements must be met: high accuracy of the predicted behavior and high computational speed. The proposed model computes large deformations and interactions of the balloon and the diseased artery during insertion and deployment. In order to achieve high computational speed while maintaining accurate predictions, a finite element model including quasi-incompressible simplex elements with an implicit contact algorithm are described. A proof-of-concept test using IVUS images of a patient who underwent balloon angioplasty is presented.

Centerline-Based Parametric Model of Colon for Colonoscopy Simulator

Presenter: Doo Yong Lee PhD

This paper presents a centerline-based parametric model of colon for collision detection and visualization of the colon lumen for colonoscopy simulator. The prevailing marching cubes algorithm for 3D surface construction can provide a high resolution mesh of triangular elements of the colon lumen from CT data. But a well organized mesh structure reflecting the geometric information of the colon is required for fast and accurate computation of contact between colonoscope and colon, and the corresponding force-feedback in the colonoscopy simulator. The colon is modeled as parametric arrangement of triangular elements consisting of its surface along the centerline of the colon. All the vertices are indexed according to their cross-sectional rings and angular direction so that the triangles around the viewpoint can be found fast. The centerline-based parametric model of colon has 75,744 triangular elements compared to 373,364 of the model constructed by the marching cubes algorithm.

Efficient Topology Modification and Deformation for Finite Element Models Using Condensation

Presenter: Bryan C. Lee PhD (Cand)

We present an extension of our work on topology modification for virtual organs, which integrates condensation and allows for real-time interaction with larger models. In contrast to other topology modification methods proposed in the literature, which rely on forces as input for the virtual interaction, thus not requiring the precomputation of the inverse, our method is driven by displacements on the touched nodes. This allows for realistic simulation of both deformation and haptic response. The integration of condensation into our scheme increases its efficiency, and allows for complex interaction on larger meshes. We present and validate our results in the context of a complete surgical simulation system with real-time haptic feedback.

Interactive Physically-Based Simulation of Catheter and Guidewire

Presenter: Julien Lenoir PhD

For over 20 years, interventional methods have improved the outcomes of patients with cardiovascular disease or stroke. However, these procedures require an intricate combination of visual and tactile feedback and extensive training periods. An essential part of this training relates to catheter or guidewire manipulation. In this paper, we propose a composite model to realistically simulate a catheter, a guidewire or a combination of both. Where a physics-based simulation of both devices would be computationally prohibitive and would require to deal with a large number of contacts, we propose to address this problem by replacing both objects by a composite model. This model has a dual visual representation and can dynamically change its material properties to locally describe a combination of both devices. Results show that the composite model exhibits the same characteristics of a catheter/guidewire combination while maintaining real-time interactions.

A Return on Investment (ROI) Model to Measure and Evaluate Medical Simulation Using a Systematic, Results-Based Approach

Presenter: William E. Lewandowski MS

As technological advances continue to improve the fidelity and realism of medical simulation devices, and as they gain acceptance as valid training tools, the questions concerning medical simulation begin to shift from, “Is medical simulation a valid training tool?” to “Is medical simulation a practical alternative for my organization?” The cost of procuring a medical simulator, for many hospitals and academic institutions, often rises to the level of a capital expense, and capital

expenses are hard enough to justify, even when the expense is directly tied to revenue generation.

During the presentation, I will show how a systematic, results-based model can be used to identify and evaluate the effectiveness and appropriateness for using medical simulation, utilizing six objective financial and non-financial return on investment (ROI) measurements. The results of this model provide a balanced evaluation approach that links simulation implementation to operational goals and objectives and institutional strategic objectives.

A VR Surgery Planning System for Craniosynostosis

Presenter: Ching-Yao Lin PhD

Virtual Reality (VR) has enormous potential as a technology to enhance teaching and training. In recent years, VR has emerged as a powerful means in medical field, such as surgical simulator, which provides training for a variety of procedures . The Craniosynostosis is the premature fusing of the sutures of an infant's head and the infant's skull growth is restricted. Surgery to release the fused suture is the method to cure this disease. However, the training for surgery of craniosynostosis was the experiences. In our project, we would like to build a system which could utilize the VR techniques for the pre-operation planning of craniosynostosis. It could be a useful tool for doctors in simulating the surgery, as well as for the family of the patients in understanding the procedures.

Vision-Assisted Automatic Detection and Segmentation of Robot-Assisted Surgical Motions

Presenter: Henry C. Lin PhD (Cand)

Our presentation consists of explaining the need for a more objective method of surgical skill evaluation and surgical training. We will then briefly talk about previous methods at addressing this problem. Our current approach attempts to recognize and skill differentiate on elementary surgical motions. The approach will be explained and discussed. The approach consists of five components: local feature extraction, feature normalization, linear discriminant analysis, Bayes classifier, and computer vision. The validation study will be discussed. We will then present our results as obtaining more than 90% recognition rate of expert surgeon data using Intuitive Surgical's daVinci robot motion and video data.

Real-Time Finite Element Based Virtual Tissue Cutting

Presenter: Alex J. Lindblad MSCE

The goal of the presentation is to demonstrate real-time soft tissue cutting in a bi-manual surgical simulator, and describe the finite element models and numerical methods that we have developed to support the real-time virtual cutting task.

The presentation will discuss the inherent difficulties in accurately modeling soft-tissue cutting in a real-time setting. It will also cover the difficulties associated with training doctors to effectively and efficiently perform soft-tissue cutting, and link the process we use to the steps a surgeon uses during pre-op. We will describe how the finite element equations are formulated using displacement constraints and how low-rank updates can be efficiently used to interactively solve for the haptic reaction forces. Results will be shown in the form of timing tests and short movie clips demonstrating the method in a haptic based suturing simulator with a few comments following on the current direction of this work.

Flat Maps: A Multi-Layer Parameterization for Surgery Simulation

Presenter: Qiang Liu PhD (Cand)

We present a multi-layer parameterized representation of virtual organs for surgery simulation purpose. Random 3D input mesh are parameterized and resampled into a regular 2D parameterized model. With this parameterized representation, a high resolution 3D organ mesh can be reconstructed and deformed interactively with a simple and fast free-form deformation method. The amount of deformation and force feed-back can be calculated rapidly. Therefore, fast haptic rendering can be achieved. In addition, the parameterized mesh can be used to handle collision detection as well as the surface contact between multi-objects in an efficient way. Several layers of flat maps are introduced for these different purposes. In this manner, realistic visual and haptic rendering environment can be provided for interactive surgical simula

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The Design and Implementation of a Pulmonary Artery Catheterization Simulator

Presenter: Alan Liu PhD

Pulmonary Artery Catheterization is a commonly performed procedure. It is used in a wide variety of seriously ill patients when hemodynamic and cardiac parameters must be accurately monitored. Competence in the use of PAC requires integration of technical skills, knowledge of potential complications and their prevention, and interpretation of the data obtained.

We describe an ongoing effort to develop a PAC simulator. Our discussion will include the teaching objectives of the simulator, as well as implementation details. In particular, we describe our approach to modeling patient physiology and specifying simulation scenarios. The approach uses an intuitive XML-based modeling language. The language permits clinicians to directly write new simulations without requiring

knowledge of computer programming. We also discuss methods where clinicians can graphically specify new scenarios. This alternative input method does not require any knowledge of the underlying modeling language.

Second Generation Haptic Ventriculostomy Simulator Using the ImmersiveTouch™ System

Presenter: Cristian J. Luciano MS

Ventriculostomy is a neurosurgical procedure for relieving the intracranial pressure. The surgeon determines the best orientation of the ventriculostomy catheter continuously moving his/her head from one side of the patient's head to another to locate certain standard landmarks. If inserted properly, a distinct "popping" or puncturing sensation is felt as the catheter reaches the frontal horn of the lateral ventricle. Previous haptic simulators lacked head tracking and assumed the surgeon does not move his/her head at all during the procedure. This made landmark location cumbersome and the graphics-haptics collocation poor as soon as the surgeon tilts his/her head. The time and number of trials of the procedure was attributable primarily to the simulator limitations and not surgeon skill limitation. We overcome major first generation limitations by introducing head tracking to display a correct viewer-centered perspective; improving, at the same time, the virtual/real catheter overlapping independently of the surgeon's view point.

Dynamic Analysis of a Spherical Mechanism for a Minimally Invasive Surgical (MIS) Robot - Design Concepts for Multiple Optimizations

Presenter: Mitchell J.H. Lum MSEE

At the University of Washington, strong emphasis has been placed on the collaboration between surgeons and engineers for the design of a next generation MIS robot system. A task-based optimization of the system resulted in a surgical robot design that maximizes performance and minimizes size. While our previous study analyzed and optimized kinematics, the current research focuses on the robot dynamics. The spherical mechanism is a rotational manipulator with all axes intersecting at the center of the sphere. In the current study, a dynamic optimization was performed using Dynamic Manipulability as the main performance metric. A dexterous workspace (DWS) and extended dexterous workspace (EDWS) are defined. Dynamic optimization across the DWS leads to a serial mechanism with link length angles (a12,a23)= (30∫,90∫), and across the EDWS, (50∫,90∫). Understanding the relationship between kinematic and dynamic performance will allow for more efficient placement of surgical arms relative to the patient and each other.

Stereopsis and User-Interaction in Anatomical learning

Presenter: Jan-Maarten Luursema PhD (Cand)

Virtual Reality training is rapidly becoming a mainstay of medical curricula, but not much is known about the learning effects of this kind of training. A series of experiments is reported that evaluate the contribution of stereopsis and user-interaction to anatomical learning. Participants' visuospatial ability was taken in account as co-variable. A combination of stereopsis and user-interaction was found beneficial to anatomical learning, especially for people of low visuo-spatial ability. Stereopsis alone did not reap those same benefits.

Data Mining of the E-Pelvis Simulator Database - A Quest for a Generalized Algorithm Capable of Objectively Assessing Medical Skill

Presenter: Thomas R. Mackel MSEE

Inherent difficulties in evaluating clinical competence of physicians has lead to the widespread use of subjective skill assessment techniques. Inspired by an analogy between medical procedure and spoken language, proven modeling methods in the field of speech recognition were adapted for use as objective skill assessment techniques. Subjects classified in this manner can be compared to one another using their performance indices. Markov chains identified in the transition matrices may be able to help reduce the number of MM states in the model, while still providing a high degree of success in subject classification. This methodology is independent of the modality under study. It was previously used to assess surgical skill in a minimally invasive surgical setup using the Blue DRAGON, and it currently applied to data collected using the E-pelvis as a physical simulator. Similarly the same methodology can be incorporated into a surgical robot as a supervisory controller.

Raman Molecular Imaging in Application to Bladder Cancer Diagnosis

Presenter: John S. Maier PhD MD

Raman Molecular Imaging (RMI) is an optical technology that combines the molecular chemical analysis of Raman Spectroscopy with high definition digital microscopic visualization. This platform permits visualization of the physical architecture and molecular environment of a cytologic sample. In this preliminary study a set of samples from a series patients with and without Transitional Cell Carcinoma were studied using a ChemImage FALCONTM Raman Molecular imaging system. Data was obtained in order to evaluate RMI as a candidate tool for bladder cancer screening and diagnosis. We present results including Raman imaging and spectroscopy measurements on cells and tissues from normal patients and patients with bladder cancer. RMI has the poten-

tial to become a powerful diagnostic tool that will allow for accurate and early identification of patients at risk for Transitional Cell Carcinoma. This work was supported by the Western Pennsylvania Prostate Cancer Foundation.

Telecommuting to Virtually Manage a Telemedicine Program in South Texas and Portions of Mexico Using Advanced Communications

Presenter: Lori Maiolo

Driscoll Children's Hospital located in Corpus Christi, Texas, supports telemedicine clinical consultative services and a distance education network using high speed networks and advanced diagnostic tools. The hospital has forged new territory by hiring its first truly virtual employee to manage this 33 county International Telemedicine network. The program director lives over 1600 miles away in North Carolina and manages the day to day operations via a consumer level broadband cable connection in the home. A video conference system, fax, phone, and web portal are used to support this telecommute. While telemarketing, freelance writing, and computer programming are obvious fits for telecommuting, managing people, technologies, and building virtual relationships within a clinical environment has been a true test for developing and maintaining a successful telehealth program. This session will cover the technology, benefits, and inherent challenges associated with virtually managing a telemedicine program in a rural and large geographic region.

A Discrete Soft Tissue Model for Simulating Complex Anatomical Environments

Presenter: Maud Marchal PhD (Cand)

Among the current challenges in human soft tissue modelling for medical purpose, the ability to model complex anatomical structures and their interactions and the ability to simulate them with accuracy and physical realism are in the forefront of research. We present a discrete soft tissue model which attempts to solve these last challenges. In this model objects can be described as volumetric (e.g. a prostate) or surfacic (e.g. a cavity like a bladder) sets of nodes depending on the physical properties. Nodes have their own properties and a definition of their neighbourhood. All these objects are submitted both to internal cohesive forces and to external attractive or interactions forces with other objects. The connections between objects and volume preservation are considered as constraints. An explicit algorithm allows to compute the dynamic evolution while guarantying the constraints. The model is applied to the simulation of the prostate and its surrounding organs.

Image-Guided Laser Projection for Port Placement in Minimally Invasive Surgery

Presenter: Jonathan Marmurek

We present an application of an augmented reality laser projection system in which procedure-specific optimal incision sites, computed from pre-operative image acquisition, are superimposed on a patient to guide port placement in minimally invasive surgery. A high resolution volumetric image of a thorax phantom was acquired using helical computed tomography imaging. Oriented within the thorax, a test organ with marked targets was visualized in a virtual environment. Optimal configurations of port positions and tool orientations were determined by an objective measure reflecting image-based geometric indices of surgical dexterity, hand-eye alignment, and collision detection. Landmark-based intra-operative registration of the simulated virtual model and the phantom anatomy was performed using an optical tracking system, which subsequently guided laser projection for port placement. Initial trials demonstrated that computed and projected incision sites provided direct access to target anatomy with an accuracy of 2 mm.

Planning and Analyzing Robotized TMS Using Virtual Reality

Presenter: Lars Matthaeus Dipl. Math. techn.

Transcranial Magnetic Stimulation (TMS) is a powerful method to examine the brain and non-invasively treat central nervous system disorders. TMS can stimulate regions of the motro cortex or other areas of eloquent brain, which in the case of the motro cortex results in the activation of the corresponding muscle groups. Furthermore, TMS is becoming an alternative treatment for depressions or chronic neuralgic pain. In all cases accurate placement of the TMS coil to the subject's head is crucial to successful stimulation. We developed a way to position the TMS coil using a KUKA robot and navigate it in virtual reality based on an online registration of the cranium relative to its 3D magnetic resonance imaging (MRI) data. In addition, we have used the advantages of a robotized system to acquire detailed magnetic field data for the TMS coil. This may provide an alternative way of brain mapping, that rather than metabolism of oxygen in functional magnetic resonance imaging (fMRI) is based on direct neuronal function.

Medical Student Evaluation Using Augmented Standardized Patients: Preliminary Results

Presenter: Frederic D. McKenzie PhD

Standardized patients (SPs), individuals trained to realistically portray patients, are commonly used to teach and assess medical students. The range of clinical problems an SP can

portray, however, is limited. They are typically healthy individuals with few or no abnormal physical findings. We have developed a functioning prototype that uses sound-based augmented reality to expand the capabilities of an SP to exhibit physically-manifested abnormalities. The primary purpose of this paper is to describe this prototype and report on its use in a study using medical students evaluated in a required annual Observed Structured Clinical Examination (OSCE). The presentation will include an overview of the prototype, a detailed description of the study, final results from the study, and conclusions drawn about the realism as perceived by experienced clinicians and about the validity of using augmented SPs as a reliable medical assessment tool.

A Meta-Analysis and Review of Virtual Reality in Training, Treatment, and Rehabilitation

Presenter: Sarah D. Miyahira PhD

The research on Virtual Reality (VR) applications has progressed from exploratory case studies and feasibility studies to comparisons with wait-list and active intervention control groups. This development of the field as a whole has set the foundation for conducting meta-analytic and review studies of current research findings. This investigation presents a comprehensive review of published VR research across three broad domains in health care: (1) medical training, (2) behavioral health and psychiatric treatment, and (3) rehabilitation. Preliminary obtained effect sizes indicate moderate to high efficacy of VR, which is a promising sign for the field and encourages further controlled research. Recent research continues to emphasize case study/uncontrolled designs, particularly for novel uses of VR. It is recommended that there be a better balance between innovation and validation in establishing VR as an effective intervention. To our knowledge, this investigation is the first comprehensive, global review and meta-analysis of VR applications.

Computer-Aided Navigation for Arthroscopic Hip Surgery Using Encoder Linkages for Position Tracking

Presenter: Emily M. Monahan MS

While arthroscopic surgery has many advantages over traditional surgery, this minimally invasive surgical technique is not often applied to the hip joint. There are two main reasons for this: the difficulties of navigating within the joint and of correctly placing portal incisions without damaging critical neurovascular structures. This paper proposes a computer-aided navigation system to address the challenges of arthroscopic hip surgery. Unlike conventional arthroscopic methods, this system uses encoder linkages to track the position and orientation of surgical instruments. The encoder position information is used to generate a computer display of patient anatomy to supplement the restricted view from a typical arthroscopic camera. Additionally, visual warnings can be displayed to inform the surgeon if tools move to a region that endangers the patient. This new computer-aided approach to arthroscopic hip surgery has been applied to a prototype system to demonstrate and verify the concept.

Project Hydra - A New Paradigm of Internet-Based Surgical Simulation

Presenter: Kevin N. Montgomery PhD

Project Hydra is a shared simulation supercomputer resource and community, made available for free. All that is required to access it is a low-end Internet-connected computer and, optionally, interaction/haptics devices as needed for the particular task. This enables supercomputer-class simulation at every desktop with much greater fidelity than any user could individually afford and provides an online community for simulation research and application. Further, by utilizing their existing, low-end PC and using the Internet as a means of simulation dissemination, distribution, and delivery, the user can have immediate access to simulation updates/upgrades and download/access new content (didactic curriculum and cases). Further, this ease of access and use could lead to accelerated adoption and use of simulation within the medical curriculum with access is provided anywhere in the world 24x7. In addition, a server-based simulation system provides a natural point for performing easy, automated clinical studies of surgical performance and skills.

Pain Reduction with Entertainment Game in Upper Gastrointestinal Endoscopies, Extensive Injuries Treatments in Infected Soft Tissues, and Cervical Conization with Diathermy Loop

Presenter: José Luis Mosso MD

Pain reduction with entertainment game in: Upper Gastrointestinal endoscopies, extensive injuries treatments in infected soft tissues and cervical conization with diathermy loop.

We present the first experience of Cyber therapy in Invasive procedures in surgery, endoscopy and colposcopy. 200 patients were underwent of upper gastrointestinal endoscopy procedures, 30 patients were underwent of surgical treatment of extensive and infected soft tissues and 20 patients were underwent in uterine cervix diathermy treatment previous colposcopy. The half of these patients used a Head Mounted Display, where was displayed an entertainment game. The half did not use a HMD. The majority of patients accepted the cyber therapy because the autonomic and somatic pain was reduced to permit perform invasive procedures. No complications were presented.

Towards a Simulator of the Upper Gastrointestinal System

Presenter: José Luis Mosso MD

At the Universidad Nacional Autonoma de México (UNAM) in Mexico City since 2003 we have been developing an Upper Gastrointestinal Simulator. Our model is just a first step towards a practical simulator for endoscopy training, but it includes several features not found in commercial systems at present; it also constitutes a development platform for simulation of complex interactions between the endoscope instrumental and the upper gastrointestinal system. Further refinements are currently being incorporated and future versions of the program will be based on MRI datasets from assorted patients and information from videos, such as textural features and dynamic behavior. We present images from the interactive navigation program, using OpenGL graphics libraries on a desktop personal computer and show qualitative comparisons side-to-side with real endoscopy videos

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Fast Rigid Registration in Radiation Therapy

Presenter: Ulrich Mueller

Based on a stochastic mutual information type matching and rprop as stochastic optimizer, image-based registration of a CT volume onto two 2D images provided by a megavoltage system is applied in interactive time. The matching process performs semi-automatic pre-segmentation, an approximate 2D-2D matching with precomputed virtual projections (DRRs) followed by an accurate 3D-2D matching step. Our sample-based approach requires only a fraction of computed DRRs for 3D-2D. A simultaneous computation of the DRR rays and their perturbations in 6 dimensions speeds up the rendering process by a factor of 6.8. The complete registration process takes 3.4-8.3 seconds on a 3 GHz Pentium IV PC, being the fastest approach for this sort of application the authors are aware of.

Hemodynamics of Hemorrhage Simulated with an Open-Loop Cardiopulmonary Model

Presenter: Maxwell L. Neal BS

To simulate the hemodynamics of ventricular penetration hemorrhage, we developed a closed-loop mathematical cardiopulmonary model then converted it to an open-loop, externally-driven model for rapid data analysis. Recorded experimental signals for heart rate, aortic flow, and arterial blood pressure drive the open-loop model, producing a running simulation of blood volumes, flows and pressures in systemic, pulmonary and coronary circulations. The open-loop model was coupled to finite element models of cardiac electromechanics and torso electrical fields for visualization of heart mechanics and electrical propagation during hemorrhage.

Lifecycle Planning and Management for IMRT Treatment

Presenter: Seza Orcun PhD

Every year, about 1.2 million new cancer cases are expected to be diagnosed and cancer is the second leading cause of death in the US, exceeded only by heart disease. Approximately 40% of these cancer cases are treated with radiation therapy, which has been proved successful for several decades. The intensity modulated radiation therapy (IMRT) technology allows delivering radiation more precisely by dividing the accelerator head into smaller units, called beamlets that can be manipulated independently. In this research we apply lifecycle planning and management concepts to the IMRT treatment planning, and develop a prototype system, once fully completed, will enable the researchers to explore different what-if scenarios, such as determining the "Target Treatment Volume" depending on the delivered dose of radiation.

Evaluation of Soft Tissue-Generated Forces by Intraoperative Contact Pressure Measurement of the Hip Joint-Supportive Structures During Total Hip Arthroplasty

Presenter: Yoshito Otake MS

We developed a system for evaluation of soft-tissue relations around the hip joint during total hip arthroplasty in order to assist the surgeon in deciding on the best-fitting implant for each patient. First, a subminiature pressure sensor to be incorporated into an implant's head component was manufactured. Eight such sensors were embedded into the customized head component, which was designed with a 3D CAD system. Each sensor recorded pressures at 1000Hz frequency. Next, we constructed software for recording and visualizing the detected pressures. The system enabled to intuitively and intraoperatively recognize pressure distribution at the sliding surfaces in 3-dimensions. Furthermore, it allowed assessment of forces generated in soft-tissues around the hip joint, their mutual relations. Based on these data surgeons will be able to estimate the best-fitting size and shape of the implant. The system will be applicable in implant selection during total hip arthroplasty.

Using Algorithmically Generated Music to Enhance VR Nephron Simulation

Presenter: Panaiotis PhD

While sonification has enjoyed much attention in VR simulation studies, music has generally been incorporated as ambiance. This is partially due to difficulties with manipulating it interactively in real-time while maintaining a sensible musicality. This presentation discusses how algorithmically generated music is used to provide ambiance, characterize the visual representation of molecular particle flow, provide orientation cues to the user, and enhance recognition of chemi-

cal gradient balances in a reified model of the kidney nephron. The technical obstacles related to the use of music in this context are also addressed.

Music created algorithmically for the nephron demonstrates how encoding information in musically structured systems is a powerful tool for analysis and learning. Software that provides the ability to create appropriate music beyond ambiance can facilitate development of VR simulations that encode data.

Can Immersive Virtual Reality Reduce Phantom Limb Pain?

Presenter: Emma L. Patchick BSc

Following an amputation the patient often experiences their missing limb as still intact, often accompanied by painful sensations. This phenomenon is known as phantom limb pain (PLP). The present study investigates the effectiveness of immersive virtual reality (IVR) as a visual therapeutic treatment for PLP. Research with mirror-boxes (in which patients seen a reflected image of their intact limb in the phenomenal space of their phantom limb) has found them to sometimes relieve PLP. This study builds upon the mirror-box work, using IVR to transpose movements of amputees' anatomical limbs into movements of a virtual limb which is presented in the phenomenal space of their phantom limb. Patients use the IVR apparatus frequently over a prolonged period and appropriate measures of level of experienced pain are taken. The initial findings of the project will be described at the conference presentation.

Rendering of Virtual Fixture for MIS Using Generalized Sigmoid Functions

Presenter: Rajni Patel PhD

Compared with open surgery, Minimally Invasive Surgery (MIS) poses some new challenges to the surgeon such as poor hand-eye coordination, restricted maneuverability and limited field of view of the surgical space. These difficulties may cause accidental damage to critical tissue or collisions between laparoscopic instruments. To avoid these undesired collisions and improve the level of safety and precision, artificial potential fields (APFs) can be employed to generate virtual forces around protected tissue and to provide surgeons with real-time force reflection through haptic feedback. Although APFs provide a simple and computationally efficient approach for generating virtual force feedback, the problem still remains as to how a potential-field model can be constructed which achieves an effective protection for arbitrary shapes without significantly reducing the surgical workspace. In this paper, we propose a potential field-based force model using the generalized sigmoid function and show that it can accurately represent a large class of shapes with real-time force reflection. The proposed approach has several advantages such as computational efficiency, easily adjustable level of force reflection, and force continuity.

A Haptics Based Simulator for Laparoscopic Pyeloplasty

Presenter: Rajni Patel PhD

We present a methodology for modeling the surgical procedures comprising a Tele-Robotic Pyeloplasy, which is a minimally invasive surgical procedure for correcting a kidney ureteropelvic junction obstruction. The simulator facilitates surgical training of laparoscopic pyeloplasty by providing both visual and haptic feedback to the trainee. We present validation results of our model.

A Hip Surgery Simulator Based on Patient Specific Models Generated by Automatic Segmentation

Presenter: Johanna Pettersson PhD (Cand)

This work presents a hip surgery simulator system with patient specific femur and pelvis models. Patient specific models are required when using simulators as pre-operative planning tools. Furthermore these models increase the selection of cases for training and education. The models are generated from CT data that has been automatically segmented using a non-rigid registration technique. This technique is called the Morphon method and was recently presented by some of the persons behind this work. The method takes a prototype volume, which holds a pre-segmented representation of the femur and pelvis, and fits it to the corresponding structure in the CT data of a specific patient. Once the segmentation is performed a model for the simulator system is created. The described approach gives an efficient technique for rapid generation of individual models. Future work involves assessing the capability of the system and generating models of bones with cervical fractures.

Semi-Automatic Segmentation and Marking of CVH Data

Presenter: Yingge Qu PhD (Cand)

The CVH data bears features of ultra-high resolution and with extremely fine anatomical details, while this brings lots of difficulties in segmenting due to the high resolution of the specific details in images. We proposed a simple yet efficient interactive segmentation technique segments all the AOI and marks them at the same time, and drastically reduces the input required from the user. The underlying technique is based on the level set methods, implemented by fast marching technique to speed up. And the key is to construct a proper speed function, so that to control the propagation of the level sets for the segmentation purpose. Here we suggest an

effective speed function to incorporate both color feature and texture feature into the propagation.

Development of Triage and Casualty Informatics Tool for Mass Casualty Incidents

Presenter: Azhar Rafiq MD MBA

Mass casualty incidents (MCI) require immediate response to categorize victims into treatment prioritization within minutes of arrival at disaster scenes. The presentation will highlight the Triage and Casualty Informatics Tool (TACIT) developed at Virginia Commonwealth University (VCU) for the PDA interface. The software interface, capabilities and ease of use will be demonstrated followed by the arenas of application within the scope of emergency medicine. This tool expands the first responder's capabilities to survey a MCI to assess victims with multiple data acquisition tools. The TACIT application is configured to record field data to the PDA itself and later synch with the scene hub vehicles using wireless communication protocols such as WiFi or Bluetooth. The capacity to capture data efficiently and archive it using a handheld device within the regional command station is validated as a possible mechanism for MCI management.

Coherent Event Capture in the Operating Room: A Tool for Patient Safety

Presenter: Azhar Rafiq MD MBA

The Agency for Healthcare Research and Quality (AHRQ) and the Joint Commission on Accreditation of Healthcare Organizations (JCAHO) has begun to require implementation of safe practices in patient care. This presentation will highlight the implementation of software application, developed at Virginia Commonwealth University (VCU), for use in the operating room to accurately record all activities relevant to surgical care. The software interface, and capabilities will be demonstrated. The capacity to capture data efficiently and archive it in real time during the course of a surgical case provides avenues for accurate review of surgical procedures. This data archive can also be used in case review, as well as education with evidence based format.

Creating and Displaying Virtual Trauma in Models Derived from the Visible Human

Presenter: Karl D. Reinig PhD

We present a simplified method for inducing trauma into models derived from cryosectioned data, such as the Visible Human. Our goal is to create altered models suitable for use as virtual patients in simulators. Our simulators often provide the user with multiple clinical modalities for interrogating the virtual patients. These modalities include simulated x-ray, fluoroscopy, ultrasound, CT, transparency and palpation. The presentation contains two basic discussions: 1) a simple method for designating and effecting simulated trauma and 2) methods for conveying the normally voxel-based foundations for the simulated clinical displays to the altered polygonal models resulting from the simulated trauma. The inclusion of trauma in the virtual patients greatly expands the potential uses of the simulator.

Mobile In Vivo Biopsy and Camera Robot

Presenter: Mark E. Rentschler MS

A mobile in vivo biopsy robot has been developed to perform a biopsy from within the abdominal cavity while being remotely controlled. The biopsy robot provides a platform for effectively sampling tissue. After reaching the specified location, the grasper is actuated to biopsy the tissue of interest. The robot has been used in vivo in a porcine model to biopsy portions of the liver and mucosa layer of the bowel. The biopsy specimen was gathered from the grasper after robot retraction from the abdominal cavity. This presentation outlines the steps towards the successful design of an in vivo biopsy robot. The clamping forces required for successful biopsy are presented and in vivo performance of this robot is addressed.

An Integrated System for Real-Time Image Guided Cardiac Catheter Ablation

Presenter: Maryam E. Rettmann PhD

Minimally invasive cardiac catheter ablation procedures for treatment of myocardial arrhythmias require effective visualization of the relevant heart anatomy and electrophysiology. In a typical ablation procedure, the visualization tools available to the cardiologist include fluoroscopy, ultrasound, and a coarse 3D model of cardiac anatomy and electrical activity. Recent advances incorporate detailed, patient specific anatomical image data into the procedure. We are currently developing a prototype system which synchronously integrates patient specific, preoperative computed tomography (CT) images along with other visualization modalities and electrophysiology into a single display. This paper focuses on two aspects of the prototype system. First, we describe the framework for integrating the various system components. Second, initial work on the integration of CT data is presented which involves registration and visualization of tracked catheter points. Simulation and phantom experiments illustrating the functionality of the system are presented along with a preliminary validation.

Haptic Device for a Ventricular Shunt Insertion Simulator

Presenter: Robert Riener Dr-Ing

Ventricular shunt insertion is a common neurosurgical treatment, which is frequently performed in patients with increased intracranial pressure. To reduce the error rate and to optimize the clinical outcomes, training and preoperative planning can be supported by a shunt insertion simulator. We present the first design of a 1 DOF haptic device, which provides realistic force and position feedback during simulated shunt insertion. The design of the haptic device is based on a push-pull cable concept. Forces produced by a motor are transferred to the user via the sliding cylinder. Force is controlled by an open-loop impedance algorithm. The device allows ranges of 12 cm and 15 N. It can be used in cooperation with the well-known BRAINTRAIN simulator in order to simulate simple shunt insertion operations.

Virtual Reality Treatment for Eating Disorders and Obesity: From Body Image to Anxiety Treatment

Presenter: Giuseppe Riva PhD

Since 1995 Virtual Reality has been used in the treatment of eating disorders and obesity. Different clinical data suggest that VR can help in addressing two key features of eating disorders and obesity not always adequately addressed by existing approaches: body experience disturbances and self-efficacy.

On one side, VR technology offers an innovative approach to the treatment of body image disturbance, a difficult concept to address in therapy.

On the other side, the experiential approach allowed by VR helps patients in discovering that difficulties can be defeated, so improving their cognitive and behavioral skills for coping with stressful situations.

The presentation will discuss the pros and cons of this approach presenting the results coming from the last controlled clinical trials. Moreover, a new approach will be presented - VR to support relaxation and reduce anxiety related eating - including the first outcome data obtained with clinical samples.

User-Centered Design Driven Development of a VR Therapy Application for Iraq War Combat-Related Post Traumatic Stress Disorder: From Training to Toy to Treatment

Presenter: Albert “Skip” Rizzo PhD

The USC Institute for Creative Technologies has initiated a project that is creating an immersive VR system for the treatment of Iraq War veterans diagnosed with combat-related PTSD. The VR treatment environment is based on a cost effective approach to recycling virtual graphic assets that were initially built for the commercially successful X-Box game and tactical simulation scenario, Full Spectrum Warrior. Thus far we have created a series of virtual scenarios designed to represent relevant contexts for exposure therapy to be conducted in VR, including a city and desert road convoy environment. User-Centered tests with the application are currently underway at the Naval Medical Center-San Diego and within an Army Combat Stress Control Team in Iraq and clinical trials are schedule to commence in Sept 2005. This presentation will describe the rationale, technical specifications, scenario and clinical interface development, user-centered design data and initial clinical results from this application.

Virtual Medical Ultrasound Simulator

Presenter: Dmitry V. Romanov

The program of virtual medical ultrasound simulation (VULSCAN) works on a personal computer and does not demand special hardware components. The program analogous to the medical ultrasonic scanner is developed. In VULSCAN program all physical properties of ultrasonic waves and scanned objects are observed. Virtual simulation is completely identical to images from medical scanners. In virtual ultrasound images is absent ultrasonic parasites. Results of simulation were compared to images of ultrasound medical systems.

Point-of-Care Decision Support System on Pocket PC Using Bayesian Inference

Presenter: Sarmad Sadeghi MD

Pocket PCs offer a powerful platform for decision support systems that require sophisticated inference mechanisms and intensive mathematical calculations and at the same time can be readily available at the point of care. The application of such systems is potentially very broad. They could be used in elective, emergency, disaster, or even battlefield settings. We are building a prototype as part of the Texas Training and Technology for Trauma and Terrorism (T5). We use Bayesian network technology on Pocket PC to create a chest pain algorithm that provides decision support for diagnosis and management of acute chest pain. Our prototype captures information through a user-friendly questionnaire and provides a posterior test probability vector for the likely causes of the presenting picture. Using a utility model, the system also provides a course of action for in-hospital and out of hospital settings. We plan to clinically test this system in late 2005.

Estimation of Skeletal Movement of Human Locomotion from Body Surface Shapes Using Dynamic Spatial Video Camera (DSVC) and 4D Human Model

Presenter: Toshikuni Saito

We have been developing a DSVC (Dynamic Spatial Video Camera) system to measure and observe human locomotion quantitatively and freely. In addition, a 4D (four-dimensional) human model having detailed skeletal structure, joint, muscle, and motor functionality has been built. The purpose of our research is to estimate skeletal movements from body surface shapes using DSVC and the 4D human model. For this purpose, we constructed a body surface model of the subject and resized the standard 4D human model to match geometrical features of the subject's body surface model. Software that integrates the DSVC system and the 4D human model, and allows dynamic skeletal state analysis from body surface movement data has been also developed. We practically applied the developed system in dynamic skeletal state analysis of a lower limb in motion and visualized the motion using geometrically resized 4D human model.

Integration of All Operating Room Digital Data on a Single, Large-Format Display

Presenter: Warren S. Sandberg MD PhD

OR personnel must integrate patient and system status data from disparate sources. We created a PC-based system that performs this integration on a display visible from anywhere in the OR. We integrated devices including physiologic, gas & level-of-consciousness monitors, infusion pumps, endosurgical equipment, surgical video, hospital information & ordering systems, anesthesia & nursing documentation systems and real-time patient & staff locations to create a continuously updating, single-display snapshot of the patient. Data trending & a case progress log are provided and all data are archived. Dynamic elements of the display advance automatically, triggered by case milestones. This provides context specific information without requiring OR personnel to interact with the system. A timeline of the day's cases appears across the bottom of the display. The project achieved whole-OR, single-display integration of key patient information that crosses traditional disciplinary boundaries. This creates a future platform for augmented vigilance and computer-assisted decision support.

Automatic Detection and Annunciation of Geographic Location Errors in a Hospital

Presenter: Warren S. Sandberg MD PhD

We developed a system for automated patient location monitoring and management. Real-time data from an active infrared/RFID tracking system provides patient locations that are robust and can be compared to an "expected process" model to automatically flag wrong-location events as soon as they occur. We deployed such a system to detect and annunciate "patient-in-wrong-OR" events. The system detected all wrong OR events and all wrong OR locations were correctly assigned within 0.50 ± 0.28 minutes (mean ± SD). This corresponded to the measured latency of the tracking system. Our hospital has 50 contiguous ORs. When patient location systems based on human performance do not work as expected, patients are brought incrementally closer to a possible "wrong patient - wrong procedure" error. Current technology can automatically collect sufficient data to remotely monitor patient flow through a hospital, provide decision support based on pre-defined rules and automatically notify stakeholders of errors.

Validation of Open-Surgery VR Trainer

Presenter: Anton J.B. Sanders MSc

VREST developed a Platform for Virtual Medical Training in which in principle all kinds of surgical techniques can be practiced. On the VREST platform a resident is educated in knowledge and skills based on "touch" and "vision" and "decision" in a VR environment. The VREST platform is used prior to the first operating room surgery of the resident. Most work on transfer of surgical skills from simulator training to the operating room has been done using laparoscopic simulators. The current study aims to validate that the VREST platform will contribute to a more efficient and effective training trajectory of the resident. Increasing efficiency will lead to a lower number of operating room procedures needed to become a qualified and skilled surgeon. The transfer of the virtual hernia repair training to the operating room is investigated in this validation.

Medical Simulation and Visualization of Pneumothorax Influenced 3D Lung Dynamics

Presenter: Anand P. Santhanam MS

In this paper we propose a method to simulate morphological changes caused by both closed and tension pneumothorax. We consider a clinical parameter, the pneumothorax-index (i.e., the degree of lung collapse), as the input to the simulation. Specifically, such index constitutes a key parameter to the computation of the changes in size and shape of the affected lung. Once the index is obtained, the increase in ventilation rate and the change in the pressure-volume relationship of the affected lung are then computed. For tension pneumothorax, the air continuously flows into the pleural cavity and thus every exhalation is followed by the changes seen for a closed pneumothorax, until the affected lung collapses. The subsequent closure of pulmonary veins and resulting hyper expansion of the apposing lung is also presented. Results show a real-time visualization of closed and

tension pneumothorax using a high-resolution 3D model obtained from a normal human subject.

Natural Progression: Multimodal Education and Procedural Training

Presenter: Eric Savitsky

The integrated use of digital video, three-dimensional modeling, and force-feedback systems holds great potential as the next significant advance in medical education and procedural training. Rapid adoption and translation of this technology into clinical practice is dependent on the creation of high quality educational content delivered over a simple-to-use yet scalable platform. This presentation will explore the concurrent provision of educational content and procedural training using text, audio, digital video, three-dimensional modeling, and force feedback systems operating off a personal computer (PC)-based platform. Case-based digital multimedia educational programs are used to deliver medical content in an engaging and realistic manner. This educational content is coupled with hands-on ultrasound-guided procedural skill training using a PC-based platform comprising handheld motion sensors and force feedback devices. The presentation will address how this innovation will impact the cost and sustainability issues that surround culturally or financially prohibitive training mechanisms (e.g., cadaver labs, animal labs, and electronic mannequins) in use today.

A Simulation-Based Training System for Surgical Wound Debridement

Presenter: Mark W. Scerbo PhD

A simulation-based training system for surgical wound debridement is described. The system comprises a multimedia introduction, a surgical simulator (tutorial component), and an assessment component. The simulator includes two PCs, a haptic device, and a mirrored display. Debridement is performed on a virtual patient with a shallow laceration wound superimposed on a model leg derived from the National Library of Medicine's Visible Human Project. Trainees are instructed to remove debris with forceps, scrub with a brush, and rinse with saline solution to maintain sterility. Research and development issues currently under investigation include tissue deformation models using mass-spring system and finite element methods; tissue cutting using a high-resolution volumetric mesh and dynamic topology; and accurate collision detection, cutting, and soft-body haptic rendering determined for two devices within the same haptic space.

Documentation and Teaching of Surgery with an Eye Movement Driven Head-Mounted Camera: See What the Surgeon Sees and Does

Presenter: Erich Schneider PhD

A first proof of concept was developed for a head-mounted video camera system that is continuously aligned with the user's orientation of gaze. In doing so, it records images from the user's perspective that can document manual tasks during, e.g., surgery. Eye movements are tracked by video-oculography and used as signals to drive servo motors that rotate the camera. Thus, the sensorimotor output of a biological system for the control of eye movements - evolved over millions of years - is used to move an artificial eye. All the capabilities of multi-sensory processing for eye, head, and surround motions are detected by the vestibular, visual, and somatosensory systems and used to drive a technical camera system. A camera guided in this way mimics the natural exploration of a visual scene and acquires video sequences from the perspective of a mobile user, while the oculomotor reflexes naturally stabilize the camera on target during head and target movements. Various documentation and teaching applications in health care, industry, and research are conceivable.

Soft Tissue Modeling Forum

Presenter: Sascha Seifert Dipl-Inform

Soft tissue modeling for surgical simulators and virtual reality systems is crucial for many fields of current medical research. But for the beginner in this field it is difficult to get an overview of modeling approaches and to obtain more practical help. In this regard, papers often are not as helpful as expected, because they rather describe facts in a general manner. Another problem is to find appropriate material laws and parameterizations if the finite element method is used to model the soft tissue's biomechanical behavior. Mostly, a research group focuses on either modeling or acquiring material data via experiments. But up-to-now there is no platform to discuss and to exchange data efficiently. Therefore, we installed an internet based forum, where such an exchange of opinions, experiences and data can be performed. The forum can be found on
http://wwwiaim.ira.uka.de/web/SoftTissueWiki.

Achieving Proper Exposure in Surgical Simulation

Presenter: Christopher M. Sewell MS

One important technique common throughout surgery is achieving proper exposure of critical anatomic structures so that their shapes, which may vary, can be confidently established and protected. In this paper, we present an algorithm for providing realistic visual cues for identifying structures through bone, and a method for the objective determination

of “sufficient exposure”. In the context of bone surgery, a single point on a structure can be considered exposed when the overlying bone has been sufficiently thinned. In order to determine the regions of the structure whose shape can then be confidently inferred, we check whether each point is within some threshold distance and angle of an exposed point. We model the partial transparency of the bone by shading of each voxel inversely proportional to its distance from underlying structures along a ray cast through it from the camera, and recompute the shadings each time the viewpoint is moved.

Modeling of a Laparoscopic Needle Driver: Implication for the Design of Virtual Reality Simulators

Presenter: Daniel C. Shang BASc

Laparoscopic training, under simulated settings, benefit from high fidelity models of the actual environment. This study was aimed at reducing uncertainty in the displacement and loads experienced by a laparoscopic instrument during surgical training.

Infrared tracking of laparoscopic instruments was ineffective when real tissues attenuated the infrared signals. Incorporating the use of strain gauges for tip deflection measurements allowed for online motion and load tracking during a procedure.

Strain gauge voltages and infrared markers indicating displacement were both linear with respect to loads up to 700 grams. The resultant strain gauge voltage equated to deflection values with a calibration constant.

The results might serve two purposes. First, it may enable the tracking and analysis of the skill level of novice surgeons using bench models. Second, the mechanical model of each instrument can be quantified and incorporated into virtual simulations, thus increasing model fidelity, effectively leading to better learning.

Realistic Irrigation Visualization in a Surgical Wound Debridement Simulator

Presenter: Yuzhong Shen PhD

Wound debridement refers to the removal of necrotic, devitalized, or contaminated tissue and/or foreign material to promote wound healing. Surgical debridement uses sharp instruments to cut dead tissue from a wound and it is the quickest and most efficient method of debridement. A wound debridement simulator can ensure that a medical trainee is competent prior to performing a procedure on a genuine patient. Irrigation is performed at different stages of debridement in order to remove debris and reduce the bacteria count through rinsing the wound. This paper presents a novel approach for realistic irrigation visualization based on texture representations of debris. This approach applies image processing techniques to a series of images, which model the cleanliness of the wound. The active texture is generated dynamically based on the irrigation state, location, and range. The result is highly realistic and the algorithm is simple to implement with low cost.

Is Practicing Medicine Virtually Impossible?

Presenter: Hisham M.F. Sherif MD

In contrast to other high-risk industries, the healthcare industry has been slower to adapt Virtual Reality technology,and it lags behind both in the number and the scope of its applications. This paper discusses the basic concepts and elements of a comprehensive Virtual Reality environment, and the reasons behind such a lag in its implementation and adoption in the practice of medicine. A comparison between the healthcare industry and the aviation industry is used for illustration.

Simulating Bending Behaviour of Suturing Thread and Needle

Presenter: Ofek Shilon MSc

The traditional approach to modeling bending of a thread consists of adding springs connecting non-neighboring spline knots. A novel alternative is introduced, consisting of articulating an intrinsic bending energy of an arbitrary joint, and deducing the resultant justification forces. The deduction does not require the bending joint to be located at a knot, so the smoothness of the resultant behavior isn't limited by the model resolution. Significant visual appeal is thus gained, with almost negligible computational cost. We apply a similar approach to the simulation of a needle/thread joint and obtain a realistic previously unachieved tendency to justify. We prove that such forces couldn't have been derived as contact forces between the rigid/spline systems. We survey several generalizations, including a method to control the locality of the bending factor throughout the thread and a 2-D generalization that we used to form a cheap and realistic simulation of a hernia mesh.

Web-Based Viewer for Systematic Combination of Anatomy and Nomenclature

Presenter: Jonathan C. Silverstein MD

Availability of electronic anatomic data and symbolic naming hierarchies generates the need to combine these in a usable fashion. For example, combining geometric models with structure names is critical for virtual anatomy teaching. The open, free system described, enables Internet users to rapidly assemble arbitrary interactive virtual reality anatomic scenes

that also self-document structure names. Educators can generate interactive illustrations from arbitrary viewpoints for communicating anatomic relationships. Key is that elemental structures are modeled and assigned to tree leaves so they assemble coherently. We assigned geometries to SNOMED concepts and computed the resulting hierarchical tree using a custom-built algorithm. Our web-application then displays the navigable tree and options to select concepts (leaves or branches), transparency, and color for passing to a VRML generation sub-system. We have integrated over 300 elemental anatomic structures. The system serves as a navigable library of anatomic structures for assembling virtual anatomic scenes.

Accelerating Change: Developing Tomorrow's Medical Toolkit

Presenter: John Smart

Many of you are or will be innovators of tomorrow's most successful medical tools, training platforms, and techniques. You are in the business of driving and thriving with change.

Unlike our parent's slower-paced era, certain types of scientific, technical, and even consumer behavioral change happen so fast today that we are increasingly caught off guard. What is accelerating change, where and how long can we expect it to continue, and what lessons does it hold for medical innovation?

As a futurist, I'm going to make the case that Predicting, Adapting to, Creating, and Profiting from accelerating processes of change have become our most important strategic skillset.

I'll give a few examples of successful and unsuccessful responses to accelerating change across the managerial repertoire (Predicting: forecasting, scenarios, planning; Adapting: business intelligence, knowledge management; Creating: R&D, manufacturing, marketing; Profiting: accounting, management). I'll discuss the importance of discriminating evolutionary from developmental change, and of recognizing and benefiting from differential rates of development, both locally and globally.

The faster our computing, communications, and simulation environments change, the more we notice other things, including human nature and culture, staying exactly the same. In fact, better our information and systems biology becomes, the better we realize that optimal, healthy behavior is a special subset of what each of us does.

I'll try to leave you with the sense that evolutionary and developmental innovations are complex and subtle processes-we are always like children in comparison to what we could know. Yet the better we understand innovation in a broad and systemic way (first-mover and second-mover advantages, globalization, collective intelligence, network theory, tipping points, etc.), the better we must become at predicting, adapting, creating, and profiting at the appropriate times.

Worst-Case Scenario: Battlefield Injury/Can't Intubate

Presenter: N. Ty Smith MD

Anthony Gallagher, at MMVR13, stated that medics, practicing on manikins, required as long as 2 1/2 minutes to insert an endotracheal tube. We asked two questions. What are the effects on the brain and heart of these apneic periods, and what is the impact of hemorrhage and/or terror on the effects of apnea? To examine these questions, we used BODY Simulation, a physiologic, pharmacologic multiple transport model of the human body. We made several runs incorporating apnea, with or without hemorrhage and/or terror, recording 15 variables that reflected the effects of these stresses on the heart and brain. Terror, hemorrhage or both increases the magnitude of and shortens the time to cardiac or brain injury or death during intubation-related apnea. The training of medics should emphasize these factors. Optimally, one would connect a detailed physiologic model, like BODY Simulation, to the manikin, to remind the medics that time is important.

Gesture Based Hand Movement Analysis and Haptic Feedback for Surgical Training

Presenter: Mark Smith MD PhD

The objective of the presentation is to familiarize the audience with common computational techniques and pattern recognition tools used for hand movement analysis, their application to surgical training and further report results of gesture based hand movement analysis and haptic feedback for surgical training being developed. The presentation would consist of the following modules: 1. Introduction to MIS and basic endoscopic movements , 2. Hand Movement Analysis Techniques, 2a. Signal processing techniques, 2b. Gesture Based Techniques, 3. Application of Hand Movement Analysis to Surgical Training (Related Work), 4. Proposed Movement Evaluation Scheme, 4a. Equipment, 4b. Hand Movement Analysis Techniques Parametric and Non-Parametric models of gesture analysis., 4c. Evaluation Measures and their validation methodology, 5. Proposed Feedback Technique, 5a. Equipment, 5b. Design of the cueing vocabulary for indicating erroneous movement, 5c. Real-time feedback generation and validation, 6. Results, 7. Conclusions, 8. References

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Haptic Feedback for the GPU-Based Surgical Simulator

Presenter: Thomas Sangild Sørensen PhD

In recent publications GPU-based spring-mass surgical simulations have been shown to significantly increase simulation rates compared to conventional CPU implementations. This approach does however put restrictions on the GPU to CPU communication model, which again limits potential implementations of haptic feedback. This presentation will discuss the pros and cons of several approaches to haptic feedback on a GPU-based surgical simulator. To goal is to balance the CPU and GPU workload and avoid serious performance bottlenecks. In order to understand and recognise such bottlenecks, a quick review of a GPU spring-mass simulation algorithm will be presented. Haptic algorithms are subsequently reached, which provides force feedback when touching and deforming the simulated shape.

Direct Volumetric Rendering Based on Point Primitives in OpenGL

Presenter: Ilana A. Souza

The aim of this paper is to describe a volumetric data renderization method based on point primitives that is simpler than other existing algorithm and that offers a good performance without the use of special graphical boards.

3D Scanner: An Aid for Planning Breast Augmentation Surgery

Presenter: David B. Stefan MSEE

Active cosmetic surgery practice utilizing 3D white light scanner to produce accurate, measurable 3D body image of patients. Conversion to VRML. Virtual surgery tools implant a series of prospective breast implants. 3D whole body models provided to patient during pre-operative consultation. Patient and surgeon select optimal whole body look prior to surgery. Post-operative scans measure and validate predictive models. Also realtime virtual surgical assistance in operating room, virtual collaborative surgery. Virtual closet.

Avionics-Compatible Video Facial Cognizer for Detection of Pilot Incapacitation

Presenter: Morris Steffin MD

High-acceleration loss of consciousness (HGLOC) is a particularly severe hazard in the operation of modern military aircraft, particularly in the case of supermaneuverable planes. In that environment, HGLOC occurs suddenly, and if it persists for only one-half minute, consequences may be disastrous. Even if consciousness is recovered, the pilot may not be able to carry out combat operations, or, indeed, to fly safely. Rapid detection of HGLOC would therefore allow automated switching control of the aircraft to autopilot, thus avoiding increased pilot and aircraft risk The approach developed in this laboratory circumvents this limitation by means of an avionics-compatible video facial cognizer operating in real time to detect the characteristic facial changes at the onset of HGLOC and to provide an electrical trigger allowing the appropriate corrective response, such as switching to autopilot. The system is flexible enough to allow pilot interaction for the prevention of inappropriate overrides. Crucial to the success of the system is that it is based on algorithms transportable to video digital signal processing (DSP) board technology which functions in a stand-alone, compact, and avionics-compatible configuration.

An Approach for Anthropometrically Correct 3D Adaptation of Human Body Models

Presenter: Michael Stoettinger Dipl-Ing

The presentation will show why these algorithms were developed and how they can be used effectively. Therefore, it is necessary to give a short introduction to BurnCase 3D which is the software system that created the need for the algorithms described in the paper. Because the algorithms were implemented as part of a software tool the presentation will include a short demostration video that shows how the tool and algortihms work and what the benefits are.

TRUS-Fluoroscopy Fusion for Intraoperative Prostate Brachytherapy Dosimetry

Presenter: Yi Su PhD

Permanent prostate brachytherapy (PPB) is an accepted and commonly employed means of treating early stage prostate cancer. Despite the improvement in implantation techniques in recent years, exact replication of the treatment plan in the operating room remains difficult. Thus, intraoperative dosimetry is an important improvement for the current PPB procedure to monitor the quality of the implant. A TRUS-fluoroscopic fusion based intraoperative dosimetry method for PPB has been developed. The implanted seeds were located in three-dimensional space with a seed reconstruction technique using multiple fluoroscopic images acquired at different angles. Although TRUS is not the best imaging modality for seed visualization, a portion of the seeds can still be identified. Thus, the registration of TRUS and fluoroscopic images can be achieved using those seeds as fiducials. A downhill simplex based optimization strategy was used to determine the best transformation for registration. Preliminary phantom studies showed promising results.

Augmented Reality with Fiber Optics

Presenter: Gunther Sudra Dipl Wi-Ing

Augmented Reality (AR) techniques directly visualize virtual objects in the surgical site. Thus the surgeon does not need to turn his head from the patient to the computer monitor and vice versa. However, the inflexible handling of existing AR systems (e.g. occlusion of video-beamers, calibration of see-through devices) reduce the benefit for the surgeon. Hence we present the concept of a small AR technique which acts very close to the patient and therefore does not impede persons and devices in the operation room. The system projects small structures (e.g. arrows for navigation) on a surface. The objective is the integration into surgical instruments, with easy change of instruments. Miniaturization is realized using a fibre optic bundle to separate image generation from image output coupler. In this paper we present a calibration algorithm and results about an augmentation with the demonstration device.

Marker Detection with Minolta Vi-900 Laser Scanner

Presenter: Gunther Sudra Dipl Wi-Ing

Elastomechanical modelling of human soft tissue is a prerequisite for realistic simulation of surgical interventions. It is of great importance to evaluate these models efficiently and accurately with real world data. For this evaluation we propose the use of a laser scanner with small artificial landmarks and report on a new algorithm to detect these landmarks accurately and almost automatically. For range images and color information we use a Minolta Vi-900 laser scanner and developed and evaluated different markers (size, shape, color, material). The process of marker detection can be separated in two steps. First step is the scanning and the creation of hypotheses about marker positions according to color information. Second step is the refinement for each marker position using an ICP algorithm. The experimental results showed that the marker positions were extracted with sufficient accuracy and an acceptable one click user interaction.

Virtual Reality as an Adjunctive Pain Control During Transurethral Microwave Thermotherapy

Presenter: Robert M. Sweet MD

Transurethral microwave thermotherapy (TUMT) is an effective, minimally invasive technique for treating benign prostatic hypertrophy (BPH) that offers the advantages of an outpatient procedure that can be performed in the office with a low rate of adverse events. The management of pain during clinic TUMT can be challenging. Pain can lead to increased pelvic blood flow which dissipates the energy delivered, limiting the amount of heat delivered to the prostate In this report, we describe the novel use of virtual reality (VR) distraction as an adjunctive mechanism for local anesthesia during TUMT in a 67-year-old man. We present physiologic data on prostatic blood flow as well as subjective assessments demonstrating the effect. This novel report is the first to demonstrate the efficacy of VR in an elderly, the first documented use for a urologic clinic procedure and the first to demonstrate efficacy for the control of thermally-induced pain.

Interactive Simulation Training: Computer Simulated Standardized Patients for Medical Diagnosis

Presenter: Tom Szeless

SIMmersion LLC is a software development company that creates human interactive training simulations. SIMmersion creates PC-based simulations of people with whom trainees are able to hold conversations. Trainees communicate with simulated characters in face-to-face conversations, using voice recognition technology. Questions and responses are scripted to emulate what people would say at any given stage of a conversation. Trainees can select from the scripted questions and the character will respond based on emotional and character state. Since each session of simulation training is unique and can be played at any time, practice is unlimited. Topics that would match well with SIMmersion's simulation capabilities include diagnosis of depression, alcoholism, or drug use; grievance counseling; marriage counseling; and suicide intervention. SIMmersion's technology can be integrated with modeling technology to create a speech-interactive, mannequin-based patient simulation system for healthcare training and assessment. Systems being developed involve early detection of smallpox as a biological weapon.

Computerized Planning of Prostate Cryosurgery

Presenter: Daigo Tanaka PhD (Cand)

Cryosurgery is the destruction of undesired tissues by freezing, as in prostate cryosurgery, for example. The optimal arrangement of the cryoprobes, which is known to have a dramatic effect on the quality of the cryoprocedure, is currently based on the cryosurgeon's experience. In effort to improve the quality of cryosurgery, a computerized technique for cryosurgery planning is presented in the current report. A two-phase optimization method is proposed for this purpose, based on two previous and independent developments by this research team. Phase I is based on a bubble-packing method, previously used as an efficient method for finite elements meshing. Phase II is based on a force-field analogy method, which has proven to be robust at the expense of a typically long runtime. This new method of planning has proven to reduce planning runtime from hours to minutes, making automated planning practical in a clinical time frame.

Segmenting the Visible Human Female

Presenter: Bharti H. Temkin PhD

Our presentation will address issues related to: 1) Side-by-side approach for segmenting the Visible Human Female (VHF) image data, for all three views, by taking advantage of known Visible Human Male (VHM) segmentation information. Generalization of this approach to other data sets will also be discussed. 2) Several segmentation algorithms will be discussed along with problems associated with them and the lessons learnt while segmenting the VHF - including evaluation of their relative usefulness, choice of parameters to reduce the over or under segmentation, optimization and automation of best algorithms. We will also address reduction of segmentation errors, error correction, and validation of the segmentation results. This will be done in the context of 3D modeling of anatomical structures and validation of segmentation for a specific structure from slice to slice. Finally, we will include integration the segmented data to the W3D-VBS that will validate the usefulness of Segm-VHF system it-self.

Registration and Segmentation for the High Resolution Visible Human Male Images

Presenter: Bharti H. Temkin PhD

We describe registration and segmentation algorithms for the Visible Human Male High Resolution images that take advantage of the already registered and segmented Visible Human Male Low Resolution images. We evaluate and quantify the accuracy of the procedure. A method of generalizing the algorithm to registration of images with different resolutions requiring rigid body transformation is discussed. We will present our tool for 3D modeling of anatomical structures using the High Resolution data. This will be followed by a demonstration of creating anatomical models in real-time. Finally, a comparison of the models created using the registered high and low resolution images will be provided.

Tracking Endoscopic Instruments without Localizers: Image Analysis-Based Approach

Presenter: Oliver Tonet PhD

In this paper we present an approach to localize endoscopic instruments with respect to the camera position, purely based on video image processing. No localizers are required. The only requirement is a coloured strip at the distal part of the tool shaft, to facilitate image segmentation. The method exploits perspective image analysis applied to the cylindrical shape of the tool shaft, allowing to measure five degrees of freedom of the tool position and orientation. We describe the method theoretically and experimentally derive calibration curves for tuning the parameters of the algorithm. Results show that the method can be used for applications where accuracy is not critical, e.g. workspace analysis, gesture analysis, augmented-reality guidance, telementoring, etc. If this method is used in combination with a robotic laparoscope camera assistant, full localization with respect to the operating room can be achieved in real-time.

Biomechanical Analysis of Surgeon's Gesture for Evaluating Skills in Virtual Laparoscopy

Presenter: Oliver Tonet PhD

Minimally invasive surgery (MIS) has become very common in recent years thanks to many advantages that patients can get. However surgeons must undergo a long and difficult training to master the perceptual-motor skills required by MIS, so that efficient training methods and ergonomic surgical instruments must be developed. In this context, biomechanical analysis of the surgeon's gesture is a fundamental aid for the overcome of these problems. In this paper we performed a biomechanical analysis of the surgeon's movement in a simulated exercise involving precise tip positioning and depth perception. Estimation of biomechanical parameters, on the exercise as a whole and on segmented sub-movements, allows us to distinguish expert surgeons from novices. This result can be used for further improving laparoscopic training methods and surgical instruments.

Face, Content and Construct Validation Study of SimPraxis™: A Novel Prototype Cognitive Simulator for Standard Teaching and Assessment

Presenter: Linh N. Tran

It has been estimated that 85% of what is learned about a medical procedure lies in the cognitive domain. We evaluated the face, content and construct validity of Simpraxis™ , a novel computer based "interactive" cognitive simulator to train the skills necessary to perform pelvic lymph node dissection (PLND). Ten prostate cancer experts from 5 different institutions volunteered to evaluate the appropriateness and cohesiveness of the simulator's content. Eight of the experts and nine first-year residents participated in the construct validation study and were asked to perform a PLND procedure on the simulator. Results show a general acceptance of experts about the simulator's face and content. In addition, experts' performance of PLND on the simulator is significantly better than novices' performance. We present the results of establishing face, content and construct validity for the SimPraxis™ simulator to train the skills necessary to perform pelvic lymph node dissection.

The Pre-Trained Novice: Bringing Simulation-Based Training to Improve Learning in the Operating Room

Presenter: Kent R. Van Sickle MD

Acquiring advanced technical skills prior to the operating room experience offers benefits for both trainee and patient. The purpose of this study was to determine whether training medical students to perform laparoscopic suturing and knot tying exclusively using simulation would achieve comparable results to the experience of senior surgery residents performing the same task.

Flatland Sound Services Design Supports Virtual Medical Training Simulations

Presenter: Victor M. Vergara MS

This paper describes the evolution of the design of a sound system required to support Project TOUCH, a multi-year collaboration between the Schools of Medicine at the state Universities of Hawaii and of New Mexico. Two specific case scenarios, a neurological trauma and a virtual kidney nephron served as models for the application of virtual reality and simulation technologies. Flatland, an open-source visualization and virtual reality application development tool created at the University of New Mexico, was used in this project.

The goal of Flatland sound development is to provide content developers with modular and extensible tools that allow them to include sound rendering, sound synthesis, voice chat, communication with external sound devices, text to speech, speech recognition, and synchrony of graphics with sound. It also gives developers the flexibility to use their preferred sound and music generating software and hardware on independent systems for specialized applications.

Tracking Instruments and Probes in the Body: Current and Future Opportunities

Presenter: Kirby G. Vosburgh PhD

Requirements for tracking in the body include an accurate and timely position signal, context and registration, display to the caregiver, and the selective inclusion of other content, such as pre-procedural images and plans, updated anatomical features, and virtual fixtures. Electronic, optical, and mechanical systems will be reviewed, and their capabilities described with reference to published work in augmented reality for clinical applications. The strengths and weakness of these subsystems will be presented. We will discuss key components of information display, including fast segmentation, accurate registration, image clutter reduction, and calibration. Practical aspects of system implementation such as display optimization, real time updating, and tracker system integration in the OR will be discussed.

'Virtual Unwrapping' of a Mummified Hand

Presenter: R. John Winder PhD

The purpose of this work is to demonstrate the feasibility of medical virtual reality technologies in the investigation of a mummified hand. The Ulster Museum obtained the hand, which originated from Thebes, without any identifying information. The mummified hand was investigated using conventional X-ray and 3D multi-slice Computed Tomography (CT). Imaging revealed a range of fractures of the wrist, phalanges and finger bones whilst 3D CT demonstrated internal structures using volume rendering. The absence of any features of bone healing at the fracture sites would imply that they occurred just prior to death or in the mummified state possibly during excavation. Conventional X-ray imaging indicated that the hand, although small, was likely to have originated from an adult. Medical imaging and virtual reality display will enable us to produce a rapid prototyped model using fused deposition technology. Therefore, further paleopathological research can be performed on the specimen.

3D Surface Accuracy of CAD Generated Skull Defect Contour

Presenter: R. John Winder PhD

The creation of a satisfactory cosmetic outcome in the repair of cranial defects relies on manual skill. However, computer aided design is gaining acceptance in the creation of custom cranial implants. The purpose of this work is to demonstrate the accuracy of a CAD generated skull defect contours. 3D multi-slice CT scanning was carried out on a life size plastic skull. Surface models were generated of the original skull and of temporofrontal and parietal defects. Surface contours were interpolated towards the centre of the defect from the edges where it was blended. The CAD contour deviation ranged from 0.0 mm to 2.0 mm with 80% of the total defect area less than 0.66 mm as measured by difference maps. CAD techniques can be used to produce contours for the repair of cranial defects with minimum deviation from the original skull contour. This enables accurate design and production of cranial implants.

Smooth Vasculature Reconstruction from Patient Volume Data

Presenter: Xunlei Wu PhD

Virtual reality based simulations are ideal for procedure training and planning of neuro-interventional therapy without putting patients at risk. To achieve interactive visualization, real-time and robust physics-based modeling; a smooth and efficient 3D patient-specific neuro-vasculature is essential. This paper presents and evaluates a streamlined reconstruction process from patient scan to smooth vascular surface. Semi-automatic tools have been developed to reduce noise in data set, to segment vascular network, to estimate vessel center-

lines and radii, and to reconstruct the associated smooth surface. The proposed scheme handles more general vascular topology than previous approaches and is more robust to present various bifurcation configurations. The accuracy and consistency of our technique are evaluated on a vascular phantom scanned in 12 different orientations as well as a real clinical data set. Experiments show that the proposed technique reaches a good balance in terms of mesh smoothness, compactness, and accuracy.

A Holographic Collaborative Medical Visualization System

Presenter: Gianluigi Zanetti PhD

We report on the development of a novel holographic display technology that targets multiple freely moving naked eye viewers and of a collaborative medical application prototype that exploits the technology to provide medical specialists with a truly interactive 3D collaborative environment for diagnostic discussions and/or pre-operative planning. The prototype is currently being evaluated as a tool for the planning of Abdominal Aortic Aneurysm (AAA) treatment.

Effects of Assembling Virtual Fixtures on a Virtual Navigation Task

Presenter: Bin Zheng MD PhD

An approach to enhance navigation task performance is to integrate sensory guidance (virtual fixtures) into a virtual training system. To evaluate the effects of adding virtual fixtures on skill acquisition, 32 subjects were required to use a PHANToM, as an input device, to transport a virtual object through a computer-generated 3-D maze. Subjects practiced navigation under 4 conditions where the maze was augmented with either a graphic (G), an attractive force field (F), both a graphic and a force field (GF), or none (N). Fifteen practice trials were given before subjects were transferred to a situation with no virtual fixtures. Results showed that the implementation of force field assisted the task performance during practice; however, it failed to show positive transfer effects. In contrast, adding a graphic fixture to the virtual maze helped subjects to define the optimal pathway throughout navigation, which sequentially facilitated skill acquisition.

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