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## Organizing Committee

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<tr>
<td>Michael J. Ackerman PhD</td>
<td>Office of High Performance Computing &amp; Communications, National Library of Medicine</td>
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<tr>
<td>Kóan Jeff Baysa MD</td>
<td>Medical Avatar, New York SENSEight, Los Angeles</td>
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<td>Steve Charles MD</td>
<td>University of Tennessee</td>
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<td>Li Felländer-Tsai MD PhD</td>
<td>Clinical Science, Intervention, and Technology, Karolinska Institutet</td>
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<td>Cali Fidopiastis PhD</td>
<td>Design Interactive</td>
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<tr>
<td>Henry Fuchs PhD</td>
<td>Department of Computer Science, University of North Carolina</td>
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<td>Walter J. Greenleaf PhD</td>
<td>Virtual Human Interaction Lab, Stanford University</td>
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<tr>
<td>Felix Hamza-Lup PhD</td>
<td>Department of Computer Science and Information Technology, Armstrong State University</td>
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<td>David M. Hananel</td>
<td>SimPortal / CREST, University of Minnesota</td>
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<td>Wm. LeRoy Heinrichs MD PhD</td>
<td>Innovation in Learning, Inc.; Stanford University School of Medicine</td>
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<tr>
<td>Pierre Jannin PhD</td>
<td>MediCIS U1099 LTSI, Inserm, Université de Rennes 1</td>
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<tr>
<td>Heinz U. Lemke PhD</td>
<td>Institute for Technical Informatics, Technical University Berlin</td>
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<tr>
<td>Cristian A. Linte PhD</td>
<td>Department of Biomedical Engineering, Rochester Institute of Technology</td>
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<tr>
<td>Alan Liu PhD</td>
<td>National Capital Area Medical Simulation Center, Uniformed Services University</td>
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<tr>
<td>Bertalan Meskó MD PhD</td>
<td>Medical Futurist</td>
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<td>Greg T. Mogel MD</td>
<td>Kaiser Permanente</td>
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<tr>
<td>Adrianne Noe PhD</td>
<td>National Museum of Health &amp; Medicine, US Depart of Defense</td>
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<td>Makoto Nonaka MD PhD</td>
<td>Foundation for International Scientific Advancement; La Jolla Institute for Allergy and Immunology</td>
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<tr>
<td>Carla M. Pugh MD PhD</td>
<td>School of Medicine and Public Health, University of Wisconsin – Madison</td>
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<tr>
<td>Giuseppe Riva PhD</td>
<td>Applied Technology for Neuro-Psychology Lab &amp; Istituto Auxologico Italiano</td>
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</table>
Albert A. "Skip" Rizzo PhD
Institute for Creative Technologies & School of Gerontology
University of Southern California

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Mayo Clinic College of Medicine

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University of Rochester, NY

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Institute of Clinical Medicine, Aarhus University (DK)

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Baylor University Medical Center

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University of California, Los Angeles

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University of Washington Medical Center

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University of Wisconsin - La Crosse

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California Institute of Computer Assisted Surgery (CiCAS)

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University of Minnesota

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University of California, San Diego

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Interface Laboratory
Ohio Supercomputer Center

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Center for Medical Devices (CMed) at Mount Sinai Heart & Icahn School of Medicine at Mount Sinai, New York City

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WWAMI Institute for Simulation in Healthcare
University of Washington

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Brigham & Women’s Hospital
Harvard Medical School

Dave Warner MD PhD
MindTel LLC;
Inst for Interventional Informatics

Brenda K. Wiederhold PhD MBA BCB BCN
Virtual Reality Medical Institute, Brussels;
Interactive Media Institute, San Diego

Mark D. Wiederhold MD PhD CPE FACP FACPE
Virtual Reality Medical Center, San Diego
Plenary Presenters

**Angelos Barmopoulos PhD**
Associate Professor, On-Line Institute & Digital Worlds Institute, Dept of Computer and Information Science and Engineering, Dept of Biomedical Engineering, University of Florida

**Joel Burdick PhD**
Richard L. and Dorothy M. Hayman Professor of Mechanical Engineering and Bioengineering, Jet Propulsion Laboratory Research Scientist, Caltech

**Tipatat Chennavasin**
Co-Founder and General Partner, The Venture Reality Fund

**Kevin Cleary PhD**
Technical Director, Sheikh Zayed Institute for Pediatric Surgical Innovation, Children’s National Health System

**Henry Fuchs PhD**
Fedorenko Distinguished Professor of Computer Science, Adjunct Professor of Biomedical Engineering, University of North Carolina at Chapel Hill

**Walter Greenleaf PhD**
Distinguished Visiting Scholar, MedixX Program, Visiting Scholar, Virtual Human Interaction Lab, Stanford University; Chief Science Officer, Pear Therapeutics & Cognitive Leap; Medical Director, AppliedVR

**David Hananel**
Associate Program Director, Center for Research in Education and Simulation Technologies, University of Minnesota

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Head, MediCIS Group, LTSI Institute DR2 INSERM Research Director Université de Rennes 1

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Founder, Silicon Valley Virtual Reality & escVR; Emerging Technology Consultant, PresenceWorks

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Professor of Computer Science, Technical University Berlin; Research Professor of Radiology, University of Southern California; Senior Advisor, Innovation Center Computer Assisted Surgery

**Daniel Low PhD**
Professor and Vice Chair of Medical Physics, UCLA Radiation Oncology University of California, Los Angeles

**Neil Martin MD**
W. Eugene Stern Chair, Dept of Neurosurgery, David Geffen School of Medicine, University of California, Los Angeles

**Jacquelyn Morie PhD**
Founder & Chief Scientist, All These Worlds LLC

**Jack Norfleet**
Chief Engineer, Medical Simulation Research Branch, US Army Research, Development and Engineering Command

**Sam Peterson**
Principal Scientist, Algorithm Development, Vital Images, Inc.

**Albert “Skip” Rizzo PhD**
Director for Medical Virtual Reality, Institute for Creative Technologies, Research Professor, Dept of Psychiatry and School of Gerontology, University of Southern California

**Cosmo Scharf**
Co-Founder and CXO, Visionary VR; Co-Founder, VRFA

**Robert Sweet MD FACS**
Professor, Urology Executive Director, WWAMI Institute for Simulation in Healthcare, Medical Director, Kidney Stone Program, University of Washington; Associate Research Professor, University of Minnesota

**Thomas Talbot MD**
Principal Medical Expert, Institute for Creative Technologies, Adjunct Associate Research Professor of Medical Education, University of Southern California

**Jeff Webb**
**Welcome**

Thank you for being part of NextMed / MMVR22—for your investment in time, effort, and resources to join us here in Los Angeles in order to share and learn.

Please note:
- The syllabus Addendum describes very recent program changes.
- The Schedule-at-a-Glance (back cover) provides an overview of session times and locations.
- The CD supplement includes an index of all presentations that clarifies where to find supporting materials.
- The Proceedings, published by IOS Press, is in a single PDF file on the CD.
- Summaries of presentations not formally published, including demos, are in a separate file on the CD.

If your device doesn’t have a CD drive, we can provide you instructions for downloading materials. Please ask at the registration desk.

Wireless Internet is available in the meeting foyer area. Disengage continuous backup applications so your fellow attendees can enjoy the bandwidth, too.

Continental breakfast will be served Thursday, Friday, and Saturday mornings. There will also be refreshments at the Thursday evening reception. During the lunch breaks, you may explore food options in this neighborhood.

Downtown Los Angeles is remarkably varied destination that reflects a vast and diverse global city. Within a short walk of the hotel are striking contrasts of people and culture. If you are not familiar with the neighborhood, we encourage you to visit the registration desk or the hotel’s concierge to ask about local attractions that suit your sense of adventure.

**Mission Statement**

NextMed / MMVR promotes the creation and adoption of IT-enabled tools for patient care and medical education that support better precision, efficiency, and outcomes. The curriculum combines traditional assessment methods with unorthodox problem-solving to stimulate forward-thinking solutions to healthcare problems. Presentations are chosen to educate participants on:

- Advances in simulation, modeling, and haptics that are upgrading medical education, skills training, psychotherapy, and physical rehabilitation
- Novel imaging, visualization, and data fusion methods that make clinical diagnosis and therapy more precise and personalized
- Robotics and sensors that extend the caregiver’s reach and provide richer patient data
- Medical intelligence networks that promote a collaborative healthcare environment and enhance decision-making
- Broader goals, accomplishments, and challenges in the development and application of emerging healthcare technologies

**Target Audience**

NextMed/MMVR is an international conference that welcomes the participation of:

- Physicians and other medical professionals who are interested in computer-enabled advances that make patient care more effective, accurate, and affordable
- IT engineers and medical device developers who must understand caregivers’ needs in order to direct projects toward the best outcome
- Medical educators and students involved with the transfer of knowledge to the next generation of physicians and fellow providers
- Military medicine specialists addressing the special demands of battlefield care and warrior rehabilitation
- Biomedical futurists, investors, and policy-makers who need to evaluate scenarios for healthcare’s future

**Acknowledgements**

Many thanks to our friends and colleagues on the Organizing Committee for their support and enthusiasm. We are especially grateful to those Committee members who review submissions during the Call for Presentations, who serve as Proceedings editors and ensure that the volume is a useful research tool, and who bring their colleagues and students to the conference to share and learn.

And our sincere thanks to all of you researchers who have labored for countless hours on projects that move the field forward, and are now sharing your experience here in support of better patient care and medical education.

*continued on following page*
The Satava Award

The 20th Satava Award will be presented on Friday morning. The award acknowledges the pioneering efforts of Dr Richard M. Satava. We present it each year to an individual or research group that demonstrates unique vision and commitment to the improvement of medicine through advanced technology. Its prior recipients are:

Ramin Shahidi PhD (2014)
Alexander Tsiaras (2013)
Albert “Skip” Rizzo PhD (2012)
Kirby Vosburgh PhD (2011)
Helene Hoffman PhD (2009)
Alan Liu PhD & Mark Bowyer MD (2008)
Naoki Suzuki PhD (2007)
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)

Disclaimer

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

Organizer Contact Info

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San Luis Obispo, CA 93405 USA
MMVR22@NextMed.com
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MMVR22

Activity
Schedule
## Activity Schedule

### THURSDAY MORNING, APRIL 7

**Location:** California Ballroom Foyer

**7:00** Registration & Continental Breakfast

### Plenary Session

**Location:** California Ballroom ABC

**8:20** Welcome & Introduction
James Westwood and Karen Morgan
Conference Organizers

**8:30** Panel
Exploring VR’s Trajectory from the Nineties’ Boom through Today’s Renaissance and into the Future

**Organizer:** Albert “Skip” Rizzo
Institute for Creative Technologies, USC

**Moderator:** Walter Greenleaf
Stanford University

**Panelists:**
- Tipatat Chennavasin
  The Venture Reality Fund
- Henry Fuchs
  University of North Carolina
- Karl Krantz
  Silicon Valley Virtual Reality
- Jacquelyn Ford Morie
  All These Worlds, LLC
- Albert “Skip” Rizzo
  Institute for Creative Technologies, USC
- Cosmo Scharf
  Virtual Reality LA

**11:30** Robotics, Navigation, and Image Guidance for Minimally Invasive Pediatric Interventions
Kevin Cleary ..........................................................33
Children’s National Health System

**12:00** Break

### THURSDAY AFTERNOON, APRIL 7

#### Track 1

**Location:** California Ballroom A

**1:25** Moderator’s Welcome
Parvati Dev

**1:30** Proficiency Based Progression Simulation Training as an ‘Outcome’ Based Approach to Graduate Medical Education and Training; What is It and How to Do It?
Anthony Gallagher ..................................................33
ASSERT Centre, University College Cork, Ireland

**1:45** Immersive Learning Experiences for Surgical Procedures
Henry Fuchs and Young-Woon Cha ...............................34
Dept of Computer Science, University of North Carolina

**2:00** The Evolution of Medical Training Simulation in the U.S. Military
Amber Linde .............................................................34
JPC-1 Medical Simulation & Information Sciences Research Program

**2:15** The Role of Game Elements in Online Learning within Health Professions Education
David Rojas .............................................................34
Wilson Centre, Faculty of Medicine, University of Toronto

**2:30** An Interactive 3D Virtual Anatomy Puzzle for Learning and Simulation - Initial Demonstration and Evaluation
Erik Messier .............................................................34
Kate Gleason College of Engineering, Rochester Institute of Technology

**2:45** Simulation-Based Training Must be More Than an Interesting Educational Experience
Anthony Gallagher ..................................................35
ASSERT Centre, University College Cork, Ireland

**3:00** Discussion

**3:15** Break
Thursday Afternoon

3:30 INDEPENDENT SESSION
What You See is What You Get? Comparing Techniques of Video as a Means of Data Collection and Analysis in Research on Interprofessional Simulation

Overview and Learning Objectives .............................. 27

Organizers:
Madeleine Abrandt Dahlgren
Linköping University
Hans Rystedt
Gothenburg University
Li Felländer-Tsai
Karolinska Institutet

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Collaborative Video-Analysis to Visualize Information Transformation in Medical Simulation
Cecilia Escher .............................................................. 27
Karolinska Institutet
Li Felländer-Tsai
Karolinska Institutet

Video-Enhanced Debriefing in Interprofessional Training of Nursing and Medical Students
Hans Rystedt ................................................................. 27
Gothenburg University

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Linköping University
Madelein Abrandt Dahlgren
Linköping University

5:00 Break

THURSDAY AFTERNOON, APRIL 7

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IMAGING

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Cristian Linte

1:30 Multi-Kinect v2 Camera Based Monitoring System for Radiotherapy Patient Safety
Anand Santhanam .......................................................... 35
Dept of Radiation Oncology,
University of California, Los Angeles

3:45 INDEPENDENT SESSION
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Jannick Rolland .............................................................. 35
The ODA Lab at The Inst of Optics,
University of Rochester

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Modeling, Simulation and Visualization
Engineering Dept, Old Dominion University

The Virtual Pediatric Airways Workbench
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Kitware, Inc.

A Toroidal Probe for Measuring Surgically Exposed Joint Centers
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School of Computing, Queen’s University

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Dept of Computer Science, Purdue University

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Towards the Implementation of an Autonomous Camera Algorithm on the da Vinci Platform
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Dept of Electrical and Computer Engineering,
Wayne State University

Discussion

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Update on the Fundamentals of Robotic Surgery
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Organizers & Presenters:
Richard Satava
University of Washington
Jeffrey Levy
CaseNetwork
THURSDAY AFTERNOON, APRIL 7

Track 3
Location: California Ballroom C
1:30 – 5:00
INDEPENDENT SESSION

BioGears: An Open-Source Human Physiology Engine Overview
Overview and Learning Objectives ........................................28
Visit https://www.biogearsengine.com/mmvr for key data, including materials to download, before the session.

Organizers:
Rachel Clipp
Jeff Webb
Aaron Bray

Presentations:
BioGears: An Open-Source Human Physiology Engine Overview
Rachel Clipp
Jeff Webb
Aaron Bray

Using the Open-Source BioGears GUI
Rachel Clipp
Jeff Webb

Interacting with the BioGears API
Aaron Bray

BioGears Q&A and Help Session
Rachel Clipp
Jeff Webb
Aaron Bray

THURSDAY EVENING, APRIL 7

Posters & Mini-Lectures Reception
Location: California Ballroom DEF
5:15 – 7:15

POSTERS
Posters will be set up late Thursday morning and displayed through Saturday morning. Poster presentations are listed starting on page 18.

Posters are numbered and displayed in syllabus order, except posters by the same individual and/or institution are grouped together. Please see the posted indices for number and display sequence.

MINI-LECTURES
Mini-lectures will be given adjacent the poster area during the Thursday evening reception. Some are stand-alone presentations while others supplement posters and demos.

Development of a Generic Tubular Tree Structure for the Modeling of Orbital Cranial Nerves
Thomas Kaltten .................................................................54
Research Unit Medical Informatics,
RISC Software GmbH

Four-Dimensional Imaging: Tracking Cancer Growth through Space and Time
Matthew Bramlet ..............................................................53
Jump Trading Simulation and Education Center,
University of Illinois School of Medicine

Humanikins: Humanity Transfer to Physical Manikins
Salam Daher .................................................................65
Institute for Simulation & Training,
The University of Central Florida

Smart Camera: Using Computer Vision to Improve the Assessment of Medical Training
Matthew Hacket ..............................................................65
Army Research Laboratory - Human Research and Engineering Directorate

Gunner Goggles: Implementing Augmented Reality into Medical Education
Nadir Bilici .................................................................50
Perelman School of Medicine,
University of Pennsylvania

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Heidi Maertens ..............................................................65
Dept of Thoracic and Vascular Surgery,
Ghent University Hospital
Thursday Evening

6:06  Project EPICSAVE - Enhanced Paramedic Vocational Training w/ Serious Games and Virtual Environments
      Jonas Schild ...............................................................51
      Institute of Visual Computing,
      Bonn-Rhein-Sieg University of Applied Sciences

6:06  Fully-Immersive 3D Multiplayer Training on $150 Laptops!
      Randy Brown .............................................................70
      Virtual Heroes Division,

6:12  Interactive Rear-Projection Physical-Virtual Patient Simulators
      Gregory Welch ...........................................................66
      College of Nursing; Dept of Computer Science and Institute for Simulation & Training,
      The University of Central Florida

6:18  Usage, Development and Refinement of a High-Fidelity Surgical Phantom for Examining Torso Exsanguination in Weightlessness and Multiple Sea States
      Anthony LaPorta .........................................................59
      Rocky Vista University LLC

      James Earl Cox III ......................................................65
      Interactive Media and Game Design Program,
      School of Cinematic Arts,
      University of Southern California

6:30  The Scarred for Life Project: The Lived Experience of Illness
      Ted Meyer .................................................................65
      David Geffen School of Medicine,
      University of California, Los Angeles

6:36  Integrated Self-Management System for Improved Treatment of Asthma
      Kristen Nguyen ..........................................................48
      Farus, LLC

6:42  The Effect of Virtual Reality in Reducing Preoperative Anxiety in Patients Undergoing Arthroscopic Knee Surgery: A Randomized Controlled Trial
      Anita Robertson .........................................................57
      Surgical Realities

6:48  Study of Event Characterization in Wireless EEG Monitoring with EMOTIV
      Wei Wang .................................................................47
      Dept of Computer Science,
      San Diego State University

6:54  The Cost Effectiveness of Research: Are These Objective Measurements the Tools of the Future?
      Anthony LaPorta .......................................................51
      Rocky Vista University LLC
FRIDAY MORNING, APRIL 8

Location: California Ballroom Foyer

7:30 Registration & Continental Breakfast

Plenary Session

Location: California Ballroom ABC

8:30 INDEPENDENT SESSION

Fidelity for Simulation in Healthcare: Pushing the Envelope
Overview and Learning Objectives ........................................29

Organizers & Chairs:
Robert Sweet
University of Washington

David Hananel
University of Minnesota

Presentations:
Tissue Fidelity
Jack Norfleet
US Army Research Laboratory

Physiology Fidelity
Thomas Talbot
Inst for Creative Technologies, University of Southern California

Jeff Webb

Anatomic Fidelity
Sam Peterson
Vital Images, Inc.

9:50 Break

10:15 Moderator’s Welcome
Carla Pugh

10:20 Synthesis and Simulation of Surgical Process Models
Pierre Jannin.................................................................37
MediCIS U1009 LTSI,
Inserm, Université de Rennes 1

10:40 Integrated Patient Care with IHE
Heinz Lemke..............................................................37
International Foundation of Computer Assisted Radiology and Surgery

11:00 Assessment of Haptic Interaction for Home-Based Physical Tele-Therapy using Wearable Devices and Depth Sensors
Angelos Bampoulis.....................................................37
Digital Worlds Inst, University of Florida

11:20 Recovery of Function after Severe Spinal Cord Injury by Spinal Stimulation
Joel Burdick...............................................................38
Engineering & Applied Science, Caltech

11:50 Presentation of the 20th Satava Award

12:00 Break

FRIDAY AFTERNOON, APRIL 8

Track 1

Location: California Ballroom A

SURGICAL SIMULATION

1:25 Moderator’s Welcome
Alan Liu

1:30 Towards Surgeon-Authored VR Training: The Scene-Development Cycle
Jörg Peters.................................................................38
Computer & Information Science & Engineering, University of Florida

1:45 Development and Evaluation of a Novel Pan-Specialty Virtual Reality Surgical Simulator for Smartphones
Jean Nehme.................................................................38
Touch Surgery Labs

2:00 A Framework for Patient-Specific Spinal Intervention Simulation: Application to Lumbar Spinal Durotomy Repair
Elvis Chen.................................................................38
Robarts Research Inst & Western University

2:15 A Methodological, Task-Based Approach to Procedure-Specific Simulations Training
Yaki Setty.................................................................39
3DSystems, Simbionix

2:30 Fabric Force Sensors for the Clinical Breast Examination Simulator
Shlomi Lauffer............................................................39
Dept of Surgery & Dept of Electrical Engineering and Computer Science, University of Wisconsin-Madison

2:45 Discussion

3:00 Break
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<td>3D Physics-Based Registration of 2D Dynamic MRI Data</td>
<td>Raffaella Trivisonne 41 Inria Nancy, CNRS Strasbourg &amp; IHU Strasbourg</td>
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<td>2:00</td>
<td>HAPTICS</td>
<td>A Unified Framework for Haptic Interaction in Multimodal Virtual Environments</td>
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<td>Venkata Arikatla 41 Medical Computing Team, Kitware Inc.</td>
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<td>Does Virtual Haptic Dissection Improve Student Learning? A Multi-Year Comparative Study</td>
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<td>Caroline Erolin 41 Centre for Anatomy and Human Identification (CAHID), University of Dundee</td>
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<td>Constrained Point-Based Framework with Efficient Mechanical Interaction for Virtual Surgery</td>
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<td>Weixin Si 41 Dept of Computer Science and Engineering, The Chinese University of Hong Kong</td>
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<tr>
<td>3:30</td>
<td>SURGICAL METRICS</td>
<td>Objective Surgical Skill Differentiation for Physical and Virtual Surgical Trainers via Functional Near-Infrared Spectroscopy</td>
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<td>Arun Nemani 39 Center for Modeling, Simulation, and Imaging in Medicine (CeMSIM), Rensselaer Polytechnic Institute</td>
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<td>Asymmetry in Dominant / Non-Dominant Hand Performance Differentiates Novices from Experts on an Arthroscopy Virtual Reality Serious Game</td>
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<td>Robert Pedowitz 40 Professor Emeritus, University of California</td>
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<tr>
<td>4:00</td>
<td>Virtual Airway Skills Trainer (VAST) Simulator</td>
<td>Doga Demirel 40 Dept of Computer Science, University of Central Arkansas</td>
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<td>Importance of Stereoscopy in Haptic Training of Novice Temporal Bone Surgery</td>
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<td>Bertram Unger 40 Faculty of Health Sciences, University of Manitoba</td>
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<td>4:30</td>
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<td>4:45 Adjourn</td>
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**FRIDAY AFTERNOON, APRIL 8**

**Track 2**

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<td>Naoki Suzuki 40 Inst for High Dimensional Medical Imaging, The Jikei University School of Medicine</td>
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**Friday Afternoon**

Moderator’s Welcome
Yunhe Shen

Nathan Delson Dept Mechanical and Aerospace Engineering, University of California, San Diego

**Surgical Metrics**

3:30 Objective Surgical Skill Differentiation for Physical and Virtual Surgical Trainers via Functional Near-Infrared Spectroscopy
Arun Nemani 39 Center for Modeling, Simulation, and Imaging in Medicine (CeMSIM), Rensselaer Polytechnic Institute

3:45 Asymmetry in Dominant / Non-Dominant Hand Performance Differentiates Novices from Experts on an Arthroscopy Virtual Reality Serious Game
Robert Pedowitz 40 Professor Emeritus, University of California

4:00 Virtual Airway Skills Trainer (VAST) Simulator
Doga Demirel 40 Dept of Computer Science, University of Central Arkansas

4:15 Importance of Stereoscopy in Haptic Training of Novice Temporal Bone Surgery
Bertram Unger 40 Faculty of Health Sciences, University of Manitoba

4:30 Discussion
4:45 Adjourn
### FRIDAY EVENING, APRIL 8

**Evening Session**

*Location: California Ballroom B*

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<td><strong>Moderator’s Welcome</strong>&lt;br&gt;Adrienne Noe</td>
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<td>9:00</td>
<td><strong>Automatic Behavior Analysis During a Clinical Interview with a Virtual Human</strong>&lt;br&gt;Albert “Skip” Rizzo, Inst for Creative Technologies &amp; Dept of Psychiatry and School of Gerontology, University of Southern California</td>
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<td>9:15</td>
<td><strong>Natural Language Understanding</strong>&lt;br&gt;Thomas Talbot, Keck School of Medicine &amp; Inst for Creative Technologies, University of Southern California</td>
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<td>9:30</td>
<td><strong>Portable Virtual Reality for Assessment and Treatment of Burnout</strong>&lt;br&gt;Brenda Wiederhold, Virtual Reality Medical Center; Interactive Media Institute</td>
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<td>9:45</td>
<td><strong>Positive and Transformative Technologies for Active Ageing</strong>&lt;br&gt;Giuseppe Riva, Ist Auxologico Italiano &amp; Università Cattolica del Sacro Cuore, Milano</td>
</tr>
<tr>
<td>10:00</td>
<td><strong>A Cost-Effective Virtual Environment for Simulating and Training Powered Wheelchairs Manoeuvres</strong>&lt;br&gt;Nigel John, Dept of Computer Science, University of Chester, UK</td>
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Dept of Electrical and Computer Engineering, University of California, San Diego

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**SATURDAY MORNING, APRIL 9**

**Track 2**

**Location:** California Ballroom B

9:00 INDEPENDENT SESSION

Introduction to Multi-Physics Simulation with SOFA. Join the Community!

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Inria
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Inria

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THURSDAY & FRIDAY AFTERNOON, APRIL 7 & 8

Demo Presentations

Locations:  California Ballroom DEF & Orpheum Room

The Demo area will be active on Thursday and Friday afternoons, from 12 Noon to 5:00 PM. Many demos are displayed continuously on both days. Others have scheduled presentation times.

Note: Scheduled times include set-up and dismantle, which vary. Please visit the demo presenters to confirm when they will be ready to share their work.

THURSDAY SCHEDULED DEMOS

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2:15 – 3:15  The Interactive Physical and Cognitive Exercise System (iPACES®)
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Union College

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School of Human Ecology, Wisconsin Institutes for Discovery, University of Wisconsin-Madison

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FRIDAY SCHEDULED DEMOS

1:30 – 2:30  The Interactive Physical and Cognitive Exercise System (iPACES®)
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Union College

2:30 – 3:00  Fully-Immersive 3D Multiplayer Training on
$150 Laptops!
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3:00 – 4:45  S3PM – Synthesis and Simulation of Surgical Process Models
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1:00 – 4:45  Videolaryngoscopy Simulator
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Dept Mechanical and Aerospace Engineering,
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THURSDAY Afternoon
TRACK 1

3:30 – 5:00 PM

What You See is What You Get? Comparing Techniques of Video as a Means of Data Collection and Analysis in Research on Interprofessional Simulation

Organizers
Madeleine Abbrandt Dahlgren
Linköping University

Hans Rystedt
Gothenburg University

Li Felländer-Tsai
Karolinska Institutet

Overview & Learning Objectives:

The learning objectives of the session are to
• Problematize video-analysis as a means of data collection
• Explore the feasibility of theory for data analysis
• Explore methodological issues in relation to collaborative analysis

This session compares and problematizes three cases of video as a means of qualitative data collection and analysis. The use of video as a means of data collection in simulation research is increasing but has in qualitative research not been subject to discussions of methodological concerns to the same extent as more traditional methods, such as interviews, fieldwork or focus groups. Typically, the methodological issues raised in relation to the use of video as a method of data collection have concerned issues of access to record, ethical issues and the possible effect of video recording on the on-going activities. In this focus session, we explore and compare how different theoretical and methodological framings relating to all stages of the research process shape the research questions, analyses and outcomes differently. The symposium will comprise presentations of three papers in which the collaborative partners have worked with the same set of video recordings of interprofessional scenario-based simulation, where the participants work together as a team in emergency scenarios. The examples stem from a nationally funded project on scenario-based interprofessional simulation with medical and nursing students in collaboration between the universities in Linköping, Gothenburg and Karolinska Institutet in Sweden.

Presentations:

Collaborative Video-Analysis to Visualize Information Transformation in Medical Simulation

Cecilia Escher
Karolinska Institutet

Li Felländer-Tsai
Karolinska Institutet

The first presentation explores an approach to collaborative video-analysis where two research teams analyzed the same video-recording of simulating medical and nursing students. The two teams iterated between individual and collaborative interpretations, in a first step within each single team and in a second step across the two teams. Findings were critically assessed, compared and negotiated between the teams to produce a shared understanding. The analysis focused on how additional information was conveyed to the participants during the scenario to overcome the shortcomings of the simulator, such as skin temperature, color and other tactile and visual information available in clinical work. The findings show that the sequencing and timing of this information during the scenarios were crucial for furthering the participants’ activities. In the presentation, we discuss different modes of providing information during the simulation scenario and their effects on the participants’ performance.

Video-Enhanced Debriefing in Interprofessional Training of Nursing and Medical Students

Hans Rystedt
Gothenburg University

The second presentation builds on conversation analysis and investigates how video recordings of simulation scenarios are used to introduce and ground facilitated feedback discussions during debriefings. The focus of the analysis is put on sequences in the debriefings where events recorded in the scenarios are explicitly referred to, both verbally and by means of gestures and bodily orientations. Through this focus, the analysis shows how the video recordings function as an indexical ground and a common point of reference through the participants’ referential actions, and how the video recordings are used to re-actualize specific events from the previous simulation scenarios on a detailed level.
The third presentation builds on practice theory. Practice theory views knowledge as being embodied and relational, intertwined with ethical reasoning and materiality. The findings show that the student teams relate to the manikin as a technical, medical, and human body, and that interprofessional knowings and enactments emerge as a fluid movement between bodily positioning in synchrony, and bodily positioning out of synchrony, in relation to the sociomaterial arrangements. The findings are related to contemporary theorisations of practice comprising an integrated view of body and mind, and it is discussed how the findings can be used in simulation exercises to support participants’ learning in new ways.

A double-blind, randomized validation trial was conducted by 12 ACS-AEI certified academic simulation centers. The skills training in the study was performed on a physical dome, a virtual dome both the DaVinci Skills System (DVSS) ‘backpack’ with software by 3D Systems/Simbionix and hardware by Intuitive Surgical and DaVinci Trainer (dV-Training) with software and hardware developed by Mimic Technologies. Preliminary results will be available by this MMVR/NextMed conference presentation.

Another consensus conference that included 8 OB/Gyn societies/boards, the AMA and JCAHO was convened to utilize the FRS basic skills curriculum template to create the advanced technical skills of the Fundamentals of Robotic Gynecologic Surgery (FRGS). All new specialty/procedure specific tasks were developed for FRGS. Due to the groundwork of the FRS development process, FRGS was completed in a fraction of the time and at a fraction of the cost compared to the original FRS project. Other specialty societies are now creating their own specialty-specific advanced FRS skills.
back mechanisms. The fluid dynamics (pressure, flow, and volumes) and thermal properties (temperature and heat transfer) are calculated using lumped-parameter models (electric circuit analog). A variety of feedback mechanisms then affect the circuits in a single system or multiple systems via system interactions.

The engine is an open-source tool meant for use in the medical training community. The software architecture was designed with a physiology engine interface that uses a Common Data Model (CDM) for data exchange. The CDM includes objects that encapsulate physiology system data and is used to define patients, substances, equipment, etc. The CDM also includes a variety of action objects that can be used to simulate unique scenarios that fit specific training goals. The application program interface (API) was designed to easily tie into a variety of applications.

Learning Objectives:
- Learn to capabilities of BioGears and how it can influence undergraduate, graduate, and professional education, power training simulations, and interface with hardware (sensors).
- Learn to operate the BioGears physiology engine through the free user interface, including creating scenarios, running scenarios, and viewing outputs.
- Learn to interact with the BioGears physiology engine via the API.
- Ask the BioGears team any questions related to integration of BioGears into specific applications/environments/use cases.

Presentations:

BioGears: An Open-Source Human Physiology Engine Overview
Rachel Clipp, Jeff Webb and Aaron Bray

Using the Open-Source BioGears GUI
Rachel Clipp and Jeff Webb

Interacting with the BioGears API
Aaron Bray
Applied Research Associates, Inc

BioGears Q&A and Help Session
Rachel Clipp, Jeff Webb and Aaron Bray
Applied Research Associates, Inc

Friday Morning
PLENARY SESSION

8:30 — 9:50 AM

Fidelity for Simulation in Healthcare: Pushing the Envelope

Organizer & Chairs
Robert Sweet
University of Washington
David Hananel
University of Minnesota

Overview:
The level of engagement and impact of VR applications for medicine have a direct relationship with fidelity. This session describes the impact of 3 distinct programs that are aimed at raising the bar for anatomic, physiologic and tissue fidelity.

Learning Objectives:
At the end of this session, learners will:
- Appreciate the distinct differences and relative importance between anatomic, physiologic and tissue fidelity for applications in healthcare.
- Be able to understand and apply the capabilities of the BioGears open source physiology engine.
- Be able to understand and apply the capabilities of Vital Images segmentation software.
- Be able to understand the relative importance of and applications of a database for mechanical, electrical, thermal and optical properties of tissue.

Presentations:

Tissue Fidelity
Jack Norfleet
US Army Research Laboratory

Physiology Fidelity
Thomas Talbot
Inst for Creative Technologies, University of Southern California

Jeff Webb

Anatomic Fidelity
Sam Peterson
Vital Images, Inc.
Saturday Morning
TRACK 2

9:00 – 12:00 PM

Introduction to Multi-Physics Simulation with SOFA. Join the Community!

Organizers & Presenters:

Hugo Talbot
Inria

Guillaume Paran
Inria

Overview & Learning Objectives:

SOFA (Simulation Open Framework Architecture) is an open source framework (LGPL License) that allows for building a new generation of surgical simulators (https://www.sofa-framework.org)

The library of SOFA, coded in C++, contains all the main components and algorithms that are needed for a surgical simulation: soft-tissue models, real-time finite element, collision detection, collision response, rigid and flexible instruments models, haptic and visual rendering, GPU computations.

The characteristics of SOFA architecture is to decompose all these features into independent components (degrees of freedom, topology, forces, constraints, differential equations, linear solvers, collision algorithms, etc.) that can be combined easily.

To ensure a consistent simulation, these models are synchronized during the simulation using a mapping mechanism. CPU and GPU implementations can be transparently combined to exploit the computational power of modern hardware architectures. As a result of this flexible and efficient architecture, SOFA can be used as a test-bed to compare models and algorithms, or as a basis for the development of complex, high-performance simulators. For additional information, visit our website www.sofa-framework.org

The objectives of the sessions are:

• Introduction to SOFA (1 hour)
  - SOFA Consortium
  - Main principles and latest features in SOFA
• Short break: give your brain some rest
• Illustration of the principles based on applications examples (30min)
• Build a scene: step by step tutorial (1 hour)
• Discussions, how to use SOFA for your projects (30min)

Attendants should bring their own computer to benefit from the best SOFA experience! Further support using SOFA can be provided after the session.
Lecture Abstracts

THURSDAY Morning, April 7
THURSDAY MORNING PLENARY

Daniel Low

Creating a Real-Time Virtual Copy of the Radiation Therapy Treatment Room

We are exploring the use of multiple 3D cameras to map the radiation therapy treatment room space in real time, with the goal of providing a number of useful tools unavailable to the current radiation therapy department. Proposed applications include automated patient identification, automated patient mispositioning detection, the ability to have a remote expert effectively in the treatment room to provide expert advice, and to allow the radiation therapists the opportunity to be virtually in the room with the patient during the treatment. We will show the status of our project, examples of the treatment room reconstruction, as well as some examples of prototype tools to make radiation therapy safer and more efficient.

Neil Martin

HTC Vive and Oculus in Neurosurgery: Virtual Reality for Preoperative and Intraoperative Procedural Planning, and for Surgical Training

Recent advancements in Virtual Reality (VR) technology have made high resolution, low latency headsets available in the consumer marketplace. While current consumer applications focus on gaming, entertainment and other mainstream uses, UCLA neuroscientists are collaborating with a 3D Imaging and Surgery Guidance company, Surgical Theater, to create comprehensive neuroscience platform enabling an immersive VR environment for imaging. For the first time it is possible to use traditional preoperative medical images to ‘tour’ within the anatomy.

The VR platform (VRStadium) makes use of traditional medical images (DICOM), such as MRI and CT scans, and renders them into a complete, continuous, real time spherical, large room size, model that can be viewed from any angle while “walking” or “flying” inside the anatomy using a VR headset.

When wearing the VR headset in the VRStadium, anatomical structures surround the user; the user can literally stand between a basal artery and the posterior side of a meningioma, move their head to the left, to see the artery, to the right, the tumor, or point their head down toward their feet to see the spinal canal from above.

VR users can tour multiple fused data sets such as post processed DTI fused with vascular data from a CTA. The user can then walk into the space between a cortocospinal tract and AVM nidus and to gain a superior situational awareness regarding the margins and the adequate approach. Furthermore, the VR user can physically walk down a planned endoscopic path or minimally invasive corridor, follow the tip of the virtual endoscope and see the path the scope will maneuver during surgery.

The VRStadium allows for multiple users (represented as avatars in the VR scene) the ability to walk a patient through their surgery, for peer to peer consultation or collaboration, and offers a unique platform to present the latest 3D imaging research in extreme immersive and comprehensive way.

We will demonstrate several brain tumor and aneurysm examples, selected from our experience with more than 200 neurosurgical operative cases.

Kevin Cleary

Robotics, Navigation, and Image Guidance for Minimally Invasive Pediatric Interventions

This talk will present technology developments and clinical applications in the Bioengineering Initiative in the Sheikh Zayed Institute for Pediatric Surgical Innovation at Children’s National Medical Center, Washington, DC, USA. The technology developments include medical robotics, image registration and fusion, and image-guided navigation for pediatric interventions. The clinical applications include laparoscopic abdominal surgery, MRI-guided interventions, craniosynostosis, ureteroscopy, and cochlear implant surgery. The institute includes scientists, radiologists, and surgeons that are dedicated to improving the precision and decreasing the invasiveness of pediatric procedures.

THURSDAY Afternoon, April 7
TRACK 1

EDUCATION

Anthony Gallagher

Proficiency Based Progression Simulation Training as an ‘Outcome’ Based Approach to Graduate Medical Education and Training: What is It and How to Do It!

The Institute of Medicine (IoM) has proposed that medicine should change from a ‘process’ driven approach for graduate medical education (GME) and training, that is one based for example on the number of years in training, the number of
procedures done, and attendance at educational events, to an ‘outcome’ based approach, that is one based on verified and validated skill levels. During the last decade, procedure-based medicine appears to have developed and implemented a competency-based training and assessment system in the USA, Canada and the UK. Although possessing considerable face validity the concept of competency as currently applied in medical education and training bears striking resemblance to a minimum competence based approach that evolved in the USA educational system post 1958. More perturbing is the fact that medical education has developed and validated assessment methodologies that have quantitatively established a pass mark, and by implication competency at the lower end of the performance scale. A particular concern is that this benchmark may be too low for the efficient and effective acquisition of skill for safe operative performance. An alternative approach is a proficiency-based-progression approach. Benchmarking for this training and assessment method is based on the identification, operational definition and assessment of performance characteristics of experienced operators. This benchmarked approach presumes that experienced practicing surgeons are at least competent, probably proficient and possibly expert. Furthermore, prospective, randomized, blinded clinical studies have demonstrated that trainees trained to a proficiency-based-progression benchmarked combined with simulation based training perform significantly better in the operating room. Furthermore, this approach to training circumvents debate about definitions of competency whilst allowing progress, and it is benchmarked on real-world standards that possess excellent face and operative validity, that is based on surgeons currently doing the procedure to the level of proficiency.

Henry Fuchs & Young-Woon Cha

**Immersive Learning Experiences for Surgical Procedures**

Young-Woon Cha, Mingsong Dou, Rohan Chabra, Federico Menozzi, Andrei State, Eric Wallen and Henry Fuchs

This paper introduces a computer-based system that is designed to record a surgical procedure with multiple depth cameras and reconstruct in three dimensions the dynamic geometry of the actions and events that occur during the procedure. The resulting 3D-plus-time data takes the form of dynamic, textured geometry and can be immersively examined at a later time; equipped with a Virtual Reality headset such as Oculus Rift DK2, a user can walk around the reconstruction of the procedure room while controlling playback of the recorded surgical procedure with simple VCR-like controls (play, pause, rewind, fast forward). The reconstruction can be annotated in space and time to provide more information of the scene to users. We expect such a system to be useful in applications such as training of medical students and nurses.

Amber Linde

**The Evolution of Medical Training Simulation in the U.S. Military**

Amber S. Linde and Kevin Kunkler

The United States has been at war since 2003. During that time, training using Medical Simulation technology has been developed and integrated into military medical training for combat medics, nurses and surgeons. Efforts stemming from the Joint Programmatic Committee-1 (JPC-1) Medical Simulation and Training Portfolio has allowed for the improvement and advancement in military medical training by focusing on research in simulation training technology in order to achieve this. Based upon lessons learned capability gaps have been identified concerning the necessity to validate and enhance combat medical training simulators. These capability gaps include 1) Open Source/Open Architecture; 2) Modularity and Interoperability; and 3) Material and Virtual Reality (VR) Models. Using the capability gaps, JPC-1 has identified important research endeavors that need to be explored.

David Rojas

**The Role of Game Elements in Online Learning within Health Professions Education**

David Rojas, Bill Kapralos and Adam Dubrowski

Given the highly competitive and motivating nature of today’s students, gamification, when properly implemented, can be an effective learning tool. Here we studied which gamification (gaming) elements that medical students would be interested in having when using an online learning system to acquire clinical skills. Focus groups sessions were held with medical students, game developers, and game designers to develop an understanding about their perception and preferences regarding gamification. Overall it was determined that gamification will lead to increased engagement and motivation and should include both competitive and social elements.

Erik Messier

**An Interactive 3D Virtual Anatomy Puzzle for Learning and Simulation - Initial Demonstration and Evaluation**

Erik Messier, Jascha Wilcox, Alexander Dawson-Elli, Gabriel Diaz and Cristian A. Linte

To inspire young students (grades 6-12) to become medical practitioners and biomedical engineers, it is necessary to expose them to key concepts of the field in a way that is both exciting and informative. Recent advances in medical image acquisition, manipulation, processing, visualization, and display have revolutionized the approach in which the human body and internal anatomy can be seen and studied. It is now possible to collect 3D, 4D, and 5D medical images of patient specific data, and display that data to the end user using consumer level 3D...
stereoscopic display technology. Despite such advancements, traditional 2D modes of content presentation such as textbooks and slides are still the standard didactic equipment used to teach young students anatomy. More sophisticated methods of display can help to elucidate the complex 3D relationships between structures that are so often missed when viewing only 2D media, and can instill in students an appreciation for the interconnection between medicine and technology. Here we describe the design, implementation, and preliminary evaluation of a 3D virtual anatomy puzzle dedicated to helping users learn the anatomy of various organs and systems by manipulating 3D virtual data. The puzzle currently comprises several components of the human anatomy and can be easily extended to include additional organs and systems. The 3D virtual anatomy puzzle game was implemented and piloted using three display paradigms – a traditional 2D monitor, a 3D TV with active shutter glasses, and the DK2 version Oculus Rift, as well as two different user interaction devices – a space mouse and traditional keyboard controls.

Anthony Gallagher

Simulation-Based Training Must be More Than an Interesting Educational Experience

The combination of high profile medical error court cases, statutory reduction in work hours for doctors in training and rapid developments in medical intervention technologies necessitates that medicine and healthcare consider new approaches to training. The appropriateness of the traditional apprenticeship model of training based on long hours of clinical service requires considered re-evaluation. Quantitative evidence demonstrates that trainees engaged in this training process accumulate considerably less clinical case exposure (never mind competency) than was previously thought. The use of simulation and technology enhanced learning (TEL) for the acquisition and maintenance of skills has an increasing and substantive role to play, particularly for learning how to safely use new treatment and diagnostic technologies.

Training with simulation and TEL ensures learning is to a quantitatively defined performance level and results in greater homogeneity in trainee skill-sets. Evidence from prospective, randomized studies shows that this ‘outcome-based’ education and training approach produces trainees with skill-sets that are 40 – 70% better than trainees using the traditional approach to training. Significantly these studies also demonstrate that trainees who receive the exact same curriculum but without the requirement to attain a quantitatively defined performance benchmark perform only marginally better than those receiving traditionally training. Furthermore, similar results have been observed for an outcome-based communication skills training program (e.g., handover). These results clearly demonstrate that simulation-based training is effective for technical as well as communication skills training BUT to be effective the simulation training must be more than an interesting educational experience.

THURSDAY Afternoon, April 7

TRACK 2

IMAGING

Anand Santhanam

Multi-Kinect v2 Camera Based Monitoring System for Radiotherapy Patient Safety

Anand P. Santhanam, Yugang Min, Patrick Kupelian and Daniel Low

3D kinect camera systems are essential for real-time imaging of 3D treatment space that consists of both the patient anatomy as well as the treatment equipment setup. In this paper, we present the technical details of a 3D treatment room monitoring system that employs a scalable number of calibrated and co-registered Kinect v2 cameras. The monitoring system tracks radiation gantry and treatment couch positions, and tracks the patient and immobilization accessories. The number and positions of the cameras were selected to avoid line-of-sight issues and to adequately cover the treatment setup. The cameras were calibrated with a calibration error of 0.1 mm. Our tracking system evaluation show that both gantry and patient motion could be acquired at a rate of 30 frames per second. The transformations between the cameras yielded a 3D treatment space accuracy of < 2 mm error in a radiotherapy setup within 500mm around the isocenter.

Jannick Rolland

Real Time Gabor-Domain Optical Coherence Microscopy for 3D Imaging

Jannick P. Rolland, Cristina Cavavesi, Patrice Tankam, Andrea Cogliati, Mara Lanis and Anand P. Santhanam

Fast, robust, nondestructive 3D imaging is needed for the characterization of microscopic tissue structures across various clinical applications. A custom microelectromechanical system (MEMS)-based 2D scanner was developed to achieve, together with a multi-level GPU architecture, 55kHz fast-axis A-scan acquisition in a Gabor-domain optical coherence microscopy (GD-OCM) custom instrument. GD-OCM yields high-definition micrometer-class volumetric images. A dynamic depth of focusing capability through a bio-inspired liquid lens-based microscope design, as in whales' eyes, was developed to enable the high definition instrument throughout a large field of view of 1 mm³ volume of imaging. Developing this technology is prime to enable integration within the workflow of clinical environments. Imaging at an invariant resolution of 2 μm has been achieved throughout a volume of 1 × 0.6 mm³, acquired in less than 2 minutes. Volumetric scans of human skin in vivo and an excised human cornea are presented.
COMPUTER-AIDED THERAPY

Mohammad Obeid

Validation of an Objective Assessment Instrument for Non-Surgical Treatments of Chest Wall Deformities

Mohammad F. Obeid, Nahom Kidane, Krzysztof J. Rechowicz, Salim Chemlal, Robert E. Kelly and Frederic D. McKenzie

Depending on the severity of the condition and associated risk, surgical intervention may not always be the first choice. This is true for treating chest wall deformities such as pectus excavatum and pectus carinatum. For both conditions, novel non-surgical treatments have been developed to gradually alleviate the malformation making use of the elastic nature of the costal cartilages at an early age of the patient. To quantify the performance of such treatments, this paper introduces and discusses the development of a software-based instrument that utilizes 3D chest optical images (surface scans) as input and uses registration techniques to produce an objective gauge of a patient’s physical improvement after undergoing treatments. Further discussed is an experiment designed to investigate the construct validity of the developed instrument.

Andinet Enquobahrie

The Virtual Pediatric Airways Workbench

Cory W. Quammen, Russell M. Taylor II, Pavel Krajcevski, Sorin Mitran, Andinet Enquobahrie, Richard Superfine, Brad Davis, Stephanie Davis and Carlton Zdanski

The Virtual Pediatric Airways Workbench (VPAW) is a patient-centered surgical planning software system targeted to pediatric patients with airway obstruction. VPAW provides an intuitive surgical planning interface for clinicians and supports quantitative analysis regarding prospective surgeries to aid clinicians deciding on potential surgical intervention. VPAW enables a full surgical planning pipeline, including importing DICOM images, segmenting the airway, interactive 3D editing of airway geometries to express potential surgical treatment planning options, and creating input files for offline geometric analysis and computational fluid dynamics simulations for evaluation of surgical outcomes. In this paper, we describe the VPAW system and its use in one case study with a clinician to successfully describe an intended surgery outcome.

Randy Ellis

A Toroidal Probe for Measuring Surgically Exposed Joint Centers

Brian J. Rasquinha, Kate S.M. Loe, Andrew W.L. Dickinson, John F. Rudan and Randy E. Ellis

Maintaining the hip center can improve the success of a total hip arthroplasty. A novel probe design, based on mating a toroid with a sphere, was used for kinematic measurements of the femoral head center and implant center in a pre-clinical study of hip joints. In an electromagnetically tracked implementation tested in a laboratory environment, the device measured a spherical center to within 1.2 ± 0.2 mm in a technical validation. Applied to a plastic model of a cadaveric femur, the center of the femoral head was measured to 1.8 ± 0.4 mm and the implant was measured to within 1.5 ± 0.5 mm. Because leg length changes and offset changes in conventional hip arthroplasty can be as much as 16 mm, this device has relatively high accuracy that may improve implant localization for the hip.

DISPLAYS

Dan Andersen

Avoiding Focus Shifts in Surgical Telementoring Using an Augmented Reality Transparent Display

Daniel Andersen, Voicu Popescu, Maria Eugenia Cabrera, Aditya Shanghavi, Gerardo Gomez, Sherri Marley, Brian Mullis and Juan Wachs

Conventional surgical telementoring systems require the trainee to shift focus away from the operating field to a nearby monitor to receive mentor guidance. This paper presents the next generation of telementoring systems. Our system, STAR (System for Telementoring with Augmented Reality) avoids focus shifts by placing mentor annotations directly into the trainee’s field of view using augmented reality transparent display technology. This prototype was tested with pre-medical and medical students. Experiments were conducted where participants were asked to identify precise operating field locations communicated to them using either STAR or a conventional telementoring system. STAR was shown to improve accuracy and to reduce focus shifts. The initial STAR prototype only provides an approximate transparent display effect, without visual continuity between the display and the surrounding area. The current version of our transparent display provides visual continuity by showing the geometry and color of the operating field from the trainee’s viewpoint.
ROBOTICS

Shahab Eslamian

Towards the Implementation of an Autonomous Camera Algorithm on the da Vinci Platform

Shahab Eslamian, Luke A. Reisner, Brady W. King and Abhilash K. Pandya

Camera positioning is critical for all telerobotic surgical systems. Inadequate visualization of the remote site can lead to serious errors that can jeopardize the patient. An autonomous camera algorithm has been developed on a medical robot (da Vinci) simulator. It is found to be robust in key scenarios of operation. This system behaves with predictable and expected actions for the camera arm with respect to the tool positions. The implementation of this system is described herein. The simulation closely models the methodology needed to implement autonomous camera control in a real hardware system. The camera control algorithm follows three rules: (1) keep the view centered on the tools, (2) keep the zoom level optimized such that the tools never leave the field of view; and (3) avoid unnecessary movement of the camera that may distract/disorient the surgeon. Our future work will apply this algorithm to the real da Vinci hardware.

FRIDAY Morning, April 8
FRIDAY MORNING PLENARY

Pierre Jannin

Synthesis and Simulation of Surgical Process Models

Guillaume Claude, Valérie Gouranton, Benoit Caillaud, Bernard Gibaud, Bruno Arnaldi and Pierre Jannin

Virtual Reality for surgical training is mainly focused on technical surgical skills. We work on providing a novel approach to the use of Virtual Reality focusing on the procedural aspects. Our system relies on a specific work-flow generating a model of the procedure from real case surgery observation in the operating room. This article presents the different technologies created in the context of our project and their relations as other components of our workflow.

Heinz Lemke

Integrated Patient Care with IHE

As a result of the recent foundation of an IHE Surgery domain, it can be observed that one of the motivational drives to develop IHE integration profiles, is to contribute towards the goal of an integrated patient care (IPC). The components contributing towards an IPC may be seen in the context of decision making for patient specific therapeutic approaches including surgery. The health care units which typically play a major role in the process of therapy decision making are specific therapy planning units, tumour boards, interventional units, operating suites, etc. Here ideally, many information sources available about the patient (radiology, pathology, oncology, surgery etc.) should be considered and integrated in a sensible way before subsequent steps in the diagnostic or therapeutic workflow are being taken. IHE Surgery has been created to promote this integration and to enable a basic interoperability of IT systems serving different clinical disciplines.

Angelos Bampoutsis

Assessment of Haptic Interaction for Home-Based Physical Tele-Therapy using Wearable Devices and Depth Sensors

Angelos Bampoutsis, Jose Alzate, Samantha Beekhuizen, Horacio Delgado, Preston Donaldson, Andrew Hall, Charlie Lago, Kevin Vidal and Emily J. Fox

In this paper a prototype system is presented for home-based physical tele-therapy using a wearable device for haptic feedback. The haptic feedback is generated as a sequence of vibratory cues from 8 vibrator motors equally spaced along an elastic wearable band. The motors guide the patients’ movement as they perform a prescribed exercise routine in a way that replaces the physical therapists’ haptic guidance in an unsuper-
vised or remotely supervised home-based therapy session. A pilot study of 25 human subjects was performed that focused on: a) testing the capability of the system to guide the users in arbitrary motion paths in the space and b) comparing the motion of the users during typical physical therapy exercises with and without haptic-based guidance. The results demonstrate the efficacy of the proposed system.

Joel Burdick

Recovery of Function after Severe Spinal Cord Injury by Spinal Stimulation

Approximately 1,250,000 people in the U.S. suffer from spinal cord injury (SCI), with 400,000 confined to wheel chairs. Not only do the injured lose the ability to stand and walk (and sometimes move their arms), they suffer from additional injury-induced complications including loss of bladder and bowel control, decreased cardiovascular and pulmonary health, inability to regulate body temperature, and loss of muscle strength and bone density. The totality of the injury and its secondary dysfunctions makes daily activities of living a challenge. Because the median age of SCI in the U.S. is 28 years; SCI individuals require an additional $2.4-$4.0 million in healthcare costs over their lifetimes.

A team of researchers at Caltech, UCLA, and Univ. of Louisville have been collaborating for several years to develop new technologies and new therapies for motor complete SCI patients—those who have lost motor control below the level of their injury. The centerpiece of this approach is a multi-electrode array which is implanted over the lumbosacral spinal cord in the epidural space between the dura and the interior of the vertebral canal. This talk will describe the basic technology behind multi-electrode epidural stimulation. When this technology is coupled with locomotor training (and drug therapy when possible), our preliminary human studies have shown that SCI patients receiving this therapy cannot only stand independently and make some voluntary movements (after being in a wheelchair for over 3 years), but more importantly, can expect to make significant gains in cardiovascular health, muscle tone, as well as improved autonomic function such as bladder, bowel, blood pressure, and temperature regulation. After reviewing these first efforts, current research in electrophysiological modeling of the epidural stimulation process, new machine algorithms for automated tuning of the stimuli parameters, and the interface of this technology with robotic devices will be reviewed.

FRIDAY Afternoon, April 8
TRACK 1

SURGICAL SIMULATION

Jörg Peters

Towards Surgeon-Authored VR Training: The Scene-Development Cycle

Saleh Dindar, Thien Nguyen and Jörg Peters

Enabling surgeon-educators to themselves create virtual reality (VR) training units promises greater variety, specialization, and relevance of the units. This paper describes a software bridge that semi-automates the scene-generation cycle, a key bottleneck in authoring, modeling, and developing VR units. Augmenting an open source modeling environment with physical behavior attachment and collision specifications yields single-click testing of the full force-feedback enabled anatomical scene.

Jean Nehme

Development and Evaluation of a Novel Pan-Specialty Virtual Reality Surgical Simulator for Smartphones

Jean Nehme, Ali N. Bahnson and Andre Chow

Touch Surgery is a novel simulator that allows cognitive task simulation and rehearsal of surgical procedures. Touch Surgery is designed for Apple and Android smartphones and tablets. This allows a global community of surgical professionals to review the steps of a procedure and test their competence. Content on Touch Surgery is developed with expert surgeons in the field from world leading institutions. Here we describe the development of Touch Surgery, its adoption by the global training community.

Elvis Chen

A Framework for Patient-Specific Spinal Intervention Simulation: Application to Lumbar Spinal Durotomy Repair

Jonathan C. Lau, Lynn Denning, Stephen P. Lownie, Terry M. Peters and Elvis C.S. Chen

We present a functional and patient-specific lumbar phantom for the training of spinal durotomy and dura closure under microscopic view, consisting of a lumbar model, pressurized dural surrogate, together immersed in a tissue-mimicking layer simulating fat, muscle and skin. The lumbar model was derived from a patient computed tomography scan, preserving the natural shape and curvature of the lumbar column. The inclusion
of the simulated soft-tissue layer was critical for preserving the surgical ergonomics and presented a realistic view under the surgical microscope. As the success of dura repair is indicated by the watertight closure of the thecal sac, the dura surrogate was connected to a pressurized and closed-loop water system to provide functional cerebrospinal fluid leakage during durotomy. This functional phantom is inexpensive to construct, provides a realistic tactile and visual environment for spinal durotomy repair, and can be easily extended to simulate other patient-specific spinal interventions.

Yaki Setty

**A Methodological, Task-Based Approach to Procedure-Specific Simulations Training**

*Oren Salzman and Yaki Setty*

Procedure-Specific Simulations (PSS) are advanced 3D realistic simulations that provide a platform to practice complete surgical procedures in a virtual-reality environment. While PSS have the potential to improve surgeons’ proficiency, there are no existing standards or guidelines for PSS development in a structured manner. Using urethrovesical anastomosis during radical prostatectomy as a representative example, we present a task-based methodological approach to PSS training. The methodology provides tasks in increasing levels of difficulty from a novice level of basic anatomy identification, to an expert level that permits testing new surgical approaches. The modular methodology can be easily extended to support more complex tasks. We foresee this methodology as a tool used to integrate PSS as a complementary training process for surgical procedures.

Shlomi Laufer

**Fabric Force Sensors for the Clinical Breast Examination Simulator**

*Shlomi Laufer, Kristen Rasske, Lauren Stopfer, Clair Kurzynski, Tim Abbott, Megan Platner, Joseph Towles and Carla M. Pugh*

Sensor enabled simulators may help in training and assessing clinical skill. Their are imitations on the locations current sensors can be placed without interfering with the clinical examination. In this study novel fabric force sensors were developed and tested. These sensors are soft and flexible and undetectable when placed in different locations in the simulator. Five sensors were added to our current sensor enabled breast simulator.

Eight participants performed the clinical breast examination on the simulator and documented their findings. There was a significant relationship for both clinical breast examination time (r(6) = 0.99, p < 0.001) and average force (r(6) = 0.92, p < 0.005) between our current sensors and the new fabric sensors. In addition the sensors were not noticed by the participants. These new sensors provide new methods to measure and assess clinical skill and performance.

Nathan Delson

**Videolaryngoscopy Simulator: New Technology Leads to New Training Challenges**

*Nathan Delson, Yanisleidy Paez, Jorge Ruiz, Arman Vatanpur, Sina Kouchaki, Mohamad Ramzi bin Abdul Majid and Randolph Hastings*

A videolaryngoscope is a more advanced tool than a traditional laryngoscope that eases endotracheal intubation by visualizing the vocal cords with a camera on the tip of the blade. However, using a videolaryngoscope can present difficulty in passing the tube into the glottic opening in some patients. This study developed a training protocol for intubation with the Glidescope videolaryngoscope and trained 22 anesthesia residents. A Parametrically Adjustable Airway Mannequin (PAAM) was set to provide easy and difficult configurations. Motion data of the videolaryngoscope, stylet, mannequin head, and hyoid bone were captured with 6 axis magnetic position sensors, along with the video image. The time to complete the various components of the task were recorded and used as an indication of competence along with observation by experts. The validity of the mannequin was supported by data that showed that the difficult configuration of PAAM took longer to intubate than the easy configuration (66 vs. 39 seconds during pre-test). The effectiveness of the training protocol was supported by improvement in trainee performance. At the beginning of the training, intubation with the difficult configuration took an average of 66 seconds, immediately after training it averaged 23 seconds, and in retention tests over a month after the training the average duration was 33 seconds.

**SURGICAL METRICS**

Arun Nemani

**Objective Surgical Skill Differentiation for Physical and Virtual Surgical Trainers via Functional Near-Infrared Spectroscopy**

*Arun Nemani, Woojin Ahn, Denise Gee, Xavier Intes, Steven Schwitzberg, Meryem Yucel and Suvaranu De*

This study proposes a methodology to objectively differentiate surgical skill for physical and virtual trainers by measuring functional activation between expert and novice surgeons. Results indicate that there is a significant increase in functional activation for novices in the right lateral prefrontal cortex, and decrease in the left medial primary motor cortex, and the supplementary motor area for the physical trainer (p<0.05). Results also indicate that there is a significant lower functional activation for novices compared to experts in the left medial primary motor cortex for the virtual skills trainer (p<0.05).
Asymmetry in Dominant / Non-Dominant Hand Performance Differentiates Novices from Experts on an Arthroscopy Virtual Reality Serious Game

Robert Pedowitz, Gregg Nicandri and Stefan Tuchschmid

Safe and effective arthroscopic surgery requires ambidextrous motor skills. The current study examined dominant versus non-dominant hand performance on a virtual reality serious game in a group of expert arthroscopic surgeons (n=15) compared to a group of orthopedic surgery residents (n=10). A virtual reality Tetris game was performed with the arthroscopic camera and arthroscope in one hand, using an arthroscopic grasping tool in the opposite hand to manipulate the virtual Tetris blocks onto the game grid. A second run was performed after swapping instruments between hands. The order of hand testing was randomized. There was no statistically significant difference in exercise time, grasper path length, or camera path length between the right and left hands of the expert surgeons. In contrast, there were statistically significant differences in all of these parameters between the two hands for the orthopedic surgery residents, with better performance when the grasping tool was used in the dominant hand. The findings of this study suggest that virtual reality games which incorporate progressive cognitive loading could be used to facilitate training, automation, and objective assessment of surgical motor skills.

Virtual Airway Skills Trainer (VAST) Simulator

Doga Demirel, Alexander Yu, Tansel Halic, Ganesh Sankaranarayanan, Adam Ryason, David Spindler, Kathryn L. Butler, Caroline Cao, Emil Petrusa, Marcos Molina, Dan Jones, Suvrana De, Marc DeMoya and Stephanie Jones

This paper presents a simulation of Virtual Airway Skill Trainer (VAST) tasks. The simulated tasks are a part of two main airway management techniques; Endotracheal Intubation (ETI) and Cricothyroidotomy (CCT). ETI is a simple nonsurgical airway management technique, while CCT is the extreme surgical alternative to secure the airway of a patient. We developed identification of Mallampati class, finding the optimal angle for positioning pharyngeal/mouth axes tasks for ETI and identification of anatomical landmarks and incision tasks for CCT. Both ETI and CCT simulators were used to get physician's feedback at Society for Education in Anesthesiology and Association for Surgical Education spring meetings. In this preliminary validation study, total 38 participants for ETI and 48 for CCT performed each simulation task and completed pre and post questionnaires. In this work, we present the details of the simulation for the tasks and also the analysis of the collected data from the validation study.

Importance of Stereoscopcy in Haptic Training of Novice Temporal Bone Surgery

Bertram Unger, Bryan Tordon, Justyn Pisa and Jordan B. Hochman

We investigate the effects of stereoscopic simulation on novice trainee surgical performance. Methods: 20 first year medical students were randomized into a stereo or non-stereo group. Each participant viewed a 13 minute instructional video and then performed 3 mastoidectomy procedures with an in-house haptic temporal bone simulation, using a 3D-capable display with either active (stereo) or inactive (non-stereo) shutter glasses. Following training, participants performed an actual mastoidectomy on a single 3D-printed bone model. The printed models were evaluated by 3 blinded neurotologic surgeons using a 7 point grading system. Results: Two-tailed t-tests showed no significant difference in overall performance (mean score across test categories over all subjects) between stereo (M=3.8, SD=1.1) and non-stereo (M=4.4, SD=1.5) conditions (p=0.163). No significant differences existed in any of the assessed sub-domains. Conclusions: The addition of stereovision to haptic training may not affect temporal bone surgical skill acquisition in novice users.
Raffaella Trivisonne

3D Physics-Based Registration of 2D Dynamic MRI Data

Raffaella Trivisonne, Igor Peterlik, Stéphane Cotin and Hadrien Courtecuisse

We present a method allowing for intra-operative targeting of a specific anatomical feature. The method is based on a registration of 3D pre-operative data to 2D intra-operative images. Such registration is performed using an elastic model reconstructed from the 3D images, in combination with sliding constraints imposed via Lagrange multipliers. We register the pre-operative data, where the feature is clearly detectable, to intra-operative dynamic images where such feature is no more visible. Despite the lack of visibility on the 2D MRI images, we are able both to determine the location of the target as well as follow its displacement due to respiratory motion.

HAPTICS

Venkata Arikatla

A Unified Framework for Haptic Interaction in Multimodal Virtual Environments

Venkata S. Arikatla, Ricardo Ortiz, Suvaranu De and Andinet Enquobahrie

In this paper we introduce a Modified Iterative Constraint Anticipation (MICA) method that provides a unified framework for direct and response-based indirect haptic interaction common in many interactive virtual environments. Collision constraints during response based interaction that are modeled using the linear complementarity problem (LCP) framework resolves collision constraints from response-based interactions while allowing for accurate computation of reaction forces. Direct user manipulation is enabled by the linear projection constraints (LPC). A smoothing filter is used to post-process the reaction forces arising from both LCP and LPC to achieve stable interactions in real-time. The effectiveness of MICA is demonstrated using example problems involving deformable bodies.

Caroline Erolin

Does Virtual Haptic Dissection Improve Student Learning? A Multi-Year Comparative Study

Caroline Erolin, Clare Lamb, Roger Soames and Caroline Wilkinson

This study investigated the haptic ‘dissection’ of a digital model of the hand and wrist in anatomy education at both undergraduate (UG) and postgraduate (PG) levels. The study ran over five successive years and was split into three discreet phases. Phase one compared the results of PG students across control, non-haptic and haptic groups. Phase two compared the results of UG students between control and haptic groups. Phase three compared the results of UG students across control, non-haptic and haptic groups. Results for all phases indicate that use of the model, both through haptic and non-haptic interfaces produced some significantly improved test results. The non-haptic group performing the strongest overall indicating that the addition of haptic feedback may not be beneficial to student learning.

Weixin Si

Constrained Point-Based Framework with Efficient Mechanical Interaction for Virtual Surgery

Weixin Si, Junliang Shan, Xiangyun Liao, Weiming Wang, Qiong Wang and Pheng-Ann Heng

This paper proposes a stable and volume conserving meshless approach for soft tissue deformation in virtual surgery, where an efficient tissue-tissue interaction scheme is designed for interacting deformable bodies. Specifically, we integrate position-based volume constraint into point-based framework in order to conserve the total volume of deformable bodies and maintain the stability of the simulation. Moreover, we resolve the tissue-tissue interactions of deformable bodies with position-based contact model, which directly computes the displacement caused by normal and shear stress. The proposed approach can be regarded as a fast approximation of the precise contact model. Experimental results demonstrate that our approach can well enforce the volume conservation of deformable bodies, and obtain visual plausible behaviors for multiple organs interactions.

MODELING

Andre Mastmeyer

Real-Time Ultrasound Simulation for Training of US-Guided Needle Insertion in Breathing Virtual Patients

Andre Mastmeyer, Matthias Wilms, Dirk Fortmeier, Julian Schröder and Heinz Handels

One draw-back of most existing VR ultrasound training simulators is the use of static 3D patient models neglecting physiological changes induced e.g. by respiration or heart motion. In this paper to the aim of more realistic Ultrasound simulation, breathing motion extracted from 4D CT image data is integrated into our visuo-haptic simulation framework. The simulated ultrasound images are used for the training of US-guided needle insertion procedures in liver surgery. The methodology developed enables US simulation, 3D visualization and haptic steering of the ultrasound probe and the needle in real-time in breathing virtual bodies.
Anand Santhanam

GPU-Based Parallelized Solver for Large Scale Vascular Blood Flow Modeling and Simulations

Anand P. Santhanam, John Neylon, Joseph Eldredge, Joseph Teran, Erik Dutson and Peyman Benharash

Cardio-vascular blood flow simulations are essential in understanding the blood flow behavior during normal and disease conditions. To date, such blood flow simulations have only been done at a macro scale level due to computational limitations. In this paper, we present a GPU based large scale solver that enables modeling the flow even in the smallest arteries. A mechanical equivalent of the circuit based flow modeling system is first developed to employ the GPU computing framework. Numerical studies were employed using a set of 10 million connected vascular elements. Run-time flow analysis were performed to simulate vascular blockages, as well as arterial cut-off. Our results showed that we can achieve ~100 FPS using a GTX 680m and ~40 FPS using a Tegra K1 computing platform.

Saurabh Dargar

Development of a Soft Tissue Elastography Robotic Arm (STIERA)

Saurabh Dargar, Ali Cagdas Akyildiz and Suvaranu De

High fidelity surgical simulations must rely upon accurate soft tissue models to ensure realism of the simulations. Simulating multi-layer tissue becomes increasingly complex due to the specific mechanical properties of each individual layer. We have developed a Soft Tissue Elastography Robotic Arm (STIERA) system capable of identifying layer specific properties of multi-layer constructs while maintaining the integrity of each layer. The system was validated using tissue mimicking agar gel phantoms and showed great promise by identifying the layer specific properties with accuracy of greater than 80% when compared to known ground truth values from a commercial material testing system.

SATURDAY Morning, April 9
TRACK 1

REHABILITATION & MENTAL HEALTH

Albert “Skip” Rizzo

Automatic Behavior Analysis During a Clinical Interview with a Virtual Human

Albert Rizzo, Gale Lucas, Jonathan Gratch, Giota Stratou, Louis-Philippe Morency, Kenneth Chavez, Russ Shilling and Stefan Scherer

SimSensei is a Virtual Human (VH) interviewing platform that uses off-the-shelf sensors (i.e., webcams, Microsoft Kinect and a microphone) to capture and interpret real-time audiovisual behavioral signals from users interacting with the VH system. The system was specifically designed for clinical interviewing and health care support by providing a face-to-face interaction between a user and a VH that can automatically react to the inferred state of the user through analysis of behavioral signals gleaned from the user's facial expressions, body gestures and vocal parameters. Akin to how non-verbal behavioral signals have an impact on human-to-human interaction and communication, SimSensei aims to capture and infer user state from signals generated from user non-verbal communication to improve engagement between a VH and a user and to quantify user state from the data captured across a 20 minute interview. Results from of sample of service members (SMs) who were interviewed before and after a deployment to Afghanistan indicate that SMs reveal more PTSD symptoms to the VH than they report on the Post Deployment Health Assessment. Pre/Post deployment facial expression analysis indicated more sad expressions and few happy expressions at post deployment.

Thomas Talbot

Natural Language Understanding Performance and Use Considerations in a Virtual Medical Encounters

Thomas B. Talbot, Nicolai Kalisch, Kelly Christoffersen, Gale Lucas and Eric Forbell

A virtual standardized patient (VSP) prototype was tested for natural language understanding (NLU) performance. The conversational VSP was evaluated in a controlled 61 subject study over four repetitions of a patient case. The prototype achieved more than 92% appropriate response rate from naïve users on their first attempt and results were stable by their fourth case repetition. This level of performance exceeds prior efforts and is at a level comparable of accuracy as seen in human conversational patient training, with caveats. This level of performance was possible due to the use of a unified medical taxonomy underpinning that allows virtual patient language training to be applied to all cases in our system as opposed to benefiting a single patient case.
Brenda Wiederhold

Physician Burnout: Improving Treatment Efficacy with Virtual Reality

Brenda K. Wiederhold, Giuseppe Riva, Andrea Gaggioli and Mark D. Wiederhold

Creating a significant negative impact on both their quality of life and the quality of patient care with an evident economical burden for the healthcare system, there is a growing concern over physician burnout. The range of interventions and treatments that have been used to address this problem, however, appear quite fragmented and lack compelling efficacy. We describe the main factors known to contribute to the development of physician burnout as well as currently available treatments. Studies seem to indicate that both specialisation area as well as personality traits may contribute to the manifestation. The highest risk specialties appear to be critical care physicians, emergency physicians, oncologists and internal medicine physicians, while the highest risk personality attributes are high neuroticism, low agreeableness, introversion, and negative affectivity. In addition, being exceedingly enthusiastic about one's work and having high aspirations at work, with an idealistic approach, also serve as factors which contribute to increased risk of burnout, and in particular for those who are new to the occupation.

Giuseppe Riva

Positive and Transformative Technologies for Active Ageing

Giuseppe Riva, Daniela Villani, Pietro Cipresso, Claudia Repetto, Stefano Triberti, Daniele Di Lernia, Alice Chirico, Silvia Serino, and Andrea Gaggioli

Due to advances in treatment and people's living longer, chronic diseases are becoming more common among our population. This is a leading contributor to the increasing burden on our current healthcare system. To reduce this burden and sufficiently meet the needs of this growing segment of the population, healthcare organizations must encourage the elderly to take a more active role in caring for their own health and well-being. Technology may offer a solution to this shortcoming. “Positive Technology” focuses on the use of technology for improving the quality of our personal experience, and it suggests specific strategies for modifying/improving each of the different dimensions involved - Emotional Quality (affect regulation); Engagement/Actualization (presence and flow); Connectedness (collective intentions and networked flow) - and for generating motivation and engagement in the process. “Transformative Technology” are technologically-mediated experiences that support positive, enduring transformation of the self-world. The transformative content is delivered through a set of experiential affordances, which are stimuli designed to elicit emotional and cognitive involvement in the designed experience: (i) emotional affordances; (ii) epistemic affordances. The paper discusses discuss the possible role of positive and transormative technologies for healthy living and active ageing by presenting different practical applications of this approach recently developed by our team.

Nigel John

A Cost-Effective Virtual Environment for Simulating and Training Powered Wheelchairs Manoeuvres

Christopher J. Headleand, Thomas Day, Serban R. Pop, Panagiotis D. Ritsos and Nigel W. John

Control of a powered wheelchair is often not intuitive, making training of new users a challenging and sometimes hazardous task. Collisions, due to a lack of experience can result in injury for the user and other individuals. By conducting training activities in virtual reality (VR), we can potentially improve driving skills whilst avoiding the risks inherent to the real world. However, until recently VR technology has been expensive and limited the commercial feasibility of a general training solution. We describe Wheelchair-Rift, a cost effective prototype simulator that makes use of the Oculus Rift head mounted display and the Leap Motion hand tracking device. It has been assessed for face validity by a panel of experts from a local Posture and Mobility Service. Initial results augur well for our cost-effective training solution.

Dave Taylor

Using Motion-Sensor Games to Encourage Physical Activity for Adults with Intellectual Disability

Michael J. Taylor, David Taylor, Patricia Gamboa, Ivo Vlaev and Ara Darzi

Adults with Intellectual Disability (ID) are at high risk of being in poor health as a result of exercising infrequently; recent evidence indicates this is often due to there being a lack of opportunities to exercise. This pilot study involved an investigation of the use of motion-sensor game technology to enable and encourage exercise for this population. Five adults (two female; 3 male, aged 34-74 [M = 55.20, SD = 16.71] with ID used motion-sensor games to conduct exercise at weekly sessions at a day-centre. Session attendees reported to have enjoyed using the games, and that they would like to use the games in the future. Interviews were conducted with six (four female; two male, aged 27-51 [M = 40.20, SD = 11.28]) day-centre staff, which indicated ways in which the motion-sensor games could be improved for use by adults with ID, and barriers to consider in relation to their possible future implementation. Findings indicate motion-sensor games provide a useful, enjoyable and accessible way for adults with ID to exercise. Future research could investigate implementation of motion-sensor games as a method for exercise promotion for this population on a larger scale.
Esteban Correa

**Computer Imagery and Neurological Rehabilitation: On the Use of Augmented Reality in Sensorimotor Training to Step Up Naturally Occurring Cortical Reorganization in Patients Following Stroke**

Esteban Correa-Agudelo, Carlos Ferrin, Paulo Velez and Juan D. Gomez

This work promotes the use of computer-generated imagery -as visual illusions- to speed up motor learning in rehabilitation. In support of this, we adhere the principles of experience-dependent neuroplasticity and the positive impact of virtual reality (VR) thereof. Specifically, post-stroke patients will undergo motor therapy with a surrogate virtual limb that fakes the paralyzed limb. Along these lines, their motor intentions will match the visual evidence, which fosters physiological, functional and structural changes over time, for recovery of lost function in an injured brain. How we make up such an illusion using computer graphics, is central to this paper.

Weina Jin

**A Virtual Reality Game for Chronic Pain Management: A Randomized, Controlled Clinical Study**

Weina Jin, Amber Choo, Diane Gromala, Chris Shaw and Pamela Squire

Although Virtual Reality (VR) applications have been shown to reduce many forms of acute pain, such research of VR applications and their effects on chronic pain is still at its infancy. In this study, we designed a VR game Cryoslide, and examined its analgesic effect on chronic pain patients, its end users, in a clinical setting. In this randomized, controlled crossover clinical study of 20 chronic pain patients, Cryoslide significantly reduced perceived pain compared to the baseline and the control group. The results demonstrate that Cryoslide can be effectively used as an analgesic intervention for chronic pain management to lessen pain intensity during short-term symptom spikes.

Diane Gromala

**Usability Comparisons of Head-Mounted vs. Stereoscopic Desktop Displays in a Virtual Reality Environment with Pain Patients**

Xin Tong, Diane Gromala, Dimple Gupta and Pam Squire

Researchers have shown that immersive Virtual Reality (VR) can serve as an unusually powerful pain control technique. However, research assessing the reported symptoms and negative effects of VR systems indicate that it is important to ascertain if these symptoms arise from the use of particular VR display devices, particularly for users who are deemed “at risk,” such as chronic pain patients. Moreover, these patients have specific and often complex needs and requirements, and because basic issues such as ‘comfort’ may trigger anxiety or panic attacks, it is important to examine basic questions of the feasibility of using VR displays. Therefore, this repeated-measured experiment was conducted with two VR displays: the Oculus Rift's head-mounted display (HMD) and Firsthand Technologies’ immersive desktop display, DeepStream3D. The characteristics of these immersive desktop displays differ: one is worn, enabling patients to move their heads, while the other is peered into, allowing less head movement. To assess the severity of physical discomforts, 20 chronic pain patients tried both displays while watching a VR pain management demo in clinical settings. Results indicated that participants experienced higher levels of Simulator Sickness using the Oculus Rift HMD. However, results also indicated other preferences of the two VR displays among patients, including physical comfort levels and a sense of immersion. Few studies have been conducted that compare usability of specific VR devices specifically with chronic pain patients using a therapeutic virtual environment in pain clinics. Thus, the results may help clinicians and researchers to choose the most appropriate VR displays for chronic pain patients and guide VR designers to enhance the usability of VR displays for long-term pain management interventions.
Poster Abstracts

BRAIN-COMPUTER INTERFACE

Chung Hyuk Park

Comparison Study on Emotional Response Identification with Brain Computer Interface

Ahmed Qureshi and Chung Hyuk Park

In this paper, we present a framework for processing electroencephalography (EEG) signals using a brain computer interface (BCI) to detect emotional responses for providing affective computing capabilities in multi-modal human-system interaction. The EEG signals from the BCI were preprocessed with Gabor filtering, power spectrum analysis, and Hjorth parameterization, and then was clustered with machine learning algorithms (CNN and SOM).

Wei Wang

Study of Event Characterization in Wireless EEG Monitoring with EMOTIV

Chase Cabrera and Wei Wang

We present and evaluate a computer science approach to constructing patient-specific classifiers that can detect events through analysis of the electroencephalogram (EEG), a non-invasive measure of the brain's electrical activity. The objective of this study is to characterize typical noise signals in EEG using the benchmark signals including 7 basic events for verification of the underlining algorithm and its ability to successfully detect each event. Training was conducted on 2 or more patient files to identify a benchmark and then applied on the 90+ additional patient files. Our algorithm detected 91.3% of the 700 events across two hardware platforms, while falsely detecting 0.61%. To gather our patient files, we used both the EMOTIV EPOC and EPOC+. We found the standard EPOC unit had a range of approximately 2.1 meters, while the EPOC+ averaged 6.9 meters. In preparation for data analysis, we wrote system tasks to transfer the files EMOTIV benchmark software produced and send them to a cloud service for storage. This study is the initial step to future research using the same algorithm, hardware, and software tasks to detect the onset of an epileptic seizure through the same analysis of EEG.

COMPUTER-AIDED THERAPY

Hossein Arabalibeik

Evaluation of RGP Contact Lens Fitting in Keratoconus Patients Using Hierarchical Fuzzy Model and Genetic Algorithms

Fatemeh Falahati Marvast, Hossein Arabalibeik, Fatemeh Alipour, Abbas Sheikh taheri, Leila Nouri, Mehdi Soozande and Masood Yarmahmood

Keratoconus is a progressive non-inflammatory disease of the cornea. Rigid gas permeable contact lenses (RGP) are prescribed when the disease progresses. Contact lens fitting and assessment is very difficult in these patients and is a concern of ophthalmologists and optometrists. In this study, a hierarchical fuzzy system is used to capture the expertise of experienced ophthalmologists during the lens evaluation phase of prescription. The system is fine-tuned using genetic algorithms. Sensitivity, specificity and accuracy of the final system are 88.9%, 94.4% and 92.6% respectively.

Francis Baek

Autonomous Patient Safety Assessment from Depth Camera Based Video Analysis

Francis Baek and Vikash Gilja

We introduce a low-cost, minimally intrusive system for the detection of high-risk postures and movements for patients. Our current focus is on the detection of when a patient leaves the bed surface based upon detection of the bed surface and patient body analysis, which could be potentially utilized to detect a fall risk in real-time. Using simulated data from healthy individuals, we develop and assess an initial detection algorithm.

Paolo Gabriel

Continuous Behavior Estimation with RGB-D Video in the Epilepsy Unit

Paolo Gabriel, Daniel Friedman, Thomas Thesen and Vikash Gilja

To augment neural monitoring, a minimally-intrusive multimodal capture system has been implemented in the epilepsy clinic. This system provides audio-visual recordings synchronized with patient electrocorticographic (ECoG) recordings across cortex. We demonstrate patient behavior estimations from video data, and the potential for continuous recording of complex behaviors. This system contributes to large-scale brain activity dataset collection in the clinic.
John Hermiz

Estimating Motor Scores with Accelerometers in the Neuro ICU

John Hermiz, Jamie LaBuzetta, Navaz Karanjia and Vikash Gilja

The neurological motor exam provides important information about a patient’s clinical status. However, there are several limitations of the exam, which include assessment subjectivity and the frequency with which it can be performed. We propose automating motor score assessment by passively measuring activity with accelerometers. In this work, we train a linear model against hourly motor scores and use past scores and accelerometer features as model inputs. In several cases, the model achieves significant correlation (p < 2.68 × 10^-5, Bonferroni corrected) with actual scores, indicating that it may be feasible to estimate motor scores with accelerometers.

Jing Jin

Normal Brain-Skull Development with Hybrid Deformable VR Models Simulation

Jing Jin, Sandrine de Ribau Pierre and Roy Eagleson

This paper describes a simulation framework for a clinical application involving skull-bone co-development in infants, leading to a platform for craniosynostosis modeling. Craniosynostosis occurs when one or more sutures are fused early in life, resulting in an abnormal skull shape. Surgery is required to reopen the suture and reduce intracranial pressure, but is difficult without any predictive model to assist surgical planning. We aim to study normal brain-skull growth by computer simulation, which requires a head model and appropriate mathematical methods for brain and skull growth respectively. On the basis of our previous model, we further specified suture model into fibrous and cartilaginous sutures and develop algorithm for skull extension. We evaluate the resulting simulation by comparison with datasets of cases and normal growth.

Kristen Nguyen

Integrated Self-Management System for Improved Treatment of Asthma

Kristen T. Nguyen, Martin O. Culjat, Andrzej P. Mierzwa, Rahul S. Singh, Benson Fong and Rebecca Vanlandingham

A mobile, affordable product that provides clinicians and patients with comprehensive asthma assessment is needed to improve asthma control. Our solution is an integrated system consisting of a portable, inexpensive, easy-to-use spirometer and a mobile application that communicates wirelessly with the spirometer. Results demonstrated that the wireless asthma management solution meets recommended American Thoracic Society (ATS) and European Respiratory Society (ERS) standards. The device is expected to empower patients to accurately self-assess their asthma for better self-management at home, work, or leisure.

Sehyung Park

The Effect of Optical Marker Configuration on Tracking Accuracy in Image Guided Surgery

Kinde Mekuria, Youngjun Kim, Hyunchul Cho, Deukhee Lee, Sehyung Park, Byung Hoon Lee, Ki-Mo Jang and Joon Ho Wang

In this study, the effect of the geometrical configuration of retroreflective markers on the maximum tracking uncertainty of target points during a medical navigation is analyzed. Methods that help users select and set up an optimal configuration for minimizing the navigation uncertainty are proposed. The methods are evaluated by simulating surgical navigation environment using an optical tracking system. The result shows that the maximum uncertainty of tracking the target points lying outside the marker region is a function of the configuration of some of the associated markers and the precision of the optical tracking system used. We also show that the use of flexible rigid bodies minimizes target tracking uncertainty by enabling a customized reconfiguration of markers for optimal pose with respect to individual surgical target position during preoperative planning phase.

Arthur Wolloco

Virtual Reality System for the Assessment and Diagnosis of Vestibular Indicators of Soldier Operational Readiness (ADVISOR)

Michael Jenkins, Arthur Wolloco, Scott Irvin and Mike Farri

Soldiers who suffer a potentially concussive injury or barotraumas need accurate, timely, in-theater assessment of symptoms. Often this initial assessment and diagnosis must be conducted by first-level responders who attempt to assess vestibular symptoms directly following a concussive event; however, these symptoms are often missed or misdiagnosed due to a lack of familiarity with the subtleties of impaired vestibular function. To address this challenge, we present a prototype system for the Assessment and Diagnosis of Vestibular Indicators of Soldier Operational Readiness (ADVISOR). ADVISOR integrates a combination of vestibular tests, relying on a mobile virtual reality solution to present a subset of visual stimuli adapted from standard clinical assessments.
DISPLAYS

Ashfaq Amin

Immersion in Cardboard VR Compared to a Traditional Head-Mounted Display

Ashfaq Amin and Diane Gromala

We describe an ongoing study which aims at finding the difference in levels of immersion between a Cardboard VR and a “traditional” Head-Mounted Display (HMD)—the Oculus Rift in our case. Users in our two groups of participants played Cry-oblax a VR game designed for pain distraction. The control group used the Oculus Rift while the experimental group used Cardboard VR. All participants then filled out Jennett et al.’s Immersive Experience Questionnaire that we used to measure immersion. Although data collection for the control group is still in progress, we present the results and findings from our experimental (Cardboard VR) group. Since ‘immersion’ is thought to play an important role in VR pain distraction, the design of studies that seek to determine the level of immersion for Cardboard VR will help determine its potential as an accessible VR device for pain management.

Luzie Schreiter

3D Perception Technologies for Surgical Operating Theatres

Tim Beyl, Luzie Schreiter, Philip Nicolai, Jörg Raczkowsky and Heinz Wörn

3D Perception technologies have been explored in various fields. This paper explores the application of such technologies for surgical operating theatres. Clinical applications can be found in workflow detection, tracking and analysis, collision avoidance with medical robots, perception of interaction between participants of the operation, training of the operation room crew, patient calibration and many more. In this paper a complete perception solution for the operating room is shown. The system is based on the ToF technology integrated to the Microsoft Kinect One implements a multi camera approach. Special emphasize is put on the tracking of the personnel and the evaluation of the system performance and accuracy.

EDUCATION

M. Emin Aksoy

Creating a Web Based Serious Game Module for Teaching Basic Life Support Protocol as a Complimentary Tool for Simulation Based Trainings in Healthcare

M. Emin Aksoy, Dilek Kitapcioglu, Mehmet K. Ozkan and Feray Guven

E-learning is being used as a complimentary tool for simulation based education in healthcare. E-learning enhances knowledge and performance of participants by offering the participants to control the content and to arrange the suitable time for learning. BLS(Basic Life Support) training courses for both medical and nonmedical trainees are the most important and frequent courses organized in medical training centers. CASE, Centre of Advanced Simulation and Education, is a multidisciplinary medical simulation and endoscopic/robotic training centre of Acibadem University and around 19000 undergraduate and postgraduate trainees have taken part at the simulation courses in the last two years. We were in a search for the best tutorial video to be shown in the content of our e-learning modules for the Basic Life Support Trainings, but the existing videos were not able to fulfill our needs. This led us to create a team for preparing a web based interactive e-learning module for Adult Basic Life Support Protocol based on the criteria of ERC (European Resuscitation Council). The system consists of multi-platform end user applications (for PC and Mac computers, iPads and Android tablets). As there was a need to evaluate and standardize the performance of the participants, an evaluation system was required. For this purpose a SCORM (Shareable Content Object Reference Model) / Tin Can compliant Learning Management System was integrated into the project.

Lauren Allen

Development of a Web-Based 3D Module for Enhanced Neuroanatomy Education

Lauren K. Allen, He Zhen Ren, Roy Eagleson and Sandrine de Ribaupeire

Neuroanatomy is a challenging subject, with novice medical students often experiencing difficulty grasping the intricate 3D spatial relationships. Most of the anatomical teaching in undergraduate medicine utilizes conventional 2D resources. E-learning technologies facilitate the development of learner-centered educational tools that can be tailored to meet each student’s educational needs, and may foster improved learning in neuroanatomy, however this has yet to be examined fully in the literature. An interactive 3D e-learning module was developed to complement gross anatomy laboratory instruction. Incorporating such 3D modules may provide additional support for students in areas of anatomy that are spatially challenging, such as neuroanatomy. Specific anatomical structures and their relative spatial positions to other structures can be clearly defined in the
3D virtual environment from viewpoints that may not readily be available using cadaveric or 2D image modalities. Providing an interactive user interface for the 3D module in which the student controls many factors may enable the student to develop an improved understanding of the spatial relationships. This work outlines the process for the development of a 3D interactive module of the cerebral structures included in the anatomy curriculum for undergraduate medical students in their second year of study.

Nadir Bilici

Gunner Goggles: Implementing Augmented Reality into Medical Education

Leo L. Wang, Hao-Hua Wu, Nadir Bilici and Rebecca Tenney-Soeiro

There is evidence that both smartphone and tablet integration into medical education has been lacking. At the same time, there is a niche for augmented reality (AR) to improve this process through the enhancement of textbook learning. Gunner Goggles is an attempt to enhance textbook learning in shelf exam preparatory review with augmented reality. Here we describe our initial prototype and detail the process by which augmented reality was implemented into our textbook through Layar. We describe the unique functionalities of our textbook pages upon augmented reality implementation, which includes links, videos and 3D figures, and surveyed 24 third year medical students for their impression of the technology. Upon demonstrating an initial prototype textbook chapter, 100% (24/24) of students felt that augmented reality improved the quality of our textbook chapter as a learning tool. Of these students, 92% (22/24) agreed that their shelf exam review was inadequate and 19/24 (79%) felt that a completed Gunner Goggles product would have been a viable alternative to their shelf exam review. Thus, while students report interest in the integration of AR into medical education test prep, future investigation into how the use of AR can improve performance on exams is warranted.

Johan Creutzfeldt

Team Members’ Self-Efficacy Correlates to Situation Awareness in Simulation-Based Teamwork Training

Johan Creutzfeldt, Cecilia Escher, Li Felländer-Tsai and Leif Hedman

In an ongoing work to establish tools for assessing situation awareness and the importance thereof in a medical emergency context, 32 medical students were trained and assessed during simulator based teamwork training. Using validated assessment methods, our main finding was a significant correlation between self-efficacy beliefs and situation awareness. Implications of this are discussed.

Cecilia Escher

Motivation and Patient Safety Attitudes in Hybrid Simulator-Based Teamwork Training for OR Teams

Cecilia Escher, Ann Kjellin, Leif Hedman, Lisbet Meurling, Johan Creutzfeldt, Hans Rystedt and Li Felländer-Tsai

In hybrid simulation for full professional OR teams patient safety attitudes, such as teamwork and safety climate, and situational motivation were self-assessed. Participants were highly motivated for training and teamwork. Safety climate scores were positively correlated to intrinsic motivation. We conclude that fully trained OR staff are highly motivated to practice teamwork particularly the ones with more positive attitudes to teamwork and safety climate.

Marie-Hélène Ferrer

Perturbed Communication in a Virtual Environment to Train Medical Team Leaders

Lauriane Huguet, Domitile Lourdeaux, Nicolas Sabouret and Marie-Hélène Ferrer

The VICTEAMS project aims at designing a virtual environment for training medical team leaders to non-technical skills. The virtual environment is populated with autonomous virtual agents who are able to make mistakes (in action or communication) in order to train rescue team leaders and to make them adaptive with all kinds of situations or teams.

Alesha Hayes

Using Human in The Loop Simulation in Virtual and Mixed Reality for Medical Training

Alesha T. Hayes and Charles E. Hughes

Poor patient care skills are a persistent problem for medical professionals at multiple levels. Virtual environments that enable virtual rehearsal of targeted behaviors with simulated humans has been demonstrated to be effective in improving targeted interpersonal behaviors. In the case of patient care, the targeted behaviors include empathy, listening, showing respect, and offering support. This paper discusses the use of human in the loop simulation for medical health care training, as compared with other approaches. Essentially, the human in the loop simulation provides a standardized experience that authentically simulated a “real world” patient – provider interaction. A human in the loop solution would revolutionize the current medical education, in a way that can be directly linked with patient health, revenue, and reductions in medical malpractice.
Gerard Lacey

The Impact of Structured Incentives on the Adoption of a Serious Game for Hand Hygiene Training in a Hospital Setting

Gerard Lacey, Michael Corr, Helga Morrow, Ann McQueen, Fiona Cameron and Chris Connolly

Hand hygiene is recognized by the CDC as the most effective method of preventing Hospital Acquired Infections (HAIs) which cost the US healthcare system $14 Billion. However, training and promotion of hand hygiene in healthcare settings is an on-going challenge. This paper describes a hand hygiene improvement campaign in Edinburgh Royal Infirmary (Scotland, UK) using the SureWash gesture recognition system (SureWash, IRL). The campaign consisted of two phases of three-months each; the first phase involved technology evaluation and familiarization in a variety of settings within the hospital. The second phase involved rotation between two units with specific changes to the incentives for completing the training. There were 2,010 individual training sessions with over 30% outside of office hours. Individuals completed an average of 2.72 training sessions each and 90% of staff passed the assessment. Senior staff noted a change in hand hygiene culture following the campaign and the good-natured competition between staff to demonstrate hand hygiene competence using the SureWash serious game. While the new technology did facilitate the culture change its successful implementation was dependent on a set of incentives for staff and a structured implementation plan.

Anthony LaPorta

The Cost Effectiveness of Research: Are These Objective Measurements the Tools of the Future?

A.J. LaPorta, A. Man, C. McKinney, J. Snider, D. Robinson and L. Bezjian

The objective marker for the quality of simulation training, in particular, the marker for high acuity and high-risk training, needs to be established. The hypothesis that hyper realistic simulation allows us to evaluate objective hormone and cardiac human factor data is the basis of the current research. To accomplish this goal we produced an artificial environment that mimics real environments as closely as possible.

Samsun Lampotang

Loading Doses Are Not Based On Patient Race During Simulated Propofol Sedation

Samsun Lampotang, Nikolaus Gravenstein, David Erik Lizdas, Bejamin Lok and John Patrick Quarles

We conducted a study in a mixed reality environment (physical mannequin and virtual human - VH, both representing a patient) to assess whether anesthesia providers account for patient race when dosing propofol. Virtual implementation allowed the external appearance of the patient based on race to be quickly switched during the study. The VH response was driven by a race-specific compartmental model of propofol pharmacodynamics using data from peer-reviewed papers. The data indicate that patient race is not considered when dosing propofol for sedation.

Lisbet Meurling

The A-TEAM Program, An Easy Way to Verbalize Teamwork Behavior for Medical Students

Lisbet Meurling, Carl-Johan Wallin, Leif Hedman, Cecilia Escher, Johan Creutzfeldt, Mini Ruiz and Li Fellander-Tsai

Teamwork behaviors are becoming increasingly acknowledged in health care. In this study we used the A-TEAM program to introduce grading of teamwork behaviors for medical students in their eleventh semester. The students reviewed videos with simulated scenarios and were able to identify and agree upon both leaders’ and followers’ grade of teamwork behaviors after only a short introduction.

Jonas Schild

Project EPICSAVE - Enhanced Paramedic\nVocational Training w/ Serious Games and Virtual Environments

Jonas Schild, Thomas Luiz, Klaus runggaldier, Claus Kemp, and Markus Herkersdorf

We introduce EPICSAVE, a publicly funded project consortium in Germany that supports paramedic vocational training through novel measures based on serious games and virtual reality. The three-year project has started in 2016 and aims at developing two prototypes each implemented into actual curricula of public and private emergency services. Technologically, we use head-mounted displays with eye-tracking and apply attention-based analysis with challenging game design and simulated experiences. Medical focus is on anaphylactic shock in children.

Kuldeep Singh

Using Flipped Class to Enhance Medical Student’s Active Learning

Kuldeep Singh and Pratibha Singh

Flipping a Classroom involves delivering relevant and concise material in video format prior to the class. The lecture time was then utilized to encourage instructor-peer interaction with focus on application of theory to workable examples and case problems. With limited evidence of the new method in medicine, a study was undertaken on 50 3rd Professional Medical students. Edited video content synchronized with PowerPoint presentation was given to students in digital format a day
before the lecture. Post class evaluation was conducted on structured questionnaire. The satisfaction index was more than 77% in all parameters. Student also demonstrated improvement of their score in semester exams and augmented skills during field postings.

Kuldeep Singh

Using Flip Classroom in Reducing IMNCl Workshop Duration in Developing Country: A Pilot Study

Kuldeep Singh and Pratibha Singh

While developed countries have access to better healthcare, the same is lacking in developing world. Many studies have found benefit of integrated approach to common diseases and introduced a program Integrated Management of Neonatal and Childhood Illnesses (IMNCl) which is skill based training and incorporates classroom teaching, demonstration and clinical sessions. We used the innovation of introducing Flip Classroom lectures given beforehand and classroom time is used for discussion, clarifications of doubt. The clinical sessions were in OPD and demonstration in afternoon. The pre-post test along with retro-post then pre structured questionnaire demonstrated desired learning among the students. We conclude that Flip Classroom can be effectively used to maintain continued contact with facilitator thereby reducing duration of workshop.

Pratibha Singh

Student’s Perception Toward Objective Structured Clinical Examination (OSCE) as a Teaching Learning Tool

Kuldeep Singh, Pratibha Singh and Pulkit Gehlani

This is a well known fact that assessment drives student’s learning. No examination is perfect and most examinations assesses cognitive skills and theoretical knowledge only. Case based Practical examinations in medical schools assess few skills, focus only on approach toward a patient and biased with subjectivity. Objective Structured Clinical Examination (OSCE) on the other hand requires lots of training, logistics and problem of feasibility. We proposed that Objective Structured Clinical Examination encounters can also be used as teaching learning tool during formative assessment. The study found its use to be highly correlated to improvement in practical marks, communication skills and procedural skills of UG students.

Linda Sonesson

How e-Learning can Support Medical Professionals Preparing for Work Under Extreme Conditions

Linda Sonesson, Kenneth D. Boffard, Lars Lundberg, Martin Rydmark and Klas Karlgren

Military emergency care differs significantly from emergency care in the civilian context. Specific issues affecting military medical work include: treating patients under fire, darkness, shortages of available medical equipment and delayed transport to hospital. In addition, major incidents involving a large number of casualties with severe injuries have to be anticipated and prepared for. It is therefore imperative that medical professionals are supported in learning to understand the extreme environment in which they will be working. Extreme conditions are difficult to visualize within the educational environment and e-learning could possibly contribute to such understanding and preparation. The aim of the study was to investigate the specific challenges of military medical education by studying an existing international course in advanced trauma surgery, and by identifying the needs for e-learning support. As a case study, an identified postgraduate surgical course was studied. The course was a high-end international course offering education on the management of multiple patients with injuries from high-energy projectile, and blast wounds from explosives. Triangulation was used to combine data from observations, video recordings, and interviews with course participants and a survey. Outcomes from the study showed that the majority of the interviewed medical professionals had previous experience of military medical work. The training seemed to support individual and team training as well as transferring theory into practice. E-learning was viewed as having the potential of developing the course further by supporting management of the course, including preparation for the skills required, and 5,795, 5,398 access to course materials. E-learning was suggested as a way of better preparing the participants of the course through pre-tests, visualization by providing filmed scenarios and gamification by the use of real case scenarios. The interviewees were not familiar with all the equipment needed within the military medical context and expressed needs for e-learning platforms with instructional films about the use of such equipment during extreme conditions. Such films could be used during the course but also during actual medical work. E-learning could support a developed interaction between theory and practice.

Alvaro Uribe

How Can Haptics Realism be “Gamed” to Learn Technical Medical Skills

Alvaro Uribe, David Rojas, Bill Kapralos and Adam Dubrowski

Despite the great technological advancement we have recently experienced in virtual reality, accurately haptic simulation in the virtual world is still challenging, computationally intensive, and currently too costly. Perceptual-based rendering whereby the rendering parameters are adjusted based on the perceptual
system, can be employed to limit computational processing. Prior work has shown significant interaction effects between sound and visuals yet little work has considered the haptic sense. Here we outline three future experiments (e.g., work-in-progress) that will examine whether sound can be used to increase our perception of haptic fidelity within a virtual simulation and thus allow us to employ low-cost and low-fidelity haptic devices in place of higher fidelity and more costly devices.

**HAPTICS**

Takafumi Marutani

**Active and Passive Haptic Training Approaches in VR Laparoscopic Surgery Training**

Takafumi Marutani, Toma Kato, Kazuyoshi Tagawa, Hiromi T. Tanaka, Masaru Komori, Yoshimasa Kurumi and Shigehiro Monkawa

Laparoscopic surgery has become a widely performed surgery as it is one of the most common minimally invasive surgeries. Doctors perform the surgery by manipulating thin and long surgical instruments precisely with the assistance of laparoscopic video with limited field of view. The power control of the instruments’ tip is especially very important, because excessive power may damage internal organs. The training of this surgical technique is mainly supervised by an expert in hands-on coaching program. However, it is difficult for the experts to spend sufficient time for coaching. Therefore, we aim to teach the expert’s hand movements in laparoscopic surgery to trainees using VR-based simulator, which is equipped with a guidance force display device. To realize the system, we propose two haptic training approaches for transferring the expert’s hand movements to the trainee. One is active training, and the other is passive training. The former approach shows the expert’s movements only when the trainee makes large errors while the latter shows the expert’s movements continuously. In this study, we validate the applicability of these approaches through tasks in VR laparoscopic surgery training simulator, and identify the differences between these approaches.

Kohei Nishio

**Development of Haptic Needle for VR-Based Injection Training System Using Simulated Patient**

Kohei Nishio and Toshiyia Nakaguchi

VR based injection training system using standardized patient was proposed. This system uses haptic needle (HNSP) which can represent haptic force. Since the previously proposed system had a few problems with haptic reproduction, biological reproducibility needed to be improved. In order to solve these problems, we developed a new HNSP to replace the haptic needle. In addition, we conducted two validation studies for the HNSP.

**IMAGING**

Hossein Arabalibeik

**Reduced Imaging Rate in Liver Elastometry Using Shear Wave Interference Patterns**

Mehdi Soozande, Hossein Arabalibeik and Seyed Moayad Alavian

Inducing interference patterns of shear wave is one of the proposed methods for reducing the frame rate in measuring wave speed during tissue elastography. Previously, the Nyquist rate must be met in order to provide an appropriate image for extracting the patterns with a reasonable accuracy. In this article we propose a technique based on image registration, and apply it to ultrasound images acquired before and after inducing the shear waves to estimate the amplitude of displacement. The displacement of the tissue is then used to form the interference pattern of shear waves. The method does not induce any restrictions on the time interval between images, so the tissue elasticity can be calculated independent of the imaging rate. The average error in measuring the elasticity of the simulated phantom is 13.7%.

Matthew Bramlet

**Four-Dimensional Imaging: Tracking Cancer Growth through Space and Time**

Beth Ripley, Justin Drawz and Matthew Bramlet

Medical imaging provides essential information to the oncologic decision making process. Current imaging techniques do not optimally reveal this information, and a more intuitive method is needed. In the case of lung cancer, tumor growth could be better visualized by a 4D modeling method that tracks the tumor in 3D across multiple time points. Four chest CT datasets were obtained throughout surveillance of a patient with lung cancer. The datasets were segmented, reconstructed in 3D, and rendered into a time lapse movie for more intuitive assessment.

Kowther Hassan

**Evaluation of Software Tools for Segmentation of Temporal Bone Anatomy**

Kowther Hassan, Joseph C. Dort, Garnette R. Sutherland and Sonny Chan

Surgeons are increasingly relying on 3D medical image data for planning interventions. Virtual 3D models of intricate anatomy, such as that found within the temporal bone, have proven useful for surgical education, planning, and rehearsal, but such applications require segmentation of surgically relevant structures in the image data. Four publicly available software packages, ITK-SNAP, MITK, 3D Slicer, and Seg3D, were evaluated for their efficacy in segmenting temporal bone anatomy from
CT and MR images to support patient-specific surgery simulation. No single application provided efficient means to segment every structure, but a combination of the tools evaluated enables creation of a complete virtual temporal bone model from raw image data with reasonably minimal effort.

Alexander Yu

**Virtual Intraoperative Cholangiogram using WebCL**

*Alexander Yu, Doga Demirel, Tansel Halic and Sinan Kockara*

In this paper, we propose a Virtual Intraoperative Cholangiogram (VIC) training platform. Intraoperative Cholangiogram (IC) is an imaging technique of biliary anatomy with using fluorescent fluids sensitive to the X-Rays. The procedure is often employed to diagnose the difficult cases such as abnormal anatomy or cholelithiasis during the laparoscopic cholecystectomy. The major challenge in cholangiogram is accurate interpretation of the X-Ray image, which requires extensive case training. However, the training platforms that support generation of various IC cases have been lacking. In this study, we developed a web based platform to generate IC images from any virtual bile duct anatomy. As the generation of X-Ray image from 3D scene is a computationally intensive task, we utilized WebCL technology to parallelize the computation for achieving real-time rates. In this work, we present details of our WebCL IC generation algorithm and benchmark results.

**MODELING**

Venkata Arikatla

**An Approach for Automated Scene Management in Real-Time Medical Simulation Framework**

*Venkata S. Arikatla, Ricardo Ortiz, Tansel Halic, Sean Radigan, David Thompson, Suvranu De and Andinet Enquobahrie*

In this paper we present an algorithm that allows for minimal end-user inputs by internally automating the creation and management of interactions amongst the objects in the scene in real-time medical simulation framework. A bi-directed graph (with nodes representing the scene objects and the connections representing the interactions) is formed based on the inputs from the user. This graph is then processed using a two stage algorithm that aims to find subgraphs that can be treated as independent sub-systems. Collision detection, collision response, assembly and solver objects are then automatically created and managed. This allows for users with limited knowledge of the underlying physics models, collision detection and contact algorithms to easily create a surgical scenario with minimal inputs.

Rachel Clipp

**Pharmacokinetic and Pharmacodynamic Modeling in BioGears**

*Rachel Clipp, Jeff Webb, Cameron Thames, Zach Swarm, Rodney Metoyer and Aaron Bray*

A pharmacokinetics/pharmacodynamics model was implemented in the BioGears® physiology engine to address the need for real time drug effects for varying patients and injury profiles. A generic model plus 12 drugs were added and validated using experimental and subject matter expert data. All plasma concentration curves demonstrated a satisfactory fit with experimental data and 58 of 60 physiologic parameters displayed a less than 10% error compared to the validation data.

Thomas Kaltofen

**Development of a Generic Tubular Tree Structure for the Modeling of Orbital Cranial Nerves**

*Thomas Kaltofen, Sara Ivcevic, Mathias Kogler and Siegfried Priglinger*

We developed a generic approach for modeling tubular tree structures as triangle meshes for the extension of our biomechanical eye model SEE-KID with a visualization of the orbital cranial nerves. Since three of the orbital nerves innervate extraocular eye muscles and move together with them, the structure must also support the partial translation and rotation of the nerves. For the SEE-KID model, this extension allows a better parameterization as well as an easier simulation of innervational disorders. Moreover, it makes the model even more useful for education and training purposes in contrast to other anatomical models. Due to its generic nature, the developed data structure and the associated algorithms can be used for any tubular tree structures, even in non-medical application areas.

Wafaa Karaki

**Measurement of Temperature Dependent Apparent Specific Heat Capacity in Electrosurgery**

*Wafaa Karaki, Ali Akyildiz, Diana-Andra Borca Tasciuc and Suvranu De*

This paper reports on the measurement of temperature dependent apparent specific heat of ex-vivo porcine liver tissue during radiofrequency alternating current heating for a large temperature range. The difference between spatial and temporal evolution of experimental temperature, obtained during electrosurgical heating by infrared thermometry, and predictions based on finite element modeling was minimized to obtain the apparent specific heat. The model was based on transient heat transfer with internal heat generation considering heat storage along with conduction. Such measurements are important to develop computational models for real time simulation of electrosurgical procedures.
Rodney Metoyer

**Multiscale Simulation of Insults and Interventions: The BioGears ® Showcase Scenarios**


Four scenarios were created to showcase the ability of the Biogears open-source physiology engine to simulate complex and combinatorial insults and interventions: combat multi-trauma, asthma attack, heat stroke, and environment exposure. We compared the simulation results to literature and to the expectations of subject matter experts. Of the 229 points of validation, 163 were within 10 percent of the expected values, and another 29 were between 10 and 30 percent of the expected value. The development of mannequins, serious games, and other medical training technologies requires accurate dynamic physiology simulation. The Biogeams Showcase Scenarios demonstrate the ability of the engine to fill the physiology simulation needs of the medical simulation community under a wide range of conditions. By filling the physiology simulation gap, Biogeams remarkably reduces the development cost of medical simulations.

Luzie Schreiter

**Hybrid Rendering Architecture for Realtime and Photorealistic Simulation of Robot-Assisted Surgery**

*Sebastijan Müller, Andreas Bihlmaier, Stephan Irgenfried and Heinz Wöhr*

In this paper we present a method for combining realtime and non-realtime (photorealistic) rendering with open source software. Realtime rendering provides sufficient realism and is a good choice for most simulation and regression testing purposes in robot-assisted surgery. However, for proper end-to-end testing of the system, some computer vision algorithms require high fidelity images that capture more minute details of the real scene. One of the central practical obstacles to combining both worlds in a uniform way is creating models that are suitable for both kinds of rendering paradigms. We build a modeling pipeline using open source tools that builds on established, open standards for data exchange. The result is demonstrated through a unified model of the medical OpenHELP phantom used in the Gazebo robotics simulator, which can at the same time be rendered with more visual fidelity in the Cycles raytracer.

Zachary Swarm

**Modeling Renal Behavior and Control in BioGears**

*Zachary Swarm, Jeff Webb, Rachel Clipp, Jenn Carter, M. Cameron Thames, Rodney Metoyer, Aaron Bray and David Byrd*

The BioGears® Renal system models both the fluid exchange and the chemical handling of the kidneys. Feedback mechanisms include oncocytic pressure, tubuloglomerular feedback and osmoreceptors. The system is well validated at steady state, with 78 of 134 parameters falling within 10% and another 26 within 30%. The feedback mechanisms account for changes in blood pressure. Osmoreceptor responses to dehydration currently lower urine production to unrealistic ranges.

M. Cameron Thames

**Dynamic Response to Heat Gain and Heat Loss in the BioGears Engine**

*M. Cameron Thames, Jeffrey Webb, Rachel Clipp, Jenn Carter, Zachary Swarm, Rodney Metoyer, Aaron Bray and David Byrd*

The heat transfer module incorporated in the BioGears Physiology Engine consists of a lumped parameter circuit model that represents heat transfer mechanisms within the human body. In addition to the circuit calculations, models are included for temperature-related feedback mechanisms which are used to ensure thermal homeostasis. This module has been validated under both resting physiologic conditions and during transient heat gain or loss scenarios.

REGISTRATION & NAVIGATION

Randy Ellis

**Personalized Guides for Registration in Surgical Navigation**

*Andrew W.L. Dickinson, Brian J. Rasquinha, John F. Rudan and Randy E. Ellis*

Personalized guides are increasingly used in orthopedic procedures but do not provide for intraoperative re-planning. This work presents a tracked guide that used physical registration to provide an anatomy-to-tracking coordinate frame transformation for surgical navigation. In a study using seven femoral models derived from clinical CT scans used for hip resurfacing, a guide characterization FRE of 0.4°±0.2°, drill-path drill-path angular TRE of 0.9°±0.4° and a positional TRE of 1.2 mm±0.4 mm were found; these values are comparable to conventional optical tracking accuracy. This novel use of a tracked guide may be particularly applicable to procedures that require a small surgical exposure, or when operating on anatomical regions with small bones that are difficult to track or reliably register.
REHABILITATION & MENTAL HEALTH

Cay Anderson-Hanley

The Interactive Physical and Cognitive Exercise System (iPACES ©): Pilot Study of In-Home Use of Memory Lane © with Older Adults Pairs

Cay Anderson-Hanley, Makenzie Michel, Marissa VanBrakle, Molly Maloney, Adrianna Ratajska, Kristina Striegnitz, Tobi Saultnier and Nicole Barcelos

Preventing or slowing progression of cognitive decline associated with aging is a critical goal given the global dementia epidemic. Exercise is known to have a significant impact on brain health and can improve cognitive function; however, few older adults exercise at recommended levels. In this pilot study, six older adults utilized an innovative neuro-exergame in their home over a 6-week period in an AB design. The neuro-exergame yielded significantly greater improvement in cognition than the initial game-only condition.

Joon Young Kang

Automated Tracking and Quantification of Autistic Behavioral Symptoms Using Microsoft Kinect

Joon Young Kang, Ryunhyung Kim, Hyunsun Kim, Yeonjune Kan, Susan Hahn, Zehngui Fu, Mamoon I. Khalid, Enja Schenck and Thomas Thesen

The prevalence of autism spectrum disorder (ASD) has risen significantly in the last ten years, and today, roughly 1 in 68 children has been diagnosed. One hallmark set of symptoms in this disorder are stereotypical motor movements. These repetitive movements may include spinning, body-rocking, or hand-flapping, amongst others. Despite the growing number of individuals affected by autism, an effective, accurate method of automatically quantifying such movements remains unavailable. This has negative implications for assessing the outcome of ASD intervention and drug studies. Here we present a novel approach to detecting autistic symptoms using the Microsoft Kinect v.2 to objectively and automatically quantify autistic body movements. The Kinect camera was used to film 12 actors performing three separate stereotypical motor movements each. Visual Gesture Builder (VGB) was implemented to analyze the skeletal structures in these recordings using a machine learning approach. In addition, movement detection was hard-coded in Matlab. Manual grading was used to confirm the validity and reliability of VGB and Matlab analysis. We found that both methods were able to detect autistic body movements with high probability. The machine learning approach yielded highest detection rates, supporting its use in automatically quantifying complex autistic behaviors with multi-dimensional input.

Alberto Odor

Transcultural Telepsychiatry, Automated Translation & Speech Recognition Technologies

Peter Yellowlees, Steven Chan, Michelle Parish, Alberto Odor, Glen Xiong, Andrés Sciolia and Shang Wei

Although machine translation (MT) and automatic speech recognition (ASR) technologies have been used for the translation of static health education materials, videoconferencing, and translation of face-to-face clinical encounters, they have not previously been clinically validated in the known research literature. The use of such technologies could potentially boost access for limited English proficiency (LEP) patients who are more proficient at speaking a foreign language, thus decreasing language disparities.

Saskia Ortiz

Hand VR Exergame for Occupational Health Care

Saskia Ortiz, Alvaro Uribe-Quevedo and Bill Kapralos

The widespread use and ubiquity of mobile computing technologies such as smartphones, tablets and portable gaming consoles has led to an increase in musculoskeletal disorders due to overuse, bad posture, repetitive movements, fixed postures and physical de-conditioning caused by low muscular demands while using (and over-using) these devices. In this paper we present the development of a hand motion-based virtual reality-based exergame for occupational health purposes that allows the user to perform simple exercises using a cost-effective non-invasive motion capture device to help overcome and prevent some of the musculoskeletal problems associated with the over-use of keyboards and mobile devices.

Kevin Ponto

SafeHOME: Promoting Safe Transitions to the Home

Markus Broecker, Kevin Ponto, Ross Tredinnick, Gail Caspar and Patricia F. Brennan

This paper introduces the SafeHome Simulator system, a set of immersive Virtual Reality Training tools and display systems to train patients in safe discharge procedures in captured environments of their actual houses. The aim is to lower patient readmission by significantly improving discharge planning and training. The SafeHOME Simulator is a project currently under review.
Anitra Robertson

The Effect of Virtual Reality in Reducing Preoperative Anxiety in Patients Undergoing Arthroscopic Knee Surgery: A Randomized Controlled Trial

Anitra Robertson, Daniel Fick, Riaz JK Khan, Ramesh Rajan, Shanil Yapa, Hunter Hoffman and William B Robertson

This study aimed to determine if exposure to a relaxing Virtual Reality (VR) immersion will function to reduce preoperative anxiety in patients undergoing arthroscopic knee surgery. Preliminary results on 36 patients across two groups indicate a trend in in difference between the Standard Care and Virtual Reality (VR) groups. This final study paper will be available in Quarter two of 2016.

Jorge Ruiz

The Communication of Global Cardiovascular Risk by Avatars

Jorge G. Ruiz, Allen D. Andrade, Chandana Karanam, Dhurga Krishnamurthy Lorena Niño, Ramankumar Anam and Joseph Shari

Communicating numerical estimates of cardiovascular risk (CVR) to patients encourage risk reduction actions. Avatars may enhance the risk messages ability to improve persuasion to adhere to healthy behaviors. We compared the efficacy of a computer-based aid communicating CVR with and without animated avatars for improving intention to adhere to lifestyle changes. Males with intermediate to high CVR received their risk message in 2 versions: an avatar using voice; voice only. Forty-one participants completed the study. Intent to change lifestyle showed a significant effect favoring the avatar (moderate effect size). Intent to follow medical treatments also showed a significant effect favoring the avatar (moderate effect size). An avatar-based computer aid significantly increased participants’ intention to adhere to positive behavioral changes.

Jorge Ruiz

Effects of an Avatar-Based Anti-Smoking Game on Smoking Cessation Intent

Allen D. Andrade, Thaer Idrees, Chandana Karanam, Ramankumar Anam and Jorge G. Ruiz

The purpose of this study was to compare the effects of a computer-based anti-smoking game on the intent and motivation to quit tobacco. Smokers with nicotine dependence were briefly exposed to an anti-smoking game with or without an avatar resembling the smoker’s self. The computer-based anti-smoking game improved participants’ immediate intent and motivation to quit smoking. Embedding an avatar resembling self into the game did not result in added benefits.

Carmen Russoniello

Development of a Deployable HRV Assessment and Training System

Carmen Russoniello, John Evans, Brenda Bart-Knauer, Matt Fish, Christiana Brown-Bochicchio, Laura Gremore and Mikayli Paluzzi

PTSD and TBI are debilitating psychological conditions that are difficult to diagnose and treat. These conditions have been directly correlated to depression, anxiety and somatic complaints consistent with hyper-arousal of the autonomic nervous system (ANS). Verification of these results with quantitative physiological data is needed to provide accurate assessment of PTSD and TBI. The Department of Defense (DoD) requested technologically based methods to measure physiology in remote locations and to conduct biofeedback training. Heart rate variability (HRV) biofeedback training and has been studied and found to be efficacious in reducing symptoms associated with hyperarousal in PTSD and TBI.

Dave Taylor

Quantified-Self for Obesity: Physical Activity Behaviour Sensing to Improve Health Outcomes

David Taylor, Jennifer Murphy, Mian Ahmad, Sanjay Purkayastha, Samantha Scholtz, Ramin Ramezani, Ivaylo Vlaev, Alexandra I.F. Blakemore and Ara Darzi

Physical activity levels in bariatric patients have not been well documented, despite their importance in maintaining weight loss following surgery. This study investigated the feasibility of tracking physical activity using a smartphone app with minimal user interaction. Thus far, we have obtained good quality data from 255 patients at various points in their weight loss journey. Preliminary analyses indicate little change in physical activity levels following surgery with pre-surgery patients reaching an average of 16 minutes per day and post-surgery patients achieving a daily average of 21 minutes. Further analyses using machine-learning techniques will be conducted to determine whether physical activity is a critical factor in distinguishing between successful and unsuccessful weight loss outcomes and in the resolution of comorbid conditions in patients with similar clinical profiles.

SENSORS

Kristen Nguyen

Wearable Ultrasound Array for Point-of-Care Imaging and Patient Monitoring

Andrzej P. Mierzwa, Sean P. Huang, Kristen T. Nguyen, Martin O. Culjat and Rahul S. Singh

A versatile, flexible piezoceramic array has been developed for a variety of ultrasound applications. The transducer can be configured as a linear or curvilinear transducer array, or mounted
directly onto the body as a patch or wearable device. Results using a prototype 16-element array demonstrated equivalence to commercial linear array probes in accuracy of vessel diameter measurements in vascular phantoms. The ability to view needle insertion for peripherally inserted central catheter (PICC) procedures was also demonstrated. Opportunities for wearable ultrasound devices include point-of-care imaging, combat casualty care, ultrasound therapy, patient monitoring, and personal health.

Yunhe Shen

**A Motion Tracking and Sensor Fusion Module for Medical Simulation**

Yunhe Shen, Fan Wu, Kuo-Shih Tseng, Ding Ye, John Raymond, Badrinhath Koney and Robert Sweet

Here we introduce a motion tracking or navigation module for medical simulation systems. Our main contribution is a sensor fusion method for proximity or distance sensors integrated with inertial measurement unit (IMU). Since IMU rotation tracking has been widely studied, we focus on the position or trajectory tracking of the instrument moving freely within a given boundary. In our experiments, we have found that this module reliably tracks instrument motion.

Ravikiran Singapogu

**A Capacitance-Based Sensor for Hemodialysis Cannulation Training: A Proof-of-Concept Study**

Ravikiran Singapogu, Anand Jagannathan, Naren Nagarajan, Chris Moody, Guigen Zhang and David Cull

In this work, we present a novel capacitance-based sensor for teaching hemodialysis cannulation skills. Initial results from a pilot experiment suggest that data from the sensor could be used to indicate puncture events in tissue-like materials.

**SURGICAL SIMULATION**

Woojin Ahn

**Developing Modularized Virtual Reality Simulators for Natural Orifice Transluminal Endoscopic Surgery (NOTES)**

Woojin Ahn, Denis Dorozhkin, Steven Schwaithzberg, Daniel B. Jones and Suvaranu De

Natural orifice transluminal endoscopic surgery (NOTES) procedures are rapidly being developed in diverse surgical fields. We are developing a Virtual Transluminal Endoscopic Surgery Trainer (VTESTTMT) built on a modularized platform that facilitates rapid development of virtual reality (VR) NOTES simulators. Both the hardware interface and software components consist of independent reusable and customizable modules. The developed modules are integrated to build a VR-NOTES simulator for training in the hybrid transvaginal NOTES cholecystectomy. The simulator was demonstrated and evaluated by expert NOTES surgeons at the 2015 Natural Orifice Surgery Consortium for Assessment and Research (NOSCAR) summit.

Ryan Beasley

**Accelerating Surgical Simulation Development via OpenSurgSim: Burr Hole Trainer**

Ryan Beasley, Haizhou Wang, Harald Scheirich, Wesley Turner, Gughan Sathyaseelan, Paul Novotny, Julien Lenoir and Timothy Kelliher

The first complete simulation based on OpenSurgSim (OSS) is used as a case study for analyzing how the toolkit can accelerate the development of surgical simulations. The Burr Hole Trainer (BHT) is designed to train non-neurosurgeons to drill holes in the skull to relieve intracranial pressure, and the majority of its simulation functionality is provided by OSS. Based on code size, using OSS cut the development time in half, reduced the necessary size of the development team by two-thirds, and saved millions of US dollars.

Calvin Kwan

**Junctional and Inguinal Hemorrhage Simulation: Tourniquet Master Training**

Calvin Kwan, Shlomi Laufer, Montserrat Calixto Contreras, Peter Weyhrauch, James Niehaus, Noa Palmon, Benjamin Bauchwitz and Carla Pugh

Hemorrhages are the leading cause of potentially survivable combat mortalities when patients are unable to reach a treatment facility in time. New tourniquet devices have been developed to combat hemorrhages in the field. However, there is a lack in training systems to properly teach and assess users on tourniquet device application. We have developed an objective feedback system applicable to various full body manikins. We tested the system with expert users and received improvement feedback and verified the system's usefulness in instructing and assessing correct tourniquet device use.

Shlomi Laufer

**A Multi-Layered Needle Injection Simulator**

Shlomi Laufer, Steve J. Kempton, Kimberly Maciolek, Aliyya Terry, Rebecca D. Ray, Carla M. Pugh and Ahmed M. Afifi

Insuring correct needle location is crucial in many medical procedures. This can be even more challenging for physicians injecting in a new location for the first time. Since they do not necessarily know how the tissue is supposed to feel, finding the correct location and correct depth can be difficult. In this study
we designed a simulator for training needle injection. The simulator was fabricated to give a realistic feeling of injecting Botox® in the temporalis and the semispinalis muscles as part of migraine treatment. In addition the simulator provided real-time feedback of correct needle location. Nine residents and medical students evaluated the simulator. They made several errors that were corrected real time using the real time feedback provided. They found the simulator to be very useful and that the training significantly improved their confidence. The methods described in this study can easily be implemented for developing needle injection simulators for other anatomical locations.

Anthony LaPorta

Usage, Development and Refinement of a High-Fidelity Surgical Phantom for Examining Torso Exsanguination in Weightlessness and Multiple Sea States

A.J. LaPorta, A.W. Kirkpatrick, T. Hoang, E. Pierce, H. Tien, J. McKe, S. Brien, D. Louw, A. Skinner and R. Dee

Exsanguination is the leading preventable cause of post-traumatic death, a risk faced by civilians, soldiers, sailors and astronauts alike. Therapy requires immediate intervention and implementation of invasive techniques with great a potential of morbidity. Learners and practicing clinicians rarely have the opportunity to rehearse such techniques. Space adventure, difficult sea states, and austere environments all have similar identifiable problems including the need for hemorrhage control by non-surgeons in and outside of the body cavity.

Chembian Parthiban

Development and Analysis of Psychomotor Skills Metrics for Procedural Skills Decay

Chembian Parthiban, Rebecca Ray, Drew Rutherford, Mike Zinn and Carla Pugh

In this paper we develop and analyze the metrics associated with a force production task involving a stationary target with the help of advanced VR and Force Dimension Omega 6 haptic device. We study the effects of force magnitude and direction on the various metrics namely path length, movement smoothness, velocity and acceleration patterns, reaction time and overall error in achieving the target. Data was collected from 47 participants who were residents. Results show a positive correlation between the maximum force applied and the deflection error, velocity while reducing the path length and increasing smoothness with a force of higher magnitude showing the stabilizing characteristics of higher magnitude forces. This approach paves a way to assess and model procedural skills decay.

Yunhe Shen

A New Design for Airway Management Training with Mixed Reality and High Fidelity Modeling

Yunhe Shen, David Hananel, Zichen Zhao, Daniel Burke, Crist Ballas, Jack Norfleet, Troy Reihsen and Robert Sweet

Restoring airway function is a vital task in many medical scenarios. Although various simulation tools have been available for learning such skills, recent research indicated that fidelity in simulating airway management deserves further improvements. In this study, we designed and implemented a new prototype for practicing relevant tasks including laryngoscopy, intubation and cricothyrotomy. A large amount of anatomical details or landmarks were meticulously selected and reconstructed from medical scans, and 3D-printed or molded to the airway intervention model. This training model was augmented by virtually and physically presented interactive modules, which are interoperable with motion tracking and sensor data feedback. Implementation results showed that this design is a feasible approach to develop higher fidelity airway models that can be integrated with mixed reality interfaces.

Kazuyoshi Tagawa

Evaluation of Network-Based Minimally Invasive VR Surgery Simulator

Kazuyoshi Tagawa, Hiromi T. Tanaka, Yoshimasa Kurumi, Masaru Kormori and Shigehiro Monikawa

In this paper, we report a result of an experiment of a field trial of our network-based minimally invasive surgery simulator. In our previous paper, we proposed a network-based visuohaptic surgery training system for laparoscopic surgery. In addition, we proposed a volume-based haptic communication approach, 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 implemented the approach into our network-based surgery simulator, and field trial of the simulator at three locations was performed.

SURGICAL SIMULATION METRICS

Ryan Armstrong

An Examination of Metrics for a Simulated Ventriculostomy Part-Task

Ryan Armstrong, Dayna Noltie, Roy Eagleson and Sandrine de Ribaupierre

As one of the most commonly performed neurosurgical procedures, ventriculostomy training simulators are becoming increasingly familiar features in research institutes and teaching
facilities. Despite their widespread implementations and adoption, simulators to date have not fully explored the landscape of performance metrics that reflect surgical proficiency. They opt instead for measures that are qualitative or simple to compute and conceptualize. In this paper, we examine and compare the use of various metrics to characterize the performance of users on simulated part-task ventriculostomy scenarios derived from patient data. As an initial study, we examine how our metrics relate to expert classification of scenario difficulty as well as measures of anatomical variation.

Shlomi Laufer

A Simulator for Measuring Forces During Surgical Knots


In this study new metrics were developed for assessing the performance of surgical knots. By adding sensors to a knot tying simulator we were able to measure the forces used while performing this basic and essential skill. Data were collected for both superficial tying and deep tying of square knots using the one hand and two hands techniques. Participants used significantly more force when tying a deep knot compared to a superficial knot (3.79N and 1.6N respectively). Different patterns for upward and downward forces were identified and showed that although most of the time upward forces are used (72% of the time), the downward forces are just as large. These data can be crucial for improving the safeness of knot tying. Combing these metrics with known metrics based on knot tensiometry and motion data may help provide feedback and objective assessment of knot tying skills.

Ravikiran Singapogu

A Novel Platform for Assessment of Surgical Suturing Skill: Preliminary Results

Ravikiran Singapogu, Tanmay Kavathekar, John Eidt, Richard Groff and Timothy Burg

In this work, we describe a novel platform for quantifying surgical suturing skill. Forces and user movements are recorded using sensors during suturing maneuvers performed on a suture patch. Preliminary results from a pilot experiment suggest that force data could be used for objective assessment of suturing skill.

Ka-Chun Siu

Investigating the Influence of Hand Dominance on Postural Sway During Traditional and Simulated Laparoscopic Surgical Skills Practice

Anthony White, Chun-Kai Huang, Dmitry Oleynikov and Ka-Chun Siu

This study examined how hand dominance could influence postural sway during laparoscopic skills practice. Ten inexperienced medical trainees performed a peg transfer task using the Fundamentals of Laparoscopic Surgery (FLS) training box and the virtual reality (VR) trainer. Surface electromyographic recordings of upper and lower limb muscles were taken, while the postural sway was measured by a pressure mapping system. Skills performance using the non-dominant hand required more muscle effort and increased more postural sway. Compared with the FLS training box, training with VR decreased the use of muscle effort and could reduce the influence of hand dominance on the overall postural sway during laparoscopic surgical skills practice.

Ka-Chun Siu

Effects of Hand Dominance and Postural Selection on Muscle Activities of Virtual Laparoscopic Surgical Training Tasks

Chun-Kai Huang, Ashley Boman, Anthony White, Dmitry Oleynikov and Ka-Chun Siu

This study investigated how the ergonomic factors, such as hand dominance and postural selection, influenced on surgical performance regarding the changes of muscle activity. Twenty novices performed two virtual laparoscopic surgical training tasks and five target muscle activities were measured. Compared with using dominant hand, surgical skills performance using non-dominant hand increased muscle activities. Muscle fatigue is more likely induced in standing position than sitting position during practice. This study suggests an emerging need to focus on hand dominance during laparoscopic surgical training to address the impact of hand discrepancy on bimanual coordination. It is also important to pay attention on postural selection during training to reduce muscle fatigue, which possibly leads to injuries.
SURGICAL SIMULATION VALIDATION

David Rojas

Improving the Acquisition of Basic Technical Surgical Skills with VR-Based Simulation Coupled with Computer-Based Video Instruction

David Rojas, Bill Kapralos and Adam Dubrowski

Next to practice, feedback is the most important variable in skill acquisition. Feedback can vary in content and the way that it is used for delivery. Health professions education research has extensively examined the different effects provided by the different feedback methodologies. In this paper we compared two different types of knowledge of performance (KP) feedback. The first type was video-based KP feedback while the second type consisted of computer generated KP feedback. Results of this study showed that computer generated performance feedback is more effective than video based performance feedback. The combination of the two feedback methodologies provides trainees with a better understanding.

Oleksiy Zaika

Evaluation of User Performance in Simulation-Based Diagnostic Cerebral Angiography Training

Oleksiy Zaika, Ngan Nyugen, Mel Boulton, Roy Eagleson and Sandrine de Ribaupierre

Simulation of anatomically complex procedures, such as angiography, is becoming more practical, however, computer-based modules require extensive research to assess their effectiveness. We organized two training schemas – alternating cases and consistent cases – and hypothesized that the alternating practice cases would be beneficial to test performance. Eight residents (4 radiology/4 neurosurgery) and 8 anatomy graduate students were trained on the Simbionix™ simulator in order to assess skill acquisition in diagnostic cerebral angiography over 8 sessions. We found that participants improve on total procedure time and total fluoroscopy time (p<0.05), but not on contrast injected or roadmaps created. There were no significant differences between alternating and consistent training types. Additional work needs to be done with higher sample numbers and visuospatial scores as criteria.
Mini-Lecture Abstracts

Please see the Poster and Demo descriptions for more information about Mini-Lectures not listed here.

James Earl Cox III


Playing games is important. While games can be for fun, the can also be much more. Games can assist in coping with stress, and they can help us open up to discussions and topics we may otherwise bury deep inside. We can share sensitive topics within games that social norms may not embrace or in real-life scenarios that subdue its discussion; interact, feel loss, or guilt for characters that don’t truly exist. Four games I designed addressing this area include Don’t Kill the Cow, Bottle Rockets, Temporality, and It’ll All Be Ok. Each of these existence-identity games represents an innovative approach that may not be considered overly “fun” but represents a forerunner to games that could aid introspection and interpersonal discussion. Games that can open dialogues about internalized emotions.

Salam Daher

Humanikins: Humanity Transfer to Physical Manikins

Salam Daher and Gregory Welch

Physical manikins are widely used in the healthcare field for simulation, training and teaching but are limited in their ability to dynamically change their appearance such as changing facial expressions and skin color. Virtual patients can be easily and dynamically animated to change their appearance, and are typically displayed on flat screens. Here we describe the augmentation of physical patient simulator manikins with virtual imagery.

Matthew Hackett

Smart Camera: Using Computer Vision to Improve the Assessment of Medical Training

The assessment of medical training combines objective measures of performance with expert instructor feedback. In many instances, exercises are video-taped for review after culmination of the training. In theory, this represents an excellent tool for debriefing trainees. In practice, the video suffers from significant issues. The raw video tends to be too long for practical use and digestion by trainees. In addition, the camera views are many times occluded by personnel, or the focus of actions is moved from the cameras line of sight. This results in a large quantity of very low quality video. An instructor wants the highlights of a 30-minute exercise, not the entire 30 minute video. In this effort, researchers are attempting to augment cameras with computer vision techniques to automatically focus on areas of interest and create a highlight reel of debrief events. The cameras will include both mounted and man-worn varieties, removing the challenge of occlusions. This talk will discuss a market survey of cameras and computer vision techniques, and discuss the feasibility of the system and the direction of the research.

Heidi Maertens

Design and Construct Validity of a Proficiency-Based Stepwise Endovascular Curricular Training (PROSPECT) Program

Heidi Maertens, Rajesh Aggarwal, Liesbeth Desender, Frank Vermassen and Isabelle Van Herzeele

Improving patient safety by shortening the learning curves and reducing errors in the operating room is driving the integration of simulation training into surgical curricula. An innovative stepwise endovascular proficiency-based curriculum including e-learning and hands-on simulation training has been developed. The feasibility and construct validity of this program has been demonstrated. A randomized-controlled trial integrating PROSPECT into surgical training is ongoing.

Ted Meyer

The Scarred for Life Project: The Lived Experience of Illness

Gregory Welch, Salam Daher, Jason Hochreiter and Laura Gonzalez

Arts and the Humanities are having a revival within the practice of medicine. Medical schools are using art to teach about observation, the humanities are being included in med school curricula to grow empathy, and national bodies that govern what we teach in medical schools all across the country are demanding that we do more.

This is great news to me, since I’ve been using art my entire life to talk about my own experience as a person with Gauchers, an inherited condition that once meant I’d live a short and painful life and die early.

All that has changed for me with modern medicine, but what I do now is still tied to medicine, and I think the next leap is tied to technology.

Let me tell you how.

The Scarred for Life Project, where I create art from prints of people's scars, pieces that have now been shown all across the country, and published alongside their narratives in book form, has shown me that it is valuable and even transformative for people to make art out of their scars.
I’ve also been the A.I.R at UCLA’s Geffen School for 5 years, and in that time I have curated art shows by patients with various illnesses, and had these artists come talk about their experiences of living with illness. I am currently setting up a program to link the content of a medical school curriculum to the art that best illustrates it.

I teamed up with a medical educator to create Art&Med, and she believes this is an important tool in teaching medical students. Something called “the lived experience of illness”.

And technology will allow us into this lived experience in radical ways in the coming years.

Gregory Welch

**Interactive Rear-Projection Physical-Virtual Patient Simulators**

*Gregory Welch, Salam Daher, Jason Hochreiter and Laura Gonzalez*

Conventional physical manikins offer little in the way of dynamic appearance such as skin pallor, facial expressions, and wounds. Virtual (computer graphics) patients are infinitely dynamic, but are flat to the touch and exist in a separate virtual space. We are exploring the combination of the physical and virtual in a new form of patient simulation that offers the hands-on interactive experience of a manikin with the richness and flexibility of a virtual patient. We present head and full-body prototypes, and some initial qualitative feedback.
Demo
Descriptions
Demo Descriptions

THURSDAY Afternoon, April 7
SCHEDULED DEMOS

1:30 – 2:15

Touchable 3D Graphics for Patient and Family Education

David Sarno
Lighthaus Inc.

Working with our main client, Lucile Packard Children's Hospital Stanford, Lighthaus has created and published several engaging, interactive explanations of complex congenital conditions. The projects are freely available both for the iPad (heart, brain), and for desktops via the stanfordchildrens.org website (heart, brain). We're currently working with the BBC, Whole Foods, the Dallas Morning News, and other education technology firms.

The projects use interactive 3D graphics -- essentially, 3D videogame graphics -- to give families and patients a vivid, hands-on new way to understand the nature of health conditions. This story in Fast Company explains the work succinctly. We’ve published projects that explain the heart condition Tetralogy of Fallot, the brain-related birth defect hydrocephalus, and placenta accreta, a condition affecting birthing mothers.

The work has received excellent feedback from doctors, patients, and in the media. Dr. Gerald Grant, the chief of pediatric neurosurgery at Stanford Children's, has said the work offers a highly effective new way to convey the complexities of anatomy and surgery to anxious parents. He has presented the work at the American Association of Neurological Surgeons.

This, too, is a common testament from parents: “I loved seeing this,” said Tricia Jorritsma, the mother of an 11-month-old being treated at Stanford. "It's the first time the specific ins and outs of Noah's operation have become really clear to me, and it's so much better than all the other explanations.”

Bioflight

Jim Reeves and David Bryant
Bioflight VR

Bioflight is an Augmented and Virtual Reality platform for the health care industry. Created for platforms like Oculus Rift, Sony’s Project Morpheus, the Samsung Gear VR and Microsoft's HoloLens, Bioflight is an immersive and interactive application. Utilizing the power of the AR/VR experience, Bioflight users will soon have access to a visual tool set that will help revolutionize medical education and training.

Our biological models are fully interactive, medically precise and built from the most comprehensive digital data sets. Our expert team of illustrators, animators programmers and medical advisors can build any simulated rendering required, including the integration of client supplied models.

Bioflight’s development program includes the integration and rendering of patient specific CT/MRI data in true 3D. Demonstrations of medical devices and surgical procedures are also part of our immersive and interactive simulations. Our live 360 capture system offers virtual presence opportunities for remote training, product or brand marketing and sales presentations.

Future developments in hardware and software applications will further innovate the Bioflight platform. We are committed to integrating new deep learning and Artificial Intelligence (AI) functionality. Use of intelligent devices and instruments

The unique design of the Bioflight application offers medical companies, educators, doctors and patients a powerful new tool for the healthcare industry.
**THURSDAY Afternoon, April 7**

**SCHEDULED DEMOS**

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<th>Time</th>
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<th>Demonstrator/Description</th>
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| 2:15 - 3:15| 3:00 - 4:00| The Interactive Physical and Cognitive Exercise System (*iPACES®*)

Cay Anderson-Hanley  
Union College

Please see Anderson-Hanley poster abstract for more information about this demo presentation.  
Page 56

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<th>Time</th>
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<th>Demonstration Description</th>
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| 3:15 - 3:45| 2:30 - 3:00| Fully-Immersive 3D Multiplayer Training on $150 Laptops!  
Randy Brown  

This demonstration shows our support at the point of need. To feature the demonstration, we are running:

- Amazon Web Services  
- Nvidia GRID GPU cloud infrastructure  
- Google Chrome AppStreaming technology  
- Nvidia $200 Shield Tablet (or $150-250 Chromebook laptop)  
- Google Android Operating System  
- Bluetooth keyboard and mouse  
- Wi-Fi connection for bandwidth  
- Virtual Heroes Browser-based Cloud Training Platform (Go)  
- Virtual Heroes Combat Medic team-training application

This demonstration showcases real-time, 30 frame per second, full HD resolution, multi-player Combat Medic team-training content, running on a very low-end trailing-edge hardware client such as a $150 Chromebook laptop and/or a $200 Nvidia Shield tablet.

Current stage of development: prototype

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| 3:45 - 4:45| 3:00 - 4:45| **S3PM – Synthesis and Simulation of Surgical Process Models**

Guillaume Claude  
INSA of Rennes, IRISA/Inria  
Pierre Jannin  
INSERM, University of Rennes 1

We present here a collaborative virtual environment for the training of scrub nurses to the craniotomy procedure. The procedure integrated in the simulator is generated from several observations of real case surgeries used through process mining technologies.

The set-up is a head mounted-display along with interaction peripheral connected to a computer. The user does not need to move around the room to participate. Both HMD and computer screen will display the virtual OR. The system will allow interactions with the virtual staff and the surgical tools according to a defined surgical scenario.

Current stage of development: main Components are developed and tested. Integration is in progress. User experiments are planned for mid 2016.

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<th>Time</th>
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| 3:15 - 5:00| 3:00 - 4:45| **vizHOME: Using LiDAR to Create Point Cloud Representations of Home Interiors**

Kevin Ponto  
School of Human Ecology,  
Wisconsin Institutes for Discovery  
University of Wisconsin-Madison

Innovative uses of advanced visualization allow deeper and more precise exploration of how private environments, such as households, are used for health purposes. Within the vizHOME project, we explore how household interiors shape health information management. This 5-year federally funded study utilizes both intensive home-based interviews and advanced imaging techniques to understand how a home setting influences personal health information management (PHIM). For the project LiDAR has been used to capture 20 homes in size ranging from 460-2,800 sq.ft. We render and display these point clouds on several visualization platforms, including the Oculus Rift and a 6-sided VR CAVE. The 3D models of all 20 homes will be released under open source licensure at the end of the experimental period. In this demonstration, participants will use an Oculus Rift to view point cloud representations of household interior.
Point cloud representations afford ample opportunities for both design companies and private sector industries. Typically, companies pay to enter homes or other environmental settings, thus limiting the variety of exposure to specific design cues of settings or unique environments. It is vital that the entirety of a setting is captured. Furthermore, at-scale VR allows for repeated exposure to unique settings, allowing designers to familiarize themselves with the environment that may not be presently available.

The demonstration will be structured to allow a participant 10 minutes to walk through a house using the Oculus Rift, which provides navigation with a gaming interface, noting specific interior features of a house that might impact health information management and to overall explore intimate, often seldom accessible spaces. We can accommodate approximately 6 people an hour.

This demonstration is important because it is the first application of LiDAR-created point clouds of home interiors and informal spaces. It affords both research and commercial applications and benefits. Specifically, it provides reproducible, human scaled, replications of households through VR, which can be utilizing by a variety of businesses, designers, or research and health care settings.

vizHOME is supported by grant number RO1HS022548 from the Agency for Healthcare Research and Quality. The content is solely the responsibility of the authors and does not necessarily represent the official views of the Agency for Healthcare Research and Quality."

THURSDAY Afternoon, April 7
CONTINUOUS DEMO

12:00 - 5:00

Medical Modeling & Simulation Innovation Center (MMSIC)

J. Harvey Magee and Lori DeBernardis

Teledmedicine & Advanced Technology Research Center (TATRC)

The Telemedicine & Advanced Technology Research Center (TATRC) is an office of the Headquarters of the U.S. Army Medical Research and Materiel Command (USAMRMC), located at Fort Detrick, Maryland. TATRC conducts and supports research through its six key laboratories and programs which include: Computational Biology, Health I.T., Mobile Health, Medical Modeling & Simulation, Operational Telemedicine and the AAMTI Program. With an extensive network of partners, TATRC expertise is focused on the entire research spectrum, from early stage innovative research to technology demonstrations and implementation to benefit the Warfighter. TATRC Labs actively collaborate with commercial entities and academic institutions to address the requirements of our medical research programs through special funding and partnership opportunities.

TATRC is engaged in essential medical research focused on advanced medical technologies and is dedicated to bringing innovative telehealth solutions to the Warfighter and the Military Health System. TATRC fosters research on health informatics, telemedicine/m-Health, medical training systems and computational biology to address gaps in DoD medical research programs and military healthcare.

Our Mission is to exploit technical innovations for the benefit of military medicine by developing, demonstrating and integrating across a variety of technology portfolios including teleHealth, medical simulation and training, health IT, medical robotics, command and control, computational biology, and mobile solutions. Sponsor bottom-up innovation through limited technology demonstrations focused on readiness, access to care, and healthcare delivery.

While at MMVR 2016, we will highlight and feature our Medical Modeling & Simulation Innovation Center (MMSIC). The MMSIC is an innovative nexus of collaboration, discovery and expertise in medical simulation and training. MMSIC seeks high value opportunities such as enabling technologies, visionary concepts, and resources.

MMSIC serves as a home to simulation developer resources such as the BioGears(r) physiology engine and other open source tools. MMSIC expertise is in high demand with the lab currently funded to assist in medical simulator transition efforts. Our laboratory research focuses on experimental concepts and novel applications. We collaborate with forward thinking research groups to realize this vision.

Please stop by and visit to Learn how TATRC plays a leading role in the advancement of military medicine!

(continued)
FRIDAY Afternoon, April 8
SCHEDULED DEMOS

1:00 - 4:45

Videolaryngoscopy Simulator
Nathan Delson
Dept Mechanical and Aerospace Engineering, University of California, San Diego

Please see Delson lecture abstract for more information about this demo presentation. Page 39

2:30 - 3:00  See Description Thursday 3:15

Fully-Immersive 3D Multiplayer Training on $150 Laptops!

3:00 - 4:45  See Description Thursday 3:15

S3PM – Synthesis and Simulation of Surgical Process Models

THURSDAY and FRIDAY Afternoon
CONTINUOUS DEMOS

12:00 NOON - 5:00

AppliedVR

Josh Sackman, Matthew Stoudt, and Ryan Anderson
AppliedVR

AppliedVR provides a virtual reality platform that focuses on enhancing patient experience, increasing efficiency, and maximizing health care value. AppliedVR’s initial perioperative platform is designed to engage the patient during all stages of procedures in hospitals and surgical centers, offering patients drug-free alternatives managing pain and anxiety associated with medical procedures. AppliedVR’s platform is based on over 20 years of clinical and academic research in the medical space.

Products:
• Pain RelieVR – acute pain management
• Anxiety RelieVR – pre-procedural anxiety reduction

Stage: In Validation and Usability Testing
• Clinical Research Studies at Cedars Sinai and Children’s Hospital Los Angeles
• Usability / Operational Testing at Ambulatory Surgery Centers

Clinical Encounter: Pain Treatment and Take Control Over Addiction

Brad Tanner and Mary Metcalf
Clinical Tools, Inc.

Clinical Encounter: Pain Treatment is a 3D serious game simulation of clinical encounters with patients with various pain-related issues. Our intended users are practicing health professionals who treat patients in pain, often with opioids.

Learners practice clinical decision making and develop clinical skills via simulated encounters with 3D patients in pain where treatment with opioids is an option (though potentially not the best option). Cases also present users with addiction, diversion risk, or malintent. Via a Unity-based 3D simulated clinical training experience, our novel training prepares members of the nations’ health workforce to successfully intervene in pain treatment while decreasing potential harm due to opioid prescription drugs.

Game Play: Learners interact with virtual patients who have challenging combinations of pain conditions and addiction risks. Game play involves making clinical decisions and experiencing realistic clinical outcomes, both immediate and delayed. Branched path learning provides for varying downstream outcomes based on prior decisions and interventions. Positive outcomes are experienced when a patient-centered approach is used and evidence-based practice guidelines are followed. Negative outcomes can be realized and corrected through alternate game play.

Development Stage/Availability: Prototype experience is available. Product is not commercially available. Launch is planned for 2017.

[Funding Source: NIH/NIDA (#1R44DA035042-01)]

Take Control Over Addiction is a motion controlled virtual reality video game available for Kinect™ on Windows PCs. The game is themed to pit the player’s avatar against the substance(s) of abuse.

Goal: Assist patients in recovery via a game where they actively challenge cues to addiction and seek out more positive behaviors in environments identified as difficult for them.

In various settings, images of alcohol, cigarettes or drugs will be offered to the player and then refused or destroyed by a variety of body movements (e.g., swiping/waving, kicking). Destroying/refusing substances via these movements will give players a sense of accomplishment, self worth
and choice. There are several subthemes of the game including trigger avoidance, seeking help, decreasing stress, and helping others.

Game Play: Players can: 1) choose a preferred background that is most relevant to their needs (e.g., bathroom, kitchen, street, bar setting), 2) select from one of several substances to make game-play relevant and engaging (e.g., cigarette pack, pills, an alcohol bottle), 3) begin kicking and punching their way through various exposure scenarios, winning points, and advance to more challenging levels. They also seek out “supports” including telephoning a sponsor, relaxation techniques, and exercise.

Development Stage/Availability: The game is available to clinics with proper treatment integration. An XBox One version is in production.

[Funding Source: NIH/NIDA (#HHSN27120120007C)]

SIMULATIONIQ

Lynn Welch
Education Management Solutions

As a pioneer of simulation-based solutions for clinical training environments, EMS provides SIMULATIONIQ, the only intelligent clinical simulation management operating platform that brings together all the programs, people, and processes into a single, simplified view that saves time, improves clinical outcomes, and delivers peace of mind. For more information visit our booth and www.SIMULATIONIQ.com

Envelop Virtual Environment

Jeff Hansen and John Root
Envelop VR

Envelop VR is the creator of the Envelop Virtual Environment (EVE), an immersive computing platform for existing windowed PC content and applications, as well as new VR-specific applications. EVE basically allows users to use their computer while in a VR headset, currently an Oculus Rift or HTC VIVE. Within EVE, users have greater functionality and benefits that they would not otherwise have with a typical two-dimensional flat screen computer.

For the medical and healthcare community, our software platform allows professionals to extend the existing applications that they use for diagnosing or planning surgical interventions into our virtual reality environment. Unlike current 2-D solutions that only offer one image of a 3D object at a time, Envelop enables those 3D objects to co-exist and interact with multiple other data sources, i.e. communication modes like email, patient data, outcome statistics, etc. This will provide clinicians with a much stronger, more effective toolset for diagnostic and surgical intervention planning.

Envelop’s software allows medical professionals and solutions providers to seamlessly transition into virtual reality because it gives them the platform to use their current computing functionalities and existing applications, but with the additional benefits that will allow those tools and data sources to perform at an optimum level.

We have been doing some preliminary studies with the University of Washington where they are looking at 3D mapping of the electrical activity of heart, along with 3D models of the heart muscle for when they destroy a small portion of the heart muscle for people who are having arrhythmias.

Our technology is in alpha, but we are currently engaged with several enterprise clients in various industries where we have a number of POC (proof of concept) engagements under way.

SimMan 3G Trauma and SonoSim
Ultrasound Solution

Patrick Smith
Laerdal Medical

SimMan 3G Trauma consists of a tetherless full-sized adult human mannequin, a ruggedized instructor tablet computer (remote control unit), amputated right and left upper and lower extremities, and a ruggedized carrying case. The system is rugged and reliable for use in multiple environments, and training scenarios from basic to advanced combat medical skills. The SimMan 3G Trauma durability is strengthened by polycarbonate plastics and a forged aluminum frame with articulating shoulder and hip joints that connect with stainless steel rods. It is a tetherless system powered by internal electrical and pneumatic engines with supplemental, wired connectivity and power, if necessary.

The SimMan 3G Trauma has been designed to train military and civilian emergency medical personnel in trauma situations, such as hemorrhage control. The durable configuration provides you
with the flexibility to perform simulation based education in the environment of your choice, from the classroom to the battlefield. We have tailored SimMan 3G for specialist use as a trauma patient simulator specifically designed for military and civilian emergency services. SimMan 3G Trauma is well suited for training the rapid assessment of trauma emergencies. It will also simulate necessary interventions such as hemorrhage control and airway management.

SimMan 3G Trauma has some essential features, such as amputated limbs and sternal IO access to provide optimal training for trauma emergency situations. These features, along with the rugged PC, wireless configuration and carry case, make SimMan 3G Trauma the quality choice for realistic training in any environment – whether in a hospital, an ambulance or in a military combat environment. The 3G Trauma are paired with LLEAP which features two unique ways to control your simulation: Automatic Mode and Manual Mode. This allows you to tailor the simulation to meet your specific needs. Validated scenario content can be purchased for SimMan 3G or developed using SimDesigner.

Laerdal SonoSim Ultrasound Solution: Laerdal and SonoSim proudly announce the integration of the SonoSim® Ultrasound Training Solution into our patient simulator platform. This means you can now include diagnostic ultrasound featuring real ultrasound cases with pathological findings into full-scale simulations. Ultrasound is a safe, portable and non-invasive way to gain clinically relevant information. Informed decisions can be made in a rapid and cost-effective fashion.

Acquiring the knowledge and skills to perform ultrasound can improve quality of care and patient safety. The Ultrasound Solution provides an easy-to-use and highly realistic ultrasound training and proficiency assessment tool. As ultrasound training technology is integrated in the simulator chest and abdominal skin, it is easy to perform an ultrasound at any time. When ultrasound is not indicated, the technology remains unseen to the learner. First available with SimMan 3G and SimMom, the Ultrasound Solution will enable your simulation training to reach a whole new level of relevancy and realism. The Ultrasound Solution allows you to assess how well trainees identify normal anatomy and physiology, key anatomical landmarks, image artefacts and pathologies, and apply this information towards medical decision-making.

Ultrasound Solution for SimMan 3G or 3G Trauma are available with focused assessment with sonography for trauma care (eFAST) and rapid ultrasound for critical care (RUSH) and cardiac resuscitation training cases. Ultrasound Solution for SimMom is available with obstetric training cases - early stage and late stage pregnancy. To increase realism additional skins are provided to give SimMom a gravid and flat abdomen.

Each case can be combined with specifically tailored scenarios from leading curriculum partners available in SimStore, so you now have access to a complete solution for skills training, competency assessment and testing. Real ultrasound cases can also be used to develop custom simulation scenarios tailored to your training needs.

Commercial and Government Availability: All products are commercially available directly through Laerdal or commercial distributors. Laerdal has also partnered with several service-disabled / veteran-owned small businesses who have all of our products available on GSA, ECAT, and through other purchasing arms to better assist customers with these purchases.

The Mursion Virtual Training Platform

Aleshia Hayes
Mursion

Mursion is the virtual environment where professionals practice and master the complex interpersonal skills required to be effective in high-stakes careers. Mursion designs customized training simulations and performance-based assessments that match the unique learning objectives of our clients.

Originally designed as a virtual training platform for teachers and school principals, Mursion’s immersive training simulator is now being leveraged by the healthcare sector to deliver more effective and efficient standardized patient training. In our simulator, healthcare professionals can practice a wide range of essential interpersonal skills. For example, Mursion is currently partnering with researchers at Duke University to investigate whether virtual standardized patients (avatars) is a more effective training method than traditional standardized patients for improving interpersonal skills related to delivering a negative diagnosis.

Launched in 2015 with $1M in seed funding from the New Schools Venture Fund and building off a decade of pioneering research on virtual simulation conducted by the University of Central Florida, Mursion is the only company capable of delivering immersive learning experiences for intense human-to-human interactions.
Mursion’s “mixed reality” platform is driven by artificial intelligence and human simulation specialists, trained actors that design and orchestrate the verbal and non-verbal interactions between avatar-based characters and the trainee during simulation. This blending provides the realism needed to make experiences that involve intense human-to-human interactions impactful. Mursion also has the ability to deliver simulations on head mounted displays.

Mursion offers live demonstrations of its virtual simulator, including the following standardized patient scenarios:
- Physician Scenario – Delivering a Negative Diagnosis
- Nurse Scenario – Pain Management
- Psychiatrist Scenario – Bipolar Disorder Diagnosis

Polhemus

Neil Schell and Pam Pelino
Research and Technology Applications,
Polhemus

Polhemus will be showing 6DOF magnetic motion tracking sensors used in healthcare applications such as VR training simulators, VR rehabilitation and physical therapy systems, and clinical applications such as image guided surgery.

Product demonstrations include G4™, a compact, tetherless tracker that works for both small and large area tracking environments. Also shown, will be the new Micro Sensor 1.8™, a tiny motion tracking sensor designed for a cardiac catheterization simulator.

Polhemus pioneered motion tracking over 40 years ago, introducing head tracking technology for aviation cockpit simulators—something they still do today. Along with their accuracy, low latency and simplicity, Polhemus trackers provide 6 Degrees-of-Freedom measurement, with sensors that are easily embedded in probes and manikins. This has made Polhemus technology a top choice for some of the world’s most sophisticated and successful healthcare training simulators.

SynDaver Patient

Conor Mahon
SynDaver Labs

The SynDaver Patient is the newest addition to our award-winning SynDaver Synthetic Human (SSH) product line. In addition to all of the existing features that have made the Synthetic Human world-famous, the SynDaver Patient also includes an open-source physiology engine that controls body motions and all aspects of synthetic biology.

The Patient’s autonomic nervous system controls respiration rate, tidal volume, end-tidal CO2, heart rate, heart waveform, arrhythmia, systemic vasoconstriction, body temperature, blink rate and pupil dilation. This means that the body will react to injury and medical intervention exactly as a live human would!

The possible interactions between the SynDaver Patient and medical students delivers simulation that was previously only possible in a real-world emergency room or battlefield. In addition, since the physiology engine is open-source, our clients can create their own scenarios. Featured with the physiology engine is the hypovolemic shock scenario and the real-time blood loss tracker.

The family of SSH products has been used in a wide variety of procedures including open-heart surgery, coronary bypass and stent placement (both femoral and radial approach) with fluoroscopy, chest tube placement, tracheotomy, carotid endarterectomy, cricothyroidotomy, infusion port placement, central line placement with ultrasound, angioplasty, appendectomy, embolotomy, endoscopic surgery with insufflation, femoral cutdown with closure device and hundreds of other procedures.

Extraordinary Features

The SynDaver Patient is the world’s only full body surgical simulator that combines the ability to operate on any part of the body, synthetic human tissues, animated limbs and an open-source physiology engine. The SynDaver Patient is quite simply the most advanced hands-on medical simulator that the world has ever seen.

Included Components

Animated full body with skin, storage and transport container, battery-powered life support equipment, wireless tablet computer to control body motions and physiology engine and physiology display.

(continued)
Included Services
Onsite installation and training, one full year of anatomy, tissue and hardware upgrades and a three-year warranty. Annual service contracts covering every aspect of the system are also available.

Computer Interface
The system includes wireless control and display tablets with native SynDaver software. Controls include body motion (limbs), respiration rate, tidal volume, end-tidal CO2, heart rate and waveform, arrhythmia, vaso-constriction, temperature, blink rate, and pupil dilation. The separate physiology display follows heart rate, blood pressure, respiration, end-tidal CO2 and temperature.

Customization
A variety of pathologies and injuries are available - based on patient images, CAD drawings or simple descriptions. Client may also select gender and skin tone.

Imaging Equipment
System is compatible with ultrasound, fluoroscopy, x-ray, and CT imaging equipment.

Surgical Equipment
System is compatible with all known surgical devices including lasers, RF ablation, plasma knives, sonic blades and cryocatheters, as well as bipolar, monopolar and harmonic devices.

**Modular MedSim Architecture with Persistent Virtual Patient**

**Ed Sims and Carol Wideman**
*Vcom3D, Inc.*

We will demonstrate a modular medical simulation architecture that can be integrated with a wide range of live, physical, virtual, and constructive simulation modules. All modules communicate via a common data bus, supporting multimodal configurations of instrumented part-task trainers, wearable devices, virtual patients and equipment, and a shared state engine and physiology model.

The proposed demonstration will include the following modules:

- A Core Simulation with a shared physiology model based on the open source BioGears physiology engine
- A Virtual Patient that exhibits appearance and behaviors consistent with the physiology model
- A Virtual Patient Monitor and Patient Lab Reports
- An instrumented IV Arm
- An Instructor Tablet that can be used to launch and control interactive scenarios and to record observed learner actions.

The demonstration scenario will show how the physical, virtual, and constructive modules can be integrated to provide the perceptual cues required for both critical decision-making and procedural training.

The Modular MedSim platform, including Core Simulation, Virtual Patient, Virtual Patient Monitor, Lab Reports, and Instructor Tablet is a fully functional prototype. It has not yet been offered for commercial sales.

**Virtual Reality Therapy System:**
**Virtually Better, Inc.**

**Marat Zanov, Margo Adams Larsen, Jonathan Huff and Michael Jacobson**
*Virtually Better, Inc.*

We’re a Virtual Reality company who develops a number of products for clinicians and researchers. We have many ongoing research collaborations, virtual reality training contracts with the government, as well as private and government (US and Canada) customers of our virtual reality therapy systems.

Our primary product is the comprehensive VR solution, which includes a powerful PC, 2 displays, head mounted display with position tracker, scent delivery system, vibrotactile platform, and numerous peripheral hardware. All of this is mounted on a medical grade mobile cart, which will allow for very easy movement of the system between providers’ offices (such as within a hospital, clinic, or practice). The specific software configurations depend on what the customer needs, and at this point, we have the following:

- Phobias suite that includes Fear of Flying, Fear of Heights, Fear of Bridges, and Fear of Public Speaking;
- Relaxation Suite that includes 2 PMR applications, one environment that can be used for imagery guided relaxation or mindfulness meditation, Calmcraft (biofeedback-based autogenic relaxation program), and several additional relaxation-inducing nature scenes;
- Addictions Suite, which has some nicotine and or alcohol cues that can be used in cue exposure work;
- Bravemind, which is the latest program containing numerous virtual Iraq and Afghanistan scenarios, including riding in convoys, conducting foot
patrols, flying in a medevac helicopter, 
experiencing IEDs, VBIEDs, and all kinds of 
insurgents' attacks.

Also, we just released a mobile phone-based 
option, which doesn’t have all the bells and whis-
tles of the traditional system (i.e., no scent deliv-
ery system, no vibrotactile platform, etc.) but is 
still quite clinically useful, particularly for individ-
ual practitioners who are on a very limited budg-
et. The first two applications available on the 
mobile VR system phone now are Fear of Flying 
and Fear of Storms.
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