# Table of Contents

Organizing Committee ................................................................. 1
Featured Speakers ........................................................................... 3
Conference Information ................................................................. 7
  Welcome ....................................................................................... 7
  Mission Statement ....................................................................... 7
  Course Objectives ........................................................................ 7
  Target Audience .......................................................................... 7
  Acknowledgments ........................................................................ 7
  Poster Judging ............................................................................ 7
Satava Award .................................................................................. 7
Evaluation ...................................................................................... 8
Disclaimer ..................................................................................... 8
Organizer Contact Info ................................................................. 8

Plenary & Parallel Session Presentation Schedule *(With Index to Presentation Summaries)* ......................................................... 11
  Thursday Morning ....................................................................... 11
    Plenary Session ........................................................................ 11
  Thursday Afternoon .................................................................... 11
    Session A - Simulation & Learning ......................................... 11
    Session B - Robotics / Information-Guided Therapy ............... 12
    Session C – Plasma Medicine: The Emerging Revolution in Surgery, Wound Care, and Pathogen Control .......... 13
    Session D – Developing a Standardized Tri-Service Medical Simulation Platform – The TOPS Initiative .... 13
    Session E – Virtual Reality and Advanced ICT in Europe .......... 14
  Friday Morning ........................................................................... 17
    Plenary Session ........................................................................ 17
  Friday Afternoon ....................................................................... 18
    Session A - Simulator Development / Training, Assessment & Simulator Validation ........................................ 18
    Session B - Does It Really Work? Validating New Surgical Techniques / Patient Care & Rehabilitation ...... 19
    Session C - Virtual Reality for Psychology’s Clinical and Research Use ......................................................... 20
  Saturday Morning ....................................................................... 23
    Session A - Modeling, Visualization & Simulation / Haptics ..... 23
    Session B - NIDRR Perspectives on VR Applications for Addressing the Needs of those Aging with and into Disability ........................................ 24
    Session C - Multi-User Virtual Environment Boot Camp and Patient Surge Triage Practice .......................... 25
  Saturday All Day ........................................................................ 26
    Adjunct Meeting - Virtual Reality Assisted Exposure Therapy in the Prevention and Treatment of PTSD and Related Conditions .................................................. 26

Poster Presentations *(With Index to Presentation Summaries)* .................................................................................................................. 12
  Thursday Posters
    Visualization, Imaging & Information-Guided Therapies .......... 14
    Simulator Design & Development - Part 1 ................................ 15
    Telemedicine & Networked Intelligence .................................... 16
  Friday Posters
    Simulator Design & Development - Part 2 ................................ 20
    Simulator Validation .................................................................. 21
    Plasma Medicine ....................................................................... 21
    Patient Care & Rehabilitation .................................................. 22
    Modeling & Simulation ............................................................. 22
    Haptics ..................................................................................... 22
    Miscellaneous Topics ............................................................... 23

Salon ............................................................................................... 29
Exhibits ......................................................................................... 33
  Exhibit Hours ............................................................................. 33
  Exhibitors .................................................................................... 33

Presentation Summaries .................................................................. 39
Presenter Contact Info ................................................................. 79
Presenter Index ............................................................................ 82
Organizing Committee

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Office of High Performance Computing & Communications,
National Library of Medicine

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Vera List Center for Art and Politics,
The New School (NY)

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University of Tennessee

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Nepean Hospital,
Sydney West Area Health Service

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Clinical Science, Intervention, and Technology
Karolinska Institute

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University of Alabama at Birmingham

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Department of Computer Science,
University of North Carolina

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Greenleaf Medical Systems

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Penn State College of Medicine

David M. Hananel
Surgical Education,
CAE Healthcare

Wm. LeRoy Heinrichs MD PhD *
Stanford University School of Medicine

Helene M. Hoffman PhD *
School of Medicine,
University of California, San Diego

Kanav Kahol PhD *
Department of Biomedical Informatics,
Arizona State University

Mounir Laroussi PhD *
Laser & Plasma Engineering Institute,
Old Dominion University

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

Alan Liu PhD *
National Capital Area Medical Simulation Center,
Uniformed Services University

Bertalan Meskó *
Medical School & Health Science Center,
University of Debrecen
Webicina.com

Greg T. Mogel MD
Kaiser Permanente

Kevin N. Montgomery PhD
National Biocomputation Center,
Stanford University

Makoto Nonaka MD PhD
Foundation for International Scientific Advancement
<table>
<thead>
<tr>
<th>Name</th>
<th>Title and Institution</th>
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</thead>
<tbody>
<tr>
<td>Roger Phillips PhD CEng FBCS CIPT</td>
<td>Dept of Computer Science, University of Hull; Virtual Ltd</td>
</tr>
<tr>
<td>Carla M. Pugh MD PhD</td>
<td>Center for Advanced Surgical Education, Northwestern University</td>
</tr>
<tr>
<td>Giuseppe Riva PhD *</td>
<td>Applied Technology for Neuro-Psychology Lab, Istituto Auxologico Italiano; Università Cattolica del Sacro Cuore di Milano</td>
</tr>
<tr>
<td>Albert A. Rizzo PhD *</td>
<td>Institute for Creative Technologies &amp; School of Gerontology, University of Southern California</td>
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<tr>
<td>Richard A. Robb PhD *</td>
<td>Biomedical Imaging Research Laboratory Mayo Clinic College of Medicine</td>
</tr>
<tr>
<td>Jannick P. Rolland PhD *</td>
<td>Institute of Optics, University of Rochester; ODA Lab, University of Central Florida</td>
</tr>
<tr>
<td>Anand P. Santhanam PhD *</td>
<td>Department of Radiation Oncology, University of California, Los Angeles</td>
</tr>
<tr>
<td>Richard M. Satava MD FACS</td>
<td>Department of Surgery, University of Washington</td>
</tr>
<tr>
<td>Steven Senger PhD *</td>
<td>Department of Computer Science, University of Wisconsin - La Crosse</td>
</tr>
<tr>
<td>Ramin Shahidi PhD *</td>
<td>California Inst of Computer Assisted Surgery, Stanford University School of Medicine</td>
</tr>
<tr>
<td>Yunhe Shen PhD *</td>
<td>Center for Research in Education and Simulation Technologies, University of Minnesota</td>
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<tr>
<th>Name</th>
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<tbody>
<tr>
<td>Marshall Smith MD PhD *</td>
<td>Simulation Center, Banner Good Samaritan Medical Center</td>
</tr>
<tr>
<td>Thomas Sangild Sorensen PhD *</td>
<td>Computer Science &amp; Inst of Clinical Medicine, University of Aarhus, Denmark</td>
</tr>
<tr>
<td>Don Stredney</td>
<td>Interface Laboratory, OSC</td>
</tr>
<tr>
<td>Julie A. Swain MD *</td>
<td>Div of Cardiovascular and Respiratory Devices, U.S. Food and Drug Administration</td>
</tr>
<tr>
<td>Robert M. Sweet MD FACS *</td>
<td>Urologic Surgery &amp; Academic Health Center, University of Minnesota</td>
</tr>
<tr>
<td>Kirby G. Vosburgh PhD *</td>
<td>Brigham &amp; Women’s Hospital; Harvard Medical School</td>
</tr>
<tr>
<td>Dave Warner MD PhD</td>
<td>MindTel LLC; Inst for Interventional Informatics</td>
</tr>
<tr>
<td>Suzanne J. Weghorst MA MS</td>
<td>Human Interface Technology Lab, University of Washington</td>
</tr>
<tr>
<td>Brenda K. Wiederhold PhD MBA BCIA *</td>
<td>Virtual Reality Medical Institute, Brussels</td>
</tr>
<tr>
<td>Mark D. Wiederhold MD PhD</td>
<td>Virtual Reality Medical Center, San Diego</td>
</tr>
<tr>
<td>Ozlem Yardimci PhD *</td>
<td>Technology Resources/Sterility Assurance Research Center, Baxter Healthcare Corporation</td>
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* Member, Review Committee
# Featured Speakers

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<tr>
<th>Name</th>
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<th>Topic</th>
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<tbody>
<tr>
<td>Richard Satava</td>
<td>Professor, Department of Surgery, University of Washington</td>
<td></td>
<td>MMVR Vision: A History of Fact, Fiction, and the Future</td>
</tr>
<tr>
<td>Don Jones</td>
<td>VP, Business Development for Health &amp; Life Sciences, Qualcomm Inc;</td>
<td>Chairman, Wireless Life Sciences Alliance</td>
<td>Wireless Technology Innovations in Healthcare</td>
</tr>
<tr>
<td>Alexander Fridman</td>
<td>Director, A. J. Drexel Plasma Institute, Drexel University</td>
<td></td>
<td>Plasma Medicine: Application for Wound Treatment</td>
</tr>
<tr>
<td>James Blascovich</td>
<td>Professor, Department of Psychology, University of California, Santa Barbara</td>
<td></td>
<td>Infinite Reality: Donning Avatars for Good Health</td>
</tr>
<tr>
<td>Kirby Vosburgh</td>
<td>Assistant Professor of Radiology, Brigham &amp; Women's Hospital / Harvard Medical School</td>
<td></td>
<td>It Looks Cool; Does it Work?</td>
</tr>
<tr>
<td>Dave Warner</td>
<td>ARCH Synergist, MindTel LLC; Institute for Interventional Informatics</td>
<td></td>
<td>Retoxing on the Elixir of Cyber-Madness—Let the Paradigm Shifts Begin Again...</td>
</tr>
<tr>
<td>JoAnn Kuchera-Morin</td>
<td>Director, AlloSphere Research Facility &amp; Professor, Media Arts &amp; Technology and Music, University of California, Santa Barbara</td>
<td></td>
<td>Immersed in Unfolding Complex Systems: Multi-Sensory Computing in the AlloSphere, One of the Largest Immersive Instruments in the World for New Scientific Discovery</td>
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<tr>
<td>Kóan Jeff Baysa</td>
<td>Medical Curator, Vera List Center for Art and Politics, The New School University</td>
<td></td>
<td>The Performance of Memory</td>
</tr>
<tr>
<td>Virgil Wong</td>
<td>Medical Cognition and Intelligent Technologies Researcher, Columbia University</td>
<td></td>
<td>The Medical Avatar and Medical History: Past, Present, and Future</td>
</tr>
<tr>
<td>Caitlin Hardy</td>
<td>Center for Biomedical Imaging, Department of Radiology, New York University Medical Center</td>
<td>7 Tesla MRI Machine; Imaging the Anatomical Basis of Memory in Schizophrenia and Olfaction</td>
<td></td>
</tr>
<tr>
<td>Alessandro Marianantoni</td>
<td>Center for Research in Engineering, Media and Performance, School of Theater and Television, University of California at Los Angeles</td>
<td>MNEMONIC SPACES: Responsive Places for Art, Culture and Healthcare; RFID Technology and Memory Disorders</td>
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MMVR 18

Conference Information
Welcome

Welcome to the 18th *Medicine Meets Virtual Reality*. After a year’s sabbatical, we are enthusiastic to meet once again with friends and colleagues, and to greet newcomers to the conference. Thank you for being here with us.

We are also pleased to offer a vigorous curriculum with more than 240 presentations: papers, posters, panels, workshops, demos, art, and more. In addition, our colleagues at the Telemedicine & Advanced Technology Research Center (www.TATRC.org) are hosting two one-day programs on high-level simulation research. The exhibit hall showcases industry, academic, and military projects and products.

We want your experience to be worthwhile and engaging. Please stop by the registration desk at any time if you have comments or questions—or just want to say hello.

Mission Statement

MMVR is organized to be an educational environment that stimulates communication and collaboration among scientists, engineers, physicians, surgeons, educators, students, military, government, and industry. It supports the development and adoption of advanced medical technologies for medical care and education. Its goal is improved precision, efficiency, and outcomes in patient care, practitioner training, and public health. The MMVR curriculum, by combining rigorous assessment with speculative vision, aims to create forward-thinking solutions to health problems.

Course Objectives

Presentations are chosen to educate participants on:

- Simulation advances that, supported by haptics and modeling, are transforming medical education, procedural training, psychotherapy, rehabilitation, and other areas of healthcare.
- The novel imaging, visualization, and data fusion techniques that are revolutionizing diagnosis and therapy.
- Robotics and sensors that extend the reach of healthcare providers in patient assessment and treatment.
- Intelligence networks that inform provider decision-making and foster a collaborative medical environment.
- Broader goals, accomplishments, and challenges in the development and application of novel devices and methods for medical care and education.

Target Audience

- Physicians, surgeons, and other medical professionals interested in emerging and future tools for diagnosis and therapy
- Educators responsible for training the next generation of doctors and scientists
- IT and medical device engineers who create state-of-the-art and next-generation simulation, imaging, robotics, and communication systems
- Data technologists creating systems for gathering, processing, and distributing medical intelligence
- Military medicine specialists confronting the challenges of warfare and domestic public health
- Biomedical futurists, investors, and policy-makers who need to understand where medicine is headed

Acknowledgements

We thank our colleagues on the Organizing Committee for their continued support during these past two years. We especially acknowledge those who contributed their time and expertise reviewing materials submitted during the Call for Presentations. We also thank the Proceedings editors for their work.

We express our sincere appreciation to TATRC for its ongoing partnership, which brings key innovations and critical dialogue to MMVR.

We thank ALL of you who are presenters during this year’s program. It is you who ultimately make this conference a valuable educational experience.

Poster Judging

Vote for the best poster presentations! Please complete your Thursday and Friday ballots and submit them at the ballot box at the registration desk. Ten winning posters (five each day) will receive prizes.

The Satava Award

The 16th Satava Award will be presented at MMVR18. Established in 1995 to acknowledge the contribution of Richard M. Satava MD FACS, the award is presented to an individual or research group demonstrating unique vision and commitment to the improvement of medicine through advanced technology. Its prior recipients are:

Helene Hoffman PhD (2009)
Alan Liu PhD & Mark Bowyer MD (2008)
Naoki Suzuki PhD (2007)

*continued*
Nigel John PhD (2006)
Brenda Wiederhold PhD MBA(2005)
Steven Dawson MD (2004)
Richard Robb PhD (2003)
SUMMIT, 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 (1996)
Richard Satava MD FACS (1995)

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

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

Organizer Contact Information
Medicine Meets Virtual Reality
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San Luis Obispo, CA 93405 USA
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MMVR18@NextMed.com
http://www.NextMed.com
MMVR 18

Presentation Schedule
## THURSDAY MORNING

### POSTER SESSION

7:00 – 8:30
During this session, poster presenters stand with their posters to discuss their research with attendees.

### THURSDAY MORNING

#### PLENARY SESSION

**Moderators:** Richard Satava & Mounir Laroussi

<table>
<thead>
<tr>
<th>Time</th>
<th>Speaker</th>
<th>Affiliation</th>
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<tr>
<td></td>
<td><strong>Moderators:</strong> Richard Satava &amp; Mounir Laroussi</td>
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<tr>
<td>8:45</td>
<td>Richard Satava</td>
<td>Professor, Department of Surgery, University of Washington</td>
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<tr>
<td>9:15</td>
<td>Don Jones</td>
<td>VP, Business Development for Health &amp; Life Sciences, Qualcomm Inc; Chairman, Wireless Life Sciences Alliance</td>
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<tr>
<td></td>
<td><strong>Wireless Technology Innovations in Health Care</strong></td>
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<td>9:45</td>
<td>Alexander Fridman</td>
<td>Director, A. J. Drexel Plasma Institute, Drexel University</td>
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<td></td>
<td><strong>Plasma Medicine: Application for Wound Treatment</strong></td>
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<tr>
<td>10:15</td>
<td>Break (Exhibits open)</td>
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<tr>
<td></td>
<td><strong>Moderator:</strong> Michael Ackerman</td>
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<tr>
<td>10:40</td>
<td>Adrienne Noe</td>
<td>Director, National Museum of Health &amp; Medicine</td>
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<tr>
<td></td>
<td><strong>The Future of the Future: MMVR and the National Museum of Health and Medicine</strong></td>
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<tr>
<td>11:10</td>
<td>James Blascovich</td>
<td>Professor, Department of Psychology, University of California, Santa Barbara</td>
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<td></td>
<td><strong>Infinite Reality: Donning Avatars for Good Health</strong></td>
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<td><strong>Adjourn</strong></td>
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## THURSDAY AFTERNOON

### SESSION A

#### SIMULATION & LEARNING

**Moderator:** Helene Hoffman

<table>
<thead>
<tr>
<th>Time</th>
<th>Speaker</th>
<th>Affiliation</th>
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<tbody>
<tr>
<td>12:50</td>
<td>Moderator’s Welcome</td>
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<tr>
<td>1:00</td>
<td>Bill Kapralos</td>
<td>Business and Information Technology, University of Ontario Institute of Technology</td>
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<td></td>
<td><strong>Serious Games in the Classroom:</strong> Gauging Student Perceptions</td>
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<tr>
<td>1:15</td>
<td>Dave Taylor</td>
<td>Imperial College London</td>
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<tr>
<td></td>
<td><strong>Implementation of Virtual Online Patient Simulation</strong></td>
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<td>1:30</td>
<td>Bryan Bergeron</td>
<td>Accella Learning, LLC</td>
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<td></td>
<td><strong>An Adaptive Signal-Processing Approach to Online Adaptive Tutoring</strong></td>
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<td>1:45</td>
<td>Samantha Hurst</td>
<td>Health Services Research &amp; Development, VA San Diego Healthcare System</td>
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<td></td>
<td><strong>Towards High-Resolution Ethnography for Evaluation of Team-Oriented Virtual Reality Training for Medicine</strong></td>
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<tr>
<td>2:00</td>
<td>Mathias Kaspar</td>
<td>Computation Institute, University of Chicago</td>
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<td></td>
<td><strong>Web-Based Stereoscopic Visualization for the Global Anatomy Classroom</strong></td>
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<tr>
<td>2:15</td>
<td>Johan Creutzfeldt</td>
<td>Center for Advanced Medical Simulation and Training, Karolinska University Hospital, Karolinska Institutet</td>
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<tr>
<td></td>
<td><strong>Retention and Transfer to Full Scale Simulation of Virtual World CPR Training with Avatars in Medical Students</strong></td>
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<tr>
<td>2:30</td>
<td>John Loewenstein</td>
<td>Ophthalmology, Harvard Medical School / Massachusetts Eye and Ear Infirmary</td>
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<tr>
<td></td>
<td><strong>Development of Cognitive Simulations for Medical Teaching</strong></td>
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<tr>
<td>2:45</td>
<td>Marko Kostic</td>
<td>Telemedicine and Advanced Technology Research Center</td>
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<td></td>
<td><strong>Establishment of the Simulation and Interactive Technology Hub (SITH) in Support of the Advanced Development and Utilization of Novel Medical Simulation Technologies in Military and Civilian Educational Curricula</strong></td>
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<tr>
<td>3:00</td>
<td>Break</td>
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</tbody>
</table>
Thursday Afternoon

SESSION A CONTINUED

Moderator: LeRoy Heinrichs

1:00 Eric Psota ..................................................42
Electrical Engineering, University of Nebraska-Lincoln
Stereo Image-Based Arm Tracking for In Vivo Surgical Robotics

1:15 Naoki Suzuki ..................................................42
Institute for High Dimensional Medical Imaging, Jikei University School of Medicine
Development of a Robot Arm that has Haptic Sensation for Augmented Reality Function of Endoscopic Surgical Robot

1:30 Annette Runge ..................................................43
Plastic Surgery, University Hospital Leipzig, University of Leipzig
Manual Accuracy in Comparison with a Miniature Master Slave Device - Preclinical Evaluation for Middle Ear Surgery

1:45 Hao Su ..........................................................43
Mechanical Engineering, Worcester Polytechnic Institute
High-Field MRI Compatible Steerable Needle Driver Robot for Percutaneous Prostate Intervention

THURSDAY AFTERNOON

SESSION B

ROBOTICS

Moderator: Kirby Vosburgh

1:45 Erol Yeniaras ..................................................43
Computer Science, University of Houston
A Novel Virtual Reality Environment for Preoperative Planning and Simulation of Image Guided Intracardiac Surgeries with Robotic Manipulators

2:00 Randy Ellis ..................................................44
School of Computing, Queen's University
3-Dimensional Visualization of Normal Wrist Kinematics: A Pilot Study

2:15 Hooman Soltanian .............................................43
Plastic Surgery, Case Medical Center
On the Use of Laser Scans to Validate Reverse Engineering of Bony Anatomy

2:30 Randy Ellis ..................................................44
School of Computing, Queen's University
Registration Stability of Physical Templates in Hip Surgery

2:45 Break

3:15 Bruce Cameron ..................................................44
Biomedical Imaging Resource, Mayo Clinic College of Medicine
Fast Adaptation of Pre-Operative Patient Specific Models to Real-Time Intra-Operative Volumetric Data Streams
<table>
<thead>
<tr>
<th>Time</th>
<th>Name</th>
<th>Institution</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>3:30</td>
<td>Kamyar Abhari</td>
<td>Biomedical Engineering, University of Western Ontario</td>
<td>Evaluation of a VR and Stereo-Endoscopic Tool to Facilitate 3rd Ventriculostomy</td>
</tr>
<tr>
<td>3:45</td>
<td>Peter Kazanzides</td>
<td>Computer Science, Johns Hopkins University</td>
<td>Development of a Wireless Hybrid Navigation System for Laparoscopic Surgery</td>
</tr>
<tr>
<td>4:00</td>
<td>Tobias Rick</td>
<td>JARA, RWTH Aachen University</td>
<td>Visualization of Probabilistic Fiber Tracts in Virtual Reality</td>
</tr>
<tr>
<td>4:15</td>
<td>Sergei Turovets</td>
<td>Neuroinformatics Center, University of Oregon</td>
<td>Computational Modeling of Human Head Electromagnetics for Source Localization of Milliscale Brain Dynamics</td>
</tr>
<tr>
<td>4:30</td>
<td>Anand Santhanam</td>
<td>College of Optics and Photonics, University of Central Florida</td>
<td>Visualization of 3D Volumetric Lung Dynamics for Real-Time External Beam Lung Radiotherapy</td>
</tr>
<tr>
<td>4:45</td>
<td>Mei Xiao</td>
<td>Biochemistry and Molecular Biology, University of Calgary</td>
<td>Generation of Connectivity-Preserving Surface Models of Multiple Sclerosis Lesions</td>
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<tr>
<td>5:00</td>
<td>Adjourn</td>
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**Thursday Afternoon**

**Session C**

**Plasma Medicine: The Emerging Revolution in Surgery, Wound Care, and Pathogen Control**

Mounir Laroussi, Co-Organizer  
Laser & Plasma Engineering Institute, Old Dominion University

Ozlem Yardimci, Co-Organizer  
Sterility Assurance Research Center, Baxter Healthcare Corporation

**THURSDAY AFTERNOON**

**Session D**

**Developing a Standardized Tri-Service Medical Simulation Platform – The TOPS Initiative**

Alan Liu, Organizer  
National Capital Area Medical Simulation Center

**12:50-5:00**  
The military’s use of simulation technology has improved medical training. It has also given rise to an unexpected problem. Commercial products employ multiple hardware platforms to simulate different procedures. There is considerable duplicate functionality. As adoption within the military becomes widespread, needless replication increases acquisition, distribution, and maintenance costs.

To address this concern, an initiative is underway to develop a standardized hardware platform. This initiative seeks to develop specifications for hardware, software, and interface requirements. The objective is to allow multiple procedures to use the same core set of computing resources. Specialized instruments will be configured as plug-ins communicating via a defined, standardized protocol. With a standardized platform, logistics can be streamlined, and mass deployment...
facilitated. Hardware vendors can leverage on the economy of scale to provide cost effective solutions. Developers can focus on application development on a known hardware platform and a large installed base. New product development is encouraged. This workshop will outline the plans by the Medical Modeling and Simulation Consortium (MMSTC) to develop such a standard. The MMSTC comprises key DoD elements involved in guiding the adoption and use of medical simulation within the military.

THURSDAY AFTERNOON

SESSION E

Virtual Reality and Advanced ICT in Europe

Giuseppe Riva, Organizer
Università Cattolica del Sacro Cuore

12:50-3:00

Since the European funded project VREPAR - Virtual Reality in Neuro-Psycho-Physiology (1995) – different European research activities have been using virtual reality and advanced information and communication technologies — telemedicine, biosensors, augmented reality – to improve the quality of care in the treatment of many different disorders including anxiety disorders, eating disorders and obesity. The panel includes the leading European researchers in the area that will discuss the research work and the more recent clinical outcomes. The panel will also discuss two recently funded projects — Interstress and Optimis — that aim at using virtual reality and mobile technologies to improve the treatment of depression and psychological stress.

Presentations

Rosa Baños........................................................47
University of Valencia
Engaging Media for Mental health Applications: the EMMA Project

Cristina Botella ..................................................47
University Jaume I de Castellón
Online Predictive Tools for Intervention in Mental Illness: The OPTIMI Project

Andrea Gaggioli ...............................................47
Istituto Auxologico Italiano
Interreality in the Management of Psychological Stress: The Interstress Project

Giuseppe Riva....................................................47
Università Cattolica del Sacro Cuore
Virtual Reality in the Treatment of Obesity and Eating Disorders: The VEPSY Updated Project

Brenda Wiederhold ............................................48
Interactive Media Institute Europe
Virtual Reality and Advanced ICT in Europe: The Role of the iACToR association

THURSDAY POSTERS

VISUALIZATION, IMAGING & INFORMATION-GUIDED THERAPIES

Boris Bracio .......................................................48
Biomedical Engineering, Anhalt University of Applied Sciences
3D Color Mapping of 2D Grayscale Transthoracic Echocardiography

Richard Bucholz.................................................48
Neurosurgery / Surgery, Saint Louis University
An Integrated Surgical Communication Network - SurgON

Lucio De Paolis ..................................................48
Innovation Engineering, Salento University
Augmented Reality Application for the Trocars Insertion in Pediatric Laparoscopy

Jayfus Doswell ..................................................48
Juxtopia
Designing a Context-Aware Augmented Reality System: An Emergency First Responder Assist Device

Randy Ellis.........................................................48
School of Computing, Queen’s University
Computed Tomography as Ground Truth for Stereo Vision Measurements of Skin

Jung Leng Foo...................................................49
Mechanical Engineering and Human Computer Interaction, Iowa State University
Development of a Customizable Software Application for Medical Imaging Analysis and Visualization

Tomoko Ikawa ...................................................49
Fixed Prosthodontics Tsurumi University
School of Dental Medicine
Novel Approaches to Functional Occlusal Surfaces through Computer-Aided Design
Shintaro Kasama ...............................................49
Fixed Prosthodontics, Tsurumi University
School of Dental Medicine
Effects of Metal Artifact for 3D Reconstructed Dentition Model

Peter Kazanzides ..............................................50
Computer Science, Johns Hopkins University
AISLE: An Automatic Volumetric Segmentation Method for the Study of Lung Allometry

Qiang Meng .......................................................49
Computer Science and Engineering, Chinese University of Hong Kong
CvhSlicer: An Interactive Cross-Sectional Anatomy Navigation System Based on High-Resolution Chinese Visible Human Data

José Mosso Vázquez..........................................49
School of Medicine, Universidad Panamericana
Night Vision and Cybertherapy for Ambulatory Surgery

José Mosso Vázquez..........................................50
School of Medicine, Universidad Panamericana
Transhiatal and Transdiaphragmatic Access for Thoracoscopy in NOTES and NOTUS

Carl Nelson ........................................................50
Mechanical Engineering, University of Nebraska
Multifunction Robotic Platform for Natural Orifice Surgery

Takumi Ogawa...................................................50
Fixed Prosthodontics, Tsurumi University
School of Dental Medicine
Virtual Reality Image Applications for Treatment Planning in Prosthodontic Dentistry

Annette Runge ..................................................49
Germany Clinic and Polyclinic for ENT, University of Leipzig
Classification of Functional EMG-Signals of the Facial Nerve

Stefan Suwelack................................................50
Institute for Anthropometrics Humanoids and Intelligence Systems Lab, Karlsruhe Institute of Technology
Web-Based Interactive Volume Rendering

Priyamvada Tewari.............................................50
Biomedical Engineering, University of California, Los Angeles
Terahertz Imaging of Biological Tissues

Geoffrey Tien ....................................................51
School of Computing Science, Simon Fraser University
Quantifying Surgeons’ Vigilance during Laparoscopic Operations Using Eyegaze Tracking

Yasushi Yamazaki...............................................51
Endodontics, Tsurumi University
Clinical Performance of Dental Fiberscope Image Guided System for Endodontic Treatment

SIMULATOR DESIGN & DEVELOPMENT - PART 1

Devin Berg.........................................................51
Mechanical Engineering, University of Minnesota
Low-Cost, Take-Home, Beating Heart Simulator for Health-Care Education

Nathan Delson ...................................................51
Mechanical and Aerospace Engineering, University of California at San Diego
Design of a Parametrically Adjustable Intubation Mannequin

Roy Eagleson.....................................................51
Electrical and Computer Engineering, University of Western Ontario
Medical Education and Evaluation through Virtual Worlds: The HLTHSIM Project

MadeLen Fahlstedt .............................................52
Neurotic Engineering, School of Technology and Health, KTH Royal Institute of Technology
Visualization through Imaging and Simulation (VIS) - A New Program for Medical Students and Personnel for Treatment of Trauma Patients

Philipp Fischer ...................................................52
Orthopaedics and Trauma Surgery, University Hospital, Bonn
VoTeKK - Preparation for Terrorist Attacks, Crises and Disasters: Web-Based Interdisciplinary Information and Training Platform to Prepare Security and Rescue Forces, Medical Personnel and the General Population for Large-Scale Emergencies

Leif Hedman ......................................................52
Psychology, Umeå University
Medical Students’ Self-Efficacy Increases by Training Diagnosis and Treatment of Cervical Spine Trauma using a New Educational Program for Visualization through Imaging and Simulation
Thursday Posters

Vassilios Hurmusiadis ........................................52
Research & Development, Primal Pictures Ltd

Validated Real-time Simulation of
Electrophysiology for ECG Training

Nigel John .........................................................52
School of Computer Science, Bangor University

A Model for Flexible Tools used in Minimally
Invasive Medical Virtual Environments

Abby Kaye .........................................................53
School of Computer Science, Bangor University

Expanding the use of Simulators as
Assessment tools: The New Pop Quiz

Thomas Knott .....................................................53
Virtual Reality Group, RWTH Aachen University

Practical Methods for Designing Medical
Training Simulators

Bertalan Meskó ..................................................53
Biochemistry and Molecular Biology, University of Debrecen, Hungary

Online Virtual Environments, Curated
Content and Digital Literacy in Medical
Education

Robert Metzler ...................................................53
Biomedical Engineering, Simulation Technology
and Immersive Learning, Northwestern University

Pressure Mapping as a Tool to Optimize
Efficacy of Fundal Massage

Caroline Needham ...............................................53
Centre for Anatomy and Human Identification,
University of Dundee

Virtual Haptic Dissection

Giuseppe Riva .....................................................54
Applied Technology for Neuro-Psychology Lab,
Istituto Auxologico Italiano

NeuroVR 2: A Free Virtual Reality Toolkit for
Assessment and Treatment in Behavioral
Health-Care

Jonathan Salud ....................................................54
School of Computer Science, Bangor University

Are Commercially Available Simulators
Durable Enough for Classroom Use?

Joseph Samosky .................................................54
Anesthesiology and Bioengineering, University of Pittsburgh

Real-Time “X-Ray Vision” for Healthcare
Simulation: An Interactive Projective
Overlay System to Enhance Intubation
Training and Other Procedural Training

Robert Sweet ....................................................54
Urologic Surgery, Center for Research in
Education and Simulation Technologies(CREST),
University of Minnesota

Web-Accessible Interactive Software of 3D
Anatomy Representing Pathophysiologic
Conditions to Enhance the Patient-Consent
Process for Procedures

Robert Sweet ....................................................55
Urologic Surgery, Center for Research in
Education and Simulation Technologies(CREST),
University of Minnesota

The Minnesota Pelvic Trainer: A Hybrid
VR/Physical Pelvis for Providing Virtual
Mentorship

Dave Taylor .......................................................55
Surgery and Cancer, Imperial College London

Single and Multi-User Virtual Patient Design
in the Virtual World

Sebastian Ullrich ................................................55
Virtual Reality Group, RWTH Aachen University

Dissecting in silico: Towards a Taxonomy for
Medical Simulators

Anant Vemuri ....................................................55
AITS, IRCAD Taiwan

A Cost Effective Simulator for Education of
Ultrasound Image Interpretation and Probe
Manipulation

Yoshinori Yoshida ..............................................55
Graduate School of Dentistry, Osaka University

Virtual Human Reaction for Haptic Dental
Training System

TELEMEDICINE & NETWORKED
INTELLIGENCE

Mary Barak-Bernhagen .......................................55
Anesthesiology, University of Nebraska Medical Center

Validation of a Virtual Preoperative
Evaluation Clinic: A Pilot Study

Jennifer Hemstreet ..............................................56
Research Service, VA Medical Center

The Initiation of a Preoperative and
Postoperative Telemedicine Urology Clinic
FRIDAY MORNING

PLENARY SESSION

Moderator: Patrick Cregan

8:30 Moderator’s Welcome

8:40 Kirby Vosburgh ...........................................57
Assistant Professor of Radiology, Brigham &
Women’s Hospital / Harvard Medical School
It Looks Cool; Does it Work?

9:00 Dave Warner ...........................................57
ARCH Synergist, MindTel LLC; Institute for
Interventional Informatics
Retoxing on the Elixir of Cyber-Madness—
Let the Paradigm Shifts Begin Again...

9:30 JoAnn Kuchera-Morin .....................................57
Director, AlloSphere Research Facility &
Professor, Media Arts & Technology and Music,
University of California, Santa Barbara
Immersed in Unfolding Complex Systems:
Multi-Sensory Computing in the
AlloSphere, One of the Largest Immersive
Instruments in the World for New
Scientific Discovery

10:00 Break

PANEL SESSION

The Performance of Memory

Kóan Jeff Baysa, Organizer & Moderator
Medical Curator, Vera List Center for Art and
Politics, The New School University

10:25–11:25 Presentations

Virgil Wong .....................................................N/A
Medical Cognition and Intelligent Technologies
Researcher, Columbia University
The Medical Avatar and Medical History:
Past, Present, and Future

Caitlin Hardy .....................................................N/A
Center for Biomedical Imaging,
Department of Radiology, New York
University Medical Center
7 Tesla MRI Machine; Imaging the
Anatomical Basis of Memory in
Schizophrenia and Olfaction

FRIDAY MORNING

POSTER SESSION

7:00 – 8:30

During this session, presenters stand with their posters to discuss their research with attendees.
### Session A

**Simulator Development**

**Moderator:** Robert Sweet

<table>
<thead>
<tr>
<th>Time</th>
<th>Speaker</th>
<th>Institution</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>12:50</td>
<td>Moderator's Welcome</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1:00</td>
<td>Sayra Cristancho</td>
<td>Centre for Education Research &amp; Innovation, University of Western Ontario</td>
<td>Progressive Simulation-Based Program for Training Cardiac Surgery-Related Skills</td>
</tr>
<tr>
<td>1:15</td>
<td>Andrea Moglia</td>
<td>Oncology, Transplants and New Technologies in Medicine, University of Pisa</td>
<td>Patient Specific Surgical Simulator for the Evaluation of the Movability of Bimanual Robotic Arms</td>
</tr>
<tr>
<td>1:30</td>
<td>Florian Beier</td>
<td>Institute for Computational Medicine, University of Heidelberg</td>
<td>NeuroSim - The Prototype of a Neurosurgical Training Simulator</td>
</tr>
<tr>
<td>1:45</td>
<td>Sonny Chan</td>
<td>Computer Science, Stanford University</td>
<td>A Virtual Surgical Environment for Rehearsal of Tympanomastoidectomy</td>
</tr>
<tr>
<td>2:00</td>
<td>Sangkyun Shin</td>
<td>Intelligence and Interaction Center, Korea Institute of Science and Technology</td>
<td>3D Tracking of Surgical Instruments using Single Camera for Laparoscopic Surgery Simulation</td>
</tr>
<tr>
<td>2:15</td>
<td>Brian Allen</td>
<td>Computer Science, University of California, Los Angeles</td>
<td>Visual Tracking of Laparoscopic Instruments in Standard Training Environments</td>
</tr>
</tbody>
</table>

**Training, Assessment & Simulator Validation**

<table>
<thead>
<tr>
<th>Time</th>
<th>Speaker</th>
<th>Institution</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>3:15</td>
<td>Eric Savitsky</td>
<td>Ctr for International Medicine / CASIT, Univ of California, Los Angeles</td>
<td>Patient-Specific Cases for an Ultrasound Training Simulator</td>
</tr>
<tr>
<td>3:30</td>
<td>Jorg Peters</td>
<td>Computer and Information Science and Engineering, University of Florida</td>
<td>Enabling Surgeons to Create Simulation-Based Teaching Modules</td>
</tr>
<tr>
<td>3:45</td>
<td>Tansel Halic</td>
<td>Mechanical Engineering, Rensselaer Polytechnic Institute</td>
<td>A Software Framework for Multimodal Interactive Simulations (SoFMIS)</td>
</tr>
<tr>
<td>4:00</td>
<td>Sayra Cristancho</td>
<td>Centre for Education Research &amp; Innovation, University of Western Ontario</td>
<td>The Validation of an Instrumented Simulator for the Assessment of Performance and Outcome of Knot Tying Skill: A Pilot Study</td>
</tr>
<tr>
<td>4:15</td>
<td>Erik Lövquist</td>
<td>National Digital Research Centre</td>
<td>VR-Based Training and Assessment in Ultrasound-Guided Regional Anesthesia: From Error Analysis to System Design</td>
</tr>
<tr>
<td>4:30</td>
<td>Imad Awad</td>
<td>Anesthesia, Sunnybrook Health Sciences Centre</td>
<td>Acquisition of Technical Skills in Ultrasound-Guided Regional Anesthesia using a High-Fidelity Simulator</td>
</tr>
</tbody>
</table>
FRIDAY AFTERNOON

**SESSION B**

**Does It Really Work? Validating New Surgical Techniques**

Kirby Vosburgh, Organizer
Brigham & Women’s Hospital / Harvard Medical School

12:50 - 3:00 PM

MMVR has been a leading forum for the presentation and discussion of high technology approaches designed to assist the physician operator during interventional procedures. Most often, these have involved guided navigation through the body and the targeting of probes to specific sites for the delivery of care, with increasing sophistication provided by advanced, less invasive, and more precise instruments, and the increasing resolution and contrast of imaging systems. In the past several years, many leading research teams have sought to move beyond conceptual demonstration of these approaches (including early stage studies in patients) toward systematic assessments of the technical performance of the systems (accuracy, precision, stability) and closing the loop to establish clinical payoff and supporting benefits such as reduced time and cost, increased ease of use and consistency, and more effective training and performance characterization. This session provides an introduction and examples of three levels of this analysis: for procedures, for technical systems, and for professional integration. Work at all these levels is facilitating the faster adoption of advanced interventions, and the more rapid realization of the visions we have shared in the MMVR community.

**FRIDAY AFTERNOON**

4:45 Adam Dubrowski  .............................................61
The Learning Institute, The Hospital for Sick Children
Bench Model Surgical Skill Training Improves Novice Ability to Multitask: A Randomized Controlled Study

5:00 Lawrence Salud .................................................61
Surgery, Northwestern University
Toward a Simulation and Assessment Method for the Practice of Camera-Guided Rigid Bronchoscopy

5:15 Bin Zheng .........................................................61
Surgery, University of British Columbia
Maintaining Forward View of the Surgical Site for Best Endoscopic Practice

5:30 Adjourn

**Addisonal Presenters**

Randy Ellis
School of Computing, Queen’s University

Pierre Janin
INSERM, University of Rennes

Patrick Cregan
Nepean Hospital, Sydney West Area Health Service

3:00 Break

**PATIENT CARE & REHABILITATION**

Moderator: Cali Fidopiastis

3:15 Christopher Wottawa .........................................62
Biomedical Engineering, University of California, Los Angeles
Applications of Tactile Feedback in Medicine

3:30 Rahman Davoodi ..............................................62
Biomedical Engineering, University of Southern California
MSMS Software for VR Simulations of Neural Prostheses and Patient Training and Rehabilitation

3:45 Michael Zeher & Janid Blanco Kiely .......................62
Johns Hopkins University Applied Physics Lab / Walter Reed Army Medical Center
Using A Virtual Integration Environment to Study Phantom Limb Pain

4:00 Cynthia Sung ...................................................62
Rice University
Comparison of Reaching Kinematics during Mirror and Parallel Robot-Assisted Movements

4:15 Thomas Parsons ...............................................62
Institute for Creative Technologies, University of Southern California
Virtual Reality Stroop Task for Neurocognitive Assessment

4:30 Josef Stoll .........................................................63
Physics & Neurophysics, Philippus-Universität Marburg
Mobile Three Dimensional Gaze Tracking

4:45 Anabel Martin-Gonzalez .....................................63
Computer Aided Medical Procedures, Technische Universität München
Simulation and Modeling of Metamorphopsia with a Deformable Amsler Grid
FRIDAY AFTERNOON

SESSION C

Virtual Reality for Psychology’s Clinical and Research Use

Melba Stetz, Organizer
Dept of Psychology, Tripler Army Medical Center, Hawaii

12:50 - 3:00 PM

Additional Presenters

Raymond Folen
Psychology, Tripler Army Medical Center

Walter Greenleaf
Virtually Better; InWord Solutions; Greenleaf Medical Systems

Sarah Miyahira
Pacific Telehealth and Technology Hui

Thomas Parsons
Institute for Creative Technologies, University of Southern California

Richard Ries
Argosy University (American School of Professional Psychology)

Doug Thompson
Remedy Communications / Metanomics

FRIDAY POSTERS

SIMULATOR DESIGN & DEVELOPMENT - PART 2

Nathan Delson ..................................................63
Mechanical and Aerospace Engineering, University of California at San Diego
Defining Tubular Regions of Expert Motion for Novice Training

Vassilios Hurmusiadis ........................................64
Research & Development, Primal Pictures Ltd
Virtual Arthroscopy Trainer for Minimally Invasive Surgery

Bill Kapralos .....................................................64
Business and Information Technology, University of Ontario Institute of Technology
A Serious Game for Off-Pump Coronary Artery Bypass Surgery Procedure Training

Sergei Kurenov ..................................................64
Surgical Oncology, Roswell Park Cancer Institute
A Simulation Framework for Wound Closure by Suture for the Endo Stitch Suturing Instrument

Vanda Luengo ....................................................64
CyberMedVPS, Laboratoire LIG, Université Joseph Fourier
Design and Implementation of a Visual and Haptic Simulator in a Platform for a TEL System in Percutaneous Orthopedic Surgery

Francisco Martinez-Martinez .............................64
LabHuman (I3BH), Politecnico University of Valencia
Pneumoperitoneum Technique Simulation in Laparoscopic Surgery on Lamb Liver Samples and 3D Reconstruction

Dwight Meglan ..................................................64
SimQuest LLC
Development of an Open Surgery Simulator

Aline Morais ....................................................64
Informatic, Federal University of Paraíba
CyberMedVPS: Visual Programming for Development of Simulators

Douglas Nelson ..................................................65
Bioengineering, University of Pittsburgh
The Tool Positioning Tutor: A Target-Pose Tracking and Display System for Learning Correct Placement of a Medical Device

Krzysztof Rechowicz ........................................65
Modeling, Simulation and Visualization Engineering, Old Dominion University
A Design for Simulating and Validating the Nuss Procedure for the Minimally Invasive Correction of Pectus Excavatum
Presentation Schedule

Friday Posters

Ravikiran Singapogu .............................................65
Bioengineering, Clemson University
Perceptual Metrics: Towards Better Methods for Assessing Realism in Laparoscopic Simulators

Ravikiran Singapogu .............................................65
Bioengineering, Clemson University
Role of Haptic Feedback in a Basic Laparoscopic Task Requiring Hand-Eye Coordination

Cyle Sprick ........................................................65
School of Medicine, Flinders University
A New Part Task Trainer for Teaching and Learning Confirmation of Endotracheal Intubation

Jocelyne Troccaz ................................................66
GMCAO, TIMC-IMAG
Biopsym: A Learning Environment for Trans-Rectal Ultrasound Guided Prostate Biopsies

SIMULATOR VALIDATION

Imad Awad...........................................................66
Anesthesia, Sunnybrook Health Sciences Centre
Anesthesia Residents’ Preference for Learning Interscalene Brachial Plexus Block (ISBPB): Traditional Winnie’s Technique vs. Ultrasound-Guided Technique

Mary Barak-Bernhagen .......................................66
Anesthesiology, University of Nebraska Medical Center
Combined Use of Simulated and Human Intubation Training for 4th Year Medical Students: Center for Advanced Technology and Telemedicine (CATT) Airway Training Program

Kirsten Boedeker .................................................66
Research, VA Medical Center
Battlefield Tracheal Intubation Training Using Virtual Simulation: A Multi Center Operational Assessment of Video Laryngoscope Technology

Jung-Hung Chien..................................................67
College of Public Health, University of Nebraska Medical Center
Electromyographic Correlates of Learning during Robotic Surgical Training in Virtual Reality

Jung-Hung Chien..................................................67
College of Public Health, University of Nebraska Medical Center
Modeling Surgical Skill Learning with Cognitive Simulation

Olivier Courteille .............................................67
Learning, Informatics, Management and Ethics, Karolinska Institutet
Mixed Virtual Reality Simulation - Taking Endoscopic Simulation One Step Further

Srinivas Ivatury ..................................................67
Surgery, University of Texas Health Science Center at San Antonio
Does Video Game Performance Correlate with Laparoscopic Camera Navigation Training in Box Trainer and Virtual Laparoscopic Environment?

T. “Kesh” Kesavadas ..........................................67
State University of New York at Buffalo
Validation of Robotic Surgery Simulator (RoSS)

Gail Kuper..........................................................67
Anesthesiology, University of Nebraska Medical Center
Field Use of the STORZ C-MAC™ Video Laryngoscope in Intubation Training with the Nebraska National Air Guard

Nikola Miljkovic ..................................................68
Anesthesiology-Center for Advanced Technology and Telemedicine, University of Nebraska Medical Center
A Comparison of Videolaryngoscopy Technologies

Marcus Schlickum .............................................68
Clinical Science Intervention and Technology, Karolinska Institutet
Performance in a Surgical Simulator Correlates with Theoretical Knowledge in Female but not in Male Medical Students

PLASMA MEDICINE

Yang-Fang Li......................................................68
Theory/Complex Group, Max-Planck-Institute for Extraterrestrial Physics
Self Surface Sterilization by Encapsulated Surface-Dielectric Barrier Discharge

Artemio Navarro..............................68
Mechanical & Aerospace Engineering, University of California, Los Angeles
Laser Induced Shockwaves on Flexible Polymers for Treatment of Bacterial Biofilms
PATIENT CARE & REHABILITATION

Giovanni Albani ..................................................68
Istituto Auxologico Italiano
Sleep Dysfunctions Influence Decision Making in Undemented Parkinson's Disease Patients: A Study in a Virtual Supermarket

Steven Barnes ...................................................68
School of Interactive Arts & Technology, Simon Fraser University
Immersive Virtual Environments for the Management of Chronic vs. Acute Pain

Alessandro De Mauro .................................................69
Biomedical & E-Health, VICOMTech
Virtual Reality System in Conjunction with Neurorobotics and Neuroprosthetics for Rehabilitation of Motor Disorders

Farzam Farahmand ............................................69
Mechanical Engineering, Sharif University of Technology
Fuzzy Control of a Hand Rehabilitation Robot to Optimize the Exercise Speed in Passive Working Mode

Olga Sourina ......................................................69
School of Electrical & Electronic Engineering, Nanyang Technological University
EEG-based “Serious” Games and Monitoring Tools for Pain Management

MODELING & SIMULATION

Venkata Arikatla ..................................................69
Mechanical, Aerospace and Nuclear Engineering, Rensselaer Polytechnic Institute
Cost-Efficient Suturing Simulation with Pre-Computed Models

Tansel Halic .......................................................69
Mechanical Engineering, Rensselaer Polytechnic Institute
SML: SoFMIS Meta Language for Surgical Simulation

Jason Kutarnia ......................................................70
Electrical and Computer Engineering, Worcester Polytechnic University
Finite Element Method for Whole Body Deformation using Organ-specific Mechanical Properties

Masashi Nakagawa .................................................70
Tokyo City University
A Bloodstream Simulation Based on Particle Method

Kazuyoshi Tagawa .................................................70
Ritsumeikan Global Innovation Research Organization, Ritsumeikan University
A Hybrid Dynamic Deformation Model for Surgery Simulation

Anette von Kapri ..................................................70
Virtual Reality Group, JARA, RWTH Aachen University
Towards the Visualization of Spiking Neurons in Virtual Reality

Matthew Wampole ..................................................70
Biochemistry & Molecular Biology, Thomas Jefferson University
Three Dimensional Projection Environment for Molecular Design and Surgical Simulation

Satoshi Yamaguchi .............................................70
Oro-Maxillofacial Regeneration, Osaka University
Needle Insertion Simulation by Arbitrary Lagrangian-Eulerian Method

HAPTICS

Timothy Coles ....................................................71
Advanced Robotics, Istituto Italiano di Tecnologia / Computer Science, Bangor University
Modification of Commercial Force Feedback Hardware for Needle Insertion Simulation

Yunjin Gu ...........................................................71
Mechanical Engineering, Korea Advanced Institute of Science and Technology
A Design of Hardware Haptic Interface for Gastrointestinal Endoscopy Simulation

Tansel Halic .......................................................71
Mechanical, Aerospace and Nuclear Engineering, Rensselaer Polytechnic Institute
A Fixed Point Proximity Method for Extended Contact Manipulation of Deformable Bodies with Pivoted Tools in Multimodal Virtual Environments

Atila Kilicarslan ..................................................71
Mechanical Engineering, University of Houston
Design of a Haptic System for Minimally Invasive Cardiac Surgeries
MISCELLANEOUS TOPICS

Ben Boedeker .................................71
Anesthesiology, Center for Advanced Technology & Telemedicine, University of Nebraska Medical Center

Comparison of a Disposable Bougie versus a Newly Designed Malleable Bougie in the Intubation of a Difficult Manikin Airway

Ben Boedeker .................................71
Anesthesiology, Center for Advanced Technology & Telemedicine, University of Nebraska Medical Center

Improving Fiberoptic Intubation with a Novel Tongue Retraction Device

Kulia Matsuo ......................................................72
Anesthesiology, Center for Advanced Technology & Telemedicine, University of Nebraska Medical Center

Technology Transfer at the University of Nebraska Medical Center

Hao Su .............................................................72
Mechanical and Industrial Engineering, University of Toronto

Piezoelectric Driven Non-Toxic Injector for Automated Cell Manipulation

SATURDAY MORNING

SESSION A

MODELING, VISUALIZATION & SIMULATION

Moderator: Yunhe Shen

8:20  Moderator’s Welcome

8:30  Graciela Santana Sosa .........................72
Research Unit Medical-Informatics, RISC Software GmbH

Collision and Containment Detection between Biomechanically Based Eye Muscle Volumes

8:45  Nigel John ............................................72
School of Computer Science, Bangor University

Realistic Visualization of Living Brain Tissue

9:00  Christos Constantinou .............................72
Urology, Stanford University

Visualization of Pelvic Floor Reflex and Voluntary Contractions

9:15  Shin Hasegawa .................................73
Computer Science and Engineering, University of Aizu

Simulation of Vaginal Wall Biomechanical Properties from Pelvic Floor Closure Forces Map

9:30  Venkata Arikatla .................................73
Mechanical, Aerospace and Nuclear Engineering, Rensselaer Polytechnic Institute

Real-Time Electrocautery Simulation for Laparoscopic Surgical Environments

9:45  Sebastien Delorme .................................73
Industrial Materials Institute

Modeling the Thermal Effect of the Bipolar Electrocautery for Neurosurgery Simulation

10:00 Masato Ogata .................................73
Research and Development, Mitsubishi Precision Co., Ltd.

A Development of Surgical Simulator for Training of Operative Skill using Patient-Specific Data

10:15  Fernando Bello .................................73
Surgery and Cancer, Imperial College London

Open Surgery Simulation of Inguinal Hernia Repair

10:30 Break

Moderator: Steven Senger

10:45  Sukitti Punak .................................74
Surgical Oncology, Roswell Park Cancer Institute

Simplified Cosserat Rod for Interactive Suture Modeling

11:00 Yunhe Shen .................................74
Urologic Surgery, University of Minnesota Medical School

Phenomenological Model of Laser-Tissue Interaction with Application to Benign Prostatic Hyperplasia (BPH) Simulation

11:15  Fernando Bello .................................74
Surgery and Cancer, Imperial College London

Guidewire and Catheter Behavioural Simulation

11:30  Farzam Farahmand ..........................74
Mechanical Engineering, Sharif University of Technology

Modeling of Interaction between a Three-Fingered Surgical Grasper and Human Spleen

11:45  Andrew Bulpitt .................................74
School of Computing, University of Leeds

Segmentation of 3D Vasculatures for Interventional Radiology Simulation
As persons with disabilities age, progressive declines in health and medical status can challenge the adaptive resources required to maintain functional independence and quality of life. The effects of these challenges can be further compounded by economic factors (e.g., decreased income, increased medical costs, reductions or loss of medical benefits), medication side effects, loss of a spouse or caregiver, and the impact of psychosocial disorders such as depression or alcohol abuse. As well, with the gradual loss of functional independence and the increased reliance on others for transportation, access to general medical and rehabilitation care can be jeopardized. The combination of these factors when seen in the context of the average increase in lifespan that is accelerating in industrialized societies has lead to a growing crisis that is truly global in proportion. While research indicates that functional abilities can be improved, maintained, or recovered via consistent participation in a cognitive/motor exercise and rehabilitation regimen, independent adherence to such preventative and/or rehabilitative programming outside the clinic setting is notoriously low. This state of affairs has produced a compelling, ethical and economic motivation to address the needs of individuals who are aging with disabilities by promoting home-based access to low-cost, interactive Virtual Reality (VR) systems designed to engage and motivate aged individuals to participate with “game”-driven physical activities and rehabilitation programming. The creation of such systems could serve to enhance, maintain and rehabilitate the cognitive/motor processes that underlie the integrated functional behaviors that are needed to maximize independence and quality of life—beyond what exists with currently available, labor intensive, under-utilized, and more costly approaches. This session will bring together NIDRR supported researchers, users and industry partners to present and discuss the issues that need to be addressed to advance the science and practice in this area.

**Additional Presenters**

**Belinda Lange**  
Institute for Creative Technologies, University of Southern California

**Phil Requejo**  
Rehabilitation Engineering Program, Rancho Los Amigos National Rehabilitation Center / Kinesiology and Biomedical Engineering, University of Southern California

**Carolee Winstein**  
Motor Behavior and Neurorehabilitation Laboratory / Biokinesiology and Physical Therapy, University of Southern California

**Gisele Ragusa**  
Rossier School of Education, University of Southern California

**James Patton**  
Northwestern University

**Alma Merians**  
University of Medicine and Dentistry of New Jersey

**Pat Banerjee**  
University of Illinois at Chicago

**Mindy Aisen**  
Rancho Los Amigos National Rehabilitation Center
SATURDAY MORNING

SESSION C

Multi-User Virtual Environment Boot Camp
and Patient Surge Triage Practice

Laura Greci, Organizer
Health Services Research & Development,
VA San Diego Healthcare System;
Dept of Medicine,
University of California San Diego,
School of Medicine

8:30 AM - 12:30 PM

Attendees will be introduced to our use of the multi-user virtual environment (MUVE) as a blended learning tool for emergency preparedness training for hospital personnel. Students will begin in the physical classroom in a traditional teacher lead session to explain the objectives for the day. They will then sign in as one of our pre-made student avatars to our virtual hospital islands. While in-world and with a facilitator avatar, student avatars will be given an interactive tour of our current virtual learning tools including a skills obstacle course, a team building scavenger hunt, the chance to interact with our robot and avatar patients, and finally a walk-thru of our virtual functional patient surge drill on the hospital grounds. With this learning experience as the context, and back in the physical classroom, our curriculum designers, subject matter experts, technology engineers, and evaluation experts will discuss and answer questions about the collaborative development process. Participants should plan on attending the entire session as skills and experiences build on each other as the workshop progresses.

During this workshop participants will:
1) Have the opportunity to explore our virtual learning environment and tools for healthcare personnel to plan and practice disaster management skills.
2) Experience and learn about the development of our blended (real life/ MUVE) curriculum.
3) Understand how we incorporate our subject matter experts to add realism to the experience.
4) Hear from our technology engineers about the behind-the-scenes successes and struggles including our move from one virtual environment to another (Second Life to Open Sim).
5) Appreciate the additional dimensions of student evaluation that the virtual learning environment adds to the experience.

Target audience: curriculum designers, technology engineers, evaluation experts, and clinical healthcare professionals (MD, RN, health tech) who would like to learn more about our virtual learning environment for hospital disaster preparedness and the lessons we have learned along the way.

Additional Facilitators

Samantha Hurst
Dept of Family & Preventive Medicine, Division of Global Health, University of California San Diego

Karen Garman
Dept of Medicine, University of California San Diego, School of Medicine

Ricky Huang
CalIT2, University of California San Diego

Helene Hoffman
Dept of Medicine, University of California San Diego, School of Medicine

Micha Cardenas
Dept of Visual Arts, Center for Research in Computing and the Arts, University of California San Diego

Michael Gates
Health Services Research & Development, VA San Diego Healthcare System

Kristen Kho
Dept of Visual Arts, Center for Research in Computing and the Arts, University of California San Diego

Todd Porteous
Dept of Medicine, University of California San Diego, School of Medicine

Erin Higginbotham
Health Services Research & Development, VA San Diego Healthcare System

Zia Agha
Health Services Research & Development, VA San Diego Healthcare System; Dept of Medicine, University of California San Diego, School of Medicine
Saturday

**SUNDAY ALL DAY**

**Adjunct Meeting**

**Virtual Reality Assisted Exposure Therapy in the Prevention and Treatment of PTSD and Related Conditions**

James L. Spira
Interactive Media Institute &
International Association of CyberPsychology, Training, & Rehabilitation’s Military Special Interest Group, Organizers

9:00 AM - 5:00 PM

The aim of this American Psychological Association Continuing Education (APA-CE) workshop is to introduce clinicians to the use of Virtual Reality systems and physiological monitoring in order to facilitate exposure-based treatment of PTSD, including combat and civilian in origin. Three major approaches to exposure will be discussed, with strengths and weaknesses of each reviewed and demonstrated. These include approaches that emphasize:

1. Maintaining Maximum Exposure/Arousal (such as Prolonged Exposure)
2. Gradual Exposure (such as Systematic Desensitization and Biofeedback)
3. Training in Attentional Engagement and Arousal Control in order to Control One’s Reactivity to Arousing Stimuli (such as Stress Inoculation Training).

All three have the intention to reduce posttraumatic stress, improve sleep and social engagement, and return to work functioning. Cognitive (attentional) and autonomic control techniques will be taught to be able to be used with a variety of therapeutic modalities, and for inter-session practice by patients. The use of imagery as a supplement to or in place of VR will be taught for clinicians without access to VR equipment. Hands-on demonstrations of the VR and physiological protocol will be included.

8-hours of APA Continuing Education credits will be provided to all in attendance at the end of the meeting.

**This adjunct meeting requires a separate paid registration.**
MMVR 18

Salon
Salon

The Salon will open Thursday and Friday at 12 Noon.

Shadows from Anatomy Lesson 2007

Resonating in pi

The pi book vol. 1 consists of 712,800 digits of pi numerals. When space permitting, the viewers are invited to sit down comfortably and simply read, or hand-copy the digits onto a piece of paper. Through this process, the two apparently different entities, the human and the digits of pi, communicate, integrate and resonate. Thoughts, feelings and ideas spark, attract and amplify. The seemingly random numbers no longer stand as being "meaningless". They began to form associations and recall memories.

"Black pi" and "White pi" are inspired by the endless numerical digits of the symbol π and explores the concept of the symbol as it intersects with data visualization, human curiosity, associations and memories.

Jiayi Young
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Shih-Wen Young
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PRAWN Diagnostic Robot

The Psychiatric Robot Analyst With Neuroimaging (PRAWN) ostensibly scans your brain via a portable fMRI device while conducting interactive psychiatric tests. It diagnoses and explains your behavioral health disorders – and then produces personalized treatments that are specific to deficits in your neurological chemistry.

continued
iPubmed: Instant Search on MEDLINE

The MEDLINE database, consisting of over 20 million publication records, is the primary source of information for biomedicine and health. Although the database itself has been growing rapidly, the search paradigm of MEDLINE has remained largely unchanged. The current search system requires users to have considerable effort and knowledge to formulate a good query that will lead to a desired result. If the user is not experienced, it takes a few trials to come up with a good query. iPubmed is a system that provides an alternative search interface for exploring the MEDLINE collection with two unique features that target to solve these concerns. The system provides instant results to a query as a user types letter by letter, and tolerates small typos to help inexperienced users to search for words difficult to spell, which is very common in the biomedicine domain.

Chen Li
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microscopy.
Exhibits
Exhibit Hours

THURSDAY, FEBRUARY 10
7:00 AM – 8:30 AM  Continental Breakfast in Exhibit Hall
10:15 AM – 10:40 AM Break in Exhibit Hall
11:40 AM – 12:40 PM Lunch in Exhibit Hall
3:00 PM – 3:15 PM  Break in Exhibit Hall
4:00 PM  Exhibits Close

FRIDAY, FEBRUARY 11
7:00 AM – 8:30 AM  Continental Breakfast in Exhibit Hall
10:00 AM – 10:25 AM Break in Exhibit Hall
11:40 AM  Exhibits Close

Exhibitors

ASCENSION TECHNOLOGY, INC.
Ascension Technology makes state-of-the-art magnetic sensors and optical markers for a wide range of medical procedures. Its products are key enabling technology for emerging minimally invasive surgery and image-guided procedures.

For navigating instruments to targets within the human body, the company has released a new DC magnetic product line, 3D Guidance, featuring the world’s smallest magnetic sensors (0.55 mm in diameter). This sensor, delivering real-time localization data, is small enough to fit in the tip of a 21-gauge needle or a 5 French catheter. Typical applications include: fusion of pre-acquired and real-time image planes, volumetric measurement, medical simulations, core tissue biopsy (which will be shown at MMVR), fluid aspiration, vascular access, and RF ablation of soft tissue lesions.

For continuously tracking human and tumor motion in radiation oncology, the company had developed a new optical tracker, spotLIGHT. It employs multiple, miniaturized IR cameras and passive wireless markers to track patient motion, respiratory gating, and equipment movement in LINAC procedural suites. This tracker is available to OEMs wishing to incorporate the latest advances in 3D optical tracking into medical as well as simulation and virtual reality products.

Ascension's sensors are prominently used in conjunction with ultrasound platforms from GE Healthcare, Ultrasound, CIVCO Medical Solutions, Hitachi, and Esaote in breakthrough needle guidance and fusion systems that improve procedural vision and remove the guesswork from difficult procedures. The combination of Ascension sensors with ultrasound imaging and visualization software, gives physicians a dynamic and accurate tool for tracking the tip of medical instruments under real-time, image-guided navigation.

CAE HEALTHCARE, INC.
CAE Healthcare offers a complete solution for ultrasound imaging training by combining cutting-edge multimedia educational material and a 3D animated simulator. Using real-time dynamic imaging and a custom-designed mannequin, the CAE VIMEDIX® ultrasonography simulator provides healthcare professionals with an unparalleled training environment for the thoracic cavity and basic to complex cardiac pathologies. The CAE ICCU® Imaging e-learning curriculum was designed to teach important theoretical and practical aspects of focused bedside ultrasound examinations using cutting-edge multimedia educational material. CAE.com/healthcare

Contact: Christian Radgowski, Regional Account Manager  Phone: 408 856 1917  Email: christian.radgowski@cae.com
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HIGH DESERT INTERACTIVE
Nephron X, by High Desert Interactive, is a real-time simulation of the reabsorption and secretion process of the kidney nephron that also shows the relationship between the vascular (blood) supply and the nephron excretory tubules. The reified animation uses mnemonic and simplified structural depictions to demonstrate this complex filtration process. The simulation reveals multiple levels of detail in its overview, while including a deeper level of detail in accompanying video animations.

In this game-like VR environment, the user can move freely within and around the nephron, view it from predetermined viewpoints, examine its behavior, and delve into a deeper level of detail at key points along the nephron by watching accompanying video animations.
Graphic representations of molecular activity are metaphorical. Many traditional simulations showing such activity use various standard depictions, including the well-known ball and stick structures to show their chemical component and bond structure. While this has many benefits, such representations may not always be the most effective means of demonstrating complex systems.

Nephron X uses mnemonic representations that are easy to remember: for example, bananas to represent potassium that are strikingly different than representations of other solutes, such as the ice-cream cones that depict glucose. Potassium has an association with the color green; hence, the bananas are shown as under-ripe. In the animated video detail, a plus sign rides on top, representing the positive ion charge of potassium.

The accompanying music is composed in real-time according to user position within the simulation, providing an aural association with various parts of the nephron.

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KYOTO KAGAKU
Kyoto Kagaku, a unique and innovated company, originated from Kyoto Japan in 1948. We provide hands-on training for Health care professionals. Our products include: simulators for medical education, training models and phantoms providing medical imaging. Our company is dedicated to provide real life scenario training in physical examination and clinical procedures.

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MOTION ANALYSIS
Motion Analysis Corporation, founded in 1982 and headquartered in Santa Rosa, California, is a leading ISO 9001:2000 developer and manufacturer of three-dimensional digital optical motion capture and analysis systems that non-invasively measure and record the movement of objects.

The Company's proprietary systems, based on over twenty five years of development, consists of digital, field-upgradeable cameras, proprietary 3D marker tracking software, and proprietary and licensed application-specific software that is used to measure and analyze, in real-time, the three dimensional movements of objects such as the human body.

The Company's systems are deployed in a wide range of industries, including: military/industrial, medical, and entertainment. The Company's systems are considered the market leader in every industry they serve. Website: <http://www.motionanalysis.com>
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Email: gary.scheirman@motionanalysis.com
http://www.MotionAnalysis.com

PHOENIX TECHNOLOGIES, INC.
PhoeniX Technologies Inc. (PTI) manufactures the industry's leading Visualeyez™ VZ4000 range of “Active Optical” based, Real-Time motion tracking systems. Visualeyez™ systems are used in a variety of research, analysis and clinical applications for extremely accurate motion capture in the fields of Telemedicine, Virtual Reality, Physical Rehabilitation, Robotics, Haptics, Sport Science, Biomechanics, etc. PTI mocap systems are professional grade and are extremely reliable, portable, wireless, easy to setup and use and offered at very “cost effective” prices.

Visualeyez™ systems do not require mundane and time-wasting manual calibration of the capture area which is done automatically in less than 2 seconds by VZAutoCal™; bundled free with all multi-tracker systems. The recently launched VZInstaCal™ now also allows collection of good data on continuously moving platforms.

PTI recently launched the world's first mocap system with “Haptic Feedback” markers. For the first time researchers can send vibration stimuli, initiate response, define tolerable deviation and acceptable motion range, and then accurately track and measure 3D coordinates.

The Visualeyez™ VZ4050, a new small format Motion Tracker measuring only 62cm in length and weighing only 2.2kgs (4.9lbs) was also recently launched by PTI. This system offers the same real-time capabilities of the VZ4000 systems through patented wide-angle technology (90 degrees in both pitch and yaw; 106 degrees diagonally at 5m). A single VZ4000 or VZ4050 system can be used to capture 3D data from up to 512 tiny markers in real-time.

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POLHEMUS
Polhemus pioneered motion tracking 40 years ago, designing pilot helmet tracking technology for the U.S. military - something they still do today.

Key market areas include virtual reality, biomechanics, and medicine (including clinical, research, and simulation and training applications). Polhemus 6DOF AC electromagnetic motion tracking products have become a
standard for top researchers and medical device manufacturers due to their accuracy, low latency, simplicity and low cost.

Polhemus’ proprietary 6DOF motion tracking technology is used in some of the world’s most sophisticated and commercially successful VR training simulators, such as Lincoln Electric’s VRTEX360 welding simulator and Medsim’s UltraSim ultrasound simulator.

Polhemus has continued to bring new products to market over the last 40 years. The latest product, G4, is a wearable, wireless tracker designed with rehabilitation, PT, human factors and biomechanics in mind. G4, although tetherless, still provides 6DOF tracking with a level of accuracy that electro-magnetics is known for.

Contact: Neil Schell, Director, Research and Technology Applications
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SENSABLE

Sensible is the world leader in force-feedback haptics, with over 8,000 of its systems installed worldwide in diverse applications such as medical skills training, stroke rehabilitation, training for the visually impaired, 3D modeling and dental CAD/CAM. At MMVR Sensable is showcasing a wide range of haptics applications written using the OpenHaptics Toolkit with the QuickHaptics microAPI to control its industry-leading PHANTOM® haptic devices. Sensable will also display a new modular PHANTOM Desktop configuration that separates the control board from the force-feedback arm, a form factor that offers more flexibility for system integrators and simulator designers.

Simulators from two partner developers will also be available on the exhibit floor. The BioRobotics Laboratory at Stanford University will be showing their tympanomastoidectomy simulator for ear-nose-throat surgeons, which incorporates actual patient-specific data from CT or MRI scans. The system is intended as a step towards surgical rehearsal, with which a surgeon can prepare for an upcoming case by practicing dissections on a virtual representation of the patient’s specific anatomy.

In addition, UK Haptics will be demonstrating their multi-simulator platform. In this instance the simulation is fitting an intrauterine contraceptive device (Mirena), and was developed with the device manufacturer, Bayer Schering Pharma. The system uses co-located haptics and photo realistic 3D graphics, two haptic devices, five end-effectors representing nine tools used during the procedure and has 32 assessment points in the reporting software which give feedback to the user. This simulator uses UK Haptics Clinical Skills Trainer and Introduction to Haptics modules and has already been distributed to 47 countries worldwide in five languages. Later this year a virtual ultrasound will also be incorporated into the system.

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SENSEGRAPHICS

Meet SenseGraphics at MMVR18 in Newport Beach to try out the SenseGraphics H3DAPI developer platform with the SenseGraphics Display System for co-location of haptics and real 3D stereo graphics. There will also be a world premier of the Haystack Nerve Blocks training simulator and demonstration of the ScanTrainer Ultrasound simulator.

SenseGraphics is devoted to the science of multi-modal interaction and real 3D stereo visualization, with the vision to facilitate and support research- and commercial application development in the medical field.

Make your work fast with Open Source!
SenseGraphics flagship product H3DAPI sets the standard for multimodal research, medical and industrial application development in real 3D stereo graphics with haptics as available under both Open Source and commercial license. SenseGraphics’ latest invention, HAPI - haptic engine, is used for adding haptic interactions to graphical or other scientific applications, which makes it easier for these applications to be haptic-enabled with minimal rewriting of the existing code.

SenseGraphics is helping companies to develop and commercialize medical simulators. Successful customer reference work includes the Simodont Dental trainer from MOOG in the Netherlands, ScanTrainer Ultrasound training simulator from Medaphor in the UK, Stroke rehabilitation from Curictus in Sweden as well as the Haystack simulator for ultrasound guided peripheral nerve blocks from NDRC in Ireland.

Through the open source community, www.H3D.org, SenseGraphics has been able to quickly spread its software amongst researchers and gain broad, world-wide user support for H3DAPI by offering Wikis, tutorials and free support based forums. SenseGraphics is also offering haptics hardware and 3D Display solutions for co-location of haptics and 3D stereo visualization.

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continued
THE TELEMEDICINE & ADVANCED TECHNOLOGY RESEARCH CENTER (TATRC)

For the 2011 Annual MMVR Conference, the U.S. Army Medical Research & Materiel Command (USAMRMC) and The Telemedicine & Advanced Technology Research Center (TATRC) have decided to take a novel approach. TATRC will extend the definition of ‘telemedicine,’ to show how advanced medical technologies, will impact the provision of healthcare to the military, as well as to the civilian sector.

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 battlespace medical awareness, and more effectively employ our medical forces in the 21st century. Funded as areas of Special Congressional interest for Army research, over 200 projects totaling more than 400 million dollars have been executed and managed by TATRC, and carried out in universities and private laboratories all over the country.

Please stop by TATRC's advanced technology showcase for an interactive, thought-provoking and exciting experience demonstrating how technology will enhance life on the battlefield, in military medicine and beyond. For more information about TATRC, please visit us at MMVR, or visit us online at: www.tatrc.org, or call Ms. Lori DeBernardis.

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TRUE VISION

TrueVision(r) 3D Surgical is the leader in digital 3D visualization and guidance for microsurgery. Based in Santa Barbara, California, TrueVision(r) has developed and patented the TrueVision System(r), an intelligent, real-time, 3D surgical visualization and computer-aided guidance platform. The system is used to record 3D surgical video for educational purposes and to present live streaming or recorded 3D surgical video content for telemedicine and medical meetings. The company is focused on developing a suite of 3D guidance applications for microsurgery to improve surgical efficiencies and patient outcomes. The first application is the TrueVision(r) Refractive Cataract Toolset(tm).

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VIRTUALLY BETTER

Since 1995, when we developed Virtual Vietnam for treatment of combat PTSD, Virtually Better has been the acknowledged leader in simulation-assisted clinical diagnosis and therapy.

Virtually Better is currently known worldwide as an innovator in the creation of evidence-based, virtual reality applications for treating cognitive and behavioral disorders, including PTSD, phobias, and substance abuse. We also provide systems for social skill training, pain distraction, and stress- inoculation. Our systems are used by all branches of the military, the VA System, the CDC, numerous research labs, and private health care networks.

Our new products focus on telemedicine technologies for training, treatment, and consultation in the field of behavioral medicine.

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THURSDAY MORNING
PLENARY SESSION

Richard Satava


Over the past 19 years, MMVR has been the leading edge multi-disciplinary medical technology conference. Contributions from engineers, psychologists, computer scientists, mathematicians, physicists, science fiction writers, government officials, military program managers and many others have enriched the imagination (and toolbox) of physicians, nurses, medics and other healthcare providers, changing the face of medicine. This presentation looks at the successes and failures of the past 20 years and extrapolates the possible direction of new technologies: MMVR Future Vision.

Don Jones

**Wireless Technology Innovations in Health Care**

Qualcomm Incorporated is the world leader in next-generation mobile technologies and the world’s largest manufacturer of chipsets for the wireless industry, and is now revolutionizing Life Sciences by partnering with medical device and health service companies to create innovative health solutions. Don Jones will be discussing the overall wireless health space, including how and why to move from unconnected medical devices to connected wireless medical devices. Mr. Jones will provide insight into how Qualcomm is making the Body Area Network (BAN) technologies a reality, increasing the effectiveness of medical solutions and bringing new capabilities to consumers who want to manage their own health. Specifically, Qualcomm is currently developing multiple technologies targeting the medical device industry, including ultra low power radios, gateway devices, digital signal processing to reduce noise, and wearable mobile device modules. Mr. Jones will speak about all of these initiatives, and how medical device manufacturers can apply the power of wireless to their solutions.

Adrianne Noe

**The Future of the Future: MMVR and the National Museum of Health and Medicine**

With the inauguration of the “Richard M. Satava, MD, FACS Advanced Medical Technologies Collection,” the National Museum of Health and Medicine reinvigorated and institutionalized its collecting initiatives in computational technologies applied to medicine. But some of the best uses of the collection to advance our interests as they are expressed here at MMVR reside in materials collected a century and a half ago. The motivation to collect then, as now, reflects an orientation toward creativity and a commitment to intellectual reaches rarely accommodated in the public setting. This brief comment will explore our opportunities and our obligations to broaden understanding of the state of our field.

James Blascovich

**Infinite Reality: Donning Avatars for Good Health**

Please see Addendum for presentation summary.

THURSDAY AFTERNOON – SESSION A

SIMULATION & LEARNING

Bill Kapralos

**Serious Games in the Classroom: Gauging Student Perceptions**

Serious games, or video game-based technology applied to training, learning applications, provide a high fidelity simulation of particular environments and situations that focus on high level skills that are required in the field.
Given the popularity of video games, particularly with today’s generation of learners, and the growing trend of restricted resident work hours and diminished operating room exposure due to limited budgets increased case complexity and medicolegal concerns, serious games provide a cost-effective viable training option. To develop effective serious games, the views and perceptions of both the end users (learners) and educators regarding their use “in the classroom” must be assessed and accounted for. Here we present the results of a survey that was designed to assess students’ perceptions of serious games.

Dave Taylor

Implementation of Virtual Online Patient Simulation

The development and use of virtual patients has become more expansive. Previous strategies have been described to aid their formation. In this study is a description of the development of a series of virtual patients following a methodology proposed by Posel et al. Ten virtual patients with surgical pathology were developed using a reproducible framework. This description serves to guide future virtual patient authors as a working description of virtual patient design in order to further assist them.

Bryan Bergeron

An Adaptive Signal-Processing Approach to Online Adaptive Tutoring

Conventional intelligent or adaptive tutoring online systems rely on domain-specific models of learner behavior based on rules, deep domain knowledge, and other resource-intensive methods. We have developed and studied a domain-independent methodology of adaptive tutoring based on domain-independent signal-processing approaches that obviate the need for the construction of explicit expert and student models. A key advantage of our method over conventional approaches is a lower barrier to entry for educators who want to develop adaptive online learning materials.

Samantha Hurst

Towards High-Resolution Ethnography for Evaluation of Team-Oriented Virtual Reality Training for Medicine

In this paper we define high-resolution (“hi-res”) ethnographic approaches for evaluation of team-oriented virtual reality training. Our objectives are to describe challenges to the application of this concept for the analysis of an experimental virtual training platform. The purpose of this evaluation is to guide both system development and evaluation of curriculum that uses this virtual training platform.

Mathias Kaspar

Web-Based Stereoscopic Visualization for the Global Anatomy Classroom

Many projects have focused on the improvement of virtual education. We have contributed with the global virtual anatomy course for teaching students in multiple locations with stereoscopic volume rendering, audio/video conferencing and additional materials. This year we focused on further simplifying the deployment of the classroom by using the new collaborative and web-based visualization system CoWebViz, to transfer stereoscopic visualization to the classrooms. Besides the necessary hardware installations for stereoscopy, only a web browser is necessary to view and to interact with the remote 3D stereo visualization. This system proved stable, gave higher quality images and increased ease of deployment. Its success within our classroom at the University of Chicago and Cardiff University has motivated us to continue CoWebViz development.

Johan Creutzfeldt

Retention and Transfer to Full Scale Simulation of Virtual World CPR Training with Avatars in Medical Students

We investigated the retention and transferability of knowledge and skills after repeated multiplayer virtual world (MMVW) team training of CPR with avatars in medical students. Two experimental groups of 12+8 students were compared to a control group of 10 students. All groups initially received traditional CPR training and the experimental groups also received 2 MMVW training sessions half a year apart. The groups were assessed dynamically in full scale simulation, the experimental groups 6 and 18 months after last MMVW training. Previously we have found supporting evidence for MMVW with positive student reactions. In the present study we aim to find how knowledge is retained and used in a live environment, if team skills are developed and how continuous training is affected.

John Loewenstein

Development of Cognitive Simulations for Medical Teaching

The apprenticeship method of medical and surgical teaching has significant limitations which are becoming
more apparent as residency curricula become more formal. In addition pressures on faculty time have encouraged new approaches to resident and medical student education. We have used an “immersion story” method to create new teaching tools. Our initial effort was a computer based simulation for teaching the cognitive aspects of cataract surgery separately from the motor aspects. This method is error based and realistic. A key feature is the use of “just in time” feedback in the form of expert stories. A multicenter randomized trial of a prototype demonstrated the effectiveness of this method as an adjunct to conventional teaching. We have now completed the cataract simulation and are developing a program for teaching screening for retinopathy of prematurity.

Marko Kostic

Establishment of the Simulation and Interactive Technology Hub (SITH) in Support of the Advanced Development and Utilization of Novel Medical Simulation Technologies in Military and Civilian Educational Curricula

Multiple barriers have limited development and commercialization of medical simulation technologies that could potentially benefit the Department of Defense (DoD) and civilian healthcare. These obstacles include limited technology transfer, lack of validation of existing systems, lack of quantifiable assessment metrics, and insufficient capital for technology development. To address these challenges, the West Coast Office of TATRC has established a forum, the SITH, designed to provide researchers, clinicians, and industry with knowledge of the DoD needs in simulation. The SITH provides a forum for the exchange of ideas and an opportunity to interact with the DoD personnel. The goal is to facilitate partnerships that can lead to more effective simulation technologies that meet both the needs of the DoD and civilian sector.

Parvati Dev

CliniSpace™: A Multiperson 3D Online Immersive Training Environment Accessible through a Browser

Immersive online medical environments, with dynamic virtual patients, have been shown to be effective for scenario-based learning (1). However, ease of use and ease of access have been barriers to their use. We used feedback from prior evaluation of these projects to design and develop CliniSpace. To improve usability, we retained the richness of prior virtual environments but modified the user interface. To improve access, we used a Software-as-a-Service (SaaS) approach to present a richly immersive 3D environment within a web browser.

Lawrence Salud

Use of Sensor Technology to Explore the Science of Touch

Two, world-renown researchers in the science of touch (Klatzky and Lederman) have shown that there are a set of reproducible and subconscious maneuvers that humans use to explore objects. Force measuring sensors may be used to electronically identify and quantify these maneuvers. Two senored silicone breast models were configured to represent two different clinical presentations. One-hundred clinicians attending a local breast cancer meeting performed clinical breast examinations on the models, and their performance was captured using sensor-based data acquisition technology. We have found that Klatzy and Lederman’s previously defined touch maneuvers are used during the clinical breast examination and can be identified and quantified for the first time using sensor technology.

Tyler Niles

A Portable Palpation Training Platform with Virtual Human Patient

Palpation (the application of touch to the surface of the body) is an essential clinical skill. Correct palpation is part of a complete physical examination and it assists a clinician in making an accurate diagnosis, while poor palpatory skills can lead to diagnostic errors. As with any clinical skill, palpation is best learned through repetitive practice with constructive feedback. Unfortunately, changes in healthcare provide fewer opportunities for hands-on learning of this essential skill. Unlike other clinical skills, palpation has no immediate feedback to the learner regarding their performance. For example, when students are learning how to insert an intravenous catheter, failure to perform the technique correctly results in no blood return in the catheter. However, students do not know if they are palpating an abnormality if they have never felt it before. This inherent difficulty makes expert feedback even more vital to learning correct palpation. Existing research tools have addressed some of these challenges through simulation techniques that do not require experts, and can provide feedback on palpation pressures and palpation patterns. We describe a novel computer-based palpation training system, leveraging existing approaches, with an emphasis on sensing accuracy, directed-feedback, portability, and user experience.

Paul Mlyniec & Jason Jerald

iMedic: A Two-Handed Immersive Medical Environment for Distributed Interactive Consultation

We describe a two-handed immersive and distributed 3D medical system that enables intuitive interaction with
multimedia objects and space. The system can be applied to a number of virtual reality and teleconsulting paradigms. Various features were implemented toward this end, including measurement tools, interactive segmentation, non-orthogonal planar views, and 3D markup. User studies demonstrated effectiveness of the system in fundamental 3D tasks. The interface enables placement and construction of 3D objects 4.5-4.7 times as fast as a mouse interface and 1.3-1.7 times as fast as a one-handed wand interface. In addition, a study comparing two styles of collaboration supported by the system—face-to-face collaboration, and virtual avatar collaboration—is described.

David Chodos

**MeRiTS: Simulation-Based Procedural Training for Healthcare Professionals**

Simulation-based training has been used in numerous settings for procedural training. In this research, we focus on a method of simulation-based procedural skills training that uses virtual worlds. This method, implemented in our MeRiTS software system, models procedures using executable workflows, which are enacted by the trainee in a virtual world. The workflows may be defined by educators, or demonstrated by experts and then extracted from system logs. To demonstrate the utility of the system, we have created a scenario for training EMTs in patient rescue and transition procedures. We have pilot tested this scenario with students at a career college, and will be conducting more rigorous testing with a range of students and institutions in the near future.

Sergei Nirenburg

**Intelligent Agents in Support of Clinical Medicine**

We have developed the capability of creating artificial agents that can feature a body and a mind, and can participate in networks of human and artificial agents. We first motivate our approach to modeling agents, then briefly describe the key capabilities of our agents on the whole, and finally discuss their broad utility in applications of clinical medicine.

Mikhail Ignatyev

**Virtual Worlds Technology for Medical Tasks**

Virtual Worlds Technology permit to generate the different variants of the medical decisions in interactive 3-dimensional pictures and sound. The main pivot of virtual worlds technology is the cybernetics bicycle – the new devices for input and output information.

Albert Rizzo

**An Intelligent Virtual Human System for Providing Healthcare Information and Support**

Over the last 15 years, a virtual revolution has taken place in the use of Virtual Reality simulation technology for clinical purposes. Seminal research and development has appeared in the creation of highly interactive, artificially intelligent and natural language capable virtual human agents that can engage real human users in a credible fashion. This paper will present an overview of the SimCoach project that aims to develop virtual human support agents to serve as online guides for promoting access to psychological healthcare information and for assisting military personnel and family members in breaking down barriers to initiating care. The SimCoach experience is being designed to attract and engage military Service Members, Veterans and motivate users to take the first step – to empower themselves to seek advice and information regarding their healthcare (e.g., psychological health, traumatic brain injury, addiction, etc.) and general personal welfare (i.e., other non-medical stressors such as economic or relationship issues) – and encourage them to take the next step towards seeking other, more formal resources if needed.

THURSDAY AFTERNOON – SESSION B

**ROBOTICS**

Eric Psota

**Stereo Image-Based Arm Tracking for In Vivo Surgical Robotics**

Motor-based tracking and image-based tracking are considered for three-dimensional in vivo tracking of the arms of a surgical robot during minimally invasive surgery. Accurate tracking of the surgical robot's arms is necessary for tele-medical applications and for the future automation of surgical procedures. An experiment is performed to compare the accuracy of the two methods, and the results show that the positioning error of image-based tracking is significantly less than that of motor-based tracking.

Naoki Suzuki

**Development of a Robot Arm that has Haptic Sensation for Augmented Reality Function of Endoscopic Surgical Robot**

We are developing an endoscopic surgical robot system for digestive organ surgery to operate on relevant
The system has forceps like robot arms at the tip of the endoscope. It goes into the body from the mouth, passing through the esophagus and the stomach. Moreover, it penetrates through the stomach wall into the abdominal cavity. The system can conduct surgical operations with the two arms that are positioned on the right and left of the robot’s eyes. In the stomach and in the abdominal cavity, these robot arms have functions which forceps shaped claws at the tips of the robot arms grab and lift up soft tissues. The robot arms are driven by traction force of several wires. In the development process, as in the normal surgical robots like da Vinci, the amount of force applied in grabbing the soft tissues could only be determined by visual information on the operation image display submitted through the tip of the endoscopic robot. Therefore, there was always concern that the arms would grab the soft tissues with too much force and damage the part they had grabbed. Calculating the grabbing force by mounting a sensor less than 5mm at the tip of the forceps did not produce good results in either safety or calculation reproduction. So, we decided to measure the change of traction force of the wires that drive the robot arms to estimate the softness of the object the arms have grabbed and displayed it to the operator. In this way, we developed a function on the surgical robot system which the operator can control the grabbing force of the object through the information.

Hao Su

High-Field MRI Compatible Steerable Needle Driver Robot for Percutaneous Prostate Intervention

This paper presents the design of a magnetic resonance imaging (MRI) compatible needle steering system actuated by piezoelectric actuators for prostate brachytherapy and biopsy. A MRI-compatible modular 3-degrees-of-freedom (DOF) needle steering driver coupled with a representative 3-DOF x-y-z stage is proposed as a slave robot to deliver radioactive seeds in an MRI-guided force feedback teleoperation framework. The modular needle driver provides needle cannula rotation and independent cannula and stylus prismatic motion. The device mimics the manual physician gesture by two point grasping and direct force measurement of needle axial puncture and lateral forces by fiber optic force sensors. CAD models and the fabricated prototype are presented and the experiment with phantom trial is analyzed to demonstrate the system compatibility.

Erol Yeniaras

A Novel Virtual Reality Environment for Preoperative Planning and Simulation of Image Guided Intracardiac Surgeries with Robotic Manipulators

The evolution of image-guided and robot-assisted procedures can be beneficial to intracardiac procedures. This paper proposes a novel approach and a virtual reality system for pre-operative planning and intra-operative guidance of cardiac procedures and for investigating the kinematics and control of a virtual robotic manipulator, based on MRI CINE images. The system incorporates dedicated software modules for processing MR images, generating dynamic trajectories for a robotic manipulator in the continuously changing environment of a beating heart, for controlling a specific generic virtual manipulator along those trajectories, and a virtual reality interface that fuses all those information. The proposed system is applied for the simulation of accessing the aortic valve annulus via a small incision on the apex by maneuvering a robotic manipulator through an access corridor that safely transverses the left ventricle (LV) of the beating heart.

INFORMATION-GUIDED THERAPIES

Hooman Soltanian

3-Dimensional Visualization of Normal Wrist Kinematics: A Pilot Study

The wrist is a complex joint involving articulation of 8 bones. The movements of the bones are difficult to
appreciate using traditional imaging modalities. The purpose of the current project was to develop an interactive, three-dimensional, and dynamic model of the carpal bones to allow users to visualize and examine the carpal bone motions from any desired angle. The same methodology can be used for any dynamic structure. The anatomic surface data of the carpal bones were obtained from high resolution Computed Tomography (CT) images of a fresh cadaver wrist. The carpal bones were modeled in several positions along its passive flexion-extension motion. These discrete models were used to create an animation demonstrating all carpal bones as the wrist completed a flexion-extension cycle. The final product was then migrated into a format which can be used on any PC or Mac computer using a commonly available internet browser. A three-dimensional carpal model was created allowing interactions during animation, with additional features such as magnification, bone removal, and 360° viewing angles. This carpal model is dynamic, three-dimensional, easily accessible, and interactive. The current model is based on real anatomic structures and is not based on artist’s renditions. It provides high academic and clinical value pertaining to carpal kinematics.

Randy Ellis

On the Use of Laser Scans to Validate Reverse Engineering of Bony Anatomy

There is a growing body of evidence to suggest the arthritic hip is an irregularly-shaped, aspherical joint, especially in severely pathological cases. Current methods used to study the shape and motion of the hip in vivo are invasive and impractical. This study aimed to assess whether a plastic model of the hip joint can be accurately made from a pelvic CT scan. A cadaver hemipelvis was CT imaged and segmented from which a 3D plastic model of the proximal femur and hemi-pelvis were fabricated using rapid-prototyping. Both the plastic model and the cadaver were then imaged using a high-resolution laser scanner. A three-way shape analysis was performed to compare the goodness-of-fit between the cadaver, image segmentation, and the plastic model. Overall, we obtained sub-millimeter fit accuracy between all three hip representations. Shape fit was least favorable in areas where the boundary between cartilage and bone is difficult to distinguish. We submit that rapid-prototyping is an accurate and efficient mechanism for obtaining 3D specimens as a means to further study the irregular geometry of the hip.

Randy Ellis

Registration Stability of Physical Templates in Hip Surgery

We tested the registration stability of individualized templates in a consecutive study with 80 patients undergoing hip resurfacing. These templates physically encode registration and navigation parameters but do not require a computer during surgery. The surgical target was the placement of the femoral guidance pin during hip resurfacing, which is a difficult and highly variable task using conventional instruments. The drill trajectory for the guidance pin of the femoral component was planned on a 3D computer model of the femur derived from a preoperative CT scan. A surface-matched drilling template was designed to perform mechanical registration on the bone surface and had a hole for the drill guide; the template was created using a rapid prototyping machine. Intraoperatively, the individualized template was positioned on the patient anatomy and the pin was drilled into the femoral neck. The final achieved pin orientation and position were measured using an optoelectronic CT-based navigation system. The measured mean deviation between planned and actual central pin alignment of 0.05° in valgus and 2.8° in anteversion shows that the proposed individualized templates for hip resurfacing have reliable registration.

Bruce Cameron

Fast Adaptation of Pre-Operative Patient Specific Models to Real-Time Intra-Operative Volumetric Data Streams

Image-guided catheter ablation therapy is becoming an increasingly popular treatment option for atrial fibrillation. Successful treatment relies on accurate guidance of the treatment catheter. Integration of high-resolution, pre-operative data with electrophysiology data and positional data from tracked catheters improves targeting, but lacks the means to monitor changes in the atrial wall. Intra-operative ultrasound provides a method for imaging the atrial wall, but the real-time, dynamic nature of the data makes it difficult to seamlessly integrate with the static pre-operative patient-specific model. In this work, we propose a technique which uses a self-organizing map (SOM) for dynamically adapting a pre-operative model to surface patch data. The surface patch would be derived from a segmentation of the anatomy in a real-time, intra-operative ultrasound data stream. The method is demonstrated on two regular geometric shapes as well as data simulated from a real, patient computed tomography dataset.

Kamyar Abhari

Evaluation of a VR and Stereo-Endoscopic Tool to Facilitate 3rd Ventriculostomy

Endoscopic third ventriculostomy is a minimally invasive technique to treat hydrocephalus, which is a condition in which the patient is retaining excessive amount of cerebrospinal fluid in the head. While this surgical procedure is fairly routine, it carries some risks, mainly...
associated with the lack of depth perception, since monocular endoscopes provide only 2D views. We studied the advantages given by a 3D stereendoscope over a 2D monocular endoscope, first by assessing the variability of stereocuacity in each subject, then in analyzing their overall correct response rate in differentiating between heights of two different images with 2D and 3D vision. Finally, this analysis extends to support a methodology for evaluating the performance in targeting this surgical site, for comparison between 2D and 3D endoscopes.

Peter Kazanzides

Development of a Wireless Hybrid Navigation System for Laparoscopic Surgery

Navigation devices have been essential components for Image-Guided Surgery (IGS) including laparoscopic surgery. We propose a wireless hybrid navigation device that integrates miniature inertial sensors and electromagnetic sensing coils, for tracking instruments both inside and outside the human body, free of the constraints of line-of-sight or entangling sensor wires. The main functional (sensor) part of the hybrid tracker is only about 15x15mm. We identify the sensor models and develop sensor fusion algorithms for the proposed system to get optimal estimation of position and orientation (pose). The proof-of-concept experimental results show that the proposed hardware and software system can meet the defined tracking requirements, in terms of tracking accuracy, latency and robustness to environmental interferences.

Tobias Rick

Visualization of Probabilistic Fiber Tracts in Virtual Reality

Understanding the connectivity structure of the human brain is a fundamental prerequisite for the treatment of psychiatric or neurological diseases. Probabilistic tractography has become an established method to account for the inherent uncertainties of the actual course of fiber bundles in magnetic resonance imaging data. This paper presents a visualization system that addresses the assessment of fiber probabilities in relation to anatomical landmarks. We employ real-time transparent rendering strategy to display fiber tracts within their structural context in a virtual environment. Thereby, we not only emphasize spatial patterns but furthermore allow an interactive control over the amount of visible anatomical information.

Sergei Turovets

Computational Modeling of Human Head Electromagnetics for Source Localization of Milliscale Brain Dynamics

Understanding the milliscale (temporal and spatial) dynamics of the human brain activity requires high-resolution modeling of head electromagnetics and source localization of EEG data. We have developed an automated environment to construct individualized computational head models from image segmentation and to estimate conductivity parameters using electrical impedance tomography methods. Algorithms incorporating tissue inhomogeneity and impedance anisotropy in electromagnetics forward simulations have been developed and parallelized. The paper reports on the application of the environment in the processing of realistic head models, including conductivity inverse estimation and lead field generation for use in EEG source analysis.

Anand Santhanam

Visualization of 3D Volumetric Lung Dynamics for Real-Time External Beam Lung Radiotherapy

This paper reports on the usage of physics-based 3D volumetric lung dynamic models for visualizing and monitoring the radiation dose deposited on the lung of a human subject during lung radiotherapy. The dynamic model of each subject is computed from a 4D Computed Tomography (4DCT) imaging acquired before the treatment. The 3D lung deformation and the radiation dose deposited is computed using Graphics Processing Units (GPU). Additionally, using the lung tissue elasticity, the airflow inside the lungs during the treatment is also investigated. Results show the radiation dose deposited on the lung tumor as well as the surrounding tissues, the combination of which is patient-specific and varies from one treatment fraction to another.

Mei Xiao

Generation of Connectivity-Preserving Surface Models of Multiple Sclerosis Lesions

Progression of multiple sclerosis (MS) results in brain lesions caused by white matter inflammation. MS lesions have various shapes, sizes and locations, affecting cognitive abilities of patients to different extents. To facilitate the visualization of the brain lesion distribution, we have developed a software tool to build 3D surface models of MS lesions. This tool allows users to create 3D models of lesions quickly and to visualize the lesions and brain tissues using various visual attributes and configurations. The software package is based on breadth-first search based 3D connected component analysis and a 3D flood-fill based region growing algorithm to generate 3D models from binary or non-binary segmented medical image stacks.
**THURSDAY AFTERNOON – SESSION C**

**Plasma Medicine: The Emerging Revolution in Surgery, Wound Care, and Pathogen Control**

Mark Kushner

**Fundamentals of Gas Phase Plasmas for Treatment of Human Tissue**

The use of gas phase plasmas for treating human tissue is at the intersection of two disciplines – plasma physics and engineering, and medicine. In this paper, a primer will be provided for the medical practitioner on the fundamentals of generating gas phase plasmas at atmospheric pressure in air for the treatment of human tissue. The mechanisms for gas phase plasmas interacting with tissue and biological fluids will also be discussed using results from computer modeling.

Greg Morfill

**Plasma Wound Treatment**

"Plasma Wound Treatment" is an emerging interdisciplinary research topic. It combines plasma physics, chemistry and engineering with life sciences. Some of the applications outside the areas of medicine currently explored are food safety, environmental hygiene, and personal care. Medical research includes ongoing studies of prion inactivation, chronic wound treatment, dermatology and plasma-mediated cancer therapy. Investigations range from basic physical processes, plasma chemical design, to the interaction of plasmas with eukaryotic (mammalian) cells; prokaryotic (bacteria) cells, viruses, spores, and fungi, also DNA, lipids, proteins, and cell membranes as well as living human, animal and plant tissues in the presence of biofluids. Of paramount interest is the need for improved and faster hospital disinfection, in particular with respect to the alarming increase in bacterial resistance to antibiotics. In this paper we briefly describe the important new aspects of "plasma medicine" – starting with the permeabilisation of cells, the molecular delivery of active agents, the possibility to "design" plasmas as possible pharmaceutical products employing new ionic (as well as molecular) agents for medical treatment. Then we discuss the present status of the clinical studies in wound care and wound healing.

Peter Gibson

**The PlasmaJet® System and Its Application in Surgery**

Many papers in plasma medicine have described the potential clinical applications of cold plasma. These include disinfection and wound healing, but cold plasma has insufficient power to provide a surgical effect. The PlasmaJet system employs a multiple electrode group to excite a low flow of argon gas to produce thermal plasma at the tip of a surgical handpiece and may be used in both cut and coagulate tissues in surgery. The PlasmaJet system is both CE marked and FDA cleared for use in surgery, and early clinical experience has confirmed its ability to cut with the precision of the surgical laser, but with greater coagulation capability and enhanced safety. As an electrically neutral energy source, the PlasmaJet handpiece provides a safer alternative to electrosurgery. This presentation will describe the PlasmaJet system, discuss the effects of this plasma energy at the tissue level, and illustrate some of its applications in surgery.

Michael Kong

**Skin and Wound Disinfection Using Cold Atmospheric Gas Plasmas**

Low-temperature gas plasma generated in open air offers great promise as a novel platform technology of disinfection and bio-decontamination. Examples include skin and tissue disinfection, and sterilization of surgical instruments and medical devices. Its underpinning science is based largely on non-equilibrium reaction chemistry of transient fluxes of reactive oxygen and nitrogen species, charged particles, and photons, produced and controlled electrically. These reactive species interact with each other dynamically to synergistically inactivate microorganisms and biological macromolecules in just a few tens of seconds typically. With appropriate plasma chemistry, this inactivation effect can be made selective against microorganisms with little damage to healthy human tissues. Considerable scope exists to engineer such gas plasmas for reproducible and controlled disinfection of diseased living tissues.

Lesley Greene

**Destruction of Amyloid Fibrils by the Plasma Pencil**

Amyloid fibrils are ordered beta-sheet aggregates that are associated with a number of neurodegenerative diseases such as Alzheimer’s and Parkinson’s. Initial studies by the Greene and Laroussi groups indicate that cold plasma, which is a room temperature ionized gas, can break amyloid fibrils into smaller units in vitro. The
plasma was generated by the “Plasma Pencil”, a device capable of emitting a long, low temperature plasma plume/jet. This avenue of research may facilitate the development of a medical treatment.

THURSDAY AFTERNOON – SESSION D

Developing a Standardized Tri-Service Medical Simulation Platform – The TOPS Initiative

See schedule for description of this independently organized session.

THURSDAY AFTERNOON – SESSION E

Virtual Reality and Advanced ICT in Europe

Giuseppe Riva, Organizer

Rosa Baños

Engaging Media for Mental Health Applications: the EMMA Project

The EMMA project has been focused on how the sense of presence in virtual environments mediates or generates emotional responses, and how to use presence and emotions responses in virtual environments effectively in clinical and non clinical settings. EMMA project has developed two different virtual environments. The first one acts as a ‘mood device’ and is aimed to induce and enhance several moods on clinical and non clinical subjects. The second one is a virtual environment that acts as an adaptive display to treat emotional disorders (Post-traumatic Stress Disorder, Adjustment Disorder and Pathological Grief). This virtual world varies the contents that are presented depending on the emotions of the patient at each moment. The goal of this presentation is to outline the main goals achieved by this project.

Cristina Botella

Online Predictive Tools for Intervention in Mental Illness: The OPTIMI Project

Mental health care represents over a third of the cost of health care to all EU nations. It additionally results in further costs to the economy in lost productivity. Depression and Stress related disorders are the most common mental illnesses and the prevention of depression and suicide is one of the 5 central focus points in the European Pact for Mental Health and Well Being. While other mental illnesses may benefit in the long term, Depression and Stress will be the focal point mental illnesses mentioned in OPTIMI. Currently the main treatments for mental illness are pharmacological and evidence based Cognitive Behavioral Therapy (CBT). OPTIMI will try to improve the state of the art by monitoring stress and poor coping behavior in high risk population, and by developing tools to perform prediction through early identification of the onset of depression. The main goal of OPTIMI is to improve CBT programs in order to enhance both efficacy and therapeutic effectiveness. The presentation will outline the main goals the project is aiming and its clinical rationale.

Andrea Gaggioli

Interreality in the Management of Psychological Stress: The Interstress Project

The term “psychological stress” describes a situation in which a subject perceives that environmental demands tax or exceed his or her adaptive capacity. According to the Cochrane Database of Systematic Reviews, the best validated approach covering both stress management and stress treatment is the Cognitive Behavioral (CBT) approach. The Interstress project aim to design, develop and test an advanced ICT based solution for the assessment and treatment of psychological stress that is able to improve the actual CBT approach. To reach this goal the project will use the “interreality” paradigm integrating assessment and treatment within a hybrid environment, that creates a bridge between the physical and virtual worlds. The presentation will outline the interreality paradigm and its clinical rationale.

Giuseppe Riva

Virtual Reality in the Treatment of Obesity and Eating Disorders: The VEPSY Updated Project

The use of VR has also been utilized in the treatment of obesity as part of Experiential Cognitive Therapy (ECT). Developed by Giuseppe Riva and his group within the VEPSY Updated European project, ECT is a relatively short-term, patient-oriented approach that focuses on individual discovery. Experiential Cognitive Therapy has been tested in different case studies and controlled trials with obese and binge eating patients and in general provides better results in the follow-up than competing approaches, including both nutritional and cognitive behavioral therapy. The presentation will discuss the obtained results and the next research lines.
Brenda Wiederhold

**Virtual Reality and Advanced ICT in Europe: The Role of the iACToR association**

iACToR - International Association of CyberPsychology, Training, and Rehabilitation (http://iactor.ning.com/) is an international non-profit association designed to promote Virtual Reality and other advanced technologies as adjuncts to more traditional forms of therapy, education, and rehabilitation. Both the past president (Cristina Botella) and the actual president (Giuseppe Riva) are leading European researchers in the area. iACToR members address the urgent need to develop a “roadmap” for the future of this rapidly growing field. The goal of this presentation is to describe the different tools – including 2 scientific journals: Journal of CyberTherapy and Rehabilitation (http://journalofcybertherapy.webs.com), Annual Review of CyberTherapy and Telemedicine (http://www.arcrt.info) - that can be used by European researchers to support and network their activity.

Lucio De Paolis

**Augmented Reality Application for the Trocars Insertion in Pediatric Laparoscopy**

This paper presents an Augmented Reality application for the visualization and the interaction with the 3D patient models of the organs built from CT images. The developed application allows the surgeon to choose on the virtual model the points for the insertion of the trocars and overlapping these on the real patient body using the Augmented Reality technology. This work is part of ARPED Project (Augmented Reality Application in Pediatric Minimally Invasive Surgery) funded by the Fondazione Cassa di Risparmio di Puglia. The aim of the ARPED project is the design and development of an Augmented Reality system that can support the surgeon through the visualization of anatomical structures of interest during a laparoscopic surgical procedure.

Jayus Doswell

**Designing a Context-Aware Augmented Reality System: An Emergency First Responder Assist Device**

Wearable Augmented Reality (AR) may provide on-demand assistance to medical first responders that treat injuries in response to manmade or natural disasters. Wearable AR has the potential of providing a natural and mobile human-computer interface to deliver context-aware assistance as multi-modal information while medical first responders perform psychomotor clinical procedures at the point of care. These multi-modal perceptual cues combining animation, graphics, text, video, and voice along with empirical instructional techniques can deliver effective assistance to the wearer. The challenge, however, is building a robust wearable AR system with capabilities to adapt to individual perceptual strengths and incorporate AR subsystems, which results in a wearable headset that is light-weight and ergonomically designed with an effective user interface tailored to first responder needs. This paper builds upon previous research on the Juxtopia® Context-Aware Augmented Reality System (CAARS) architecture for developing wearable AR headsets and software services to improve first responder performance.

Richard Bucholz

**An Integrated Surgical Communication Network - SurgON**

An integrated communication network, SurgON, has been developed to enable a surgeon to control multiple operating room systems and devices and monitor data streams from diverse sources via a single console. The system also enables the surgeon to grant access and control to remote observers and participants. A test configuration has been evaluated.
limbs were delineated with colored tape, imaged, and compared with computed tomography scans. The most accurate system used visually projected texture captured by a binocular stereo camera, capable of measuring areas to within 3.4% of the ground-truth areas. This simple, inexpensive technology shows promise for postoperative monitoring of dysesthesia surrounding surgical scars.

Jung Leng Foo

Development of a Customizable Software Application for Medical Imaging Analysis and Visualization

Graphics technology has extended medical imaging tools to the hands of surgeons and doctors, beyond the radiology suite. However, a common issue in most medical imaging software is the added complexity for non-radiologists. This paper presents the development of a unique software toolset that is highly customizable and targeted at the general physicians as well as the medical specialists. The core functionality includes features such as viewing medical images in two- and three-dimensional representations, clipping, tissue windowing, and coloring. Additional features can be loaded in the form of ‘add-ons’ such as tumor segmentation, tissue deformation, auscultation, and surgical planning. This allows the software to be lightweight and easy to use while still giving the user the flexibility of adding only the necessary features, thus catering to a larger user population.

Tomoko Ikawa

Design for Functional Occlusal Surface of CAD/CAM Crown Using VR Articulator

In this present study, we would like to introduce an approach that utilizes the VR articulator to reproduce lateral excursions and design a functional occlusal surface. We will take the resultant occlusal surface from this approach and compare it with a conventional method. We developed a novel CAD/CAM system which can render a functional occlusal surface, via a VR articulator. The marginal fit and occlusion in our CAD/CAM crown was sufficient to apply to the clinic.

Shintaro Kasama

Effects of Metal Artifact for 3D Reconstructed Dentition Model

This study reviews a four-dimensional analysis system for mandibular movement that is part of our clinical practice. The presence of metal artifacts often distort the accuracy of the images captured for analysis. In this study, we evaluated the extent metal artifacts can distort the imaging, and utilized an approach that could return the captured images into a more insightful form. The VR contact areas in absent and moderate restorated Skulls show a close similarity to the 200 m thickness adjacent to the occlusal contacts. On the other hand, the result of large restorated Skull turned out to be different.

Annette Runge

Classification of Functional EMG-Signals of the Facial Nerve

The goal of this work is to apply functional data of the facial nerve through analyzing intraoperative EMG–signals. Thus, developing a classification scheme for the nerve’s action potentials is necessary. Free-running EMG signals were recorded in muscles targeted by the facial nerve and analyzed with different parameters. Due to significant differences in the analyzed parameters it is possible to develop a classification scheme with different classes for EMG monitoring signals of the facial nerve.

Qiang Meng

CvhSlicer: An Interactive Cross-Sectional Anatomy Navigation System Based on High-Resolution Chinese Visible Human Data

We introduce the design and implementation of an interactive system for the navigation of cross-sectional anatomy based on Chinese Visible Human (CVH) data, named CvhSlicer. This system is featured in real-time computation and rendering of high-resolution anatomical images on standard personal computers (PCs) equipped with commodity Graphics Processing Units (GPUs). To allow the whole-body dataset to be loaded into the memory of a common PC, several processing steps are first applied to compress the huge CVH data, without compromising anatomical details. Thereafter, an adaptive CPU-GPU balancing scheme is performed to dynamically assign rendering tasks to CPU and GPU based on parameters of computing resources. Experimental results demonstrate that our system can achieve real-time performance and has great potential to be used in anatomy education.

José Mosso Vázquez

Night Vision and Cybertherapy for Ambulatory Surgery

5 cases of ambulatory surgeries under total darkness and immersion were performed. Patients navigated through virtual reality scenarios in the intraoperative to reduce pain. Methodology. 2 wireless microcameras and goggles were used to facilitate performance of night-vision
surgeries. Results. 5 ambulatory surgeries were done under total darkness on humans. A right inguinal hernia repair and 4 big lipomas resections were performed without complications. Pain and anxiety was reduced considerably in the intraoperative period. Conclusions. Night vision is an alternative for cybertherapy to reduce pain and anxiety in ambulatory surgery.

José Mosso Vázquez

Transhiatal and Transdiaphragmatic Access for Thoracoscopy in NOTES and NOTUS

Objective. Transhiatal and transdiaphragmatic access to explore thorax is a possibility technique. Methodology. 2 left and 2 right thoracoscopies were done in 2 pigs of 5 Kg of weight. To penetrate abdominal cavity we used two ways, vagina and umbilical scar. The first access was to perforate esophagus membrane of hiatus and to explore left thorax and the second way was to perforate right diaphragm to explore right thorax. Results. Transhiatal access was the easily method to explore left thorax compared with transdiaphragmatic access to explore right thorax. Umbilical scar access was easily to introduce endoscope in abdominal cavity compared with vaginal access. Conclusions. Transhiatal and transdiaphragmatic access to explore thorax have been demonstrated on pigs. We must consider a proper management of intrathoracic pressure for future work. The contribution of the present project is to demonstrate a surgical technique proposing a new route to explorer thorax with conventional endoscopic pediatric equipment aided with laparoscopy.

Carl Nelson

Multifunction Robotic Platform for Natural Orifice Surgery

A new robotic platform for natural orifice surgery is described. The robot is designed to carry multiple tool tips in a single end-effector arm. Design and experimental validation are presented. Although the design is still being improved, results suggest that the new robotic tool will enable dexterous abdominal surgery with improved force transmission capability.

Takumi Ogawa

Virtual Reality Image Applications for Treatment Planning in Prosthodontic Dentistry

For successful occlusal reconstruction, the prosthodontists must take several points into consideration, such as those involving issues with functional and morphological findings and aesthetics. They then must unify this information into a coherent treatment plan. In this present study we focused on prosthodontic treatment and investigated how treatment planning and simulation could be applied to two cases. The personal occlusion condition can be reproduced on the virtual articulator in VR space. In addition, various simulations can be performed that involve prosthesis design

Peter Kazanzides

AISLE: An Automatic Volumetric Segmentation Method for the Study of Lung Allometry

We developed a fully automatic segmentation method for the volumetric CT (computer tomography) datasets used in the study of allometric relationships of the lung to assess the effects of blast injury. The proposed segmentation method, AISLE (Automated ITK-Snap based on Level-set), is based on the level-set implementation from an existing semi-automatic segmentation program, ITK-Snap. AISLE can segment the lung field without human interaction and provide intermediate graphical results as desired. The preliminary experimental results show that the proposed method can achieve accurate segmentation, in terms of volumetric overlap metric, by comparing with the ground-truth segmentation performed by a radiologist.

Stefan Suwelack

Web-Based Interactive Volume Rendering

In this paper we present a web-based remote visualization system. The system makes use of video stream based techniques to reduce the network bandwidth requirements and is capable of performing interactive volume rendering on computed tomography data in real-time. The technique allows embedding interactive volume rendering into a website. The concrete contribution of this paper is twofold. First, we outline a Microsoft Silverlight based implementation of the prototype and describe the applied video encoding techniques. Furthermore we present experimental results that allow evaluating the system in terms of latency and image quality. In particular, we show that the additional delay of stream based remote visualization is very small if compared to picture based techniques.

Priyamvada Tewari

Terahertz Imaging of Biological Tissues

A reflective THz imaging system sensitive to slight variations in water concentrations has been developed. Biological tissues have been imaged to test the feasibility of
the imaging system. Contrast is seen in THz images between diseased and normal regions most probably due to differences in water contents. The results obtained are in accordance with previous published reports suggesting that the imaging system has the potential for in vivo medical imaging.

Geoffrey Tien

**Quantifying Surgeons' Vigilance during Laparoscopic Operations Using Eyegaze Tracking**

The vigilance of surgeons while operating is an important consideration for patient safety. Using a lightweight mobile eyegaze tracker, we can objectively observe and quantify a surgeon's vigilance measured as the frequency and duration of time spent gazing at an anaesthesia monitor displaying various patient vital signs. Expert surgeons and training surgical residents had their eyegaze recorded while performing a mock partial cholecystectomy on a computer simulator. Results show that experts glanced at the patient vital signs more than the residents, indicating at higher level of surgical vigilance.

Yasushi Yamazaki

**Clinical Performance of Dental Fiberscope Image Guided System for Endodontic Treatment**

We developed a dental fiberscope that can be navigated. As a result we are able to better grasp the device position relative to the teeth, aiming at the lesion more precisely. However, the device position and the precise target setting were difficult to consistently ascertain. The aim of this study is to navigate the position of tip of the dental fiberscope fiber in the root canal with our navigation system. A 3D tooth model was made from the raw dental CT data. In addition, the optical position of the measurement device, OPTOTRAK system was used for registration of the 3D model and actual teeth position and to chase the scope movement. We developed exclusive software to unify information. We were subsequently able to precisely indicate the relation of the position between the device and the teeth on the 3D model in the monitor.

**SIMULATOR DESIGN & DEVELOPMENT - PART 1**

Devin Berg

**Low-Cost, Take-Home, Beating Heart Simulator for Health-Care Education**

Intended for medical students studying the evaluation and diagnosis of heart arrhythmias, the beating heart arrhythmia simulator combines visual, auditory, and tactile stimuli to enhance the student's retention of the subtle differences between various conditions of the heart necessary for diagnosis. Unlike existing heart arrhythmia simulators, our simulator is low cost and easily deployable in the classroom setting. A design consisting of solenoid actuators, a silicon heart model, and a graphical user interface has been developed and prototyped. Future design development and conceptual validation is necessary prior to deployment.

Nathan Delson

**Design of a Parametrically Adjustable Intubation Mannequin**

A parametrically adjustable medical mannequin was built for the facilitated instruction of endotracheal intubation. This mannequin has adjustable anatomy so that it could act as a superior teaching aid by providing variations in configurations not present in other mannequins. The primary adjustable features included the upper teeth, the lower jaw, and a replaceable spine. In addition, the trajectory of the trainee is measured with 3D motion and force sensors. An LCD screen is mounted on the face of the mannequin to provide real-time guidance. The mannequin was evaluated by 3 experts and used in training by 20 residents.

Roy Eagleson

**Medical Education through Virtual Worlds: The HLTHSIM Project**

VR-based training tools are becoming more popular and cost-effective to develop, but are difficult to evaluate objectively. There are a wide range of training scenarios that can be scripted, from high level simulations of emergency response using avatars, to low-level skills-based trainers where surgeons can practise sensorimotor skills such as suturing and cutting. We propose a framework whereby these simulators to be tools that serve a dual role for both training and evaluation at each of these levels of abstraction. We have created a set of scenarios and case studies as VR situations, and have articulated a framework whereby objective measures involving task time and error rates can be formal-
ized at the lower levels, and related subjective and objective measures can be identified at the top. Our framework is implemented under the auspices of a recently funded New Media project in Canada (GRAND NCE) that spans two health training and simulation facilities (CSTAR and HSERC).

Philipp Fischer

VoTeKK - Preparation for Terrorist Attacks, Crises and Disasters: Web-Based Interdisciplinary Information and Training Platform to Prepare Security and Rescue Forces, Medical Personnel and the General Population for Large-Scale Emergencies

Motivation: Germany’s security, rescue forces and its general population suffer from scientifically proven deficits in handling Mass Casualty Incidents. Scenario: E-learning and virtual reality modules based on scenarios will be offered to target groups via the Internet on an individualised basis. Project description and goals: The aim of this project is to develop a platform to prepare security and rescue forces, doctors, caregivers and the general population for terrorist attacks, crises and disasters. A broad spectrum of web-based learning forms will be developed as models and tested. Innovations and applications: Modern teaching methods and computer-based simulations mentioned here are excellent tools to help train people efficiently to respond to events that cannot be planned, such as terrorist attacks and other catastrophes.

Leif Hedman

Medical Students’ Self-Efficacy Increases by Training Diagnosis and Treatment of Cervical Spine Trauma using a New Educational Program for Visualization through Imaging and Simulation

This study describes a refined approach for usability evaluation of medical students’ experiences of a new software for training diagnosis and treatment of patients with cervical spine trauma (VISed). 16 highly motivated Swedish medical students (24.5 years) participated. We examined whether students were positive or not to the training session, the user interface and if they became more self-confident after training. The evaluation included heuristic evaluation, and self-assessments of the students’ perceived self-efficacy before and after training. Students found the training as well as the user interface as positive but not satisfactory. Their self-efficacy was unchanged.

Madelen Fahlstedt

Visualization through Imaging and Simulation (VIS) - A New Program for Medical Students and Personnel for Treatment of Trauma Patients

This paper presents the new program developed within the project Visualization through Imaging and Simulation (VIS) that visualizes the biomechanical trauma responses of the human head and neck. This is thought to improve the knowledge of medical students and personnel in injury mechanism of trauma patients. The project will generate 2 programs; a web-based program with an atlas of generic accident situations for reference while encountering trauma patients and an educational program with real accident reconstructions of pedagogical interest for medical students. The programs are called VISweb and VISed, respectively. The project is in progress but the programs have received positive response by the reference group of physicians and a test group consisted of medical students.

Vassilios Hurmusiadis

Validated Real-time Simulation of Electrophysiology for ECG Training

The Electrocardiogram (ECG) is a static 2D graphical representation of the heart’s complex, dynamic 4-dimensional electrical function. The work focuses on presenting the dynamic electrical events of the heart in synchronization with simulated normal and pathological ECG’s. The aim is to create a direct visual link between pathology and ECG (“cause” and “effect”). Validated simulations of normal rhythm, left/right bundle branch blocks and Wolf-Parkinson-White syndrome with accessory pathways have been implemented. We have created a novel training method based on real-time simulation of electrocardiography using interactive 3D computer graphics. The end application enables interaction with a virtual heart and generates validated 12-lead ECG tracings.

Nigel John

A Model for Flexible Tools used in Minimally Invasive Medical Virtual Environments

A virtual environment can be defined as a collection of technologies that allow people to interact efficiently with 3D data in real time using their natural senses and skills. Within the limits of current technology, many applications of a virtual environment will trade-off accuracy for speed. This is not an acceptable compromise in a medical application, e.g. for training a medical procedure, where both accuracy and real time response are essential. Efficient algorithms must therefore be developed. The purpose of this project is the development
and validation of a novel physics-based real time tool manipulation model, which is easy to integrate into any medical virtual environment that requires support for the insertion of long flexible tools into complex geometries. This encompasses medical specialties such as vascular interventional radiology, endoscopy, and laparoscopy, where training, prototyping of new instruments/tools and mission rehearsal can all be facilitated by using an immersive medical virtual environment. These environments often include a haptic force feedback simulation of tool manipulation such as catheter insertion using patient specific data. Our model recognizes and uses accurately this data and adapts to the geometrical complexity of the vessel in real time.

Abby Kaye

Expanding the Use of Simulators as Assessment Tools: The New Pop Quiz

This study introduces a novel way to implement simulation in medical education. We investigated the feasibility of using a newly developed breast examination simulator to facilitate a breast lecture while also collecting detailed data on medical students' breast exam skills. Local faculty modified their lectures to accommodate simulator use in the classroom. A lecture, followed by students' simulator examination and subsequent clinician demonstration and discussion of findings at each simulator, were all completed within the time allowed for a traditional clerkship lecture. Results indicate that it is feasible to integrate simulation technology into the classroom environment and collect detailed performance data that can be analyzed and used for skills assessment.

Thomas Knott

Practical Methods for Designing Medical Training Simulators

We reviewed several approaches in literature used in the design process of medical training simulators. We have collected a set of useful practical methods which should help to efficiently derive a well-founded design for a specific surgical intervention in a structured manner.

Bertalan Meskó

Online Virtual Environments, Curated Content and Digital Literacy in Medical Education

Online literacy is becoming crucial in medical education as the number of e-patients and medical websites are exponentially growing. There is also a huge amount of medicine-related content in social media. Examples include Facebook, community sites, video channels, Twitter accounts, blogs and slideshows, among others and it is becoming increasingly difficult to find relevant and reliable resources. In order to investigate whether the online literacy of medical students can be improved in the medical curriculum, we launched the first university elective credit course at the University of Debrecen, Medical School and Health Science Center focusing on how medical students can and should use the world wide web. The course consisted of 20 lectures in 10 occasions covering medical blogs, the advantages and disadvantages of using Facebook or Wikipedia, virtual worlds and mobile applications, among others. The material was made available online [3], 115 students completed the course and filled a survey before and after. The surveys aimed to determine how their attitude and knowledge of web 2.0 and medicine changed during the education. Paired and unpaired Student’s T-test were used for statistical analysis in GraphPad Prism 5.0. According to the survey results, such a course in the structure of the basic medical curriculum can improve the knowledge of medical students about the world wide web in terms of medicine and healthcare and might help them meet the expectations of e-patients.

Robert Metzler

Pressure Mapping as a Tool to Optimize Efficacy of Fundal Massage

The fundal massage has been proven effective to contract the uterus, preventing maternal death by postpartum hemorrhage (PPH). Using pressure mapping to physiologically evaluate the uterus during the fundal massage provides novel data used to evaluate the current fundal massage technique’s efficacy. Pressure mapping has beneficial applications in many industries. This technique is used to determine risk factors for pressure ulcers in long term care populations, in analyzing sleep studies, and in determining tire tread patterns. These measurements could provide the basis for a fundal massage simulator in the future. Pressure mapping allows for a standard fundal massage to be established in the education of new healthcare practitioners. Through this evaluation, potential alternative methods for fundal massage may be generated in order to increase efficacy.

Caroline Needham

Virtual Haptic Dissection

This project aims to create a three-dimensional digital model of the hand and wrist which can be virtually ‘dissected’ through a haptic interface. Tissue properties will be added to the various anatomical structures to replicate a realistic look and feel. The project will explore the role of the medical artist and investigate the cross-discipline collaborations required in the field of virtual anatomy. The software will be used to train anatomy
students in dissection skills before experience on a real cadaver. The effectiveness of the software will be evaluated and assessed both quantitatively as well as qualitatively.

Jonathan Salud

Are Commercially Available Simulators Durable Enough for Classroom Use?

While mannequin-based simulations are effective modalities for hands-on medical training, the technology requires expensive and time-consuming maintenance [1]. There are numerous mannequins designed for simulation and classroom training, but several of them do not feel realistic or are not built to withstand regular use in the classroom. In an effort to improve realism and durability we modified a commercially available diagnostic prostate trainer.

Giuseppe Riva

NeuroVR 2 - A Free Virtual Reality Platform for the Assessment and Treatment in Behavioral Health Care

At MMVR 2007 we presented NeuroVR (http://www.neurovr.org) a free virtual reality platform based on open-source software. The software allows non-expert users to adapt the content of 14 pre-designed virtual environments to the specific needs of the clinical or experimental setting. Following the feedbacks of the 2000 users who downloaded the first versions (1 and 1.5), we developed a new version – NeuroVR 2 (http://www.neurovr2.org) – that improves the possibility for the therapist to enhance the patient’s feeling of familiaryness and intimacy with the virtual scene, by using external sounds, photos or videos. More, when running a simulation, the system offers a set of standard features that contribute to increase the realism of the simulated scene. These include collision detection to control movements in the environment, realistic walk-style motion, advanced lighting techniques for enhanced image quality, and streaming of video textures using alpha channel for transparency.

Joseph Samosky

Toward a Comprehensive Hybrid Physical-Virtual Reality Simulator of Peripheral Anesthesia with Ultrasound and Neurostimulator Guidance

We are developing a simulator of peripheral nerve block utilizing a mixed-reality approach: the combination of a physical model, an MRI-derived virtual model, mechatronics and spatial tracking. Our design uses tangible (physical) interfaces to simulate surface anatomy, haptic feedback during needle insertion, mechatronic display of muscle twitch corresponding to the specific nerve stimulated, and visual and haptic feedback for the injection syringe. The twitch response is calculated incorporating the sensed output of a real neurostimulator. The virtual model is isomorphic with the physical model and is derived from segmented MRI data. This model provides the subsurface anatomy and, combined with electromagnetic tracking of a sham ultrasound probe and a standard nerve block needle, supports simulated ultrasound display and measurement of needle location and proximity to nerves and vessels. The needle tracking and virtual model also support objective performance metrics of needle targeting technique.

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Robert Sweet

The Minnesota Pelvic Trainer: A Hybrid VR/Physical Pelvis for Providing Virtual Mentorship

Obtaining accurate understanding of three dimensional structures and their relationships is important in learning human anatomy. To leverage the learning advantages of using both physical and virtual models, we built a hybrid platform consisting of virtual and mannequin pelvis, motion tracking interface, anatomy and pathology knowledge base. The virtual mentorship concept is to allow learners to conveniently manipulate and explore the virtual pelvic structures through the mannequin model and VR interface, and practice on anatomy identification tasks and pathology quizzes more intuitively and interactively than in a traditional self-study classroom, and to reduce the demands of access to dissection lab or wet lab.

Dave Taylor

Single and Multi-User Virtual Patient Design in the Virtual World

This research addresses the need for the flexible creation of immersive clinical training simulations for multiple interacting participants and virtual patients by using scalable open source virtual world technologies. Initial development of single-user surgical virtual patients has been followed by that of multi-user multiple casualties in a field environment and an acute hospital emergency department. The authors aim to validate and extend their reproducible framework for eventual application of virtual worlds to whole hospital major incident response simulation and to multi-agency, pan-geographic mass casualty exercises.

Sebastian Ullrich

Dissecting in Silico: Towards a Taxonomy for Medical Simulators

In this paper we investigated several approaches in literature that classify different aspects of medical simulators. We have merged these definitions to form a structured taxonomy. This new taxonomy should facilitate the design of new medical simulators and allow to analyze and classify existing simulators, algorithms, toolkits and hardware.

Anant Vemuri

A Cost Effective Simulator for Education of Ultrasound Image Interpretation and Probe Manipulation

Ultrasoundography is the lowest cost no risk medical imaging technique. It provides a quick way to gather information on patient’s anatomical and pathological structures. However, reading an ultrasonographic (US) image as well as performing a good US probe positioning remain difficult tasks. Education in this domain is today performed on patients, thus limiting it to the most common cases and clinical practice. In this paper, we present a cost effective simulator that allows US image practice and realistic probe manipulation on patient CT. More precisely, we tackle in this paper the issue of providing a cost effective realistic interface for the probe manipulation with a basic haptic feedback. We firstly explain how we can robustly track with a web camera the position of a fake US probe held by the user. Secondly, we propose a very simple approach using either a foam phantom or a cardboard box to provide haptic feedback when manipulating the probe. We finally show that a novice user can easily and quickly perform all the necessary calibration procedures and efficiently practice on our simulator.

Yoshinori Yoshida

Virtual Human Reaction for Haptic Dental Training System

Human reaction as a new function in dental training simulators is important to bridge the gap between a clinical site and a student site with conventional simulation training at a dental school. One of the reasons is no human reaction in conventional dental mannequin. In the present study, we implemented virtual human reactions such as bleeding and face expressions (anxious and painful) in our haptic dental training system.

Mary Barak-Bernhagen

Validation of a Virtual Preoperative Evaluation Clinic: A Pilot Study

Patients scheduled for surgery at the Omaha VA Medical Center were evaluated preoperatively via telemedicine. Following their examination, the patients completed a questionnaire defining their perception of the virtual preoperative evaluation. These evaluations were overseen by a staff anesthesiologist and performed under the scope of nationally recognized guidelines and recommendations of experts in the field of perioperative medicine. The majority of the patients had a positive
perception of the virtual preoperative exam, showing that effective preoperative evaluation can be performed via telemedicine. The patients were receptive to the video teleconferencing (VTC) format and, in the majority of cases, preferred it to face-to-face evaluation.

Jennifer Hemstreet

The Initiation of a Preoperative and Postoperative Telemedicine Urology Clinic

This work describes the establishment of a Telemedicine Urology Clinic at the VA Medical Center in Omaha, Nebraska to serve an underserved veteran population in rural Nebraska. Results from patient satisfaction surveys show that both the patient and the healthcare provider benefit from the telemedicine encounter for both the preoperative and the postoperative setting.

Gail Kuper

The Combined Use of Skype™ and the STORZ CMAC™ Video Laryngoscope in Field Intubation Training with the Nebraska National Air Guard

This study examined the teaching value of using Skype™ in basic manikin intubation instruction of Nebraska National Air Guard personnel at a Casualty Training Exercise. Results show that the Skype™ monitor provided clear sound and visualization of the airway view to the trainees and the combination of VoIP technology and videolaryngoscopy for intubation training was highly valued by the study participants.

Christophe Laurent

Using the Web as Interface for the Use of Personally Controlled Health Records to Potentiate Patient Participation in Preemptive Disaster Management during Mass Gatherings

As scientists and users of technology, we have an obligation to use whatever means we can to safeguard the life and safety of our fellow men. During Mass Gatherings, measures are taken to adequately look after the public in case of an adverse event or even a calamity. Mass Gatherings are especially prone to disasters and terrorist activity. Recent evolution in the use of Web 2.0 technologies has successfully stimulated Participatory and Collaborative Medicine. And as Society is becoming more open to medical collaboration, we have enabled the public to participate in their potential rescue, by allowing them to contribute through a Web 2.0 interface. Combined with RFID technology, the contribution of the participants offer a never before experienced source of information in case of need.

Shuping Liu

Machine Learning based Automatic Patient Monitoring and Prioritizing using Body Sensor Network Systems

Tiny and inexpensive sensors are being increasingly used in a wide range of real world applications. In this short paper, we consider a machine learning based body area sensor network system, which aims for automatic patient monitoring and prioritizing, especially for monitoring large number of patients. The proposed approach can reduce physician’s labor cost and human error, and increase the efficiency in a hospital. We present our current work in progress.

Nikola Miljkovic

Telemedicine Using Free Voice over Internet Protocol (VoIP) Technology

The purpose of this study was to analyze the feasibility of using commercially available VoIP technology to provide telemedical mentoring and telemedicine. Providing airway management training does not require high-dollar VTC equipment. Although image quality is less than that of expensive VTC equipment, it is more cost effective and can be used over long distances. Also with commercially available technology to provide video and audio, it is adequate to teach and perform intubations.

Onur Mudanyali

Light-Weight and Cost-Effective Lensfree Microscopy for Wireless Health Applications

We introduce a new telemedicine-microscopy platform which operates based on lensfree digital holography. It utilizes an incoherent light-source and an opto-electronic sensor-array to record lensfree holograms of micro-objects within a sample, which are then rapidly processed using custom-developed algorithms to provide microscopic images of the sample without any lenses, lasers or other bulky optical/mechanical components. This holographic-microscope achieves sub-cellular resolution (~1.5-2.0µm) over a field-of-view of ~24mm² which is >20 fold larger than a typical 10X objective-lens field-of-view. We implemented this lensfree microscopy platform on a compact stand-alone unit (~46grams with dimensions of ~4.2x4.2x5.8cm) as well as on a commercially-available cell-phone which is modified with a light-weight attachment (~38grams). The imaging performance of these lensfree telemedicine-microscopes is demonstrated using several micro-objects including blood-cells and waterborne parasites.
Hector Parra

Telios: Bridging Telehomecare and the Home Media Center

We present a low-cost Web 2.0-based home media center that implements teleconsulting and remote health monitoring alongside traditional television programming and movie viewing. The flexibility and standards of Web 2.0 may make it possible for telehomecare and multimedia to merge and produce novel applications in chronic disease management and preventative healthcare.

Robert Walker

Virtual Training to Support Insertion of Advanced Technology at Remote Military Locations

Effective training in advanced medical technologies is essential for military healthcare providers to support the far forward battlefield. The use of modern video communication technologies and novel medical devices can be utilized for meeting this challenge. This study demonstrates the combined use of video conferencing equipment and videolaryngoscopy in the virtual training of a novice in videolaryngoscopy, nasal intubation and airway foreign body removal.

FRIDAY MORNING PLENARY SESSION

Kirby Vosburgh

It Looks Cool; Does it Work?

“Can you give me Avatar in my OR?” one of my colleagues asked. Of course, he would love the nifty displays, but very quickly he would expect that virtual world to represent the real situation, so that his interventions are both appropriate and effective—that is, that the Virtual Reality “works.” That’s a tough goal, but we are making progress. At every step, we are learning how to relate things we can measure to what a caregiver actually does, and support their performing more competently and confidently. This presentation will describe several ways caregivers and developers can work together most effectively to ensure our new care environments have the Virtue of Reality.

Dave Warner

Retoxing on the Elixir of Cyber-Madness—Let the Paradigm Shifts Begin Again...

In the beginning, MMVR allowed the intoxicating excitement of the preweb cyber culture to be driven into the fields of medical science. The emerging accessibility of an extraordinary array of human interface technologies was being pulled into a field that so desperately needed them. This access brought together a wide range of diverse cultures, academic disciplines, and professional societies into a common discussion that sustains itself here today.

In the early days, MMVR gave a platform to the “lingua futura” of the day and encouraged /fostered an ongoing open discussion of cross-disciplinary possibilities that were once excluded from within established disciplines. Paradigms were shifting. Technologies were changing the way we perceive and interact with knowledge, information and data.

The past was dark. Participants of early emerging organizations such as MMVR were at risk of grave professional disregard and often were openly ridiculed for their folly. Yet we persisted. Why did we do it if it was at our professional peril? Because we believed—because we had experienced “first mind” for ourselves—that new things were not only possible, they were inevitable and it was now just a matter of time before the paradigms shifted enough to make the spectacular the norm. We were intoxicated with a sort of cyber madness that comes when edge seekers encounter new capabilities and those new capabilities enable new tools to emerge allowing motivated humans to fundamentally and continually change the ways of the future.

Having the power to change things is addictive. Tools forged in this cyber madness are changing the way we communicate our experience with others. A new multi-participant co-experiential interaction distributed across space and time now exists.

We are here again. Since the early days when MMVR first began, the internet became the web, and the web became a global resource enabling unimagined worlds of new commerce and new modes of communications, thus allowing for the emergence whole new clouds of resources and crowds of social interaction.

Let us begin Retoxing on the Elixir of Cyber-Madness—Let the Paradigm Shifts Begin Again!

JoAnn Kuchera-Morin

Immersed in Unfolding Complex Systems: Multi-Sensory Computing in the AlloSphere, One of the Largest Immersive Instruments in the World for New Scientific Discovery

In this information-rich age, where voluminous amounts of scientific data are being generated at ever increasing rates from specialized biological instruments and supercomputer simulations, how does one represent and transform this complex information with intuitive precision and control? Can one use all one’s senses while working with information technology systems that are interactively displaying tremendous amounts of informa-
tion in real-time, and move seamlessly from data to knowledge?

For many years, a team of interdisciplinary researchers - media artists, scientists, and engineers - at the University of California, Santa Barbara has developed a new approach to working with multidimensional scientific and mathematical data, intuitively using all the senses. This is leading to a computational framework based on the creative process, developed for one of the largest immersive instruments in the world for scientific visualization and artistic creation: the AlloSphere, a three-story metal sphere in an echo-free chamber. In this talk I will discuss how my work as a composer has led to the creation and design of the AlloSphere instrument, making total immersion in complex spatial and time varying data a reality.

Alessandro Marianantoni

MNEMONIC SPACES: Responsive Places for Art, Culture and Healthcare; RFID Technology and Memory Disorders

Alessandro Marianantoni works at the intersection of technology and art; his work has been exhibited internationally. This lecture presents Mnemonic Spaces a series of installation projects loosely inspired by the extensive works of Giordano Bruno on mnemonic techniques and principles based on images called Art of Memory. He claimed it is possible to improve the memory using particularly meaningful images and using them to create equally vivid relationships. The projects want to establish an interactive place connecting the people and the installation system and the people among themselves. This series of works on memory has led to developing an interactive system that aims to support patients with Alzheimer's disease through the organization and the representation of digital personal memories.

FRIDAY AFTERNOON - SESSION A

SIMULATOR DEVELOPMENT

Sayra Cristancho

Progressive Simulation-Based Program for Training Cardiac Surgery-Related Skills

Off Pump Coronary Artery Bypass (OPCAB) surgery is a strategy for revascularizing diseased coronary arteries without cardiopulmonary bypass. The complete operation can be deconstructed into individual tasks and sub-tasks that are ideal for creating simulation modules. Recently, we have developed a modular mechanical beating-heart OPCAB simulator for use in learner-centered training. In the present study, we describe the design of a progressive, simulation-augmented training program for OPCAB surgery. In particular, we a) define need-driven education and training goals, b) create simulation scenarios with progressive difficulty to specifically address these goals, and c) design corresponding assessment tools for both formative and summative purposes.

Andrea Moglia

Patient Specific Surgical Simulator for the Evaluation of the Movability of Bimanual Robotic Arms

This work presents a simulator based on patient specific data for bimanual surgical robots. Given a bimanual robot with a particular geometry and kinematics, and a patient specific virtual anatomy, the aim of this simulator was to evaluate if a dexterous movability was obtainable to avoid collisions with the surrounding virtual anatomy in order to prevent potential damages to the tissues during the real surgical procedure. In addition, it could help surgeons to find the optimal positioning of the robot before entering the operative room. This application was tested using a haptic device to reproduce the interactions of the robot with deformable organs. The results showed good performances in terms of frame rate for the graphic, haptic, and dynamic processes.

Florian Beier

NeuroSim - The Prototype of a Neurosurgical Training Simulator

We present NeuroSim, the prototype of a training simulator for open surgical interventions on the human brain. The simulator is based on virtual reality and uses real-time tissue algorithms to interact with models generated from MRT- or CT-datasets. NeuroSim provides a native interface by using a real surgical microscope and original instruments tracked by a combination of inertial measurement units and optical tracking. Conclusively an immersive environment is generated. In a first step the navigation in an open surgery setup as well as the hand-eye coordination through a microscope can be trained. Due to its modular design further training modules and extensions can be integrated. NeuroSim has been developed in cooperation with the neurosurgical clinic of the University of Heidelberg and the VRmagic GmbH in Mannheim.
Sonny Chan

**A Virtual Surgical Environment for Rehearsal of Tympanomastoidectomy**

This article presents a virtual surgical environment whose purpose is to assist the surgeon in preparation for individual cases. The system constructs interactive anatomical models from patient-specific, multi-modal preoperative image data, and incorporates new methods for visually and haptically rendering the volumetric data. Evaluation of the system’s ability to replicate temporal bone dissections for tympanomastoidectomy, using intraoperative video of the same patients as guides, showed strong correlations between virtual and intraoperative anatomy. The result is a portable and cost-effective tool that may prove highly beneficial for the purposes of surgical planning and rehearsal.

Sangkyun Shin

**3D Tracking of Surgical Instruments Using a Single Camera for Laparoscopic Surgery Simulation**

Most laparoscopic surgery simulation systems are expensive and complex. To overcome these problems, this study presents a novel three-dimensional tracking method for laparoscopic surgical instruments that uses only a single camera and fiducial markers. The proposed method does not require any mechanical parts to measure the three-dimensional positions/orientations of surgical instruments and the opening angle of graspers. We implemented simple and cost-effective hardware using the proposed method and successfully combined it with virtual simulation software for laparoscopic surgery.

Brian Allen

**Visual Tracking of Laparoscopic Instruments in Standard Training Environments**

We propose a method for accurately tracking the spatial motion of standard laparoscopic instruments from video. By exploiting the geometric and pho-tometric invariants common to standard FLS training boxes, we achieve robust and accurate tracking of instruments from unmodified video feeds of training tasks. The proposed method requires no modifications to the FLS training box, camera or instruments, and provides robust and accurate 2D tracking of instrument motions, which is then extended to full 3D tracking with a geometric construction.

Asaki Hattori

**Development of Training System for Endoscopic Surgical Robot System for Abdominal Surgery**

Our research group is developing endoscopic surgical robot system for abdominal surgery. We are also simultaneously developing a training system for the robot system. A new training system is essential for the operator to adapt to the robot system because the operator will need to acquire new operational methods for the robot system that is significantly different from the current abdominal endoscopic operation. We have built the same operational environment as in the real case in virtual reality and in this created environment, the operator is able to train himself using a robot simulator that has the same functions as the real robot system. In addition, we have created the robot's function in the training system so that it will be updated according to the improvements in the real robot system. We have also mounted development simulation functions in the training robot system to find out what can be improved in the real robot. The training system basically has the following functions. In building an operational environment in virtually reality space, we used organ models that can change shape in real time. When forceps shaped manipulator like the ones used by the real operation robot system grab and lift up soft tissue or dissection is conducted by a needle knife, we were able to have the organ model change shape as in a real operation. Using this organ model, we were able to conduct gastric mucosa excision, which was one of the aims in adapting the operation robot in development. In this report, we describe how it was developed and its results.

Yunhe Shen

**Laser Surgery Simulation Platform: Toward Full-Procedure Training and Rehearsal for Benign Prostatic Hyperplasia (BPH) Therapy**

Recently, photo-selective vaporization of the prostate (PVP) has been a popular alternative to the standard electrocautery - transurethral resection of prostate (TURP). Here we introduce a new training system for practicing the laser therapy by using a virtual reality (VR) simulator. To interactively and realistically simulate this operation on a virtual organ with an order of a quarter million elements, a few novel and practical solutions have been applied to handle the challenges in modeling tissue ablation, contact/collision and deformation; endoscopic instruments tracking, haptic rendering and a web/database curriculum management module are integrated into the system. Over 40 board-certified urologists and surgical experts have been invited nationally and participated in the system verification.
Eric Savitsky

**Patient-Specific Cases for an Ultrasound Training Simulator**

We present a laptop-based ultrasound training simulator and a novel method for creation of patient-specific training datasets. The simulator consists of a laptop computer, a peripheral probe interface device with an embedded three-degree-of-freedom orientation sensor, a virtual US probe, a virtual patient model, a simulated US brightness scan (B-scan). Simulated B-scans are rendered from US volumes, which are synthesized using volume reconstruction methods from two-dimensional US imagery captured in a data acquisition stage from clinical patients. This methodology enables creation of patient-specific ultrasound simulation datasets for training purposes.

Jorg Peters

**Enabling Surgeons to Create Simulation-Based Teaching Modules**

To broaden the use of simulation for teaching, in particular of new procedures and of low-volume procedures, we propose an environment and workflow that lets surgeon-educators create the teaching modules. Our challenge is to make the simulation tools accessible, modifiable and sharable by users with moderate computer and VR experience. Our contribution is a workflow that promotes consistency between instructional material and measured criteria and makes the authoring process efficient, both for the surgeon, and for computer scientists supporting the simulation environment.

Tansel Halic

**A Software Framework for Multimodal Interactive Simulations (SoFMIS)**

The development of a multimodal interactive simulation is a very elaborate task due to the various complex software components involved, which run simultaneously at very high rates with maximum CPU load. In this work, we propose a multimodal parallel simulation framework called SoFMIS to create rapid interactive simulations such as surgical simulations. Our framework offers great flexibility and customization allowing simulation developers and researchers to concentrate on the simulation logic rather than component development.

TRAINING, ASSESSMENT & SIMULATOR VALIDATION

Sayra Cristancho

**The Validation of an Instrumented Simulator for the Assessment of Performance and Outcome of Knot Tying Skill: A Pilot Study**

We examined the construct validity of a surgical benchtop simulator with built-in computer acquired assessments. It features two parallel elastic tubes instrumented with flexion sensors simulating the walls of a wound. Participants from three groups (9 novices, 7 intermediates, 9 advanced) performed 10 two-handed, double square knots. The peak tensions at the initiation, the completion of the first knot, the completion of the second knot, and movement economy indicated measures of technical performance. Product quality was indicated by knot stability defined as the amount of slippage of the knot under the tension. There were significant differences between advanced and novices for peak tension on first knot (p=.03), movement economy (p=.02), and knot stability (p=.002). The results support the construct validity of these objective measures.

Erik Lövquist

**VR-Based Training and Assessment in Ultrasound-Guided Regional Anesthesia: From Error Analysis to System Design**

If VR-based medical training and assessment is to improve patient care and safety (i.e. a genuine health gain), it has to be based on clinically relevant measurement of performance. Metrics on errors are particularly useful for capturing and correcting undesired behaviors before they occur in the operating room. However, translating clinically relevant metrics and errors into meaningful system design is a challenging process. This paper discusses how an existing task and error analysis was translated into the system design of a VR-based training and assessment environment for Ultrasound Guided Regional Anesthesia (UGRA).

Imad Awad

**Acquisition of Technical Skills in Ultrasound-Guided Regional Anesthesia Using a High-Fidelity Simulator**

Despite the increasing popularity of ultrasound-guided regional anesthesia (UGRA), structured training programs during residency are often lacking. The lack of a regional block area, lack of expertise, and lack of structured training programs have limited hands-on experience in residency programs. However, these constraints may be cir-
cumvented through the use of simulation. This observational study looked at the use of a high-fidelity simulator for training novice undergraduate students UGRA techniques. Despite some improvement in the second trial with the simulator, the ability to maintain visualization of their needle (p<0.05), align needle with probe (p<0.05), and angle their needle approach (p<0.05), as well as reduce needle passes (p<0.05) did not improve. The results show students had difficulty learning skills requiring more coordination and fine motor control.

Adam Dubrowski

**Bench Model Surgical Skill Training Improves Novice Ability to Multitask: A Randomized Controlled Study**

Skills training in simulation laboratories is becoming increasingly common. However, the educational benefit of these laboratories remains unclear. This study examined whether such training enables better performance on the simultaneous execution of technical skill and knowledge retention. Twenty-four novice trainees completed the elliptical excision on baseline testing. Following baseline testing twelve of the novices completed a technical practice (simulation training group) session, while the other twelve did not (control group). One week later, all participants returned for dual-task follow up testing, in which they performed the excision while listening to a didactic lesson on the staging and treatment of cutaneous melanoma. The dual-tasking during the post test was standardized, where excision sutures 3 and 5 were performed alone (single), and sutures 4 and 6 were performed concurrently with the didactic lecture (dual). Seven additional trainees also participated as controls that were randomized to listen to the didactic lesson alone (knowledge retention group). Knowledge retention was assessed by a multiple choice questionnaire (MCQ). Technical performance was evaluated with computer and expert-based measures. Time to complete the performance improved among both groups completing the elliptical excision on follow-up testing (p < 0.01). The simulation training group demonstrated superior hand motion performance on simultaneous didactic lesson testing (p < 0.01). Novices from the no-training group performed statistically worse while suturing concurrently with the didactic lesson (p < 0.01). The pre-training of novices in surgical skills laboratories leads to improved technical performance during periods of increased attentional demands.

Lawrence Salud

**Toward a Simulation and Assessment Method for the Practice of Camera-Guided Rigid Bronchoscopy**

We have developed a way to measure performance during a camera-guided rigid bronchoscopy using manikin-based simulation. In an effort to measure contact pressures within the airway during a rigid bronchoscopy, we instrumented pressure sensors in a commercially available bronchoscopy task trainer. Participants were divided into two groups based on self-reported levels of expertise: novice (None to Minimal) and experts (Moderate to Extensive experience in rigid bronchoscopy). Results show there were no significant differences between experts and novices in the time taken to complete the rigid bronchoscopy. However, the number of areas touched was higher on average for the novices than for the experts showing that novices induce a higher number of unnecessary soft-tissue collisions compared to experts. Moreover, our results also show that experts exert significantly less soft tissue pressure compared to novices.

Bin Zheng

**Maintaining Forward View of the Surgical Site for Best Endoscopic Practice**

Current endoscopic surgery performed through patients’ natural orifices (NOTES procedure) often require some degree of retroflexion of the operating system. This can cause a misalignment between the displayed image and the actual work plane, leading to performance difficulties. This study investigated the impact of retroflexion on task performance in a simulated environment. Surgeons were required to perform an aiming and pointing task under two experimental conditions: forward-view vs. retroflexed-view. Results showed that both expert and novice surgeons required significantly longer time for completing the task when the scope was retroflexed, compared to when the scope faced forwards. Results address the importance of careful selection of the surgical approach to avoid image retroflexion. Further analysis revealed that the novices were more vulnerable than experts to image distortion with the retroflexed view. This addresses the necessity for surgeons to go through extensive endoscopic training to overcome the visual-motor challenges before they can perform NOTES procedures safely and effectively.

**FRIDAY AFTERNOON – SESSION B**

**Does It Really Work? Validating New Surgical Techniques**

See schedule for description of this independently organized session.
PATIENT CARE & REHABILITATION

Christopher Wottawa

Applications of Tactile Feedback in Medicine

A tactile feedback system has been developed in order to provide augmentative sensory feedback for a number of medical applications. The key component to the system is a pneumatic balloon-based tactile display, which can be scaled and adapted for a variety of configurations. The system also features pneumatic and electronic control system components, a commercial force sensor modified to fit the desired application, and Bluetooth connectivity that together enable the transmission of pressure information from periphery or external sources to a user. To date, this technology has been successfully applied to medical robotics, minimally invasive surgery, and rehabilitation medicine.

Rahman Davoodi

MSMS Software for VR Simulations of Neural Prostheses and Patient Training and Rehabilitation

In the increasingly complex prosthetic limbs for upper extremity amputees, more mechanical degrees of freedom are combined with various neural commands to produce versatile human-like movements. Development, testing, and fitting of such neural prosthetic systems and training patients to control them effectively are complex processes that cannot be performed efficiently or safely by ad hoc and trial-and-error approaches. We have developed a software tool known as MSMS to enable researchers and engineers to simulate the movement of these neural prostheses and evaluate their performance before they are built and to train the patients in virtual simulation environments to operate their prostheses before receiving them. Further, MSMS facilitates development of interactive virtual reality applications for training, rehabilitation, and treatment of patients suffering from movement disorders.

Michael Zeher & Janid Blanco Kiely

Using A Virtual Integration Environment to Study Phantom Limb Pain

The Revolutionizing Prosthetics 2009 program conducted by the Defense Advanced Research Projects Agency (DARPA) has resulted in a Virtual Integration Environment (VIE) that provides a common development platform for researchers and clinicians that design, model and build prosthetic limbs and then integrate and test them with patients. One clinical need that arose during the VIE development was a feature to easily create and model animations that represent patient activities of daily living (ADLs) and simultaneously capture real-time surface EMG activity from the residual limb corresponding to the ADLs. An application of this feature is being made by the Walter Reed Military Amputee Research Program (MARP) where they are utilizing the VIE to investigate methods of reducing upper extremity amputee phantom limb pain (PLP).

Cynthia Sung

Comparison of Reaching Kinematics During Mirror and Parallel Robot-Assisted Movements

The use of robotic devices in rehabilitation allows therapists to administer the desired movement with the preferred level of assistance while expending minimum effort. Robotic devices have been used in recent years to enhance sensori-motor recovery of the impaired arm in persons with stroke. Despite recent recommendations for bimanual practice, robot-assisted bimanual activities are rarely explored and are limited to mirror image movements. We developed a novel parallel movement mode for the Mirror Image Movement Enabler robotic system and investigated trajectory error (TE) exhibited by healthy adults during parallel and mirror image motions to various target locations. TE values differed for parallel and mirror image motions and for certain target locations, suggesting the importance of considering these factors when developing robot-assisted bimanual activities.

Thomas Parsons

Virtual Reality Stroop Task for Neurocognitive Assessment

Given the prevalence of traumatic brain injury (TBI), and the fact that many mind TBIs (mTBIs) have no external marker of injury, there is a pressing need for innovative technology for initial assessment, treatment, and rehabilitation. The demand for enhanced TBI assessment and rehabilitative treatment has ushered in the use of automated neurocognitive testing for increased precision and efficiency and virtual environment technology for enhanced ecological validity and more functional-based assessment. To address these issues, a Virtual Reality Stroop Task (VRST) that involves the subject being immersed in a virtual Humvee as Stroop stimuli appear on the windshield was developed. This study was an initial validation of the VRST as a neurocognitive assessment of neurocognitive functioning. When compared to the Automated Neuropsychological Assessment Metrics, the VRST appears to have enhanced capacity for providing an indication of a participant’s reaction time and ability to inhibit a prepotent response while immersed in a military relevant simulation that present psychophysiological arousing high and low threat presentations.
Josef Stoll

**Mobile Three Dimensional Gaze Tracking**

Mobile eyetracking is a recent method enabling research on attention during real-life behavior. With the “EyeSeeCam”, we have recently presented a mobile eye-tracking device, whose camera-motion device (“gazecam”) records movies orientated in user’s direction of gaze. Here we show that the EyeSeeCam can extract a reliable vergence signal, to measure the fixation distance. We extend the system to determine not only the direction of gaze for short distances more precisely, but also the fixation point in 3 dimensions (3D). Such information is vital, if gaze-tracking shall be combined with tasks requiring 3D information in the peripersonal space, such as grasping. Hence our method substantially extends the application range for mobile gaze-tracking devices and makes a decisive step towards their routine application in standardized clinical settings.

Anabel Martin-Gonzalez

**Simulation and Modeling of Metamorphopsia with a Deformable Amsler Grid**

A method to simulate and model metamorphopsia by means of a deformable Amsler grid is proposed. The interactively deformable grid is based on cubic B-splines to obtain a locally controlled deformation. By simulating metamorphopsia on normal sight volunteers, acquisition of a correction percentage is possible as a result of analyzing the magnitude of the simulated distortion and the applied correction model. The correction percentage obtained is 75.78% (7.36% standard deviation). This can express the feasible correction rate with the guidance of the patient qualitative feedback. The present work is motivated by the idea of obtaining a correction model of a patient with metamorphopsia and to implement this model into a head-mounted display to compensate the patient’s deformation in the near future.

Gregorij Kurillo

**Real-Time 3D Avatars for Tele-Rehabilitation in Virtual Reality**

We present work in progress on a tele-immersion system for tele-rehabilitation using real-time stereo vision and virtual environments. Stereo reconstruction is used to capture user’s 3D avatar in real time and project it into a shared virtual environment, enabling a patient and therapist to interact remotely. Captured data can also be used to analyze the movement and provide feedback to the patient as we present in a preliminary study of stepping-in-place task. Such tele-presence system could in the future allow patients to interact remotely with remote physical therapist and virtual environment while objectively tracking their performance.

Dennis Wood

**Virtual Reality Graded Exposure Therapy With Physiological Monitoring for the Treatment of Combat-Related Posttraumatic Stress Disorder: A Pilot Study**

A significant number of Operation Iraqi Freedom (OIF) and Operation Enduring Freedom (OEF) combat veterans are being diagnosed with Posttraumatic Stress Disorder (PTSD) during and following their respective combat tours. Virtual Reality (VR) treatment has been documented as an exceptional treatment for anxiety disorders and specifically for PTSD. Recently, the pilot phase of a Virtual Reality Graded Exposure Therapy (VRGET) study, with participants who had been diagnosed with PTSD following their combat deployments to Iraq and/or Afghanistan has been completed. As a result of VRGET, a significant reduction in PTSD and depression symptom severity was noted. Implications for VRGET treatment and future research areas of investigation are suggested.

FRIDAY AFTERNOON – SESSION C

**Virtual Reality for Psychology’s Clinical and Research Use**

See schedule for description of this independently organized session.

FRIDAY POSTER PRESENTATIONS

**SIMULATOR DESIGN & DEVELOPMENT - PART 2**

Nathan Delson

**Defining Tubular Regions of Expert Motion for Novice Training**

An instrumented mannequin for airway intubation has been developed to aid laryngoscopy training. An algorithm is presented which uses multiple demonstrations of an expert to identify a tubular region of acceptable motion. Trainee trajectories are compared relative to the expert region to assess competence and to identify specific areas for where improvement is needed.
Vassilios Hurmusiadis

**Virtual Arthroscopy Trainer for Minimally Invasive Surgery**

The presented work introduces an innovative technology solution to a major challenge in minimally invasive surgical training. It is focused on the development of a low-cost, real-time simulation of arthroscopy accessible online via the web. The aim is to enable users to develop their cognitive skills and to comprehend the disorientating images seen through arthoscopes. The simulation is incorporated into a software training tool that provides virtual arthroscopy and e-learning and assessment.

Bill Kapralos

**A Serious Game for Off-Pump Coronary Artery Bypass Surgery Procedure Training**

We have begun development of an interactive, multi-player serious game for the purpose of training cardiac surgeons, fellows, and residents the steps of comprising the Off-Pump Coronary Artery Bypass grafting (OPCAB) surgical procedure. It is hypothesized that by learning the OPCAB procedure in a “first-person-shooter gaming environment”, trainees will have a much better understanding of the procedure than by traditional learning modalities.

Sergei Kurenov

**A Simulation Framework for Wound Closure by Suture for the Endo Stitch Suturing Instrument**

Our simulation framework for wound closure by suture is designed for education and training purposes. Currently, it is designed specifically to support a simulation of the Endo Stitch™ suturing instrument by Covidien, but could be extended to use with other suturing instruments designed for intracorporeal suturing. The framework allows user to perform a virtual wound closure by suture on a computer with the real surgical instrument handle customized to fit on a haptic device. The wound simulation is based on a triangular surface mesh embedded in a linear hexahedral finite element mesh, whereas the suture simulation is based on a simplified Cosserat theory of elastic rods. The simulation utilizes combination of physically-based simulation and control-based simulation.

Vanda Luengo

**Design and Implementation of a Visual and Haptic Simulator in a Platform for a TEL System in Percutaneous Orthopedic Surgery**

Within a research project whose aim is to promote the learning of percutaneous operation in orthopedic surgery, we investigate some representation models of empirical, deductive, and perceptivo-gestural knowledge. From these models, we design a Technological Enhanced Learning (TEL) system. This project belongs to a multidisciplinary field including computer, orthopedic surgery, medical imaging, didactic and cognitive sciences. The article presents the design principles of TEL with a particular interest in the development of a simulator. This simulator allows a virtual exercise interacting with the learner in visual, temporal and haptic dimension.

Francisco Martinez-Martinez

**Pneumoperitoneum Technique Simulation in Laparoscopic Surgery on Lamb Liver Samples and 3D Reconstruction**

Laparoscopy is a minimally invasive technique based on the execution of little incisions on the abdomen in order to introduce the instrumental needed to perform the intervention. At the beginning of this, CO2 is insufflated in the abdomen (pneumoperitoneum) through a trocar in order to create enough space to make possible the intervention.

Dwight Meglan

**Development of an Open Surgery Simulator**

Over several years, we have developed a simulation-based surgical training system focused on providing proprioceptive training for a broad set of open incision surgical skills and procedures. This system is designed to provide an experience that has computational provenance (traceability of its calculations and output to state-of-the-art engineering and biomechanics techniques), appropriate human factors (minicking the OR table pose), generality in scenarios that can be provided through a tool chain to produce content and define metrics, and haptic correctness and flexibility in surgical tools held and used to interact with the simulation. The system is now functional in its prototype stage and undergoing transfer of training assessment.

Aline Morais

**CyberMedVPS: Visual Programming for Development of Simulators**

Computer applications based on Virtual Reality (VR) has been outstanding in training and teaching jobs in the medical field because of its ability to simulate realistic scenarios and environments, interactive and immersive. These simulations enable users to practice skills and decision making in the face of different situations. But
was realized in these frameworks a hard interaction of non-programmers users. Based on this problematic will be shown the CyberMedVPS, a graphical module which implement Visual Programming concepts to solve a interaction trouble.

Douglas Nelson

**The Tool Positioning Tutor: A Target-Pose Tracking and Display System for Learning Correct Placement of a Medical Device**

Safe and successful performance of medical procedures often requires the correct manual positioning of a tool. For example, during endotracheal intubation a laryngoscope is used to open a passage in the airway through which a breathing tube is inserted. During training it can be challenging for an experienced practitioner to effectively communicate to a novice the correct placement and orientation of a tool. We have implemented a real-time tracking and position display system to enhance learning correct laryngoscope placement. The system displays a 3D model of the laryngoscope. A clinical teacher can correctly position the laryngoscope to open the airway of a full-body simulator, then set this tool pose as a target position. The system displays to the learner the fixed, target pose and a real-time display of the current, “live” laryngoscope position. Positional error metrics are displayed as color-coded visual cues to guide the user toward successful targeting of the reference position. This technique provides quantitative assessment of the degree to which a learner has matched a specified “expert” position with a tool, and is potentially applicable to a wide variety of tools and procedures.

Krzysztof Rechowicz

**A Design for Simulating and Validating the Nuss Procedure for the Minimally Invasive Correction of Pectus Excavatum**

Surgical planners are used to achieve the optimal outcome for a surgery, especially in procedures where a positive aesthetic outcome is the primary goal, such as the Nuss procedure which is a minimally invasive surgery for correcting pectus excavatum (PE) - a congenital chest wall deformity. Although this procedure is routinely performed, the outcome depends mostly on the correct placement of the bar. It would be beneficial if a surgeon had a chance to practice and review possible strategies for placement of the corrective bar and the associated appearance of the chest. Therefore, we propose a strategy for the development and validation of a Nuss procedure surgical trainer and planner.

Ravikiran Singapogu

**Perceptual Metrics: Towards Better Methods for Assessing Realism in Laparoscopic Simulators**

A common criticisms of simulators for laparoscopic skills training is the lack of realism. Until recently, most laparoscopic simulators did not feature haptic feedback. The advent of viable haptic devices holds the promise of more realistic simulators. But how is realism in simulators assessed? Traditionally, realism of simulators (face validity) was assessed be soliciting expert opinion, which can involve inherent biases because of the subjective nature of the process. This work proposes a metric to objectively assess the haptic realism of laparoscopic simulators. Pilot data using the proposed metric is presented as proof-of-concept. The designing of more objective and robust metrics for assessing realism is an important step toward efficient simulators.

Ravikiran Singapogu

**Role of Haptic Feedback in a Basic Laparoscopic Task Requiring Hand-Eye Coordination**

The efficacy and role of haptic feedback during laparoscopic surgery is a topic of continued debate. Recent studies seem to suggest that haptic feedback is useful for certain laparoscopic tasks where force application is critical (for example, tissue manipulation). The role of haptic feedback in more basic laparoscopic tasks, however, is not well understood. In this study, we examine the effect of haptic feedback on a basic, peg transfer-like task. Results from a pilot study are presented confirming the hypothesis that a significant difference in performance exists when haptic feedback is present in the simulator. Other implications of the research are also presented.

Cyle Sprick

**A New Part Task Trainer for Teaching and Learning Confirmation of Endotracheal Intubation**

Endotracheal intubation is a skill employed by a diverse range of healthcare professionals in a wide variety of circumstances. Failure to put this tube in the right place (in the trachea) can result in serious injury and death. There are a wide variety of methods for verification of proper placement. Some are more widely accepted than others. A universal guideline should be adopted to allow consistent and safe practice in all situations by all who do this procedure. Training for endotracheal intubation must also include training in the verification methods. We have developed a new airway part-task trainer that allows the use of all of the methods of tube placement verification.
Biopsym: A Learning Environment for Trans-Rectal Ultrasound Guided Prostate Biopsies

This paper describes a learning environment for image-guided prostate biopsies in cancer diagnosis; it is based on an ultrasound probe simulator virtually exploring real datasets obtained from patients. The aim is to make the training of young physicians easier and faster with a tool that combines lectures, biopsy simulations and recommended exercises to master this medical gesture. It will particularly help acquiring the three-dimensional representation of the prostate needed for practicing biopsy sequences. The simulator uses a haptic feedback to compute the position of the virtual probe from three-dimensional (3D) ultrasound recorded data. This paper presents the current version of this learning environment.

SIMULATOR VALIDATION

Imad Awad

Anesthesia Residents' Preference for Learning Interscalene Brachial Plexus Block (ISBPB): Traditional Winnie's Technique vs. Ultrasound-Guided Technique

There is a recent shift from traditional nerve stimulation (NS) to ultrasound-guided (UG) techniques in regional anesthesia (RA). This shift prompted educators to readdress the best way to teach these two modalities. Development of a more structured curriculum requires an understanding of student preferences and perceptions. To help in structuring the teaching curriculum of RA, we examined residents’ preferences to the methods of instruction (NS Vs. UG techniques). Novice residents (n=12) were enrolled in this parallel crossover trial. Two groups of 6 residents received a didactic lecture on NS or UG techniques. The groups then crossed over to view the other lecture. After they observed a demo of ISBPB on two patients using NS and US. The residents completed a questionnaire regarding their impression of each technique and the learning experience. UG technique was perceived to be safer and to have more educational value than NS. However, residents felt both techniques should be mandatory in the teaching curriculum.

Mary Barak-Bernhagen

Combined Use of Simulated and Human Intubation Training for 4th Year Medical Students: Center for Advanced Technology and Telemedicine (CATT) Airway Training Program

The videolaryngoscope is a useful tool in intubation training as it allows both the instructor and the student to share the same view of the airway during intubation. In this study, the Center for Advanced Technology and Telemedicine’s airway training program employed videolaryngoscopy (VL) in teaching both simulated (manikin) and human intubation. The videolaryngoscope statistically improved the glottic view in both the standard and difficult manikin airways when compared to that with standard (direct) laryngoscopy. The success rate in simulated difficult airway intubation was significantly improved using VL. With human intubation training, there was statistically significant improvement in airway views using the videolaryngoscope and a 97.5% success rate. The enhanced view of the videolaryngoscope in airway intubation facilitates the learning process in performing both simulated and human intubation, making it a powerful tool in intubation training.

Kirsten Boedeker

Battlefield Tracheal Intubation Training Using Virtual Simulation: A Multi Center Operational Assessment of Video Laryngoscope Technology

Airway management is an essential skill in providing care in trauma situations. The video laryngoscope is a tool which offers improvement in teaching airway management skills and in managing airways of trauma patients on the far forward battlefield. An Operational Assessment (OA) of videolaryngoscope technology for medical training and airway management was conducted by the Center for Advanced Technology and Telemedicine (at the University of Nebraska Medical Center) for the US Air Force Modernization Command to validate this technology in the provision of Out of OR airway management and in airway management training in military simulation centers. The value of both for training and performance of intubations was highly-rated and the majority of respondents indicated interest in having a video laryngoscope in their facility.

Kirsten Boedeker

Intubation Success Rates and Perceived User Satisfaction Using the Videolaryngoscope to Train Deploying Far Forward Combat Medical Personnel

Studies show that the videolaryngoscope enhances intubation training by facilitating visualization of airway anatomy. This study examined the performance and training of deploying military healthcare providers in a brief intubation training course which included both direct and indirect (video) laryngoscopy. After completing the training, the subjects reported increased confidence levels for successful intubation. Web-based training paired with hands-on instruction with the videolaryngoscope should be considered as a model for military basic airway management training.
Jung-Hung Chien

**Electromyographic Correlates of Learning during Robotic Surgical Training in Virtual Reality**

The present study was part of research study that investigated the effectiveness of a simulated virtual reality environment for learning of surgical skills and transferring these skills to a real surgical task. In this study, changes in the muscle activity of the upper limb were explored. The virtual surgical tasks consisted of bimanual carrying, needle passing and mesh alignment. Significant changes between the pre- and post-training tests were found in the muscular activation and frequency response of the electromyographic signals of the robotic surgical system users. Training of novices using simulated virtual reality yields quantifiable changes in skill acquisition. Virtual reality surgical skills training may produce a significant learning effect that can transfer to actual robot-assisted laparoscopic procedures.

Jung-Hung Chien

**Modeling Surgical Skill Learning with Cognitive Simulation**

The purpose of this study was to use a cognitive architecture (ACT-R) to explore the procedural learning of surgical tasks and then to understand the process of perceptual motor learning and skill decay in surgical skill performance. ACT-R is a cognitive model to simulate declarative memory process during motor learning. In this ongoing study, four surgical tasks (bimanual carrying, peg transfer, needle passing and suture tying) performed using the da Vinci® surgical system to obtain experimental data. Preliminary results revealed that ACT-R produced similar learning effects compared with the experimental data. In conclusion, cognitive simulation could be used to demonstrate the perceptual motor learning and skill decay in surgical skill training.

Olivier Courtelie

**Mixed Virtual Reality Simulation - Taking Endoscopic Simulation One Step Further**

This pilot study aimed to assess medical students’ appraisals of a “mixed” virtual reality simulation for endoscopic surgery (with a virtual patient case in addition to a virtual colonoscopy) as well as the impact of this simulation set-up on students’ performance. Findings indicate that virtual patients can enhance contextualization of simulated endoscopy and thus facilitate an authentic learning environment, which is important in order to increase motivation.

Srinivas Ivatury

**Does Video Game Performance Correlate with Laparoscopic Camera Navigation Training in Box Trainer and Virtual Laparoscopic Environments?**

Research has suggested that a relationship between video game performance and laparoscopic skills exists. This prospective, randomized study was performed with 20 novices in laparoscopy examining the correlation between video game performance and performance on box trainer (BT) and virtual reality (VR) laparoscopic camera navigation (LCN). Video game fine motor skill performance correlates with VR but not BT LCN. Performance on BT and VR LCN training do not correlate. Both findings support the presumption that the VR laparoscopic environments differ from real laparoscopic environments.

T. “Kesh” Kesavadas

**Validation of Robotic Surgery Simulator (RoSS)**

Recent growth of daVinci® Robotic Surgical System, as minimally invasive surgery tool, has led to call for better training of future surgeons. In this paper, a new virtual reality simulator, called RoSS is presented. Initial results from two studies – face and content validity, are very encouraging. 90% cohort of expert robotic surgeons felt that the simulator was excellent or somewhat close to the touch and feel of da Vinci console. Content validity of the simulator received 90% approval in some cases. This leads to the conclusion that RoSS has the potential of becoming an important training tool for da Vinci robot.

Gail Kuper

**Field Use of the STORZ C-MAC™ Video Laryngoscope in Intubation Training with the Nebraska National Air Guard**

Previous studies have shown that the videolaryngoscope is an excellent intubation training tool as it allows the student and trainer to share the same anatomical view of the airway. Use of this training tool is limited; however, as many times intubation training must take place outside the hospital environment (as in the training of military health care providers). In this environment, the device can prove to be large and cumbersome. This study examined the use of the Storz CMAC™, a compact video laryngoscope system, for intubation training in a simulated field hospital setting with the Nebraska National Air Guard. The study showed that the C-MACTM was well-received by the trainees and would be useful in a deployment or hospital setting.
Nikola Miljkovic

**A Comparison of Videolaryngoscopic Technologies**

Difficulty in managing the airway is a major contributor to the morbidity and mortality of the trauma patient. The video laryngoscope, with its camera at the distal tip of the intubation blade, allows the practitioner an improved view of the glottic opening during intubation. The image from this viewer is transmitted to a monitor, allowing the intubating practitioner to “see around the corner” of a patient’s airway. The purpose of the present study was to assess and compare the video quality of commercially available video laryngoscopy systems. It was found that between the STORZ C-MAC® and the Verathon GlideScope®, there was little difference between the video quality; the difference came down to user preference.

Marcus Schlickum

**Performance in a Surgical Simulator Correlates with Theoretical Knowledge in Female but not in Male Medical Students**

There are a number of abilities and features that predict surgical skills as measured with simulator testing. The question has arisen whether to use these predictors when training future surgeons. We need more information about predictors for surgical performance. In this study we investigated whether theoretical knowledge in basic surgery correlated to surgical performance. 123 medical students participated in the study; 66 females and 57 males, all surgical novices. The performance of the study population in the Uro Mentor simulator was recorded together with the results of the final theoretical examination of the course in basic surgery. When performing a Pearson’s product correlation test, we found no statistically significant correlation between the theoretical examination and the simulator performance when looking at the total study population ($r=0.071$, $p=0.433$) nor when looking at the male medical students ($r=-0.044$, $p=0.749$). However, when looking at the female medical students we found a significant correlation between the examination score and the surgical simulator performance ($r=-0.301$, $p=0.013$). Female medical students with high scores in the theoretical examination had a faster task completion in the surgical simulator. Several explanations for this correlation are presented.

**PLASMA MEDICINE**

Yang-Fang Li

**Self Surface Sterilization by Encapsulated Surface-Dielectric Barrier Discharge**

A new configuration of dielectric barrier discharge is proposed for the surface self sterilization. The electrodes are encapsulated into dielectric materials and the plasma is ignited on selected surface(s) of the device by applying low frequency (~ 1 kHz) and high voltage (~10 kV) signals. The bactericidal effect is tested for different conditions and the results shows typically a 5-log bacteria reduction for a 10-second plasma operation. The effects of the after glow is checked. In addition, the power consumption, the UV emission, and the ozone concentration are also measured for this device.

Artemio Navarro

**Laser Induced Shockwaves on Flexible Polymers for Treatment of Bacterial Biofilms**

Bacterial biofilm-related infections are a burden on the healthcare industry. The effect of laser generated shockwaves through polycarbonate, a flexible polymer, is explored for its ability to generate high peak stresses, and also for its ability to conform to complex wound surfaces. Shockwave pulses in Al coated polycarbonate substrates and a resulting peak stress of greater than 60 MPa was measured which should provide sufficient pressure to kill bacteria.

**PATIENT CARE & REHABILITATION**

Giovanni Albani

**Sleep Dysfunctions Influence Decision Making in Undemented Parkinson’s Disease Patients: A Study in a Virtual Supermarket**

In the early-middle stages of Parkinson’s disease (PD), polysomnographic studies show early alterations of the structure of the sleep, which may explain frequent symptoms reported by patients, such as daytime drowsiness, loss of attention and concentration, feeling of tiredness. Aim of this study was to verify if there is a correlation between the sleep dysfunction and decision making ability. We used a Virtual Reality version of the Multiple Errand Test (VMET) in order to evaluate decision making ability in 12 PD not-demented patients and 14 controls. Five of our not-demented 12 PD patients of this study show abnormalities in the videopolysomnographic recordings.

Steven Barnes

**Immersive Virtual Environments for the Management of Chronic vs. Acute Pain**

Immersive virtual reality (VR) been shown to be an effective treatment for acute forms of pain. Can VR also be used for the management of chronic pain? We are developing novel VR environments for that purpose. As
part of that design process, we are also exploring the environmental characteristics that will amplify the effectiveness of VR for chronic pain.

Alessandro De Mauro

**Virtual Reality System in Conjunction with Neurorobotics and Neuroprosthetics for Rehabilitation of Motor Disorders**

Cerebrovascular accidents (CVA) and spinal cord injuries (SCI) are the most common causes of paralysis and paresis with reported prevalence of 12,000 cases per million and 800 cases per million, respectively. Disabilities that follow CVA (hemiplegia) or SCI (paraplegia, tetraplegia) severely impair motor functions (e.g., standing, walking, reaching and grasping) and prevent the affected individuals from healthy-like, full and autonomous participation in daily activities. Our research focuses on the development of a new virtual reality (VR) system combined with wearable neurorobotic (NR), neuroprosthetic (NP) and brain computer interface (BCI) to overcome the major limitations of current rehabilitation solutions.

Farzam Farahmand

**Fuzzy Control of a Hand Rehabilitation Robot to Optimize the Exercise Speed in Passive Working Mode**

The robotic rehabilitation devices can undertake the difficult physical therapy tasks and provide improved treatment procedures for post stroke patients. During passive working mode, the robot should control the exercise speed to avoid excessive injurious torques. We designed a fuzzy controller for a hand rehabilitation robot to adjust the exercise speed in each step by considering the wrist angle and joint resistive torque, measured continuously, and the patient's general condition determined by the therapist. With a set of rules based on an expert therapist experiences, the fuzzy system could work as an adaptive system with the changing conditions of patient's paretic hand. Preliminary clinical tests revealed that the fuzzy controller provided a much smoother change of exercise speed than that of the conventional controllers, similar to what is expected from an experienced therapist. This promotes the robot functionality for a wider clinical usage.

Olga Sourina

**EEG-based “Serious” Games and Monitoring Tools for Pain Management**

EEG-based “serious games” for medical applications attracted recently more attention from the research community and industry as wireless EEG reading devices became easily available on the market. EEG-based technology has been applied in anaesthesiology, psychology, etc. In this paper, we proposed and developed EEG-based “serious” games and doctor's monitoring tools that could be used for pain management. As EEG signal is considered to have a fractal nature, we proposed and develop a novel spatio-temporal fractal based algorithm for brain state quantification. The algorithm is implemented with blobby visualization tools for patient monitoring and in EEG-based “serious” games. Such games could be used by patient even at home convenience for pain management as an alternative to traditional drug treatment.

Hyun Joong Yoon

**A Framework for Treatment of Autism Using Affective Computing**

It is known that as many as 1 in 91 children are diagnosed with autistic spectrum disorder. Since the children with autism usually do not express their own emotional status, it is needed to develop a novel technology to sense their emotional status and give proper psychological treatment. This article presents a framework of the treatment system for children with autism using affective computing technologies.

Venkata Arikatla

**Cost-Efficient Suturing Simulation with Pre-Computed Models**

Suturing is currently one of the most common procedures in minimally invasive surgery (MIS). We present a suturing simulation paradigm with pre-computed finite element models which include detailed needle-tissue and thread-tissue interaction. The interaction forces are derived through a reanalysis technique for haptic feedback. Besides providing deformation updates and high fidelity forces, our simulation is computationally less costly.

Tansel Halic

**SML: SoFMIS Meta Language for Surgical Simulation**

Developing a surgical simulation is a very complex task, requiring various components and usually the involvement of multiple people. As the complexity of the simulator increases, the functionality and the functional semantics of the components become very challenging to manage. In order to mitigate these issues, in this
work we introduce a novel language that facilitates the development of surgical simulations and also supports semantic embedding in the surgical simulation development without extra programming effort.

Jason Kutarnia

**Finite Element Method for Whole Body Deformation using Organ-specific Mechanical Properties**

This paper describes the deformation of individual organs in an image volume, as well as the deformation of the overall image volume, in response to an applied external (or internal) force, after appropriate segmentation and assignment of elastic properties of the individual organs. The image volume may be anatomical, CT, MRI or ultrasound. The results presented here are based on active contour segmentation of abdominal organs from the female dataset from the Visible Human Project, followed by the linear deformation calculation utilizing the finite element software Comsol.

Masashi Nakagawa

**A Bloodstream Simulation Based on Particle Method**

Many surgical simulators use mesh method to deform CG models such as organs and blood vessels because the method can easily calculate deformation of models, however, it has to split and reconstruct the mesh of the models when the model is broken such as bleeding. On the other hand, particle method considers a continuous body such as solid and liquid as a set of particles and does not have to construct the mesh. Therefore, in this paper, we describe how to simulate bloodstream by using MPS method (Moving Particle Semi-implicit) that is one of particle ones. In the simulation, we use the aorta model as the blood vessel model, and the model is constructed with particles. As the result of the simulation, it takes 20ms to deform the blood vessel and to simulate bleeding with the model that is constructed with 15,880 particles for the blood vessel and 6,688 particles for the blood.

Kazuyoshi Tagawa

**A Hybrid Dynamic Deformation Model for Surgery Simulation**

In this paper, a hybrid dynamic deformation model is presented. This approach is capable of haptic interaction with dynamically deformable object. In addition, it is capable of considering object’s large deformation and topological change. Computational amount of this approach is proportional to sum of square of number of shared nodes and number of whole nodes of online-remesh model. The approach was implemented to our prototype system, and feasibility and performance were confirmed.

Anette von Kapri

**Towards the Visualization of Spiking Neurons in Virtual Reality**

This paper presents a prototype that addresses the visualization of the microscopic activity structure in the mammalian brain. Our approach displays the spiking behaviour of neurons in multiple layers based on large-scale simulations of the cortical micro-circuit. We will apply this visualization to the activity of brain-scale simulations by coupling the microscopic structure with the macroscopic level. Thereby, we hope to convey an intuitive understanding of the concise interaction and the activity flow of pairs of distant brain areas.

Matthew Wampole

**Three Dimensional Projection Environment for Molecular Design and Surgical Simulation**

We are developing agents for PET imaging of cancer gene mRNA expression and software to fuse mRNA PET images with anatomical CT images to enable volumetric (3D) haptic (touch-and-feel) simulation of pancreatic cancer and surrounding organs prior to surgery in a particular patient. We will (1) direct agent uptake specifically into pancreatic cancer cells by molecular design of a novel ligand specific for epidermal growth factor receptor (EGFR), and (2) create volumetric haptic surgical simulation of human pancreatic cancer reconstructed from patient PET/CT data.

Satoshi Yamaguchi

**Needle Insertion Simulation by Arbitrary Lagrangian-Eulerian Method**

In this paper, we performed a needle insertion simulation considering a needle tip shape by Arbitrary Lagrangian-Eulerian (ALE) method. ALE method is suitable for a large deformation and a fracture. To evaluate developed model, we compared a needle deflection between experimental results and simulation results. As a result, errors in each needle between both results were less than 3 mm.
HAPTICS

Timothy Coles

Modification of Commercial Force Feedback Hardware for Needle Insertion Simulation

A SensAble Omni force feedback device has been modified to increase the face validity of a needle insertion simulation. The new end effector uses a real needle hub and shortened needle shaft in place of the Omni's pre-fitted pen shaped end effector. This modification facilitates correct procedural training through the simulation of co-located visual and haptic cues in an augmented reality approach to simulation. The development of the new end effector is described and a pictorial guide to its manufacture and the fitting process is provided. Two Omni devices have been modified for a full simulation validation.

Yunjin Gu

A Design of Hardware Haptic Interface for Gastrointestinal Endoscopy Simulation

Medical simulation for training and planning in gastrointestinal endoscopy is needed since the operation is difficult and frequent. Many commercialized simulators for gastrointestinal endoscopy are more focused on developing realistic virtual modeling and visual effects. But realistic haptic feedback is also critical since it is important for surgeon to feel touch during the operation. For providing haptic feedback in endoscopy simulation, a design of haptic device is proposed. The haptic device consists of three mechanisms, which are for gripping the endoscope tightly and providing translational / rotational feedback force. The entire size of the haptic device is small and the moment of inertia during free motion is reduced.

Tansel Halic

A Fixed Point Proximity Method for Extended Contact Manipulation of Deformable Bodies with Pivoted Tools in Multimodal Virtual Environments

The development of a multimodal interactive simulation is a very elaborate task due to the various complex software components involved, which run simultaneously at very high rates with maximum CPU load. In this work, we propose a multimodal parallel simulation framework called SoFMIS to create rapid interactive simulations such as surgical simulations. Our framework offers great flexibility and customization allowing simulation developers and researchers to concentrate on the simulation logic rather than component development.

Atilla Kilicarslan

Design of a Haptic System for Minimally Invasive Cardiac Surgeries

In the present paper, we describe the mechanical design and working principle of a haptic device to be used during minimally invasive single port access cardiac surgeries. The details to hardware/software design and implementation to electronically actuate the device will be also presented. The viability of the design will be demonstrated by integrating the virtual representation of the left ventricle (as a simulation model) to define the unilateral constraints and find a safe corridor for haptic guidance and control of the surgical robo.

MISCELLANEOUS TOPICS

Ben Boedeker

Comparison of a Disposable Bougie versus a Newly Designed Malleable Bougie in the Intubation of a Difficult Manikin Airway

The endotracheal bougie is used for difficult intubations when only a minimal glottic view is obtained. Standard bougies are designed for use during direct, line-of-site viewing of the glottic opening. With video-laryngoscopy, intubators see "around the corner", thus requiring a bougie which can be shaped to follow a significant curve. A malleable bougie with an imbedded internal wire was created to enable intubators to shape the curve to best fit a difficult airway. This pilot study examined the malleable bougie compared to the SunMed™ bougie in a simulated difficult airway intubation.

Ben Boedeker

Improving Fiberoptic Intubation with a Novel Tongue Retraction Device

This study examined the utility of a novel tongue retractor created with a wider working blade and a more ergonomic curve to provide jaw lift and tongue management with one hand during intubation. Anesthesia providers participated in simulated intubation of a difficult manikin using the novel tongue retractor with the Bonfils video fiberscope. Results show that the tongue retractor improved placement success and was well received by the study participants.
Kulia Matsuo

**Technology Transfer at the University of Nebraska Medical Center**

The course of developing a new product from an idea is an extensive and complicated process. This paper will discuss that process, in detail, from conception to product. We approach this by first discussing what the inventor must do begin the process of developing his or her idea, and then two pathways that occur simultaneously: the Technology Transfer process of patenting, marketing, and licensing the invention; and the engineering process of developing, modifying, and manufacturing the invention. Although the process is lengthy and most ideas never become a marketed product, there are those few ideas that do become realized into marketed products.

Hao Su

**Piezoelectric Driven Non-toxic Injector for Automated Cell Manipulation**

Stimulated by state-of-the-art robotic and computer technology, Intra Cytoplasmic Sperm Injection (ICSI) automation aims to scale and seamlessly transfer the human hand movements into more precise and fast movements of the micro manipulator. Piezo-drill cell injection, a novel technique using piezo-driven pipettes with a very small mercury column, has significantly improves the survival rates of the ICSI process. It is found that complications are due, in large part, to toxicity of mercury and the damage to the cell membrane because of the lateral tip oscillations of injector pipette. In this paper, a new design of piezo-driven cell injector is proposed for automated suspended cell injection. This new piezo-driven cell injector design centralizes the piezo oscillation power on the injector pipette which eliminates the vibration effect on other parts of the micromanipulator. Detrimental lateral tip oscillations of the injector pipette are attenuated to a desirable level even without the help of mercury column. This mercury-free injector can sublime the piezoelectric driven injection technique to completely non-toxic level with great research and commercial application in gene injection, in-vitro fertilization, ICSI and drug development.

Graciela Santana Sosa

**Collision and Containment Detection between Biomechanically Based Eye Muscle Volumes**

Collision and containment detection between three-dimensional objects is a common requirement in simulation systems. However, few solutions exist when exclusively working with deformable bodies. In our ophthalmologic diagnostic software system, the extraocular eye muscles are represented by surface models, which have been reconstructed from magnetic resonance images. Those models are projected onto the muscle paths calculated by the system’s biomechanical model. Due to this projection collisions occur. For their detection, three approaches have been implemented, which we present in this paper: one based on image-space techniques using OpenGL, one based on the Bullet physics library and one using an optimized space-array data structure together with software rendering. Finally, an outlook on a possible response to the detected collisions is given.

Nigel John

**Realistic Visualization of Living Brain Tissue**

This paper presents an advanced method of visualizing the surface appearance of living brain tissue. We have been granted access to the operating theatre during neurosurgical procedures to obtain colour data via calibrated photography of exposed brain tissue. The specular reflectivity of the brain’s surface is approximated by analyzing a gelatine layer applied to animal flesh. This provides data for a bidirectional reflectance distribution function (BRDF) that is then used the rendering process. Rendering is achieved in realtime by utilizing the GPU, and includes support for ambient occlusion, advanced texturing, sub surface scattering and specularity. Our goal is to investigate whether realistic visualizations of living anatomy can be produced and so provide added value to anatomy education.

Christos Constantinou

**Visualization of Pelvic Floor Reflex and Voluntary Contractions**

Visualization of the geometric deformation and associated displacement patterns of tubular abdominal organs to mechanical stimuli provides a quantitative measure that is useful in modeling their elastic properties. The origin
of the stimulus may be the result of direct and voluntary muscle contraction or in response to a triggered reflex activity. Using trans-perineal 2D ultrasound imaging we examined the characteristics of deformation and displacement of these organs in response to voluntary activity, contraction, straining, and fast reflex responses to stimuli such as coughing. The relative time sequence in movement was examined by serially segmenting the outline of these structures and mapping their temporal characteristics.

Shin Hasegawa

Simulation of Vaginal Wall Biomechanical Properties from Pelvic Floor Closure Forces Map

We simulated the way that Pelvic Floor Muscles (PFM) generate zonal compression on the vagina and urethra in order to maintain urinary continence. Raw data were obtained using a probe to map the distribution of vaginal closure forces. Simulation model was made using ordinary Spring-mass model. The biomechanical properties are applied to the spring of the model. We simulated four models that are applied to asymptomatic subjects as controls and patients based on information obtained from the measured force maps. PFM values are measured when subjects are relaxed and during voluntary PFM contraction. Results show that simulation clearly distinguished between controls and patents and demonstrates that in the controls, after a period of 0.075 sec from the time when the rest force was added, the model was deformed to a neutral shape, and after another period of 0.075 sec from the time when the contract force was added at intervals of 0.001 sec, the closure force reaches maximum. The results render the simulation of the vaginal wall deformations that was obtained directly by the force maps. It shows that in controls the wall model is significantly deformed compared to that from the patient's model. In this research we simulated the response of the vaginal walls using spring mass model and the force maps of vaginal closure forces applied to control subjects and patients. The process of deformation of the vaginal wall is thus visualized demonstrating the relative pathologic differences between the two groups.

Sebastien Delorme

Modeling the Thermal Effect of the Bipolar Electrocautery for Neurosurgery Simulation

Real-time surgical simulation requires computationally-fast models describing the interaction between each type of surgical instrument and each type of tissue. In this study, a model for predicting the temperature distribution in brain tissue when using a bipolar electrocautery is proposed and validated against experimental in vitro animal data. Joule heat generation and heat conduction in the tissue are considered. The agreement between simulated temperature distributions and experimental data could be improved by modeling the output power as a function of electrical resistance between the electrodes, and by considering the heat exchange with surrounding air and bipolar tips.

Masato Ogata

A Development of Surgical Simulator for Training of Operative Skills Using Patient-Specific Data

The authors have been developing a practical surgical simulator for renal surgery at Advanced Medical Research Center in Yokohama City University Graduate School of Medicine. Unlike already commercialized laparoscopic surgical simulators, our surgical simulator is capable for training to improve operation skill and pre-operative trainings using patient-specific model. Currently, we have been studying clinical evaluation aiming for the product of renal surgery at Yokohama City University Hospital. The simulator can be applied to the other laparoscopic surgeries such as for gynecological, thoracic, and gastrointestinal surgery. We report this simulator from technical point of view.

Fernando Bello

Open Surgery Simulation of Inguinal Hernia Repair

Inguinal hernia repair procedures are often one of the first surgical procedures junior surgeons are faced with. The biggest challenge with this procedure for novice trainees is understanding the 3D spatial relations of the complex anatomy of the inguinal region, which are crucial for the effective and careful handling of the present anatomical structures in order to perform a successful and lasting repair. Such relationships are difficult to illustrate and comprehend through standard learning material.

This paper presents our work in progress to develop a simulation-based teaching tool allowing junior surgeons to train the Lichtenstein tension-free open inguinal hernia repair technique for repair of direct and indirect hernias, as well as to enforce their understanding of the spatial relations of the involved anatomy.
Sukitti Punak

**Simplified Cosserat Rod for Interactive Suture Modeling**

Our simulation framework for wound closure by suture is designed for education and training purposes. Currently, it is designed specifically to support a simulation of the Endo Stitch™ suturing instrument by Covidien, but could be extended to use with other suturing instruments designed for intracorporeal suturing. The framework allows user to perform a virtual wound closure by suture on a computer with the real surgical instrument handle customized to fit on a haptic device. The wound simulation is based on a triangular surface mesh embedded in a linear hexahedral finite element mesh, whereas the suture simulation is based on a simplified Cosserat theory of elastic rods. The simulation utilizes combination of physically-based simulation and control-based simulation.

Yunhe Shen

**Phenomenological Model of Laser-Tissue Interaction with Application to Benign Prostatic Hyperplasia (BPH) Simulation**

Laser-tissue interaction is a multi-physics phenomenon not yet mathematically describable and computationally predictable. It is a challenge to model the laser-tissue interaction for real time laser Benign Prostatic Hyperplasia (BPH) simulation which requires the laser-tissue interaction model to be computationally efficient and accurate. A phenomenological model of laser-tissue interaction is developed under the consideration and enforcement of the thermodynamic first law and treating the laser-tissue interaction as a gray-box. Utilizing the sensitivity analysis of some key parameters that will affect the laser intensity on the tissue surface with respect to the tissue vaporization rate, the resulting laser-tissue interaction model has been implemented in a laser in BPH simulator with real time performance (more than 30 frames per second). The simulation results agree well with experimental data.

Fernando Bello

**Guidewire and Catheter Behavioural Simulation**

Guidewire and catheter manipulation is a core skill in endovascular interventional radiology. It is usually acquired in an apprenticeship on patients, but this training is expensive and carries some risk. Simulation offers an efficient alternative for core skills training, though the complex behaviour of the instruments requires accurate replication. This paper reviews the mass-spring model used to simulate seven guidewires and three catheters, and the matching with their real world counterparts by tuning our model's bending coefficient, which allows replication of the instrument flexibility. This coefficient was matched through computed tomography imaging of a vascular phantom in which each instrument was inserted and manipulated. With an average distance of 2.27mm (standard deviation: 1.54) between real and virtual instruments, our representation showed a realistic behaviour.

Farzam Farahmand

**Modeling of Interaction between a Three-Fingered Surgical Grasper and Human Spleen**

The aim of this study was to develop a more sophisticated model of the spleen tissue and investigate its interactions with a three-fingered laparoscopic grasper. The spleen tissue, modeled as a hyper visco elastic material, was subjected to external loadings, imposed by rigid grasping jaws. The tissue deformation as well as the sliding occurrence between tissue and jaws was investigated using nonlinear finite element method. Results indicated that a grasping configuration which aimed a sufficiently large piece of spleen with small radius of curvature was more successful for effective grasping. The trends and magnitudes of the tool-tissue interaction forces obtained during effective and ineffective grasping were quite different. A force with progressively increasing trend toward a high magnitude was found to be indicative of effective and safe grasping. This finding might be used to predict the effectiveness of different grasping configurations and sliding thresholds during spleen and other soft organs surgery.

Andrew Bulpitt

**Segmentation of 3D Vasculatures for Interventional Radiology Simulation**

Training in interventional radiology is slowly shifting towards simulation which allows the repetition of many interventions without putting the patient at risk. Accurate segmentation of anatomical structures is a prerequisite of realistic surgical simulation. Therefore, our aim is to develop a generic approach to provide fast and precise segmentation of various virtual anatomies covering a wide range of pathology, directly from patient CT/MRA images. This paper presents a segmentation framework including two segmentation methods: region model based level set segmentation and hierarchical segmentation. We compare them to an open source application ITK-SNAP which provides similar approaches. The subjective human influence such as inconsistent inter-observer errors and aliasing artifacts etc. are analysed. The proposed segmentation techniques have been successfully applied to create a database of various anatomies with different pathologies, which is used in computer-based simulation for interventional radiology training.
HAPTICS

Sebastian Ullrich

Quantizing the Void: Extending Web3D for Space-Filling Haptic Meshes

In this paper we summarize the progress of the Web3D scene graph model, and associated standards, specifically Extensible 3D (X3D) in the domain of medical simulation. Historically, the Web3D nodesets have focused on the representation and rendering of point, line or surface geometry. More recently, significant progress in X3D Volume rendering has been made available through the co-operative DICOM work item, n-Dimensional Presentation States. However, here we outline the need for a standard for simulation meshes and review several related approaches. As a result, we propose preliminary requirements for a simulation mesh standard and provide several use case scenarios of how Web3D and haptic technologies can aid the fulfillment of these requirements. We conclude with an X3D proposal to describe simulation meshes for soft (deformable) bodies.

Rui Hu

A Generalized Haptic Feedback Approach for Arbitrarily Shaped Objects

In surgery procedures, haptic interaction provides surgeons with indispensable information to accurately locate the surgery target. This is especially critical when visual information cannot provide sufficient information and tactile interrogation, such as palpating some region of tissue, is required to locate a specific underlying tumor. However, in most current surgery simulators, the haptic interaction model is usually simplified into a contact sphere or rod model, leaving arbitrarily shaped intersection haptic feedback between target tissue and surgery instrument less unreliable. In this paper, a novel haptic feedback algorithm is introduced for generating the feedback forces in surgery simulations. The proposed algorithm initially employs three Layered Depth Images (LDI) to sample the 3D objects in X, Y and Z directions. A secondary analysis scans through two sampled meshes and detects their penetration volume. Based on the principle that interaction force should minimize the penetration volume, the haptic feedback force is derived directly. Additionally, a post-processing technique is developed to render distinct physical tissue properties across different interaction areas. The proposed approach does not require any pre-processing and is applicable for both rigid and deformable objects.

Tatsuro Bito

A Synchronization Method for Haptic Collaborative Virtual Environments of Multipoint and Multi-Level Computer Performance Systems

We have developed a novel volume-based haptic communication system, which allows participants at remote sites on the network to simultaneously interact with the same target object in virtual environments presented by multi-level computer performance systems, by only exchanging a small set of manipulation parameters for the target object and additional packet for synchronization of status of binary tree and deformation of shared volume model. We first developed an online-remesh volume models, we call dynamic adaptive grids, for simulating deformable objects such as soft tissues in each remote site. Then haptic sensation during interaction with the target object, is achieved by rendering the reflection force from the object, simulated with the online-remesh volume model from the manipulation parameters exchanged among all remote sites. We investigated the efficiency of our system via experiments with high force feedback rates at remote locations on a WAN between Tokyo, Osaka and Kyoto.

SATURDAY MORNING – SESSION B

NIDRR Perspectives on VR Applications for Addressing the Needs of those Aging with and into Disability

See schedule for description of this independently organized session

SATURDAY MORNING – SESSION C

Multi-User Virtual Environment Boot Camp and Patient Surge Triage Practice

See schedule for description of this independently organized session.
## Presenter Index

<table>
<thead>
<tr>
<th><strong>Name</strong></th>
<th><strong>Schedule</strong></th>
<th><strong>Summary</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Abhari, Kamyar</td>
<td>13</td>
<td>44</td>
</tr>
<tr>
<td>Aisen, Mindy</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>Albani, Giovanni</td>
<td>22</td>
<td>68</td>
</tr>
<tr>
<td>Allen, Brian</td>
<td>18</td>
<td>59</td>
</tr>
<tr>
<td>Arikatla, Venkata</td>
<td>22, 23</td>
<td>69, 73</td>
</tr>
<tr>
<td>Awad, Imad</td>
<td>18, 21</td>
<td>60, 66</td>
</tr>
<tr>
<td>Banerjee, Pat</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>Baños, Rosa</td>
<td>14</td>
<td>47</td>
</tr>
<tr>
<td>Barak-Bernhagen, Mary</td>
<td>16, 21</td>
<td>55, 66</td>
</tr>
<tr>
<td>Barnes, Steven</td>
<td>22</td>
<td>68</td>
</tr>
<tr>
<td>Baysa, Kóan Jeff</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>Beier, Florian</td>
<td>18</td>
<td>58</td>
</tr>
<tr>
<td>Bello, Fernando</td>
<td>23, 23</td>
<td>73, 74</td>
</tr>
<tr>
<td>Berg, Devin</td>
<td>15</td>
<td>51</td>
</tr>
<tr>
<td>Bergeron, Bryan</td>
<td>11</td>
<td>40</td>
</tr>
<tr>
<td>Bito, Tatsuro</td>
<td>24</td>
<td>75</td>
</tr>
<tr>
<td>Blascovich, James</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>Boedeker, Ben</td>
<td>23, 23</td>
<td>71, 71</td>
</tr>
<tr>
<td>Boedeker, Kirsten</td>
<td>21, 21</td>
<td>66, 66</td>
</tr>
<tr>
<td>Botella, Cristina</td>
<td>14</td>
<td>47</td>
</tr>
<tr>
<td>Bracio, Boris</td>
<td>14</td>
<td>48</td>
</tr>
<tr>
<td>Bucholz, Richard</td>
<td>14</td>
<td>48</td>
</tr>
<tr>
<td>Bulpert, Andrew</td>
<td>23</td>
<td>74</td>
</tr>
<tr>
<td>Cameron, Bruce</td>
<td>12</td>
<td>44</td>
</tr>
<tr>
<td>Chan, Sonny</td>
<td>18</td>
<td>59</td>
</tr>
<tr>
<td>Chien, Jung-Hung</td>
<td>21, 21</td>
<td>67, 67</td>
</tr>
<tr>
<td>Chodos, David</td>
<td>12</td>
<td>42</td>
</tr>
<tr>
<td>Coles, Timothy</td>
<td>22</td>
<td>71</td>
</tr>
<tr>
<td>Constantinou, Christos</td>
<td>23</td>
<td>72</td>
</tr>
<tr>
<td>Courtelie, Olivier</td>
<td>21</td>
<td>67</td>
</tr>
<tr>
<td>Cregan, Patrick</td>
<td>19</td>
<td></td>
</tr>
<tr>
<td>Creutzfeldt, Johan</td>
<td>11</td>
<td>40</td>
</tr>
<tr>
<td>Cristancho, Sayra</td>
<td>18, 18</td>
<td>58, 60</td>
</tr>
<tr>
<td>Cutler-Shaw, Joyce</td>
<td>29</td>
<td></td>
</tr>
<tr>
<td>Davoodi, Rahman</td>
<td>19</td>
<td>62</td>
</tr>
<tr>
<td>De Mauro, Alessandro</td>
<td>22</td>
<td>69</td>
</tr>
<tr>
<td>De Paolis, Lucio</td>
<td>14</td>
<td>48</td>
</tr>
<tr>
<td>Delorme, Sebastien</td>
<td>23</td>
<td>73</td>
</tr>
<tr>
<td>Delson, Nathan</td>
<td>15, 20</td>
<td>51, 63</td>
</tr>
<tr>
<td>Dev, Parvati</td>
<td>12</td>
<td>41</td>
</tr>
<tr>
<td>Doswell, Jayfus</td>
<td>14</td>
<td>48</td>
</tr>
<tr>
<td>Dubrowski, Adam</td>
<td>19</td>
<td>61</td>
</tr>
<tr>
<td>Eagleson, Roy</td>
<td>15</td>
<td>51</td>
</tr>
<tr>
<td>Ellis, Randy</td>
<td>12, 14, 19</td>
<td>44, 44, 48</td>
</tr>
<tr>
<td>Fahlstedt, Madelen</td>
<td>15</td>
<td>52</td>
</tr>
<tr>
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